SAPDC (P.) LIMITED

ARUN-3 HYDRO ELECTRIC PROJECT NEPAL
(4x225 MW)

TECHNICAL SPECIFICATION

FOR

HVAC SYSTEM

SPECIFICATION NO.: - PE-TS-437-571-11000-A-A001 (REV0)
(OCTOBER-2020)

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

	TITLE: ARUN-3 HYDRO ELECTRIC PROJECT NEPAL (4X225 MW) TECHNICAL SPECIFICATIONS FOR HVAC SYSTEM	SPECIFICATION No: PE-TS-437-571-11000-A-A001	
		SECTION	
		REV. 00	DATE: OCTOBER 2020
		SHEET : 1 OF 2	

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SECTION - I

	ARUN-3 HYDRO ELECTRIC PROJECT NEPAL (4X225 MW) HVAC SYSTEM INTENT OF SPECIFICATION	SPECIFICATION No: PE-TS-437-571-11000A-A001	
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SECTION-I

SUB-SECTION-A

INTENT OF SPECIFICATION

	ARUN-3 HYDRO ELECTRIC PROJECT NEPAL (4X225 MW) HVAC SYSTEM INTENT OF SPECIFICATION	SPECIFICATION No: PE-TS-437-571-11000A-A001	
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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, mandatory spares along with spares for erection, start-up and commissioning as required, forwarding, proper packing and shipment and delivery at site , supervision for erection & commissioning, trial run at site and carrying out Performance guarantee / Functional / Demonstration tests at site (As applicable), training of customer/client O&M staff, 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 **4X225 MW ARUN-3 HYDRO ELECTRIC PROJECT NEPAL.**

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, supervision of 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 items required for completion of the system and not withstanding that they may have been omitted in drawings / specifications or schedules.

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

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

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

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

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

1.9 In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, Section – 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).

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

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

SECTION: I

SUB-SECTION: B

PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA

SECTION-1

GENERAL TECHNICAL SPECIFICATION

1.0 General

Arun-III Hydro-Electric Project in Nepal is contemplated for generation of hydro power with design energy of 3924 MU per annum in 90% dependable year. Project is proposed to be Run of River with Pondage Scheme.

1.1 Site Specific Information

1.1.1 Project Name

- Project Title:……..ARUN-III HEP
- Capacity:……4 X 225MW
- Owner:……..SAPDC

1.1.2 Location

The proposed project site is located at a distance of 50 km from Khandbari, the headquarters of Sankhuwa sabha District of Nepal. It is at about 240 km from Biratnagar and about 740 km from Kathmandu. The location details of the proposed project site are as indicated below:

- Latitude …….. .27º-30'N – 27 º -35'N
- Longitude …….. ...87º -12'E – 88 º-20'E
- Distance from Tumlingtar (domestic airport) town is…….About 68 km
- Distance of Kathmandu (international airport) from Tumlingtar…..About 660.km

1.1.3 Climatic Condition

Average max temp	:	30º C	
Average Minimum Temp	:	20º C	
Maximum river water temperature	:	25ºC	
Minimum river water temperature	:	10ºC	
Standard Design Temperature for for EM equipment	:	40º C*	* Wherever specific design temperature is mentioned in different section, those clauses shall prevail.

1.1.4 Seismic Zone

The equipments shall be designed for operation in seismic zone four for earthquake resistance. The equipment and each part of it shall be strong enough and sufficiently well connected to resist total operating stresses resulting from forces in normal operation, abnormal condition and forces superimposed due to occurrence of earthquakes of intensity which cause a ground acceleration of 0.16 g in vertical direction and 0.24 g in the other horizontal directions.

1.1.5 Transportation

The nearest major airport is at Kathmandu which is at a distance of 740km from Project Site. Biratnagar is connected to Kathmandu by Road.

The major nearest seaport for the trans-shipment of heavy equipment to Nepal is Kolkata. Other sea ports for imported equipment would be Mumbai or Chennai as convenient. The two sea ports Mumbai & Chennai are connected to Kolkata and Jogbani by rail as well as roads.

Railway transport is available from Kolkata and other locations of Indian Cities to the Nepal-India border only. The broad gauge line from Kolkata ends at Jogbani, Bihar. All rail freight for Nepal has to be unloaded there. The distance of Kolkata by rail route is about 800 km. From Jogbani, the road distance to the projects sites via Biratnagar is about 300km.

Road access to Arun-3 project from Kolkata to Jogbani is 600km; from Biratnagar to Project Area via Hile is 300km. Total distance to project area from Kolkata is 900km.

Alternative route could be from Kolkata to Raxaul which is 800km, further from Birganj to Dhalkebar to Hile to Project Area which is 450km. Total distance Kolkata to Project Area is 1250km.

1.1.6 Transport Limitation

The transport limitation by road from Jogbani to the project site is the governing factor for determining permissible package size and weight.

The existing roads allow the transport of the packages of the following size and weight.

Size (in mm) (l x b x h)	9700 x 6000 x 6000*
Weight (Tonnes)	70R

Heaviest package to be transported with suitable number of axle for safe transportation of consignment for 70R bridge capacity.
* Height from the ground

1.2 Salient features of Project

The salient features of Arun-3 HEP are as follows:

A.	**Hydrology**	
i.	Catchment Area	26747 KM^2
ii.	Probable Maximum Flood (PMF)	8880 cumec
iii.	Glacial Lake Outburst Flood (GLOF)	6830 cumec
B.	**Reservoir**	
i.	Maximum Water Level (MWL)	847.73 m
ii.	Full Reservoir Level (FRL)	845 m
iii.	Minimum Drawdown Level (MDDL)	835 m
iv.	Live Storage / Active Storage / Peaking Volume	5.65 MCM
v.	Inactive Storage (below MDDL)	8.29 MCM
vi.	Submergence Area at FRL	66.3 Ha
C.	**Dam**	
i.	Type of Dam	Concrete Gravity Dam
ii.	Dam top Level	El.849 m
iii.	River bed Level	El. 790 m
iv.	Dam Height above River bed	59 m
v.	Deepest Foundation Level	El.779 m
vi.	Height above deepest Foundation Level	70 m

vii.	Length of Dam at Top	197.30 m
viii.	Top Width of Dam	7 m
D.	**Diversion Arrangement**	
D.1	**Diversion Tunnel**	425 m long, 11 m diameter circular-shaped to divert 1300 cumecs
D.2	**Upstream Coffer Dam**	
i.	Type	Concrete Dam
ii.	Top Level	El. 817 m
iii.	Height of U/s Coffer Dam	26 m
iv.	Length	120 m
D.3	**Downstream Coffer Dam**	
i.	Type	Rock fill Dam
ii.	Top Level	El. 797.5 m
iii.	Height of D/s Coffer Dam	8.5 m
iv.	Length	92 m
E.	**Spillway**	
i.	Design Flood	PMF-8880 cumec GLOF -6830 cumec
ii.	Energy Dissipation System	Trajectory Bucket type
iii.	i)Sluice spillway No. Size ii)Overflow spillway No. Size	 6 9.0 m (W)X 14.0 m (H) 1 5.0 m (W)X 5.0 m (H)
iv.	Crest Level	El 808m-Sluice type

			El 840m-Overflow spillway	
F.	**Power Intake**			
i.	No. & Type		2 Nos., Straight intake with bell mouth	
ii.	Invert Level		El.819m	
iii.	Top Level		El.849m	
G.	**Intake Tunnels**			
	No. & Type		2 Nos., 7 m diameter, horse-shoe shaped	
	Length		181.50 m & 173.30 m	
	C.L. of Intake Tunnel		El 822 m	
H.	**Head Race Tunnel**			
i.	Diameter and shape		9.5m circular	
ii.	Length		11778.68 m	
iii.	Design Discharge		344.68 cumecs	
iv.	No. of Adits & size		4 Nos.,7 m X 7 m D - shaped	
v.	Adit	Adit Length	RD of HRT	Distance between Adits
	1	691.32m	1052.51 m	
	2	768.39m	5148.20 m	4095.69 m
	3	386.13 m	8205.02 m	3056.82 m
	4	365.32 m	11727.41 m	3522.39 m
I.	**Surge Shaft**			
i.	Size & shape		Open to sky, Restricted Orifice 1No., 24.0m diameter, Circular	
ii.	Height		149 m	

iii.	Top Level		El 940.00 m	
iv.	Gates, No. & Size		2 Nos., 5.5m (W)X 7.5m (H)	
v.	Surge Levels			
	Load case 100-0-0 (up)		El. 879.75 m	
	33-100-0 (up)		El. 863.35 m	
	100-0-33 (down)		El. 826.79 m	
	10-100-100 (down)		El. 801.61 m	
J.	**BUTTERFLY VALVE CHAMBER - UNDER GROUND**			
i.	Size		62 m (L) x 12 m (W) x 21 m (H)	
ii.	Butterfly valve		2 Nos. 5.5 m dia.	
K.	**Pressure Shaft**			
i.	Nos.		Underground, 2 Nos.	
ii.	Type & Size		Circular, each 5.5 m dia bifurcating into two nos of 4.0 m diameter to feed four units	
iii.	Length of pressure shafts 1 and 2			
	Pressure shaft-I	447.413 m	Pressure shaft-2	411.681 m
	Branch 1	82.208 m	Branch 3	55.970 m
	Branch 2	58.82 m	Branch 4	54.358 m
L.	**POWER HOUSE COMPLEX**			
i.	Power House Cavern		Underground on Left bank	
ii.	Installed capacity		900 MW	
iii.	No. of units		4	
iv.	Unit Capacity		225 MW	
v.	Size of Power House Cavern		179.50m (L) x 22.5m (W) x 49.5m(H)	

vi.	Centre line of Turbine	EL. 525 M
vii.	MIV Floor level	El 520.5M
viii.	Turbine Floor Level	EL. 529 M
ix.	Generator Floor Level	EL. 534 M
x.	Machine Hall Level	EL. 539 M
xi.	Service Bay Level	EL. 539 M
xii.	Dewatering Gallery	EL. 512.50 M
M.	**TURBINE**	
i.	Type	Vertical Francis
ii.	Number	4
iii.	Rated Capacity	225 MW
iv.	Head Loss for calculation of Design net head	21.46 m
v.	Design Net Head	286.21 m
vi.	Rated Discharge	86.17 m3/Sec
vii.	Speed	250 rpm
N.	**GENERATOR**	
i.	Type	Vertical shaft, Francis turbine driven, alternating current synchronous generators
ii.	Number	4
iii.	Rated Output	250 MVA
iv.	Continuous overload output (110% of rated)	275 MVA
v.	Rated Voltage	15.75 kV
O.	**Bus Duct**	4 Nos. The bus duct shall be natural air cooled and rated for 17.5 kV and

		shall be designed to carry 10.5 kA continuous current.
P.	**UNDERGROUND TRANSFORMER CAVERN**	
i.	Size	146.14m (L) x 16 m(W)x 23m(H)
ii.	Transformer Type	Single Phase
iii.	Number and rating	13 nos. (including 1 spare), 15.75/420/√3kV, 50Hz, 92MVA
iv.	Transformer Hall level	El. 552 m
Q.	**Switchyard & Transmission**	
i.	Type of Switching	Gas Insulated Substation and Pothead Yard
ii.	Size	207m (L) x 106m (W)
iii.	Switchyard level	El. 557 m
iv.	Number of bays	11 Nos. (4 Nos. GT Bays + 2 Nos. Line Bays + 2 Nos. Line Reactor Bays + 2 Nos. Bus Reactors Bays+ 1 No. Bus Coupler Bay)
v.	Transmission System	400kV Arun III HEP – Muzzafarpur via Dhalkebar D/c Quad Moose Lines with LILO of both circuits at Dhalkebar 400/220kV substation (310kms)
R.	**Draft Tube Gate**	4 Nos. fixed wheel type of size 5m(W) X 5.5m(H)
S.	**Tail Race**	
i.	Type and size	Circular shaped, 10 m
ii.	Length of TRT	108.12 m
iii.	Minimum Tail Water Level	El 533m
iv.	Maximum Tail Water Level	El 535m
v.	Average Tail Water Level	El 534m

1.3. Water Sample Details

Petro graphic Analysis Report of silt in the river at Project site is attached as Annexure - B of this Section.

1.4. Operating Pattern of the Plant

During High flow season (i.e. from June to September), Plant shall be operated as base load station. However, during lean flow season (i.e. from December to March), it shall be operated as peaking Plant.

Relative Humidity Parameter for HVAC Design of Arun-3 HEP

1. Bioclimatic Zone of Arun-3 HEP — Temperate Climate *(Fig 2 below)**

   (For Project Elevations, pl refere GTS & Tender Drgs)

2. Temperature — Pl refer GTS 1.1.3

3. **Design Parameter for Relative Humidity** — **20-90%** ***(Table 1)****

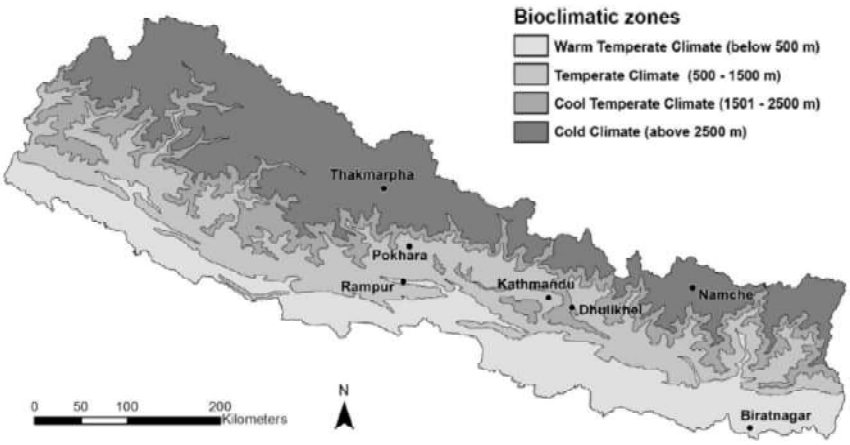


Fig. 2. Bioclimatic zoning map of Nepal with selected locations for energy simulation.

Table 1
Climate conditions in bioclimatic zones of Nepal (Bodach, 2014).

Bioclimatic zone	Temperature in Summer	Temperature in Winter	Relative Humidity
Warm temperate	22–35 °C	9–26 °C	25–90%
Temperate	18–35 °C	5–25 °C	20–90%
Cool Temperate	14–26 °C	−2–20 °C	30–90%
Cold	7–22 °C	−10– −2 °C	10–90%

* **Source:** Design guidelines for energy efficient hotel in Nepal (international journal of sustainable built environment / www.sciencedirect.com)

SECTION: I

SUB SECTION: C

TECHNICAL SPECIFICATION

SECTION: I

SUB-SECTION: C 1

SPECIFIC TECHNICAL REQUIREMENT

	ARUN-3 HYDRO ELECTRIC PROJECT NEPAL (4X225 MW) HVAC SYSTEM SPECIFIC TECHNICAL REQUIREMENT	SPECIFICATION No: PE-TS-437-571-11000A-A001	
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1.0 FUNCTION

The purpose of the system is to provide Air-Conditioning & Ventilation for different areas of 4 x225 MW ARUN-3 Hydro Electric Project Nepal under the scope of this tender. To achieve proper working conditions inside the power house complex, transformer hall, BFV house & dam complex, HVAC system is provided to serve the following purpose:

i. To prevent temperature stratification
ii. To remove contaminated air
iii. To remove waste heat from equipment
iv. To provide outside fresh air necessary for human comfort
v. To evacuate smoke and remove heat

2.0 SYSTEM DESCRIPTION

The power station shall be divided into two zones as below:

i. Air Conditioning Zone
ii. Ventilation zone

2.1 AIR CONDITIONING ZONE

Air cooled Split type / Cassette type air conditioning units with all necessary auxiliary of suitable capacity shall be provided to cater to the air conditioning requirements of the following areas of the all four units

i. Control & protection panel area for Power House, Transformer Hall and Dam Site Area
ii. Control Room area of power House and dam site area
iii. Power house offices
iv. Power house conference room
v. Dam control building offices and Conference room

2.2 VENTILATION ZONE

2.2.1 SUPPLY AIR SYSTEM

Fresh supply air through fresh air blower shall be fed to various ventilation areas as mentioned below:

2.2.1.1 Three Nos. Ventilation Blowers (2 W+1S) each of capacity 50% of the total required fresh air for the ventilation of the following areas:

i. Main Inlet Valve floor at EL. 520.5M
ii. Turbine floor at EL. 529.0M
iii. Generator Floor at EL. 534.0M.
iv. Machine floor at EL. 539.0M
v. Transformer hall at EL. 552 M
vi. Service Bay area at EL. 539.0M
vii. Bus Duct Galleries
viii. Drainage/Dewatering gallery at EL 512.50M
ix. Non AC areas of Control Block
x. Cable Access Tunnel

xi. Escape and Interconnecting Tunnel (connecting Power House and Transformer Hall)
xii. Any other area in the vicinity of Power House and Transformer Hall and not mentioned above.

These fresh air blowers shall be located inside blower room located near MAT/CAT entry portal. Ventilation system shall be designed such that fresh air requirement shall be 100 % of the total quantity of air required for maintaining desired temperature in above mentioned areas. Supply/fresh Air shall be distributed through duct for various ventilation areas based on layout.

2.2.1.2 Two nos. Ventilation Blowers (1W+1S) each of capacity 100% of the total required fresh air for the ventilation of the Butterfly Valve House.
Ventilation of Non-AC areas (DG Room, Battery room etc.) at portal of Butterfly valve house shall be ventilated by combination of Axial fans and intake Louvers/ back draft dampers.

2.2.1.3 Two nos. Ventilation Blowers (1W+1S) each of capacity 100% of the total required fresh air for the ventilation of Auxiliary building at Dam site area.
Ventilation for Non AC areas of Dam control building shall be done by combination of Axial fans and Intake Louvers/ Back draft dampers.

2.2.1.4 Axial supply air fans with (pre and fine filters) fans along with back draft dampers shall be provided for Supply of fresh air inside HT room located inside Switchyard area.

2.2.2 EXHAUST SYSTEM

Set of Exhaust blower/ exhaust fan, axial fan shall be provided for removal of foul air from from following areas:

i. Power House
ii. Transformer hall
iii. Butterfly Valve House
iv. Dam Control room building and Auxiliary building at Dam site including general/ open area and specific requirement from battery room, DG Room, toilets, kitchen etc.

2.2.2.1 Two (2) nos. Exhaust Air Blowers (1W+ 1S) shall be provided for removal of foul air from Power house. These Blowers shall be placed at Niche at EL 552.0 M at connection of branch Adit to Power house (refer enclosed Ventilation scheme in Sub section-6 of section-II).
Due to space constraints inside Main Access Tunnel (MAT), Exhaust of air inside MAT shall be non-ducted during normal operation, however to exhaust smoke in case of fire inside Power house, supply air duct in MAT shall act as exhaust air duct by using combination of motorized dampers.

2.2.2.2 Two (2) nos. Exhaust Blowers (1W+1S) shall be provided for removal of foul air from Transformer Hall. These blowers shall be located inside blower room located near CAT/MAT entry portal.

2.2.2.3 Two (2) nos. Exhaust Blowers (1W+1S) shall be provided for removal of foul air from

Butterfly Valve House.

2.2.2.4 Exhaust Blowers shall be provided for removal of foul air from battery Room and toilets of Power House area.

2.2.2.5 Axial fans with combination of intake louvers/Back draft dampers shall be provided for Ventilation of all other areas not mentioned above but are in the vicinity of Power house, Transformer hall, butterfly Valve house area and Dam complex.

2.3 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 (Pre-fabricated) for routing supply/exhaust duct/cable trays etc. from Supply air blower room located between MAT and CAT to MAT/CAT entry is in bidder's scope.

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 such that 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.

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

2.4 Supervision of erection and commissioning is in bidder's scope. Bidder shall familiarise themselves with site prior to preparation of drawings for duct routing, equipment placement etc. Duct fabrication and erection drawings/procedure, pre-commissioning, commissioning checklist/procedure shall be provided by bidder.

3. DESIGN CRITERIA

3.1 SYSTEM DESIGN CRITERIA –AMBIENT CONDITIONS

The outside design conditions considered shall be under: -

i. Average Max Temp: 30 Deg. C
ii. Average Min Temp: 20 Deg. C

For further details for Outdoor design conditions, please refer project information under sub section B.

3.2 SYSTEM DESIGN CRITERIA - AIR CONDITIONING SYSTEM

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

24°C ± 1^0C for air conditioned areas.

3.2.2 A design margin of 5% on total sensible and latent heat shall be considered while designing the AC equipment capacity for each area.

3.2.3 Split AC/Cassette AC shall be selected for MAX temp: 40 deg. C**.**

3.2.4 Necessary Heaters and humidifier arrangement shall be provided for AC areas served with duct able Split ACs (if required as per Heat load calculations). However, no humidity control shall be provided where wall mounted split AC / cassette type AC shall be used.

3.2.5 Necessary arrangement of Fresh Air arrangement shall be provided in AC areas served With duct able Split ACs.

3.3 SYSTEM DESIGN CRITERIA - VENTILATION SYSTEM

3.3.1 Average ambient condition shall be considered as 30 deg. C. Inside room condition shall be maintained. 10 deg. C above ambient temperature in power house, Transformer hall, bus duct tunnel, Butterfly valve house and DAM control building. All ventilation area shall be designed to maintain a positive pressure by supplying fresh air blowers except for battery room, toilets, DG set and pantry.

3.3.2 Ventilation provision for various location shall be envisaged as follows:

S.No.	Name of premises	Type of Ventilation	ACPH
1.	Lift & staircase area	Supply Through Fresh air blower and Exhaust Through exhaust air blower for Power house.	4
2.	Battery room / Battery charger room	Inside Power house – Exhaust through Blower and supply through fresh air duct. Above surface – Exhaust by Axial exhaust fans (spark proof construction) and Supply through Intake Louvers.	6
3.	Machine Hall	Supply Through Fresh air blower and Exhaust through exhaust air blower for Power house.	2
4.	Service bay	Supply Through Fresh air blower and Exhaust through exhaust air blower for Power house.	2
5.	Switchgear room	Supply by Axial flow fans with Pre and Fine filters and Exhaust through Gravity dampers.	4
6.	Generator floor	Supply Through Fresh air blower and Exhaust through exhaust air blower for Power house.	4
7.	Electrical workshop	Through fresh air supply	4
8.	Turbine floor	Supply Through Fresh air blower and Exhaust through exhaust air blower for Power house.	4
9.	Mechanical workshop & compressor room	Exhaust by means of wall mounted axial flow fans. Fresh air supply through of Louvers	4
10.	MIV Floor	Supply Through Fresh air blower and Exhaust through exhaust air blower for Power house.	2

11.	Butterfly valve house	Supply Through Fresh air blower and Exhaust through exhaust air blower for BVH.	2
12.	DG set Room	Exhaust by means of wall mounted axial flow exhaust fans and fresh air supply by Intake louvers.	6
13.	Toilets & pantries for Power House	Exhaust by means of exhaust blower/ propeller type exhaust fan. Supply through door undercuts / door louvers	8
14.	Transformer Hall cubicles, LTAC room & Electrical testing lab	Supply Through Fresh air blower and Exhaust through exhaust air blower for Transformer Hall.	4
15.	Transformer Cavern hall	Supply Through Fresh air blower and Exhaust through exhaust air blower for Transformer Hall.	2
16.	Bus duct Gallery	Supply Through Fresh air blower and Exhaust through exhaust air blower for Power House.	4
17.	Drainage and dewatering gallery	Supply Through Fresh air blower and Exhaust through exhaust air blower for Power House.	2
18.	Mechanical and Electrical store inside Power House	Supply Through Fresh air blower and Exhaust through Axial exhaust fans.	2
19.	Dam Control Building	For Switchgear/Cable vault & other Electrical areas – Supply Air by Axial fans with Pre and Fine filters and Exhaust by gravity dampers. For Battery room – Exhaust by Axial exhaust fans (spark proof construction) and supply by intake louvers. For other areas- by combination of Axial fans and Intake louver/gravity dampers as per requirement.	4
20.	Auxiliary building at Dam area	Supply by Fresh air blower and exhaust through Axial fans / gravity dampers as per requirement.	4

3.3.3 Air quantities shall be calculated based on heat load basis based on heat dissipation values from the various equipment, other heat source in various areas and the air quantity calculated based on air changes per hour and adopting higher of the two values.

3.3.4 The maximum air velocity through ventilation duct shall be as per following:

In Main Ducts	11 m/s
In Branch Ducts	8 m/s

In case any space/technical constraint is noticed during detailed engineering, minor changes in above values for velocity of air may be allowed.

3.4 CODES AND STANDARDS

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

i. ASHRAE Guide and data book: American Society of Heating, Refrigerating and Air Conditioning Engineers.
ii. IS: 655: Metal Air Ducts
iii. IS 4720: Indian Standard Code of Practice for Ventilation of Surface Hydel Power Stations.
iv. IS: 3103: Code of practice for industrial ventilation
v. ANSI 62: Ventilation for acceptable indoor air quality
vi. IS 659: Safety code for Air-conditioning.
vii. IS 4894: Centrifugal fans
viii. IS 7613: Air filters
ix. IS 277: Specification for Galvanized Steel Sheets
x. IS 2312: Propeller type AC ventilation fans
xi. IS 900: Induction Motor installation
xii. IS 660: Safety code Mechanical refrigeration
xiii. IS 325: Three phase induction motors
xiv. IS 5111: Measurement for testing refrigerant compressor
xv. IS 2825: Unfired pressure vessels
xvi. IS 4503: Shell and tube type Heat exchangers
xvii. ANSI B9.1: Safety code for Mechanical refrigeration
xviii. IS 3069: Relating to insulation material
xix. IS 4671: Expanded polystyrene for thermal insulation purpose
xx. IS 1822: AC motor starters of voltage not exceeding 1000V
xxi. IS 4029: Guide for testing of Three phase induction motor
xxii. IS 3588: Specifications for electric Axial flow fans
xxiii. IS 737: Specifications for Wrought Aluminum or aluminum alloy sheets and strips
xxiv. IS 661: Code of practice for insulation

3.5 GENERAL PRINCIPLES

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

3.5.2 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 ducting and fans.

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

3.5.4 The Occupancy for various areas have been considered as follows:

- Power House – 50 persons (sum of all floors)
- Transformer Hall – 5 persons
- PPV House – 3 persons
- Dam site – 10 persons
- AC areas - 1 person in 25 SQM or actual whichever is higher

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

4 VENTILATION AND AIR CONDITIONING SCHEME ENVSIAGED FOR VARIOUS AREAS

4.1 VENTILATION SYSTEM

4.1.1 POWER HOUSE AREA AND TRANSFORMER CAVERN

i. The supply air quantity requirement will be worked out based on air changes as per IS:4720 or based on heat dissipation method for maintaining inside temperature within required limits.

ii. In order to meet the above requirements, 3x50% Fresh air blowers shall be provided.

iii. Each fresh air blower of required capacity shall be placed inside blower room located near MAT/CAT entry portal. These units shall be in floor mounted horizontal design, comprising of pre-filters (provided on blower room wall) and fan section having supply air centrifugal fan with driving/ installation accessories and shall supply the fresh air to the various areas of the power house, cable tunnel, escape tunnel, bus duct gallery and transformer cavern with the help of air conveyance ducting and grilles.

iv. The exhaust air from toilets, pantry and battery room in power house shall be evacuated by means of separate ducted exhaust system. The exhaust air ducting for battery room shall be suitably protected against acidic fumes.

v. Motorized dampers shall be provided as per layout requirement with Fire rating of dampers shall be 90 minutes. In order to avoid spreading of fire, the motorized damper having provision of interfacing with the control panel of fire-fighting equipment of power house shall be provided.

vi. For Exhaust of Stale air from Power House and transformer caver, two sets of exhaust air fans to exhaust 60 % of air requirement shall be provided. Presently one set of exhaust fans for exhaust of air from Power house (one working and one standby fans) is envisaged to be located at niche at EL 552.0 M at connection of branch adit to Power house cavern (refer attached Ventilation Scheme) Second set of Exhaust fans (one working and one standby fan) for exhaust of air from transformer hall is envisaged to be located inside blower room adjacent to fresh air blower room near MAT/CAT entry portal. Provisions shall also be made for an automatic shutdown of the fresh air blowers to the respective area in case of fire by using a signal of fire protection system. In such a case all exhaust fans shall work as a smoke exhaust fans.

4.1.2 BUTTERFLY VALVE HOUSE

i. Two Nos. ventilation blowers (1W+1S) each of capacity 100 % of total required air for butterfly valve house shall be located inside blower room at Adit-4 Portal.

ii. In order to create positive pressure inside butterfly valve house,60% of inducted fresh air supplied to valve house shall be exhausted with the help of exhaust blowers.

iii. Pre filter, supply dampers, bird screen, grills, louvers wherever required for above units shall be provided.

4.1.3 DAM CONTROL ROOM BUILDING

i. Two nos. ventilation Blowers (1W+1S) each of capacity 100% of the total required fresh air for the ventilation of Auxiliary building at Dam site area shall be provided whereas Ventilation for Dam control building shall be done by combination of Axial fans and Intake louvers/dampers.

ii. Pre Filter, Bird screen, grills, louvers wherever required for above units shall be provided.

4.2 AIR-CONDITIONING SYSTEM

4.2.1 POWER HOUSE AREA

4.2.1.1 Duct Split/High wall Split/Cassette air cooled conditioner shall be provided for following areas in power house based on final selected Tonnage during detail engineering with redundancy as defined below.

Sr. No.	Area to be Air-Conditioned	Redundancy
1.	Control Room area for power house	100 % standby
2.	Conference room	N+1 redundancy (where N is working no. of units)
3.	Power house Office area and shift in-charge room	N+1 redundancy (where N is working no. of units)
4.	Control & protection panel area	N+1 redundancy (where N is working no. of units)

4.2.2 CONTROL BUILDING AT DAM SITE AREA

Multiple nos. of Split type/ cassette air conditioners of suitable capacity with N+1 redundancy (where N is working no. of units) Shall be provided for conditioning of control room of Dam site area.

4.2.3 CONTROL ROOM FOR BFV HOUSE

Multiple nos. of Split type/ cassette air conditioners of suitable capacity with N+1 redundancy (where N is working no. of units) Shall be provided for conditioning of control room of BFV house (if applicable).

4.2.4 The load / capacity of the air conditioning system for above areas shall be worked out as per detailed Heat load calculations.

5.0 AIR CONDITIONING EQUIPMENT

5.1 DUCTABLE SPLIT/SPLIT / CASSETTE AIR CONDITIONER

Air cooled duct able or wall mounted Split ACs/ cassette ACs of suitable capacity with R-134a/R-407c/410a refrigerants complete with all accessories described hereinafter shall be provided to cater Air Conditioning requirements of areas as specified under clause 2.1.

5.1.1 Local isolator/ MCB shall be provided with split/cassette units. Hand operated remote and accessories as specified shall be provided. Each split/cassette unit shall be provided with suitable rating stabilizer.

5.1.2 Lot- Refrigerant piping with insulation and fittings such as elbows, tees, reducers, flanges etc.

5.1.3 Lot – Drain water piping out of GI pipes confirming to IS-1239, part I, heavy grade and Galvanized as per IS:4736, from various equipment like duct able Split ACs etc. up to nearest drain point.

5.2 One (1) lot humidifiers (if required as per heat load calculations) shall be provided for AC areas catered with duct able Split ACs.

5.3 One (1) lot Strip type duct heaters shall be provided for AC areas catered with duct able Split ACs.

5.4 Fresh Air arrangement complete with filters and all other accessories shall be for AC areas catered with duct able split ACs.

5.5 Fill of refrigerant and compressor lube oil.

5.6 Duct Split AC/Split AC/ Cassette AC shall confirm to latest BEE star rating.

5.7 For other details please refer relevant clauses of Section 25 of customer technical Specifications section C2A.

6. VENTILATION EQUIPMENT

6.1 FRESH AIR AND EXHAUT AIR BLOWERS

Fresh air and exhaust air blowers with electric dive motor and other all accessories as per details mentioned under clause 25.4.1.1 and other relevant clauses of section 25 of customer technical specifications under section C2A shall be provided to cater ventilation requirement of various areas mentioned under clause 2.2.

6.2 WALL MOUNTED AXIAL FLOW FAN/ TUBE AXIAL FAN/ PRPOPELLER FAN

Each wall mounted axial flow fan shall be complete with

(i) Fan impeller with aerofoil section of cast aluminium alloy & casing/short duct as required.

(ii) Electric drive motor with coupling if any, including motor brackets.

(iii) Inlet cone and grouting framework, if any.

(iv) Rain protection cowl with bird-screen adjustable damper, vibration isolators, Back draft dampers etc. shall be provided.

(v) 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.

(vi) Each Axial fan comprises of fan, fan motor, inlet and outlet cone (for Tube axial), Louvered shutter (exhaust fans), bird screen and supporting arrangement.

(vii) For other details please refer clause 25.4.4 and other relevant clauses of section 25 of Customer Technical specifications under section C2A.

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

b.	4,000 CMH	0.75 KW	600mmx600mm
3	Axial flow exhaust fans (Bifurcated type) with 15 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	7,500 CMH	1.1 KW	700mmx700mm
b.	4,000 CMH	0.75 KW	600mmx600mm
c.	2,000 CMH	0.55 KW	500mmx500mm
4	Axial flow exhaust fans with 10 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	7,500 CMH	0.55 KW	700mmx700mm
b.	6,000 CMH	0.55 KW	600mmx600mm
c.	4,000 CMH	0.55 KW	600mmx600mm
d.	2,000 CMH	0.37 KW	500mmx500mm
5	Exhaust fan (propeller type) with 5 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	1200 CMH	100 W	300 mm circular

7. ITEMS COMMON TO AC AND VENTILATION SYSTEM

7.1 1 Lot – GSS Ducting (as per IS-277) with 275 g/sq.m. of zinc coating sheet metal work With thickness varying from 18 G to 22 Gauge as per air flow requirement and code requirement, complete with powder coated mild steel construction diffusers and grills, hangers, support, flexible connection etc.

However, ducting for battery room and toilets shall be epoxy painted MS ducts. For further details, please refer clause 25.9 and other relevant clauses of section 25 of customer technical specifications under section C2A.

7.2 Air conditioning system ducting shall be insulated in line with details mentioned in clause 25.5.9 of section 25 of customer technical specifications and other relevant clauses of specifications.

7.3 1 Lot – Pre-filters having efficiency of 90% down to 10-micron particle size at suction of

supply air fans of Ventilation system and 1 Lot – Fine-filters (for supply air axial fans in electrical areas and Fresh air arrangement for AC areas catered with duct able Split ACs) having efficiency of 95% down to 5-Micron particle size at fan suction. For other details please refer clause 25.4.1.3 and other relevant clauses of section 25 of customer technical specifications under section C2A.

7.4 Fire dampers shall be of minimum rating of 90 minutes and shall be provided as per system requirement. For further details of Fire dampers and all other splitter and dampers, please refer clause 25.5.2 and other relevant clauses of section 25 of customer technical Specifications under section C2A.

8.0 CONTROL PHILOSOHY

For Control of AC & Ventilation system please refer clause 25.1.1.2, 25.4.3 and other Relevant clauses of section 25 of Customer Technical specifications under section C2A and Electrical and C&I portion of technical specifications under sections C3 & C4.

9.0 ACCEPTANCE TEST

Type tests, Routine tests, field tests and Commissioning tests shall be as per clause no. 25.7 of section 25 of Customer Technical Specifications under Section C2A.

10.0 GENERAL

1) Basis of design, all calculations including heat load calculations for summer seasons, equipment selection criterion, layout drawings/ schemes/G.A. drawings 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, this equipment / 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, consumable, 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 /motorised volume control damper / motorised valves, power supply shall be derived by vendor from respective control panels/switchgear. 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 DCS / panel / MCC shall be selected. Any Electrical / C&I item 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 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.

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

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

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

28) The bidder shall arrange to provide training on operation & Maintenance of complete HVAC system to Employer Personnel.

11. EXCLUSIONS

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

a) Construction of Blower room, foundations for HVAC equipment.

b) Provision of drain traps / points,

12. 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 mentioned under clause 3.4 of Sub section C1 and relevant clauses of sub section C2 B, C3 & C4.

Material Handling Equipments

1.0 ELECTRIC HOIST AND MANUAL HOIST (CHAIN PULLEY BLOCK)

Required number of electric hoist / manual hoist of adequate capacity, to meet the erection and maintenance requirements are to be provided for the various areas.

Manual hoists (hand operated) shall be designed to duty class 2 as per IS 3832 and electric wire rope hoist shall be designed as per IS: 3938 (latest).

The stipulations of all statutory codes like Indian Electricity Act, Indian Electricity Rules, Factory Acts, Local Municipality act etc. shall however prevail over the specification requirements, in case any conflict arises between this specification and the statutory codes.

Maintenance tools and tackles shall be as per data sheet attached.

DESIGN CRITERIA

1.0.0 Electrically operated wire rope hoists of suitable capacity, lift, and travel length shall be provided for handling of items weighing 1000 kgs and/or having lifting height more than 10m. The hoist capacity shall be selected considering 25% margin over the weight of heaviest component /equipment to be handled. The hoist parameters (i.e. lift & travel) are subject to change/s, to suit the final layout of the area in which it is intended to be installed.

Electric hoist shall be provided for capacity >2T. Electric hoists shall be provided for lifts >10m irrespective of the capacity.
Chain pulley block (Manual hoist) - 300kg to <2T, wherever feasible, considering layout constraints.

Capacity of electric and manual (Chain pulley block) hoists shall be decided keeping 25% margin over equipment to be handled.

For hand operated hoists, the hoists shall be suitable for operation from floor level. Hand chain shall be provided for long travel of trolley and the Hoisting mechanism. The operator shall be able to control the movement of the electrical/ manual hoist with the help of floor operated pendant

MINIMUM LIFTING REQUIREMENT

S.N.	AREA DESCRIPTION	QTY (nos)	CAPACITY (T)	TYPE
1	LIST TO BE MENTIONED AS APPLICABLE			
2				
3				

Note:
1. Area, type, capacity mentioned are minimum requirement and shall be finalised during detail engineering without any commercial implication
2. Travel and Lift are layout dependent and shall be finalised during detail engineering without any commercial implication
3. Additional electric/manual hoist required during detail engineering shall be provided as per design criteria given above without any commercial implication.

2.0 SCOPE OF SUPPLIES

Equipment and services to be furnished by the bidder for the ELECTRIC HOIST/ MANUAL HOIST with accessories as per the details given in the technical specification and data sheet A. Any equipment / accessories not specified in the specification but required to make the ELECTRIC HOIST/ MANUAL HOIST complete and efficient operation shall also be under the

bidder's scope of work.
Compliance with this specification shall not relieve the bidder of the responsibility of furnishing material and workmanship to meet the specified working/duty conditions.

2.1.0 Electric hoist shall include but not be limited to the following: -

a) Equipment offered shall be suitable for indoor duty conforming to Class II of IS: 3938.
b) Equipment shall be designed to operate in non- hazardous area.
c) Electric hoists shall be pendent operated.
d) Both hoisting and trolley movement shall be motor driven.
e) Hoisting motion shall be thru' VVVF drives to achieve creep speed of 10% of main speed.
f) Wheels shall be single flanged type.
g) Hook shall be swiveling type and fitted with a safety latch.
h) Control panel shall be hoist mounted.
i) Power feeding to the electric hoists shall be thru' PVC shrouded DSL.
j) Brakes shall be fail to safety.
k) Load/overload testing of the hoists shall be carried out as per IS: 3938.
l) All material, castings and forgings will be of tested quality & certificates shall be made available for review as per approved QAP

2.2.0 Erection and Commissioning spares (ELECTRIC HOIST)
The Bidder shall also supply erection & commissioning spares along with his main equipment as per his experience, for replacement of damaged or unserviceable parts during the execution of the project at site, to avoid delay in the project schedule. This shall form part of the main equipment supply. The Purchaser shall retain the unutilized commissioning spares. The initial fill of lubricants, oil etc. shall also be supplied by the bidder.

2.3.0 Services to be provided by the bidder
Packing, forwarding and transportation to site, storage and handling at site.

2.4.0 Erection and Commissioning

2.5.0 Functional test (Overload testing, load testing at rated speed, travel and hoisting motion checks as per relevant Indian standards)

2.6.0 Obtaining clearance and acceptance certificate from the concerned competent authority after site test as applicable. Necessary fees/expenditure as required shall be borne by the supplier.

3.0 Inspection and Testing

As per enclosed reference quality plan and as per IS 3938 (latest revision). Prime inspection agency shall be Consultant/ End Customer. Equipment supplied shall be strictly in accordance with nomenclature & technical specification. Any additional testing requirement/CHP (Customer Hold Point) at any stage of inspection deemed necessary by Consultant/ End Customer during detailed engineering shall be carried out without any commercial or technical implication.

4.0 Works Excluded

Supply of ISMB monorail.

5.0 PAINTING SPECIFICATION

As per painting details specified elsewhere in specification.

6.0 PACKING

In general packing shall be wooden box packing.

7.0 TESTING AT VENDOR'S WORKS

Hoist along with its drives, controls and other accessories shall be demonstrated for the rated capacity against the rated speed of motions and for the service conditions specified as specified in QAP and as per IS 3938 for electric hoist and IS 3832 for manual hoist.

The bidder shall have the full responsibility for the safe and efficient operation of the hoist with

associated accessories as a single unit.

If the shop performance tests indicate the failure of any of the components to achieve the guaranteed performance, the deficiency shall be made good at bidder's cost.

Demonstration tests shall be carried out each time after the rectification /modification is carried out.

8.0 MAKE OF SUB - VENDOR ITEMS

Makes of bought out items will be as per list specified in the specification. No other make will be acceptable, until and unless specifically got it approved by the purchaser/ end client. (Refer annexure-I)

9.0 TESTING AT SITE

A) ELECTRIC HOIST:
As required for statutory clearance for operating at site i.e., overload test, load test and other tests as per IS 3938.

Test for Operation -After the supply has been connected, tests shall be carried out to prove the following:
a) The satisfactory operation of each controller, switch, contactor, relay and other control devices and in particular the correct operation of all limit switches under the most unfavorable conditions;
b) The correctness of all circuits and interlocks and sequence of operation; and
c) The satisfactory operation of all protective devices.

Overload Test -After test but before the hoist is put into service, it shall be tested with overload relays appropriately set, to lift and sustain a test load of 125 percent of the working load. During the overload test, the hoist shall sustain the load under full control. The specified speeds need not be attained but the hoist shall show itself capable of dealing with the overload without difficulty.

B) MANUAL HOIST:
As required for statutory clearance for operating at site with following minimum test i.e., overload and load test.

10.0 TECHNICAL DATA SHEET:

A) Technical data sheet-A for ELECTRIC HOIST:

Sl.no	DESCRIPTION	TECHNICAL PARTICULARS
1.0	Type	Steel wire electric hoist with electrically operated trolley
2.0	Scope (Qty., Capacity, Lift, Travel Length)	As mentioned in specification
3.0	Type of service	Indoor
4.0	Overload test	125% of SWL
5.0	Design Ambient temperature	50° C
6.0	General Design	As per IS: 3938 / 1983 or latest, Class-II duty
7.0	Operating speed	
7.1	Hoisting speed/ Creep speed (thru' VVVF drive)	3 MPM with creep speed 10% of main speed.
7.2	Trolley speed	10 MPM

8.0	Type of transmission	Through Electric motor and gear box.
9.0	Wire Rope	
9.1	Construction / core	6 x 36 or 6 x 37 construction, steel/ Fibre core
9.2	Code	IS:2266
9.3	Tensile designation	1770/1960 N/mm2
9.4	Number of falls	Min. 4
9.5	Factor of safety	Not less than 5
10.0	Load Hook and block	Normalized hook only
10.1	Type of load hook	Plain shank trapezoidal section with safety latch.
10.2	Load hook Code	IS: 15560
10.3	Load hook Material	Alloy steel/carbon steel as per IS:15560
10.4	Hook suspension	Thrust bearing
10.5	Material of block suspension	Fabricated from steel plate, Material: IS: 2062
10.6	Hook can swivel freely under full load	Yes
10.7	Safety latch on hook provided	Yes
10.8	Locking device on swivelling hook	Provided
10.9	Bearing type	Antifriction Ball / Roller
10.10	Bearing life	10,000 working hours.
11.0	Gearing	
11.1	Type	Spur / Helical, hardened and tempered with machine cut teeth
11.2	Gear material	Forged steel as per IS 3938
11.3	Lubrication	Oil splash/ grease lubricated
11.4	Bearing type	Antifriction Ball / Roller
11.5	Bearing life	10,000 working hours.
12.0	Trolley drive	
12.1	Wheel	Single flange taper thread
12.2	Wheel conform to (Std. / code)	IS: 3938
12.3	Wheel material	Heat treated carbon steel/ low alloy steel, graded cast iron.
12.4	Bearing type	Antifriction Ball / Roller

12.5	Bearing life	10,000 working hours.
12.6	Trolley type	Rolled structural steel with side plates extended beyond wheel flanges to protect wheels.
12.7	Hardness	Max hardness 200 BHN
13.0	SHEAVE	
13.1	Material	Cast steel or mild steel.
13.2	Bearing type	Antifriction Ball / Roller.
13.3	Bearing life	10,000 working hours.
14.0	BRAKE (HOIST)	
14.1	Type	DC EM brakes disc type (fail to safety).
14.2	Capacity	As per IS 3938.
14.3	Number	One number for each motor.
15.0	BRAKE (TROLLEY)	
15.1	Type	DC EM brakes disc type (fail to safety).
15.2	Capacity	As per IS 3938.
15.3	Number	One number for each motor
16.0	ROPE DRUM	
16.1	Material	Cast iron, cast steel or mild steel.
16.2	Flange / Flangeless	Flanged
16.3	Type of groove	As per manufacturers standard to suit the layout requirement.(Shall be decided during detail engineering)
17.0	TYPE OF DSL	
17.1	CT travel	PVC shrouded GI conductor bus bar -DSL shall be sized with a margin of 10% over load requirement.
18.0	MOTORS	
18.1	Type	Sq. Cage induction, TEFC, S4 duty, 60% CDF.
18.2	Number of start	300starts / hr, Motors shall be suitable for direct on-line (DOL) starting
18.3	Voltage , Phase and Frequency	Suitable for rated frequency of 50 Hz with a voltage variation of +/-10% and frequency variation of +3 to -5% occurring separately or combined voltage and frequency variation of 10%. 3 phase, 4 wire
18.4	Class of insulation	Class “F” and temperature rise limited to class B.
18.5	Type of enclosure	TEFC

18.6	Degree of protection provided for enclosure	IP-55	
18.7	Margin	Motor nameplate rating at 50 deg C shall have Motor rating will be calculated keeping margin of at least 25% over the maximum power requirement. The hoist motors shall be rated to lift 125% of the design load at rated speed	
19.0	LIMIT SWITCHES	Hoisting	Trolley
19.1	Type	One (1) no. Snap action, self-actuating type	One (1) no. two way limit switch
20.0	Control panel	* Fabricated from CRCA sheet steel not less than 1.6 mm thick * Degree of protection shall be IP 52 * Power on indicating lamps shall be provided * Panel illumination lamps operated by door switch. * 2 nos earthing terminals on panel. * Gland plate thickness shall be minimum 3mm. * Gland plate shall be double brass compression type.	
20.1	Qty	1 No.	
21.0	Pendent Push buttons	Up /down / forward / Reverse push buttons. Indicative marking for easy operation shall be provided.	
22.0	Fixed type Power cables	Copper/Aluminum material, minimum size : Min. 2.5 mm2 for Cu/ min 6 mm2 for Aluminum. Extruded PVC insulated, armoured and FRLS PVC sheathed heavy duty 1100 V	
23.0	Fixed type Control cable	Copper material, min. 1.5 mm2 Control cables shall have stranded copper conductor, Extruded PVC insulated, armoured and FRLS PVC sheathed heavy duty 1100 V	
24.0	Trailing cable (Power/ Control)	EPR insulated, copper conductor trailing cables, as per IS:9968.	
25.0	Control Voltage	110 V	
26.0	End stopper for CT	2 nos., MOC shall be as per IS 2062	
27.0	Buffer for CT	2 nos. Spring/rubber type shall be provided on trolley	
28.0	Bearing (Type/life)	Antifriction Ball / Roller, 10,000 working hours life	

B) MANUAL HOIST (CHAIN PULLEY BLOCK):

DATA SHEET-A

1.0	**Type**	Chain pulley block with/without trolley
2.0	**General Design**	IS: 3832
3.0	**Duty Class as per IS:3832**	Class –II
4.0	**Hoisting Mechanism**	
a)	Type	Hand operated gear transmission
b)	Type of gear	Spur / Helical
c)	Load Chain	
i)	Type	Link type
ii)	Material	As per relevant standard

iii)	Conforms to (Std./Code)	IS: 6216 / IS 3077/IS 3019
d)	Hand Chain	
i)	Type	Link type
ii)	Material	Mild steel Grade 30
iii)	Conform to Std.	IS:2429 (Part II)
e)	Load Hook & Hook Block	
e)		
i)	Type of load hook	Plain shank- Trapezoidal section/ 'C' type
ii)	Load hooks conforms to	IS: 15560
iii)	Type of hook suspension	Swivelling type with safety latch
iv)	Type of make of bearing	Thrust ball bearing of hook suspension
v)	Type & Material of hook	As per IS 15560
f)	Gears/ Pinions	
i)	Type	Spur
ii)	Material	Alloy steel / carbon steel/ High graded cast iron
	Type of Bearing	Antifriction ball bearing / Roller
g)	Sprockets :	
	Type of bearings used	Antifriction ball bearing / Roller
i)	Method of lubrication	
	Bearings	Grease
	Gearing & Pinions	Grease
	Sprocket	Grease
h)	Brakes Type	Screw and friction disc type
5.0	**Trolley and Bridge drive**	
a)	Trolley	
i)	Type	Geared (Manually operated)
ii)	Material of frame	Mild steel (IS:2062 Grade A or B)
b)	Drive Chain	
i)	Type	Link type
ii)	Material	Steel Gr.30
iii)	Design of drive chain	IS : 2429 part 1 :1870
c)	Wheel	
i)	Number of pairs of wheel	Two in each trolley/bridge
ii)	Flange	Single flanged
iii)	Type of bearings need	Antifriction
iv)	Wheel material	As per IS 3832
d)	Gears	
i)	Type	Spur / helical
ii)	Material	Cast iron/EN8
iii)	Type of bearings used	Antifriction
e)	Method of lubrication for	
i)	Bearings	Grease
ii)	General	Grease
iii)	Sprockets	Grease
6.0	**Painting**	As per manufacturer's standard

11.0 Maintenance Tools and Tackles

One (1) complete unused new set of special purpose tools, tackles and accessories along with detailed instructions and maintenance manual shall be supplied. Tools shall be of suitable sizes for maintenance of electric hoist of each type and capacity. Each tool and wrench shall be stamped so as to be identified easy for its use. The tools shall be supplied in steel toolbox and with a copy of instruction manual. The items supplied shall be of the best quality, specially protected against rusting. The following shall be provided as minimum requirement:

S. No.	Description	Qty.
1	Complete set of ring spanners	1 Set
2	Complete set of screwdrivers (Min. 6 nos of suitable sizes)	1 Set
3	Adjustable Spanner	1 No.
4	Insulated pliers	1 No.
5	Wrench spanner	1 No.
6	Grease Gun	1 No.
7	Oil Gun	1 No.
8	Hand Lamp	1 No.
9	Line tester	1 No.

Note: -The tools shall be supplied in one tool box .Bidder shall ensure that the tools & tackles mentioned in above list are sufficient to handle all sizes/capacities of hoists & in case any other /additional tool is required for handling/maintenance any size/capacity of hoist the same shall be included in this list.

12.0 DRAWING/DOCUMENT SUBMISSION

The successful bidder shall submit the following drawings / documents during detail engineering for customer's approval /information:

A) ELECTRIC HOIST

Sl. No.	BHEL DRG.NO	DRAWING TITLE
1	PE-V0-xxx-553-A100	Manufacturing Quality Plan with Sub vendor list
2	PE-V0-xxx-553-A101	GA Drawing for Electric Hoist, DSL arrangement and painting details
3	PE-V0-xxx-553-A102	Schematic Circuit Diagram
4	PE-V0-xxx-553-A103	Mechanism Sizing Calculation
5	PE-V0-xxx-553-A105	O & M Manual

B) MANUAL HOIST (CHAIN PULLEY BLOCK):

Sl. No.	BHEL DRG.NO	DRAWING TITLE
1	PE-V0-xxx-553-A200	Manufacturing Quality Plan
2	PE-V0-xxx-553-A201	GA Drawing for Chain Pulley Block with detail BOM with painting details
3	PE-V0-xxx-553-A202	O & M Manual

Notes:

1. The above drawing list is tentative and shall be finalized with the successful bidder after placement of order.

2. Drawings shall be prepared in Auto-Cad latest edition. Required no. of hard and soft copies (editable) of the drawings shall be furnished as per requirement specified elsewhere in the specification.

3. All the drawings and documents including general arrangement drawing, data sheet, calculation etc. to be furnished to the customer during detailed engineering stage shall include / indicate the following details for clarity w.r.t. Inspection, construction, erection and maintenance etc.:-

   a) All drawings and documents shall indicate the list of all reference drawings including general arrangement.

   b) All drawings shall include / show plan, elevation, side view, cross - section, skin section, blow - up view; all major self-manufactured and bought out items shall be labeled and included in BOQ / BOM in tabular form.

   c) Painting schedule shall also be made as a part of general arrangement drawing of each equipment / items indicating at least 3 trade names.

   d) All the drawings required to be furnished to customer during detailed engineering stage shall include technical parameters, details of paints and lubrication, hardness and BOQ / BOM in tabular form indicating all major components including bought out items and their quantity, material of construction indicating its applicable code / standard, weight, make etc.

   e) Drawings/ documents to be submitted for purchasers review/ approval shall be under Revision A, B, C… etc. while drawings /documents to be submitted thereafter for customer's approval after purchaser's approval shall be under R-0, 1, 2, 3 ….etc.

ANNEXURE I: MAKES AND SUB VENDOR LIST

Package Name	Vendor Name
ELECTRIC HOIST	Alpha Services
	CONSOLIDATED HOISTS PVT LTD
	CENTURY CRANE ENGINEERS PVT. LTD.
	TECHNO INDUSTRIES
	EDDY CRANES PVT. LTD.
	Grip Engineers Pvt. Ltd.,
	TRACTEL TIRFOR INDIA PVT. LTD.
	Mangla Hoists Pvt Ltd
	BRADY & MORRIS ENGINEERING CO. LTD.
	REVA INDUSTRIES LTD.
	UNIVERSAL HOIST-O-FABRIK
CHAIN PULLEY BLOCK	UNIVERSAL HOIST-O-FABRIK
	CENTURY CRANE ENGINEERS PVT. LTD.
	BAKELITE ELECTRICAL MFG. CO. PVT. LTD.
	TRACTEL TIRFOR INDIA PVT. LTD.
	BRADY & MORRIS ENGINEERING CO. LTD.
	TUOBRO FURGUSON (INDIA) PVT LTD
	TECHNO INDUSTRIES

Note: No other make will be acceptable, until and unless specifically got approved by BHEL/Customer / Customer's consultant during detail engineering only. Acceptance/non acceptance of same shall not have any impact on manufacturing, delivery schedule and on cost of the Electric hoists/CPB.

MAKES OF SUB VENDORS ITEMS AS APPLICABLE TO ELECTRIC HOIST:

Sl no.	ITEM	MAKES
1.0	STEEL	SAIL/IISCO/TATA STEEL / JINDAL
2.0	HOOKS	MOOZUMDAR / SIMRITI FORGING / HARMAN MOHTA / STEEL FORGING & ENGG. CO., KOLKATA /
3.0	GEAR COUPLINGS	ALLIANCE / HICLIFF / OEM
4.0	WIRE ROPE	USHA MARTIN Black / BOMBAY WIRE ROPES / FORT WILLIAMS / UNITED WIRE ROPE/BHARAT WIRE ROPES.
5.0	BEARINGS	SKF/ FAG
6.0	MOTORS	SIEMEN/ ABB /NGEF/ CROMPTON /KIRLOSKAR /GECA / BHARAT BIJLI / MARATHON / LHP.
7.0	BRAKES	STROM CRAFT/ ELECTROMAG /SPEED-O- CONTROL / EMCO LENZE
8.0	CONTACTOR	SIEMENS / L&T /TELE MECHANIQUE / BCH

9.0	OVER LOAD RELAYS	SIEMENS / L&T / TELE MACHANIQUE / ABB
10.0	HRC FUSES	SIEMENS / L&T/ ENGLISH ELECTRIC/GE Power
11.0	ISOLATING SWITCH	SIEMENS/ L&T / CONTROL & SWITCH GEAR
12.0	SWITCH FUSE UNITS	SIEMENS/ L&T/ CONTROL/ & SWITCH GEAR/ GEC A
13.0	TIME DELAY RELAYS	SIEMENS/ L&T/ ABB/ BCH/ GEC A
14.0	TRANSFORMERS	INDCOIL/AE / LOGICSTAT/ PRAGATI / KAPPA / SOUTHERN ELECTRIC
15.0	BULB & FLOURESCENT TUBES/FITTINGS	PHILIPS/ BAJAJ/ CROMPTON
16.0	CABLE LUGS (HEAVY DUTY)	DOWELLS
17.0	CABLES	
a)	POWER CABLES	NICCO / UNIVERSAL / INCAB / FORT GLOSTER TORRENT / CCI / ICL / RADIANT / FINOLEX/ POLYCAB/KEI/HAVELL
b)	CONTROL CABLES	NICCO / UNIVERSAL / INCAB / FORT GLOSTER / DELTON / FINOLEX / TORRENT / CCI / ICL / RADIANT POLYCAB / KEI/ HAVELL.
c)	TRAILING CABLE	UNIVERSAL/ FGL/CCL/HVP/KEI/RADIANT.
18.0	CABLE GLAND	COMMET / SIEMEN / SUNIL&CO.
19.0	PUSH BUTTONS	SIEMENS / L&T / BCH /TEKNIC/VAISHNO
20.0	LIMIT SWITCHES	SPEED-O-CONTROL / ELECTROMAG / JAI BALA JI / KAYCEE / BCH
21	SELECTOR SWITCHES	KAYCEE/ SULZER
22	PENDENT PUSH BUTTON STATION	OEM
23	INDICATING LAMPS	TECKNIC / BCH / SIEMENS / STANDARD/ VAISHNO
24	MCB	MDS / INDO COPP / STANDARD
25	PANELS	OEM/BCH
26	DSL	SUSHEEL/STROMAG
27	TERMINAL BLOCKS	ELMEX/CONNECTWELL/WAGO (FOR CONTROL ONLY)
28	VVVF	YASAKAWA(L&T)/ABB/SIEMENS/SCHNIDER
29	CASTING	KOLHAPUR STEEL / GNAT FOUNDARY / KIRTI ALLOYS
30	Tools & tackles	Reputed make

MAKES OF SUB VENDORS ITEMS AS APPLICABLE TO MANUAL HOIST:

Sl no.	ITEM	MAKES
1.0	STEEL	SAIL/IISCO/TATA STEEL / JINDAL
2.0	HOOKS	STEEL FORGINGS/ KARACHIWALA/SMRITI/NASIK FORGE.
3.0	STEEL FORGINGS	CHOWDHARY/WESTERN INDIA FORGINGS/ HINDUSTAN STEEL FORGINGS/ RUBY FORGINGS OR AS APPROVED BY BHEL.
4.0	BRAKES	OEM

NOTE:

1. THE SUB VENDOR LIST ABOVE IS INDICATIVE ONLY AND IS SUBJECT TO BHEL AND CUSTOMER APPROVAL DURING DETAILED ENGINEERING STAGE WITHOUT ANY COMMERCIAL & DELIVERY IMPLICATION TO BHEL.

PAINTING SPECIFICATION

1. Painting specification for steel structures:-

Surface preparation: De greasing and Mechanical cleaning with wire brush or blasting according to SIS 055900, Grade 2 ½ .

Primer : HB Zn Phosphate - 2 coat, Minimum DFT 80 µ per coat.

Finish Coat : HB MIO epoxy - 1 coat, Minimum DFT 120 µ per coat

Total DFT : 260 µm

2. Painting specification for Indoor components such as motors, electrical parts etc:-

Surface preparation: blasting according to SIS 055900, Grade 2 ½ . Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 25 µm may be used.

Primer : Zinc phosphate epoxy - 2 coat, Total DFT 80 µm.

Finish Coat : Chlorinated rubber paint- 2 coats, Total DFT 80 µm for indoor and 100 µm for outdoor.

Total DFT : 160 µm for indoor and 180 µm for outdoor.

3. Color Shade:

SL. No	Item Description	Color Shade
1	Crane Structure	Golden Yellow shade 356 as per IS-5
2	Trolley and hook	Crimson shade 540 as per IS-5
3	Motors	Light grey, shade 631 as per IS-5
4	Control Panels	Paint shade shall be RAL 9002 for front & rear and RAL 5012 for side covers.
5	Bottom Block assembly.	Golden Yellow shade 356 as per IS-5
6	End Carriage sweep.	Golden Yellow shade 356 as per IS-5

REV: 00 DATE:

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGE: ELECTRIC HOIST FOR AC VENTILATION

PROJECT 1X660 MW UPRVUNL PANKI TPS EXTN

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

S. NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	I S	V	V	HEL 415 V(3 , 3W) . A (AC DC) . M .
2	P , , ( ) .	V	V	C HEL .
3	C (, , ,).	V	V	
4	E E	V	V	A , . HEL.
5	M	V	V	
	C	V	V	1. D N-C 2. S & .
	) I (C & I)) C) C	V V V	- - -	C C I C x .
	E	V	-	
	E E GA	V	-	F .

	MANUFACTURERS NAME & ADDRESS		MANUFACTURING QUALITY PLAN				PROJECT	1X660 MW UPRVUNL PANKI TPS EXTN.				
	AS PER APPROVED VENDOR LIST		ITEM:	ELECTRIC WIRE ROPE	QP NO		PACKAGE	ELECTRIC WIRE ROPE HOIST				
					REV	0	CONTRACT No					
					DATE	Mar, 2017	CONTRACTOR	BHEL-PEM				
					PAGE	1 of 4						

Sl.No	COMPONENT & OPERATIONS	CHARACTERISTICS	CATEGORY	TYPE OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	M	C	N	REMARKS
										AGENCY			
1	2	3	4	5	6	7	8	9		**	10		11
1.0	**RAW-MATERIALS**												
1.1	a) STRUCTURAL MATERIAL b) RAW MATERIAL FOR HOIST AND GEAR BOX HOUSING, TROLLEY PLATE, ROPE DRUM IF FABRICATED ETC	CHEM & MECH PROPS	MA	Lab analysis	1 SAMPLE PER LOT%	IS 2062 /APPD. DRG./ DATA SHEET		MTC/IR	√	P/V	V	V	Test shall be carried out in absence of mill TC or non-correlation of TC with material.BHEL to identify Samples for testing. Test to be carried out at NABL accredited Lab. Reports to be submitted for verification during inspection.
		NDT	MA	UT	100%	ASTM A388-2004	NOTE 1	IR	√	P	V	V	For dia / plate thickness above 25 mm
1.1 A	SEAMLESS PIPE FOR ROPE DRUM	CHEMICAL , MECHANICAL	MA	Lab analysis	1 SAMPLE /pipe	Approved drg/ASTM A 106 Grade A or B		MTC/IR	√	P/V	V	V	Test shall be carried out in absence of mill TC or non-correlation of TC with material.BHEL to identify Samples for testing. Test to be carried out at NABL accredited Lab. Reports to be submitted for verification during inspection
		Flattening & Acid Etching test	MA	PHYSICAL & METALLOGRAPHY	1 SAMPLE /pipe	No cracks, pitting, rusting , damage etc		IR	√	P	V	V	
		SURFACE DEFECTS	MA	Visual	100%								
1.2	FORGINGS FOR GEARS BLANKS ,PINIONS, SHAFT/AXLES, WHEELS , STEEL CASTINGS	MECH , CHEM. PROPS	MA	Lab analysis	100%	APPD. DRG./ DATA SHEET	APPD. DRG./ DATA SHEET / IS:3938	LAB. REPORT / MANUFACTURER'S TEST CERTIFICATE	√	P	V	V	
		NDT	CR	UT	100%	ASTM A 388	NOTE 1	INSPN. REPORT	√	P	**V**	V	IF DIA or THK > 50mm
		Hardeness , surface defects after hardfacing and machining/grinding	MA	DPT/MPI	100%	ASTM E -165 /E-709, No linear indication		MTC	√	P	**V**	V	
1.3	WIRE ROPE	Dimensional, type, constrcution ,	MI	measurement	100%	APPD. DRG./ DATA SHEET	APPD. DRG./ DATA SHEET	MFRS' TEST CERT.	√	P	V	V	
		EXAMINATION OF REPORT OF BREAKING LOAD CAPACITY	CR	Review of TC	100%	IS: 2266		MFRS' TEST CERT.	√	P	V	V	
1.4	HOOKS	MECH. , CHEM. PROPS.	MA	LAb analysis	100%	APPROVED DRG/DATA SHEET IS:15560		MFRS' TEST CERT.	√	P	V	V	
		U.T IF SHANK DIA > 50mm	CR	NDT	100%	ASTM A 388	NOTE 1	INSPN. REPORT	√	P	V/W	V	SHANK PORTION ONLY
		Dimension & PROOF LOAD TESTING	CR	Measurment , PROOF LOAD TEST	100%	APPROVED DRG/DATA SHEET / IS:3938 / IS:15560		QCR	√	P	V/W	V	IF REQUIRED BY END CUSTOMER.
		DPT AFTER PROOF LOAD	CR	NDT	100%	ASTM E-165	NO CRACKS	INSPN. REPORT	√	P	V/W	V	
1.5	SHEAVES	MECH	MA	Tensile & hardness	1/lot	Approved drgs		MTC/IR	√	P	V	V	

	MANUFACTURERS NAME & ADDRESS		MANUFACTURING QUALITY PLAN				PROJECT	1X660 MW UPRVUNL PANKI TPS EXTN.				
	AS PER APPROVED VENDOR LIST		ITEM:	ELECTRIC WIRE ROPE	QP NO		PACKAGE	ELECTRIC WIRE ROPE HOIST				
					REV	0	CONTRACT No					
					DATE	Mar, 2017	CONTRACTOR	BHEL-PEM				
					PAGE	1 of 4						

Sl.No	COMPONENT & OPERATIONS	CHARACTERISTICS	CATEGORY	TYPE OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	AGENCY M	AGENCY C	AGENCY N	REMARKS
1	2	3	4	5	6	7	8	9		**	10		11
1.6	CASTING FOR BEARING PLATED, ROPE GUIDES, PULLEYS ETC	CHEMICAL & MECHANICAL	MAJOR	LAB ANALYSIS	1/LOT	APPROVED DRG/MFG STANDARD	APPROVED DRG/MFG STANDARD	LAB REPORT	√	P	V	V	
2.0	**IN-PROCESS**												
2.1	Welding process capability and welder skill	WPS,PQR & WPQ	MA	Welding procedure approval and Welder performance qualification in accordance with ASME Section IX	100%	ASME Section IX		WPS,PQR & WPQ		P	V	V	In case approved WPS/PQR/WPQ from BHEL/NTPC/EIL/LLOYDS/TPL available, then documents/records to be submitted for verification during inspection, else, Vendor shall get the approval of Welding Procedure / Welder from the identified agency prior to carrying out welding at the
2.2	Welding of trolley, rope drum etc	Fillet weld	MA	DPT	10%	ASTM E165 or Eq/ No cracks or linear indication		INSPN. REPORT	√	P	V	V	
		Butt welds	MA	RT, DPT	100%	ASME SEC VIII, DIV 1, UW 51/52		RT FILM & REPORT	√	P	V	V	100% RT for butt weld in tension and 10 % in compression. 100% RT on butt weld of rope drum
		DPT AFTER STRESS RELIEVING OF ROPE DRUM	MA	NDT	100%	ASTM E-165	NO CRACKS	INSPN. REPORT	√	P	V	V	
2.3	NDT OF LOAD BEARING BUTT WELDS (**IF ANY**)	WELD QUALITY OF BUTT WELDS IN TENSION	CR	PT & RT	100%	ASME SEC. VIII DIV. I	ASME SEC. VIII DIV. 4 . CLUW-51 FOR RT APPENDIX -8 FOR PT	INSPN. REPORT ND FILM	√	P	W	V/W	FILMS TO BE REVIEWED BY BHEL & END CUSTOMER/THIRD PARTY. DPT SHALL BE CHP .
2.4	**GEAR BOXES**												
	COMPLETE ASSEMBLY	OVERALL DIMENSIONS. LEAK TEST, REDUCTION RATIO, BACK LASH AND CONTACT PATTERN	MA	MEAS./VISUAL	100%	MFG. DRG./KERSON E TEST	MFG. DRG./NO LEAKAGE WHEN FILLED	INSPN. REPORT	√	P	V		
	NO LOAD RUN TEST FOR 4 HRS	CHECK FOR OIL LEAKAGE, VIBRATION, NOISE ,TEMP. RISE. REDUCTION RATIO, BACKLASH , CONTACT PATTERN	MA	PERFORMANCE	100%	APPROVED DRGS /No leakage,Noise 85dbA maxat 1 mtrs, vibration 75 microns max, oil temp rise 20 deg above ambient max		- DO -	√	P	V	V	
3.0	**ELECTRICALS**												
1	MOTORS & CABLES	Make, type , rating	MA	Visual /measurment	100%	Apprvd drg	IS 325 / IS:3938	IR, MTC	√	P	V	V	For motor refer Note: 2
		ROUTINE TESTS											
3	LIMIT SWITCHES,SFU, ISOLATOR/ O/L RELAY, MCB, FUSES,PUSH BUTTONS,CONTACTOR, INDICATING LAMPS etc	Make , type , rating, functional, Continuity	MA	Review of TC	100%	Approved drgs		IR	√	P	V	V	
4	BRAKES	Make , type , rating, HV/IR, Functional test	MA	Review of TC	100%	Approved drgs		IR, MTC	√	P	V	V	
5	DSL	Make , type , rating, dimension	MA	Review of TC	100%	Approved drgs		IR	√	P	V	V	
6	Control transformer	Make , type , rating, input/output	MA	Review of TC	100%	Approved drgs		IR	√	P	V	V	

	MANUFACTURERS NAME & ADDRESS	MANUFACTURING QUALITY PLAN				PROJECT	1X660 MW UPRVUNL PANKI TPS EXTN.
	AS PER APPROVED VENDOR LIST	ITEM:	ELECTRIC WIRE ROPE	QP NO		PACKAGE	ELECTRIC WIRE ROPE HOIST
				REV	0	CONTRACT No	
				DATE	Mar, 2017	CONTRACTOR	BHEL-PEM
				PAGE	1 of 4		

Sl.No	COMPONENT & OPERATIONS	CHARACTERISTICS	CATEGORY	TYPE OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	AGENCY M	AGENCY C	AGENCY N	REMARKS
1	2	3	4	5	6	7	8	9	**		10		11
`	CONTROL PANEL, PENDANT SWITCH	* FIXING OF COMPONENTS WIRING MARKING CONTINUITY * FUNCTIONAL TEST * IR & H.V. TEST * IP - PROTECTION TEST * PAINT SHADE, THICKNESS, SHEET THICHKNESS, ADHESION TEST	MA	VISUAL/MEASUR	100%	APPD.DRG. WIRING DIAGRAM,	APPD. DRG. WIRING DIAGRAM,	IR	√	P	V	V	
8	VVVF DRIVES (IF APPLICABLE)	MAKE , TYPE , RATING , ROUTINE TESTS	MA	VISUAL/ VERIFY	100%	APPROVED DRAWINGS	APPROVED DRAWINGS	MTC	√	P	V	V	
4.0	FINAL INSPECTION												
4.1	COMPLETELY ASSEMBLED HOIST	1. COMPLETENESS, CORRECTNESS, WELD QUALITY, OVERALL DIMENSIONS	MA	VISUAL, MEAS	100%	APPD. DRG.	APPD. DRG.	MNFRS' TEST CERT.	√	P	W	V	CHP
4.2	ASSEMBLED HOIST PERFORMANCE WITH ACTUAL CONTROL PANEL, AND PENDENT PUSH BUTTON	1. LOAD TEST	CR	LOAD TEST at SWL	100%	IS:6547 / IS:39	IS:6547 / IS:3938	MNFRS' TEST CERT.	√	P	W	V	CHP
		2. HOISTING & LOWERING SPEED, PERFORMANCE OF CONTROLLERS SWITCHES CONTACTORS, RELAYS AND OTHER CONTROL DEVICES CORRELATIONS OF CIRCUITS AND INTERLOCKS AND SEQUENCES OF OPERATION , CURRENT MEASUREMENT,LIMIT SWITCH OPERATION.	CR	MEAS & VISUAL	100%	IS:3938, TECH SPEC.	TECH SPEC.	MNFRS' TEST CERT.	√	P	W	V	CHP
		3. OPERATION OF ALL PROTECTIVE DEVICES	CR	VISUAL	100%	TECH SPEC	TECH SPEC.	MNFRS' TEST CERT.	√	P	W	V	CHP
4.3	OVER LOAD TEST	OVER LOAD TEST INCLUDING HOLDING CAPACITY OF BRAKES, LIFTING LOAD FROM MID AIR, SOUNDNESS OF WELD AFTER OVERLOAD TEST.	CR	TEST AT 125 % OF-SWL	100%	IS:3938	IS:3938	INSPN. REPORT	√	P	W	V	CHP
5	PAINTING												
5.1	PRIMER & FINISHING AND SHADE	Examination - Shade , DOP by paper insertion method	MI	visual	100%	DRG. & DATA SHEET & RELV. IS SPEC.		MNFRS' TEST CERT.		P	V		
		DFT	MA	measurement	Sample					P	V		
6	PACKING	STURDINESS, PROTECTION MARKING	MA	VISUAL	100%	MFG STD	MFG STD			P			
	NOTE:												
1	When back wall echo is set to 100% in sound area then a) defect echo shall not exceed 20% b) Back echo shall be minimum 80% in any area.												
2	Less than 30 KW. Acceptance of motor less than 30 KW is based on COC of the manufacturer & the contractor confirming as follows : It is hereby confirmed that the above mentioned motor/motors was/were manufactured taking care of specific requirement regarding ambient temp, voltage & frequency variation, hot start, pull out torque, starting KVA/KW, temp rise, distance between centerof stud and gland plate and tested in accordance with approved drawing/data sheet.												

		LEGNDS		
		* RECORDS INDENTIFIED WITH 'TICK' SHALL BE ESSENTIALLY INCLUDED BY MANUFACTURER IN QA DOCUMENTATION.		
		** M: MANUFACTURER/SUBCONTRACTOR		
		C: BHEL/BHEL NOMINATED THIRD PARTY INSPECTION AGENCY		
MANUFACTURER/ SUB CONTRACTOR		N: CUSTOMER/CUSTOMER'S CONSULTANT/CUSTOMER'S APPOINTED THIRD PARTY		
		'P'- PERFORM", W"- WITNESS AND "V"- VERIFICATION " CHP" CUSTOMER HOLD POINT		
SIGNATURE			REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY &SEAL

	MANUFACTURER'S NAME & ADDRESS :	**MANUFACTURING QUALITY PLAN** **ITEM :** Chain Pulley Block **QP No.:** **REV**.:0, **Date.: , PAGE**: 1 OF 4	**PROJECT : 1X660 MW UPRVUNL PANKI TPS EXTN.** **PACKAGE : CHAIN PULLEY BLOCK**

Sr. No.	COMPONENT / OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
					M	C/N				M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.	10.			11.
1	**RAW MATERIAL & B/OUT ITEMS:**												
1.1	HOOKS	CHEMICAL & MECH	MA	LAB ANALYSIS	ONE SAMPLE PER HEAT		MATERIAL SPECIFICATION AS PER APPROVED DRAWINGS.		MTC. ✓	P	V	V	
		MARK & IDENTIFICATION	MA	VISUAL	100%		HOOK TC FROM COMPETENT AUTHORITY		TC ✓	P	V	V	
		INTERNAL DEFECTS	MA	UT	100%		ASTM A-388	(REFER NOTE I)	IR ✓	P	V	V	ON SHANK PORTION
		PROOF LOAD TEST	MA	REVIEW	100%		IS 15560		TC ✓	P	V	V	
		NDT AFTER PROOF LOAD TEST	MA	DPT	100%		ASTM E-165	NO RELEVANT INDICATTION	TC ✓	P	V	V	
1.2	LOAD CHAIN	- DIMENSIONS	MA	MEASUREMENT	100%		APPD. DRGS	APPD. DRGS.	IR ✓	P	V	V	
		- BREAKING STR & % ELONGATION	MA	-TENSILE TEST	1/LOT		-DO-	-DO-	MTC ✓	P	V	V	
		- PROOF LOAD -HEAT TREATMENT	MA	-TENSILE TEST	100%		-DO-	-DO-	MTC ✓	P	V	V	
			MA	REVIEW	100%		-DO-	-DO-	HT CHRT ✓	P	V	V	
		-GRADE	MA	REVIEW	1/BATCH		-DO-	-DO-	MTC ✓	P	V	V	

	LEGEND:	FOR CUSTOMER USE	
MANUFACTURER / CONTRACTOR SUB-CONTRACTOR	** M : MANUFACTURER / SUB-SUPPLIER C : BHEL / NOMINATED INSPECTION AGENCY. N : CUSTOMER/ NOMINATED INSPECTION AGENCY. INDICATE "P" PERFORM "W" WITNESS AND "V" VERIFICATION		
SIGNATURE		REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY & SEAL

	MANUFACTURER'S NAME & ADDRESS :	**MANUFACTURING QUALITY PLAN** **ITEM :** Chain Pulley Block **QP No.:** **REV**.:0, **Date.:** , **PAGE**: 2 OF 4	**PROJECT : 1X660 MW UPRVUNL PANKI TPS EXTN.** **PACKAGE : CHAIN PULLEY BLOCK**

Sr. No.	COMPONENT / OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C/N					M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.		10.			11.
1.3	RAW MATL. (BAR /FORGING) FOR GEAR BLANKS/SHAFTS/ PINIONS/AXLE/ RATCHET PAWL / RATCHET WHEEL & PLATES FOR FABRICATION ETC	CHEMICAL COMPOSITION	MA	Review	ONE SAMPLE PER HEAT		Material specification as per approved drawings.		MFR'S TC	✓	P	V	V	TC or inspection report for components shall be given. For rounds ≥50mm and plates ≥25 mm.
		MECHANICAL	MA	Review										
		INTERNAL DEFECTS	MA	UT	100%		ASTM A-388 REFER NOTE 1		IR	✓	P	V	V	
		NDT AFTER MACHINING	MA	DPT	100%		ASTM E-165 NO RELEVANT INDICATION		TC	✓	P	V	V	
1.4.	LOAD CHAIN WHEELS	- CHEMICAL & MECHANICAL PROPERTIES	MA	CHEMICAL MECHANICAL PROPERTIES	ONE SAMPLE PER LOT		APPD. DRG.	APPD. DRG.	MTC	✓	P	V	V	
1.5	BEARINGS	MAKE, TYPE, CATALOUGE NO.	MA	VISUAL	RANDOM		APP DRG / MFR"S CATALOGUE	APP DRG / MFR"S CATALOGUE	IR	✓	P	V	V	
1.6	HAND CHAIN WHEEL	CHEMICAL MECHANICAL PROPERTIES	MA	CHEMICAL MECHANICAL PROPERTIES	ONE SAMPLE PER LOT		AS PER DRAWING	AS PER DRAWING	MTC	✓	P	V	V	
1.7	HAND CHAIN	GRADE/ DIMENSION	MA	GRADE DIMENSION	100%		AS PER DRAWING	AS PER DRAWING	MTC	✓	P	V	V	

	LEGEND:	FOR CUSTOMER USE	
MANUFACTURER / CONTRACTOR SUB-CONTRACTOR	** M : MANUFACTURER / SUB-SUPPLIER C : BHEL / NOMINATED INSPECTION AGENCY. N : CUSTOMER/ NOMINATED INSPECTION AGENCY. INDICATE "P" PERFORM "W" WITNESS AND "V" VERIFICATION		
SIGNATURE		REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY & SEAL

	MANUFACTURER'S NAME & ADDRESS :	**MANUFACTURING QUALITY PLAN** **ITEM :** Chain Pulley Block **QP No.:** **REV**.:0, **Date.:** , **PAGE**: 3 OF 4	**PROJECT : 1X660 MW UPRVUNL PANKI TPS EXTN.** **PACKAGE : CHAIN PULLEY BLOCK**

Sr. No.	COMPONENT / OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C/N					M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.		10.			11.
1.8	TROLLEY GEARS, PINION,WHEELS, AXLE	CHEMICAL & MECHANICAL	MA	LAB ANALYSIS,	100%		APPVD DRGS	APPVD DRGS	IR/TC	✓	P	V	V	
2	**IN PROCESS**													
2.1	RATCHET PAWL / RATCHET WHEEL	-HARDNESS	MA	HARDNESS	100%		IS:3832/ APPD DRG.	IS:3832/ APPD. DRG.	IR	✓	P	V	V	
		-SURFACE CRACK	MA	DPT	100 %		ASTM E165	NO DEFECT	IR	✓	P	V	V	
2.2	COMPONENTS AFTER HARDFACING & MACHINING	HEAT TREATMENT	MA	HT CHART	100%		IS 1875/IS 4367/IS 3832		IR	✓	P	V	V	
		SURFACE HARDNESS	MA	HARDNESS	10%		--DO--		IR	✓	P	V	V	
		SURFACE CRACK	MA	DPT FOR SURFACE CRACK	100%		ASTM E 165	NO DEFECT	IR	✓	P	V	V	
		DIMENSION	MA	MEASURE	10%			IS 3832	IR	✓	P	V	V	
3.0	**FINAL INSPECTION**													
3.1	COMPLETE ASSEMBLY	OVERALL DIMENSION	CR	MEASUREMENT	100 %		IS:3832 /APPD DRG	IS:3832 /APPD DRG	IR	✓	P	W	V	
		ENDURANCE TYPE TEST	MA	TYPE TEST	1 PER SIZE		IS 3832	IS 3832	TC	✓	P	V	V	
		OPERATIONAL PROOF LOAD & LIGHT LOAD TEST, EFFORT.	CR	LOAD TEST	100%		-DO-	-DO-	IR	✓	P	W	V	
		HEIGHT OF LIFT	MA	VISUAL	100 %		-DO-	-DO-	IR	✓	P	W	V	

	LEGEND:	FOR CUSTOMER USE	
MANUFACTURER / CONTRACTOR SUB-CONTRACTOR	** M : MANUFACTURER / SUB-SUPPLIER C : BHEL / NOMINATED INSPECTION AGENCY. N : CUSTOMER/ NOMINATED INSPECTION AGENCY. INDICATE "P" PERFORM "W" WITNESS AND "V" VERIFICATION		
SIGNATURE		REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY & SEAL

भीएचई पी	MANUFACTURER'S NAME & ADDRESS :	**MANUFACTURING QUALITY PLAN** **ITEM :** Chain Pulley Block **QP No.:** **REV**.:0, **Date.: , PAGE**: 4 OF 4	**PROJECT : 1X660 MW UPRVUNL PANKI TPS EXTN.** **PACKAGE : CHAIN PULLEY BLOCK**

Sr. No.	COMPONENT / OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C/N					M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.		10.			11.
		SWIVELING OF HOOK	MA	VISUAL	100%		APPROVED DRG	APPROVED DRG	IR	✓	P	W	V	
		EFFORT	MA	PULL ON CHAIN	100%		-DO-	-DO-	IR	✓	P	W	V	
3.2	PAINTING	-CLEANING	MA	VISUAL	AT RANDOM		APPROVED DRAWING/ **SPECIFICATION**	APPROVED DRAWING/ **SPECIFICATION**	IR		P	---	---	
		- SHADE & DFT OF PAINT	MI	VISUAL	AT RANDOM				IR		p	W	---	
3.3	NAME PLATE	VERIFICATION	MA	VISUAL	100%				IR		P	V	---	
3.4	PACKING	-VERIFICATION	MI	VISUAL	100%		SPECS.	SPECS.	IR		P	---	---	
3.5	REVIEW OF QA DOCUMENTATION	VERIFICATION	MA	VISUAL	100%		APPD. QP	APPD. QP		✓	V	V	V	

CR – CRITICAL, MA – MAJOR , MI – MINOR

NOTE 1: WHEN BACK WALL ECHO (BWE) IS SET AT 100% OF FULL SCREEN HEIGHT (FSH) IN DEFECT FREE AREA THEN
(A) DEFECT ECHO SHALL NOT EXCEED 20% OF FSH &
(B) BWE SHOULD BE MINIMUM 80% OF FSH IN ANY AREA.
NOTE 2: RECORDS IDENTIFIED WITH TICK SHALL BE ESSENTIALLY INLCUDED IN QA DOCUMENTATION.

MANUFACTURER / CONTRACTOR SUB-CONTRACTOR	LEGEND: ** M : MANUFACTURER / SUB-SUPPLIER C : BHEL / NOMINATED INSPECTION AGENCY. N : CUSTOMER/ NOMINATED INSPECTION AGENCY. INDICATE "P" PERFORM "W" WITNESS AND "V" VERIFICATION	FOR CUSTOMER USE	
SIGNATURE		REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY & SEAL

SECTION: I

SUB-SECTION: C2-A

CUSTOMER SPECIFICATION

(TECHNICAL REQUIREMENT)

TECHNICAL SPECIFICATIONS

FOR

HVAC SYSTEM

SECTION-25

HVAC SYSTEM

25.1 SCOPE OF WORK

Scope of work under this section covers the provision of ~~labour~~, tools, plants, materials and performance of work necessary for the design, engineering, manufacture, quality assurance, quality control, shop assembly, shop testing, packaging & delivery at site including insurance, ~~unloading, site storage and preservation, in plant transportation at site, erection / installation~~, testing supervision, ~~pre commissioning, successful commissioning~~, performance and acceptance testing, handing over and warrantee for two years of HVAC system, as per the specifications hereunder, each complete with all auxiliaries, accessories, spare parts and warranting a trouble free safe operation of the installation. The scope of work covered under this section shall be read in conjunction with General Technical specifications, Chapter-1. (Refer section C2B)

25.1.1 Detailed Scope of Work

The scope of work shall be a comprehensive functional system covering all supply and services including but not be limited to following:

25.1.1.1 Main equipments & auxiliaries

i) Three Nos. ventilation blowers (2W+1S) each of capacity 50% of the total required air for power house, transformer hall and GIS Building area.

ii) Two Nos. ventilation blowers (1W+1S) each of capacity 100% of the total required air for BFV.

iii) Two Nos. ventilation blowers (1W+1S) each of capacity 100% of the total required air for Dam Control room building.

iv) Any other booster blowers system required to ensure a well ventilated fresh air in the power house, transformer hall, GIS building area, BFV house, dam control room building to maintain a positive draft under all circumstances of operation.

v) One (1) lot of Split type/cassette type air conditioning units with all necessary auxiliaries of suitable capacity for Control & protection panel area for Power house,, Transformer Hall, GIS Building area and Dam site area, control room

area for Power house and Dam site area, Power House office, Power house conference room.

vi) One (1) lot of Exhaust blower / Exhaust fan system, axial fan system for removal of foul air through exhaust ducts / natural ducts from Power house, transformer hall, BVH, GIS Building area, dam control room building.. Requirement of exhaust system shall be determined during detailed engineering based on the layout condition. Above Exhaust system shall include general / open area, specific requirement from battery rooms, DG room, Toilets, Kitchens etc.

vii) Air duct distribution system for supply and return air of all Ventilation and exhaust systems as per the ventilation layout drawing, complete from blower room along with accessories for termination, with necessary galvanized sheet metal ducts. Separate ducts to be provided for battery room, toilets, kitchen etc.

viii) One (1) lot of motorized damper with manual override facility including damper control panel shall be provided in each ventilation blower system and each ventilation zone of the ventilated area. Control of motorized damper shall be automatic through fire panel and manual trough blower control panels.

ix) Elbows, tees, supports, fixations, foundation plates including anti vibration pads, hangers, inserts, filters including all necessary grills, louvers, outside air louvers, adjusting duct dampers etc. to complete the ducting network.

x) Necessary piping, valves, fittings, insulation, cladding etc. required for air conditioning system.

25.1.1.2 Control, monitoring and related items and services

i) Control panel for Air Blowers, exhaust system, motorized damper etc. complete with all necessary accessories.

ii) Necessary instrumentation such as temperature, thermostat, humidity sensor, flow rate sensors in main & booster etc. for the above system.

iii) Coordination and provision of necessary contacts and/ or ports for integration with plant SCADA system

25.1.1.3 Common supplies and services

i) Drawings, documents and design calculations as per clause 25.6.
ii) Shop, assembly, inspection & tests as per clause no. 25.7.
iii) Packaging, ~~handling and site storage~~ as per clause no. 25.8.
iv) Delivery, ~~installation and commissioning~~ as per clause no. 25.9.
v) Tools and instruments as per clause no. 25.10.
vi) Spare parts as per clause no. 25.11
vii) Field/touch-up painting including all painting materials.

25.1.1.4 Completeness of System

Any other item(s) not mentioned specifically but necessary for the satisfactory completion of scope of work defined above, as per accepted standard(s)/best international practices

25.2 STANDARDS & REGULATIONS

The design, manufacture and testing of the various equipment covered under this specification shall comply with the requirements of the latest edition of the relevant IEC/IS/IEEE/ISO standards only. Preference for latest IEC standards for particular equipment / system shall be governed over IEEE/ IS/ ISO standards. Further rules, guide lines and standard laid down by international/ national agency shall be applicable in this specification.

The relevant abstract (in soft / hard copy) of all referred standards shall be provided free of cost during engineering stage for facilitating review/ approval of submitted drawing/documents

25.3 PARAMETERS & GUARANTEES

25.3.1 Specific Parameters and Layout Conditions

The Power House, Transformer hall, GIS building area, BVH, dam control room area, shall be ventilated and air conditioned as detailed in this specification., The Fresh Air & Exhaust air fans shall be placed suitably at MAT/cable ventilation tunnel. Split/ Cassatte type ACs 's shall be distributed suitably as per the requirement in the power house area, Transformer Hall, GIS building area, and Dam Site.

Ventilation System of the Power House: Refer attached amendment for this clause at end of section C2A

Ventilation system shall be designed so that outdoor air (50% of the quantity required) is taken through the cable tunnel from the fan room located at switchyard. The cable duct is divided into two parts , one for transformer hall cavern and other for power house. The exhaust air will be thrown out by means of exhaust ducts suitably places in Power house & transformer yard –MATs.

Ventilation System of the BFV:

Fresh air after being filtered is forced by the blower in supply air duct and is distributed in the butterfly valve cavern through air ducts. The used air is exhausted through access tunnel by natural exhaust. If required necessary exhaust system has to be provided for exhaust of air, which shall be decided during detail engineering.

Ventilation System of the Dam Control Room area:

Fresh air forced from the blower room through suitable duct is further distributed in the DG room, HT LT room, battery room etc. The used air is exhausted through exhaust fans. If required necessary exhaust system has to be provided for exhaust of air, which shall be decided during detail engineering.

Air Conditioning System

The Air Conditioning System by split type / cassette type is to be provided at the following location of ARUN III HEP.

- Control Room in Power House, GIS Building and Dam Site.
- Offices and Conference Room in Power house control building and Dam Control building.
- Control & protection panel room at Power House and GIS Building.

All unit shall be identical. The system shall be complete with all requisite control drain pipes, regenerating pipes. The system shall be capable of maintaining desired room temp. Adjustable by thermostat which to be provided.

25.3.2 Rating And Functional Characteristics

Rating and functional characteristics of all the components of the HVAC system shall be of latest state of the art. If the system components mentioned in the awarded contract becomes obsolete at the time of approval of General technical particulars during detail engineering, the Contractor shall offer the latest model without any extra cost to purchaser. The system design shall be based on criteria,

factors, and details recommended as specified in national / international standards / handbooks such as ASHRAE handbook.

25.3.2.1 Ventilation areas and Air changes per hour

All ventilated and air conditioned area shall be designed to maintain a positive pressure within the designated areas as defined above. For all ventilated and air conditioned rooms the air changes shall be as per latest edition of IS 4720. The dimensions of the various areas are as shown in the layout drawings.

25.3.2.2 Noise levels

The noise level when measured at 1.5 m from source, caused by operation of the VENTILATION & AIR CONDITIONING systems shall be as per relevant standards. Silencer , as required, shall be provided to guarantee the sound levels.

25.3.2.3 Maximum air velocities in ducts

In main ducts 11 m/s

In branch ducts 8 m/s

25.3.3 Performance Criteria and Guarantee

The HVAC system along with all auxiliaries and accessories shall be capable of performing intended duties under specified conditions It is the responsibility of the Contractor to supply the equipment as per relevant standards and shall also guarantee the reliability and performance for the same to meet the provisions of contract.

25.3.4 Power supply arrangement

The Contractor shall design HVAC control system based on 240V AC UPS or 220V DC supply as per section -19.. However, if the offered equipment is operating at different voltage level, the Contractor shall provide all required hardware to make the offered system compatible with specified power supply arrangement.

25.4 DESIGN AND CONSTRUCTION

25.4.1 Ventilation System

25.4.1.1 Electric Fans

1. General

The capacities of the fresh air blowers shall be worked out on the basis of air changes per hour. The blowers shall be installed in the blower room.

2. Design

The fans shall be designed to comply with the maximum noise levels in the powerhouse as specified. The fans shall be resistant to the moisture. The fan shall be designed for optimum performance at a given duty however; it should be capable of working over a range of pressure and volume. The fans should be designed for the static pressures suitable for site conditions.

The casing of the blowers shall be 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. The impeller, pulley and shaft sleeves shall be secured to the shaft by keys and nuts. The impeller shall be statically and dynamically balanced. The bearings may be ball, roller or sleeve and shall be adequately supported. They shall be easily accessible and properly lubricated. Inlet for air shall have a smooth contour. The blower dampers at the plenums shall be electrically operated and the openings and closings of these dampers shall be automatically /manually switch operated with the starting of the blowers. The blower shall be provided with anti-vibration pads at the bottom.

25.4.1.2 Induction Motors (General Purpose)

Blower motors shall be totally enclosed type and shall be to latest standard.. The motors shall be suitable for operation at 415 Volts and 50 C/S, three phase supply with variation as given below:-

)	Variation of supply voltage from rated motor voltage.	±10%
ii)	Variation of supply frequency from rated frequency.	± 3%

The motors shall be provided with anti-vibration pads at the bottom**.** Starting method shall be as per GTS clause no.1.8.9 (Refer section C2B)

25.4.1.3 Filters

Filters shall consist of V fold galvanized wire mesh inter spaced with a flat layer of galvanized wire mesh. The density of the filter medium shall increase in the direction of air flow. Wire mesh edges shall be suitably hemmed to eliminate danger of abrasion during handling. Filter media shall be supported on either side by galvanized expanded metal casing. Filter frame shall be fabricated from

aluminum alloy of minimum 16 gauge thickness conforming to IS: 737 or 18 gauge GI sheets. The filter shall be dry type. The filter must be capable of being completely cleaned of their accumulated dust by flushing with tap water.

25.4.2 AIR CONDITIONING SYSTEM

Air conditioning system in the designated area as specified above shall be designed by using Split type/cassette type air conditioning units with all necessary auxiliaries of suitable capacity suitable for control area. To be finalized during detailed engineering based on the final layout. Contractor shall coordinate with the civil & architecture group for finalizing the size, color, type matching with the ceiling color / alignment etc.

Necessary piping, valves, fittings, insulation, cladding etc. required for air conditioning system shall be part of the scope. Contractor shall coordinate with civil group for the drainage upto the drain point.

Power supply receptacles at strategic location shall be cover under section 22. However, connection cable from AC to receptacles including plug top shall be supplied by the contractor.

25.4.3 Description Of Control Panels / MCC PANEL

Panels shall be provided at different locations for supply and control of different motors for blowers/ exhaust fans, and motorized dampers, etc. Panel shall include necessary relay, push buttons, indicating lamps and electronic display unit for voltage, current, kW and power factor and electronic energy meter at incomer feeder.

Provision for display of flow rate (m^3/hr) shall also be made in the control panel of ventilation / booster blower system panel.

25.4.4 Exhaust Fans

The design and construction of the exhaust fans shall comply with latest standards. Exhaust air fans shall be adjustable axial flow fans. Axial air fans shall be of the multi blade vane type. The vanes shall be adjustable individually at standstill. The hub of the impeller shall be directly coupled to the motor shaft and its diameter adapted to the motor frame. The impeller shall be statically and dynamically balanced. The exhaust fans shall be placed at a suitable location for easy maintenance.

All bearings shall be pre-lubricated, self-aligning and selected for a trouble free operation. If, however, frequent lubrication is required this should be possible from the outside of the fan casing without disturbing the fan duct assembly, Bearings supports shall be specially designed for trouble-free bearing service. All fan shafts and wheels shall be designed to operate at their maximum rated speed. Anti-vibration mountings shall be provided for each fan for minimum noise level.

25.5 AUXILIARY SYSTEM AND MISCELLANEOUS COMPONENTS

25.5.1 Material Requirements for duct construction

1. The rolled steel sheet before galvanizing shall be properly annealed or normalized so as to allow fabrication of ducts without developing cracks and zinc coating on the steel shall not be less than 275 gms/m^2 Class IV as per IS-277-1969 or latest revised.

2. The thickness of steel sheets, type of bracings and other construction and fabrication details shall be in accordance with IS 655 of latest version. The ducts shall be swedged 40mm from the ends so that the larger and 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 paper to ensure a tight joint. The galvanized steel sheet ducting shall be fabricated at site with latest mechanized method form various sections of the duct.

25.5.2 Splitters and Dampers

1. Splitters and dampers shall be placed at all suitable points for proportional volume control of the system. Splitters and dampers shall be made of 18 gauge GSS of quadrant type with suitable locking device mounted outside of duct in an accessible location.

2. Motorized fire dampers or fire doors shall be provided in main ventilation blower and each ventilation zone. Same shall be finalized during detailed engineering. Motorized fire dampers shall be actuated automatically through fire protection panel and manually from the damper control panel.

25.5.3 Plenums

All the plenum chambers or connections to fans, dampers etc. shall be supported on suitable angle frames of GSS.

25.5.4 Painting

The ducts in the battery room shall be painted or lined with suitable anti corrosive paints/lining to prevent corrosion of the sheet metal.

25.5.5 Diffusers & Grilles

The type and the quantity of diffusers and grilles required shall be worked out by the Contractor. The Contractor shall ensure that the diffusers/grilles offered are of requisite capacity, throw and terminal velocity. The diffusers shall be of powder coated mild steel construction. The grills for the battery room shall be acid proof. The diffusers/ grilles shall have facility of controlling air flow.

Contractor shall coordinate with the civil architecture group for finalizing the size, color, type matching with the ceiling color / alignment etc.

25.5.6 Outside Air Louvers

Outside air louvers of each of the fresh air and exhaust air system shall prevent the entrance of rain, insects, birds and trash into the ducts.

They shall be stamped and pressed out of one piece of aluminum sheet of at least 2mm thickness. The frames shall also be made of aluminum.

25.5.7 Balancing

1. The air distribution system shall be tested/ balanced by Contractor so that the air flow are maintained throughout the space to be ventilated.
2. All instruments required for testing/balancing the air distribution system shall be provided by the Contractor.

25.5.8 Piping System

The necessary piping installation for Air conditioning system shall be the part of supply.

25.5.9 Insulations

The fresh air and cooled down supply air ducts / pipe shall be insulated to prevent condensation on the duct / pipe surfaces in Air conditioning system.

The insulation material (thickness to be as per detailed design) shall non-hygroscopic, rot-proof. The insulation mats or plates shall be fastened on the duct

/ pipe and wrapped with aluminum foils. The insulation material shall be also sufficient to obtain the acoustic guarantee.

25.6 Drawings, Documents and Design Calculations (For GTS refer section C2B)

After award of contract, the contractor shall furnish all drawings, documents, design calculations, data, manuals & other necessary literature, pertaining to equipment offered by them & so specified under various clauses, in accordance with requirements stipulated in "clause 1.19 of Section – 1 i.e. General Technical Specification (GTS)". A comprehensive list of all such drawings/documents planned to be submitted for reference/approval shall be provided beforehand for approval of the purchaser as already explained in clause no. 1.19.6 of Section – 1 (GTS). The list of drawings & documents to be furnished for approval / reference shall not be limited to the following:-

i) Drawings, documents, design calculations literatures, manuals etc. as per clause no. 1.19 of Section-1 (GTS)

ii) Drawings, documents, design calculations, literatures, manuals as listed in Annexure – D of Section -1 (GTS) referred under clause no. 1.19.6

iii) Detailed quality assurance plan, giving complete specifications of the materials and specifications relating to inspection and testing of materials and finished components.

iv) All drawings having bearing on civil foundations, equipments foundation details and loads

v) Arrangement, installation, foundation, plan, section, detailing of main equipment and sub-assemblies including piping, control & instrumentation system.

vi) All Electrical, Hydraulic & Control Drawings such as Electrical Panels OGA, Cable Block & Termination Diagram, Schematic Diagram, JB/MB/Kiosk Diagram etc. in respect of this section.

vii) All manufacturing drawings not specifically covered under approval/reference category shall be submitted for record and facilitate inspection of the component in the shop and assembly at site.

Any other drawings, documents, design calculations, literatures, manuals etc. not covered anywhere in the specification, but required to be furnished for approval / reference of employer for suitability of design to fulfill the scope of work..

25.7 SHOP ASSEMBLY, INSPECTION AND TESTS

25.7.1 Type test

Type test of HVAC system shall fall under the Cat-II (refer clause no 1.16 of GTS). The list of type test is given below: (For GTS refer section C2B)

a)	**Blower fans and associated motors**
i.	High voltage
ii.	Insulation resistance
iii.	Earthing continuity
iv.	Electrical Power
v.	Fan speed
vi.	Power factor
vii.	Leakage current
viii.	Starting
ix.	Test for capacitor
x.	Air delivery
xi.	Temperature rise
xii.	Characteristic curve of ventilation, exhaust & blower

25.7.2 Routine tests

Routine tests on all the types of motors, fans, Air Conditioner, filters, grilles, louvers, dampers,, pipes, ducting coils, valves, V belts, pulley, coupling shaft, fan impeller shaft, bearings and fittings shall be conducted as per relevant standards.

25.7.3 Field tests

25.7.3.1 Test during installation and pre commissioning

At least following tests shall be conducted during installation and pre commissioning:

i) Dielectric and insulation resistance on all electrical circuits

ii) Tests to verify electrical ratings

iii) Functional tests on panels

iv) Checking of various sizes of ducts (dimensional checks)

v) Fixing of ducts supports as per drawing.

25.7.3.2 Commissioning tests

At least following tests shall be conducted during commissioning:

i) General running test
ii) Leakage test
iii) Checking of air velocity at different locations
iv) Checking for abnormal noise and vibration
v) Capacity rating test
vi) Power consumption test
vii) Functional test of Air Conditioner in respect of temperature and humidity.

25.7.4 Performance Testing

After completion of commissioning tests and commissioning of complete system (ventilation and air conditioning), the test service period of thirty (30) days shall follow before taking over. During this test service period , the system / installations must perform satisfactorily & if any defects are observed , same shall be rectified by contractor without any financial implication to employer.

25.8 PACKAGING, ~~HANDLING & SITE STORAGE~~

The contractor shall be liable for all packing, ~~handling and site storage~~ of all the equipment till the installation is handed over to the Engineer in charge.

25.9 SITE INSTALLATION AND COMMISSIONING

REFER SUPERVISION OF E&C UNDER SCOPE OF SERVICES

25.9.1 General

The Contractor has to do all the work related to assembly, erection, testing and commissioning complete in all respects. All necessary tools, plants, labour, materials including consumables for performing installation, testing and pre-commissioning shall be provided by the Contractor.

The Contractor shall provide and install the concrete inserts/embedment; support steels and/or components for foundation /supports purpose, shall do any chipping / leveling works , denting / painting etc.

The Contractor shall supply sufficient number of erection and commissioning spare based on their experience so that erection, testing and commissioning work progresses smoothly and is not hampered for want of such spares. These spares shall be in addition to the spare arts described under clause “Spare Parts”.

25.10 TOOLS AND INSTRUMENTS

25.10.1 Tools for erection and Installation.

The Contractor shall bring his own tools, devices, testing instruments / equipments to site in order to erect and install the complete equipment delivered under this section. These shall remain the property of the Contractor unless otherwise agreed to take over any / all of these at mutually agreed conditions.

25.11 SPARE PARTS

The spare parts mentioned here under are meant for use by the Employer during operation and maintenance stage and shall not be used as erection spares required during installation.

25.11.1 Mandatory Spare Parts

(For Mandatory spare refer Annexure-II of Subsection E and other relevant clauses)

The Contractor shall supply the mandatory spare parts as per schedule-III.

Manufacturing Quality Assurance Test Requirements

Project Name (MW): ARUN-III HEP (4X225 MW)	**Doc. No.:** QAI/A/M/EM/HVAC/01	**Rev. No.:** 02
Item Description: HVAC System	**Issue Date:** 30.05.2017	**Pages.:** 3

Sr. No.	Component, Operation & Characteristics	Applicable Standard	Remark
1	2	3	4
A	**Split Type/ Cassette Type Air Conditioners**		
1	Make, Type & Rating, Functional Test	TS/DRG/ REL STD	V
2	Load Capacity	TS/DRG/ REL STD	V
B	**Ventilation Fans**		
1	**Incoming Material**		
1.1	**Scroll Casing, Impeller, Shaft, Shaft Sleeves, Base Plate**		
	Visual & Dimensional Check, Chemical & Mechanical Properties	TS/DRG/ REL STD	V
1.2	**Anti- Vibration Pads**		
	Type, Vibration Level	TS/DATASHEET/DRG/ REL STD	V
1.3	**Motor**		
	Make & Rating, Type Test, Routine Tests	IS 325	V
2	**In process Inspection**		
2.1	**Scroll Casing**		
	Dimensional Check, NDT of Weld Joints	TS/DRG/ REL STD/ ASME Section V & VII	V
2.2	**Impeller**		
	Dimensional Check, NDT of Weld Joints, Balancing (Static & Dynamic)	TS/DRG/ REL STD/ ASME Section V & VII	V
2.3	**Shaft**		
	NDT of Weld Joints	TS/DRG/ REL STD/ ASME Section V & VII	V
3	**Final Inspection**		
3.2	**Acceptance Test**	IS 4894	
	High Voltage test, Insulation Resistance, Earthing Continuity, Electrical Input, Fan Speed, Noise & Vibration Level	IS 4894	W
3.3	**Routine Test**		
	Flash Test, Insulation Resistance, Run test to determine the functionality of the fan	IS 4894	W
C	**Exahust fans**		
1	**Raw Material Stage**		
1.1	**Raw Material Casing/ Fan Base**		
	Physical Check, Zinc Coating, Visual & Dimensional Check	IS 277	V
1.2	**Motor**		
	Type,Model	IS 325	V
1.3	**Impeller**		
	Type, Dimensional check	TS/DATASHEET/DRG/ REL STD	V
1.4	**Anti- Vibration Pads**		
	Type, Vibration Level	TS/DATASHEET/DRG/ REL STD	V
2	**Inprocess Inspection**		
2.1	**Fan Casing Roll Forming**		
	Visual & Dimensional Check	TS/DATASHEET/DRG/ REL STD	V
2.2	**Weld Casing**		
	Welding	AWS-ASTM-4	V
2.3	**Flanging & Punch Flange Holes**		
	Dimensional check	TS/DATASHEET/DRG/ REL STD	V
2.4	**Fan Base Fabrication**		
	Visual & Dimensional Check	TS/DATASHEET/DRG/ REL STD	V
2.5	**Impeller Balancing**		
	Unbalance	TS/DATASHEET/DRG/ REL STD	V
2.6	**Complete Fan Assembly**		
	Visual & Dimensional Check	TS/DATASHEET/DRG/ REL STD	V
2.7	**Vibration Test**		
	Vibration Level	TS/DATASHEET/DRG/ REL STD	V
3	**Final Inspection**		
3.1	**Axial Type Exhaust fans (fully assembled)**		
3.1.1	**Routine Test**		
	Flash Test, Insulation Resistance, Simple Running Test, Noise Free Operation	IS 3588	W

3.1.2	**Acceptance Type**		
	High Voltage, Insulation Resistance, Earthing Continuity, Electrical Input, Fan Speed	IS 3588	W
3.2	**Propellor Type Exhaust Fans**		
3.2.1	**Routine Test**		
	Flash Test, Insulation Resistance, Simple Running Test, Noise Free Operation	IS 2312	W/V
3.2.2	**Acceptance Type**		
	High Voltage, Insulation Resistance, Earthing Continuity, Electrical Input, Fan Speed	IS 2312	W/V
3.2	**Pre-Dispatch Inspection**		
	Packing	TS/ TS/DRG/ REL STD	V
D	**Electric Panel**		
1	**Raw Material**		
1.1	**CT, PT & control transformers**	TS/DATASHEET/DRG/ REL STD	V
	Routine & Acceptance tests		
1.2	**ACB, MCCB, MCB, Contactors, Relays**	TS/DATASHEET/DRG/ REL STD	V
	Routine & Acceptance tests		
1.3	**Bus Bar**	TS/DATASHEET/DRG/ REL STD	V
	Material Test, Dimension Check		
1.4	**Meters**		
	Make, Model &Type and Calibration certificates of all meters	TS/DATASHEET/DRG/ REL STD	V
2	**Final Inspection**		
	Dimension check for height, width, depth & sheet thickness of panel	Datasheet/ TS/DRG/ REL STD/ IEC 60204-1/ IEC 62271-203	W
	Dimension check of bus bar	Datasheet/ TS/DRG/ REL STD/ IEC 60204-1/ IEC 62271-203	W
	Visual check as per OGA, TS/DRG/ REL STD & verification of BOM	Datasheet/ TS/DRG/ REL STD/ IEC 60204-1/ IEC 62271-203	W
	Verification of correct wiring, Ferruling, dressing, routing, bunching	Datasheet/ TS/DRG/ REL STD/ IEC 60204-1/ IEC 62271-203	W
	continuity check, colour coding and earthing	Datasheet/ TS/ DRG/ REL STD/ IEC 60204-1/ IEC 62271-203	W
	Insulation resistance measurement before & after HV test	Datasheet/ TS/ DRG/ REL STD/ IEC 60204-1/ IEC 62271-203	W
	Dielectric tests on auxiliary and control circuits	Datasheet/ TS/ DRG/ REL STD/ IEC 60204-1/ IEC 62271-203	W
	Functional test on all AC & DC circuit including heating, Lighting, Fan & thermostat	Datasheet/ TS/ DRG/ REL STD/ IEC 60204-1/ IEC 62271-203	W
	Operational & functional test	Datasheet/ TS/DRG/ REL STD/ IEC 60204-1/ IEC 62271-203	W
	Verification of IP Class	Datasheet/ TS/DRG/ REL STD/ IEC 60204-1/ IEC 62271-203	W
	Surface Protection coating, Paint Shade & Finish, Adhesion test	Datasheet/ TS/DRG/ REL STD/ IEC 60204-1/ IEC 62271-203	W
E	**Auxiliary System and Misellenous Components**		
1	**Incoming Material**		
1.1	**Air Ducts**		
1.1.1	**Ducting Sheets**		
	Visual & Dimensional Check, Chemical & Mechanical Properties	TS/DRG/ REL STD/ IS 655/ IS 277/ IS 737	V
1.1.2	**Supporting Channels/ Rods**		
	Visual & Dimensional Check, Chemical & Mechanical Properties	TS/DRG/ REL STD	V
1.2	**Filters**		
	Visual & Dimensional Check, Filter frame Material Test Certificate, Support Mesh, Metal Casing Material Test Certificate	TS/DRG/ REL STD/ IS 737	V
	Efficiency test, Pressure Drop Vs Flow, Sodium Flame test	IS 7613, BS 3928	W
1.3	**Temperature & Humidity Sensors**		
	Functional Test	TS/ DRG/ REL STD	V
1.4	**Splitters & Duct Damper, Fire Damper**		
	Visual & Dimensional Check, Movement of louver and damper blades, Electrical actuator for fire dampers	TS/DRG/ REL STD	V
1.5	**Plenum**		
	Mechanical & Chemical Properties of material	TS/DATASHEET/DRG/ REL STD	V
1.6	**Insulation Material**		
1.6.1	**Glass wool/ Expanded Polystyrene**		

	Visual & Dimensional Check, Chemical & Mechanical Properties, Thickness, Density	TS/DRG/ REL STD/IS 3069/ IS 4671	V
1.6.2	**Sheet/ Coils for cladding Aluminium Material**		
	Visual & Dimensional Check, Chemical & Mechanical Properties	TS/DRG/ REL STD	V
1.7	**Grills & Diffusers**		
	Visual & Dimensional Check, Functional test	TS/DRG/ REL STD	V
1.8	**Outside Air Louvers**		
	Visual & Dimensional Check, Chemical & Mechanical Properties	TS/DRG/ REL STD	V
1.9	**Piping Material: Pipes/ Pipe fittings/ flanges**		
	Visual & Dimensional Check, Chemical & Mechanical Properties	TS/DRG/ REL STD	V

LEGENDS	
TS: TECHNICAL SPECIFICATIONS	REL. STD.: RELEVENT STANDARD
V: VERIFICATION OF REPORTS/TCs	DRG: DRAWING
W: CUSTOMER HOLD POINT (CHP)	

NOTES	
1	Any test at any stage not covered in Quaility Assurance Test Requirement (QATR), but part of technical specification of contract, shall also be carried out by Contractor/ firm.
2	QATR shall be read in conjunction with General Quality Assurance Requirement given as part of Technical Specification
W/V	The final testing for exhaust fans shall be witness (CHP) for rating above 2500 CMH and TC Review for rating below 2500 CMH

Field Quality Assurance Test Requirements

	Project Name (MW): ARUN-III HEP (4X225 MW)	**Doc. No.:** QAI/A/F/EM/HVAC/01	**Rev. No.:** 02
	Item Description: HVAC System	**Issue Date:** 30.05.2017	**Pages.:** 1

Sr. No.	Component, Operation & Characteristics	Applicable Standard	Remark
1	2	3	4
1	**Receipt of Material & Storage**		
1.1	**Electric Fans, Motors, Filters, Air Ducts, Splitters Dampers, Plenums, Diffusers, Grills etc**		
	External conditions of equipment free from damage, Proper placement of equipment as per Instruction Manual, Ensure that no damage of rusting takes place during storage, Ensure that all delicate instruments are stored in protected area	TS/DRG/ REL STD	W*
2	**Pre Erection/ Erection Check**		
2.1	**Electric Fan**		
	System No./ Equipment No., Orientation/ Direction of rotation, Motor rating & IR test before erection, Impeller No, Fixing/ grouting of casing, Check for secureness. Tightness of all fixing bolts/ nuts, No load running of motor, Locking of impeller on motor, check for provision of accessories	TS/DRG/ REL STD	W*
2.2	**Filters**		
	Proper levelling, alignment & fixation	TS/DRG/ REL STD	W*
2.3	**Finished Air Ducts**		
	Visual check for surface defects, Final Dimensional check, Installation of ducts as per Drawing, Check for Tightness, Vibration and Noise due to turbulence, Fixing of support of ducts as per drawing	TS/DRG/ REL STD	W*
2.4	**Finshed Grills**		
	Visual check for surface defect, louver movement check, Proper levelling, alignment	TS/DRG/ REL STD	W*
2.5	**Finished Dampers & Spilters**		
	Visual check for surface defect, Final Dimensional check, Functional check, Proper levelling, alignment	TS/DRG/ REL STD	W*
2.6	**Panels**		
	Proper alignment, Leveling and location, Earthing continuity, Cable Glanding & termination	TS/DRG/ REL STD	W*
3	**Pre Commissioning Checks**		
3.1	**Electric Fan**		
	Noise & Vibration Check, IR Check, Free rotation check, Direction of rotation	TS/DRG/ REL STD	W*
3.2	**Panels**		
	IR test, Earthing, Paint shade & finish, Functional test	TS/DRG/ REL STD	W*
3.3	**Motorised Air Dampers**		
	Functional test, Dimensional check & visual check	TS/DRG/ REL STD	W*
3.4	**Test during Pre Commissioning**		
	Dielectric and insulation resistance on all electrical circuits	TS/DRG/ REL STD	W*
	Tests to verify electrical ratings	TS/DRG/ REL STD	W*
4	**Commissioning test**		
4.1	**Complete Ventilation and Air Conditioning System**		
	General Running Test	TS/DRG/ REL STD	W*
	Pressure Test or Leakage Test	TS/DRG/ REL STD	W*
	Checking of air velopcity at different locations	TS/DRG/ REL STD	W*
	Checking for abnormal noise and vibrations	TS/DRG/ REL STD	W*
	Capacity Rating Test	TS/DRG/ REL STD	W*
	Power Consumption Test	TS/DRG/ REL STD	W*
	Functional test of air conditioner in respect of temperatue and humidity	TS/DRG/ REL STD	W*
	Test to verify the dust holding capacity of air filters	TS/DRG/ REL STD	W*
5	**Performance Test**	TS	W*

LEGENDS

TS: TECHNICAL SPECIFICATIONS	REL. STD.: RELEVENT STANDARD
V: VERIFICATION OF REPORTS/TCs	DRG: DRAWING
W: CUSTOMER HOLD POINT	W*: WITNESS BY SAPDC/ MAIN CONTRACTOR

NOTES

1	Any test at any stage not covered in Quaility Assurance Test Requirement (QATR), but part of technical specification of contract, shall also be carried out by Contractor/ firm.
2	QATR shall be read in conjunction with General Quality Assurance Requirement given as part of Technical Specification
3	Responsibitiy for witnessing (W*) at site shall be decided mutually at the time of finalization of FQAP as per the criticality of test.

Sr. No	Vol. / Section & Clause No.	Original Tender Provision / Amendment- I Provisions	Amended Tender Provision
28.	Clause 7B.4.2 (2.), page no. 14-38 (Original TS Provision)	The valve disc shall be bi-plane (double disc) through flow type and designed to ensure smooth water flow, low head loss, and maximum cross sectional area for given valve size in open position and to with stand full differential pressure across the closed valve. The valve disc of biplane design will have two full discs to provide safe working conditions for replacement crew to replace both maintenance seals and service seals. Although surge shaft gates are envisaged to be provided, but same is to be decided subsequently. The dewatering of HRT is not envisaged for replacement of damaged seal, the contractor shall ensure that maintenance crew shall be able to work safely on the downstream side of the valve. The firm may also confirm that the valve shall not cause any abnormal vibration during full opening or during opening and closing operation or transmit fluttering and shall not cause much water leakage.	The valve disc shall be bi-plane (double disc) through flow type and designed to ensure smooth water flow, low head loss, and maximum cross sectional area for given valve size in open position and to with stand full differential pressure across the closed valve. The valve disc of biplane design will have two full discs to provide safe working conditions for replacement crew to replace both maintenance seals and service seals. Although surge shaft gates are envisaged to be provided, but same is to be decided subsequently. The dewatering of HRT is not envisaged for replacement of damaged seal, the contractor shall ensure that maintenance crew shall be able to work safely on the downstream side of the valve. The firm may also confirm that the valve shall not cause any abnormal vibration during full opening or during opening and closing operation or transmit fluttering and shall not cause much water leakage. In addition to above, bidder may also propose valve disc as single plane (single disc) meeting all the technical requirements specified in this section. Seals (service and maintenance) arran[illegible]er requirements shall be finalised du[illegible] of supply of single disc valve. Please refer Drawing no. PE-DG-437-571-11000-A002 under subsection 6 (tender drawings) of section II
29.	Clause 25.3.1, page no. 3-13 (Original TS Provision)	**Ventilation System of the Power House:** Ventilation system shall be designed so that outdoor air (50% of the quantity required) is taken through the cable tunnel from the fan room located at switchyard. The cable duct is divided into two parts , one for transformer hall cavern and other for power house. The exhaust air will be thrown out by means of exhaust ducts suitably places in Power house & transformer yard –MATs.	**Ventilation System of the Power House:** Ventilation system shall be designed so that outdoor air is taken through the cable tunnel / escape tunnel / ventilation duct from the fan room located at switchyard. The exhaust air will be thrown out by means of exhaust ducts suitably placed in Power house & transformer yard & through MATs. The tentative scheme of ventilation system shall be as per drg. no. SJVN/ED/Arun-III/EM-2017-11 Rev. Dec 2017. However detailed scheme shall b[illegible]alized during detailed engineering.
30.	Section-VI Tender Drawings	i. Power House Cooling Water System (Drg. No. SJVN/ED/ARUN-III/EM-2017-06) Rev. Oct 2017 (Amended Drawing in Amendment - I) ii. Ventilation System (Drg. No. SJVN/ED/ARUN-III/EM-2017-11) Rev. Jun 2017 (Original Tender Drawing)	i. Power House Cooling Water System (Drg. No. SJVN/ED/ARUN-III/EM-2017-06) Rev. Dec 2017 ii. Ventilation System (Drg. No. SJVN/ED/ARUN-III/EM-2017-11) Rev. Dec 2017

SECTION: I

SUB-SECTION: C2-B

CUSTOMER SPECIFICATION

(PROJECT SPECIFIC GENERAL REQUIREMENTS)

1.5. Intent of Specification

1.5.1 Intent of Specification

This specification is intended to cover the provision of ~~labour~~, tools, plants, materials and performance of work necessary for the design, engineering, manufacture, quality assurance, quality control, shop assembly, shop testing, packaging & delivery at site including insurance, ~~unloading, site storage and preservation, in plant transportation at site, erection / installation,~~ testing, supervision, ~~pre commissioning, successful commissioning,~~ performance and acceptance testing, handing over to Employer and warrantee for two (2) years of various components for Arun-III Hydro power project having four (4) units of 225 MW consisting of generator & its auxiliaries, Francis turbine & its auxiliaries, Station Auxiliaries and accessories and as specified herein.

1.5.1.1 Scope of the proposal shall cover following activities and services in respect of all the equipment and works specified in various sections of this specification:

i) Basic engineering of all equipment and equipment systems;

ii) Detailed design of all the equipment and equipment system(s)

iii) Providing engineering drawings, data, instruction manuals, as built drawings and other information for purchaser's review / approval / records.

iv) Compliance with statutory requirements and obtaining clearances from statutory authorities, wherever required.

viii) Complete manufacturing, quality assurance, quality control, shop assembly including shop testing.

ix) Packing and transportation from the manufacturer's works to the site including Insurance.

xii) Performance & acceptance testing after successful completion of initial operation.

xiii) Warranting equipment performance for a period of 24 months from the date of taking over or 18 months from the date of operational acceptance.

xiv) Supply of mandatory spares as per schedule

xv) Supply of any other equipment including special tools and tackles, commissioning spares and services required for satisfactory completion of the project and operation and maintenance of the same.

xvi) Training of purchaser's personnel nominated by the purchaser during erection, testing and commissioning, and for operation and maintenance.

xvii) Reconciliation with customs authorities, in case of imported equipments;

xviii) Satisfactory conclusion of the contract.

xix) All items and equipment though not specifically mentioned in the specification, but needed to complete the system to meet the intent of the specification shall be deemed to be included in the scope of the bidder.

It is not the intent to completely specify all details of design and construction, but only to lay down broad sizing and quality criteria for the major equipment and systems and it is expected that the equipments shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation up to the contractor's guarantee in a specified manner acceptable to the purchaser.

1.6 Standards

The design, manufacture and testing of the various equipment covered under this specification shall comply with the requirements of the latest edition of the relevant IEC/IS/IEEE/ISO standards only. Preference for latest IEC standards for particular equipment / system shall be governed over IEEE/ IS/ ISO standards.

The relevant abstract (in soft / hard copy) of all referred standards shall be provided free of cost during engineering stage for facilitating review/ approval of submitted drawing/documents.

Further rules, guide lines and standard laid down by International/ national agencies shall be applicable in this specification.

List of standards is attached at annexure C.

1.7 Logistics

The Contractor shall establish facilities i.e. office, wireless communication system, internet facilities for smooth and effective monitoring of ongoing activities at site.

1.8 Electrical Works

General Information:-

- Dimensions of Panel, Kiosk, Marshalling Box, Junction Box.
- Weight of above
- Lifting arrangement (All arrangement shall be made through hooks only)
- Baseframe (Suitable for anchoring through anchor bolts in embedded foundation channel)
- Pushbuttons, Indicating lamps, indicating instruments, recording instruments shall be from same supplier throughout the EM Package.
- Numerical relays and Electromagnetic relays shall be from same supplier respectively throughout the EM Package.

1.8.1 Power Supplies

1.8.1.1 AC power

Three-phase system with grounded neutral for feeding three-phase and one-phase consumers (connected between phase and neutral), 415/240V ± 10% and 50Hz ,-5% to +3 %. All motors and other electrical apparatus should be designed to work continuously under,-5% to +3 % frequency variation and ±10% voltage variation.

1.8.1.2 DC power

DC Systems, ungrounded, with earth fault detection 220V plus (+) 10% and minus (-) 20% for the supply of main control circuits for high and medium voltage switchgear, protection circuits and to other larger essentials loads.

Other voltage systems eventually needed, shall be generated from the above systems by means of dc/dc converters, inverters etc.

1.8.2 IP requirement

IP requirement shall be based on applicable National/ international standards and the same shall be finalized during detail engineering. However the minimum requirement shall be as under or as specified in the particular technical specifications of various componenets:

- The cubicles and enclosures shall be of protection class IP 42 or higher according to their location.
- For outside installation and area which are humid, corrosive, and prone to dripping and/ or spray of water, the protection class of cubicles shall be IP 65.
- Cubicles housing electronic cards/modules such as of unit control boards/local control boards, digital governors, static excitation equipments shall be of protection class of IP 52.

1.8.3 Cabling & wiring

Wiring within cubicles and equipment enclosures shall conform to requirements of this section unless otherwise specified. Control wiring shall be single / stranded copper subjected to prior approval by purchaser during detailed engineering and shall not be smaller than 2.5 Sq. mm, except as otherwise agreed by the purchaser.

All Distribution Boards, Control & Protection panels, Motor Control control panels etc. shall be supplied completely wired internally up to the terminal blocks ready to receive purchaser control cable.

All inter cubicle and inter panel wiring and connections between panels of same Distribution Board, Control & Protection panels, Motor Control panels including all bus wiring for AC and DC supplies shall be provided by the tenderer.

Larger size wiring shall be used where needed for the current carrying capacity requirements.

Cables shall have at least 1000 V PVC insulation except for 220V DC and telemetering or communication system equipment for which 650V and 300 V ratings respectively are acceptable.

For current and potential transformer secondary circuits the minimum cross section of the conductors shall not be less than 4.0 Sq. mm.

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 wire ways accessible from the front door.

Engraved core identification ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire.

Each cubical 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.

1.8.4 Power outlets

Power outlet for utilities such as electric drills, welding equipment etc., shall be provided in all floors of the powerhouse to enable repair and maintenance works to be done locally/ in-situ.

1.8.5 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.

Terminal blocks shall be 1100V grade and have continuous rating to carry the maximum expected current on the terminals.

Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short circuiting and earthing facilities.

The terminal shall be such that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally.

The conducting part in contact with cable shall preferably be tinned or silver plated. The terminal blocks shall be of extensible design. The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.

The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.

Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.

All circuits except CT/ PT circuits	Minimum of two of 2.5 sq. mm copper flexible
All CT/ PT circuits	Minimum of 2 nos. of 6 sq. mm copper flexible

The arrangements shall be made in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.

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

At least 20% spare terminals shall be provided on ach panel / cubicle / box and these spare terminals shall be uniformly distributed on all terminals rows.

There shall be minimum clearance of 250 mm between the first / bottom row of terminal block and the associated cable gland plate. Also, the clearance between two rows of terminal blocks shall be a minimum of 150 mm.

1.8.6 Protection requirement

For short circuit and overload protection of power and control circuits, air circuit breakers, moulded case circuit breakers or MCBs shall be used. Outlets from AC (and DC) distribution panels are protected in their respective panels.

1.8.7 Switches, Lamps & Instruments

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 “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 co-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.

Control and Selector switches

The switches and push buttons shall be provided with ample contact ratings, suitable cam or block arrangements necessary for the control functions on 230 V AC or 220 V DC circuits. The control switches used in mimic diagrams shall be of discrepancy type with built in lamp indication.

Control and Selector switches shall be rotary type with escutcheon plates clearly marked to show the function and positions. The switches shall be of sturdy construction suitable for mounting on panel front.

Switches with shrouding of live parts and sealing of contacts against dust ingress shall be provided.

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 (2) contacts closing in close position, and two (2) contacts closing in trip position unless specified otherwise.

Ammeter and voltmeter selector switches shall have four stay out position 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.

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 230V AC and 0.5A 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

Indicating and signaling lamps

Each indicating and signaling lamp shall have a removable cap, which can be

inscribed with wording and shall not be affected with the heat of the lamp.

Indicating lamps are preferably of LED type & low watt consumption and shall be replaceable from the front of the panel. The indicating and signaling lamps shall be of the same size and type.

Lamps shall be provided with series resistors, preferably built-in the lamps assembly. The lamps shall have escutcheon plates marked with its function, wherever necessary.

Lamps shall have translucent lamp-covers of the following colours, as warranted by the application.

Red	:	ACB's/MCCB's close
Green	:	ACB's/MCCB's open
White	:	Auto trip
Amber	:	For all healthy conditions e.g. control supply
Voilet	:	Circuit breaker spring charged
Blue	:	For all alarm conditions (e.g. overload) Also for "SERVICE" & "TEST" positions indicators

Indication lamps should be located just above the associated push buttons/control switches. All indicating lamps shall be suitable for continuous operation at 90% to 110% of their rated voltage.

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 insulated fuse pulling handles shall be supplied with each switchgear.

HRC-Fuse rating shall be chosen by the tenderer depending upon the circuit requirements.

Indicating instruments and Meters

Instruments mounted on panels, shall be of the semi flush type back connected, matching pattern, shape, and of approved finish to present neat and fitting appearance consistent with functional requirements Mechanical quantity measuring instruments which are directly mounted on equipment shall have circular dials and shall be properly supported and guarded against accidental injury/breakage. These shall be placed in convenient locations.

The instruments shall accurately measure and indicate the quantity under all conditions of operation with minimum instrument errors. Changes in ambient temperature within the range prevailing at site shall not affect the accuracy

Contact making instruments shall have contacts suitable for 240 V AC or 220 V DC circuits.

The reading scales on the dials shall be in metric units only and range shall be such that the normal operating values of the quantities are indicated in the middle 3rd of the scale. The dials pointer etc. shall be designed to facilitate accurate reading by minimizing parallax and glare from instrument window and by providing clear bold dial markings. The size of dial and length of the scales of the indicating instruments shall be large enough to suit the requirements. The scale plates of panel mounted indicating instruments shall have a permanent white mat finish with black graduations and the pointer shall also be of the black colour. Instruments mounted on panels shall be of flush type and shall be back connected. All instruments on a switchgear panel shall be of matching pattern, shape and finish so as to present a pleasing appearance consistent with the functional requirements.

All instruments shall conform to relevant International or national applicable standards. These shall be subjected to tests prior to dispatch. The instruments shall be shock, vibration and moisture proof. The electrical instruments shall withstand dielectric test of 2000 V RMS to ground for one (1) minute as per standards.

The coils of electrical instruments shall be designed for continuous operation at 110% of the full load current at instrument potential. The coil rating of the measuring instruments shall be coordinated with those of the associated instrument transformers (i.e. CTs, PTs, etc.) by the supplier. The VA burden of the instruments shall be as low as possible. The meters shall be of the first grade in respect of accuracy

classification.

Energy meter shall be suitable for 3-phase, 4-wire unbalanced system and shall comply generally with the relevant standard. All instruments shall be tested in accordance with the requirements of relevant standards.

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 secondary of potential transformers and from secondary of current transformers, with transformer ratios and connections indicated on the contract drawings.

The meters shall be provided with primary-rated, direct reading registers, with five or more 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 isolation according to IEC Publication 60521. The tolerance ambient temperature range of the meters shall be 0 to 45 degrees C.

The protection class of the Wh meters shall be 0.2 and the VArh meters 0.2 according to IEC Publication 60687.

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 an output signal of 4-20 mA, filtered DC.

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 elements, three-phase.

Accuracy class of the transducers shall be 0.5 or better.

Measuring transformers

All current and voltage transformers shall be completely encapsulated cast resin insulated type suitable for continuous operation at the temperature prevailing inside the switchgear enclosure, when the distribution board is operating at its rated condition and the outside ambient temperature is 40 deg.C.

All instrument transformers shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit and momentary current ratings of the associated switchgear.
All instrument transformer shall have clear indelible polarity markings. All secondary terminals shall be wired to a separate terminal on an accessible terminal block where star-point formation and earthing shall be done.

All VTs shall have readily accessible HRC current limiting fuses on both primary and secondary sides.The class of insulation should be E or better.

The parameter & rating of CTs & PTs are minimum requirement & tentative only. Contactor shall submit the calculations for selection of CT/PT for approval to purchaser.

Potential transformer secondary windings shall be rated 110 / V3 V

Current transformer secondary windings shall have a rated current of 1A / 5A.

1.8.8 Nameplates and Labels

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.

The module identification plate shall clearly give the feeder number and feeder designation wherever applicable. For single front switchboards, similar panel and board identification labels shall be provided at the rear also.

All name plates shall be of non rusting metal or 3-ply lamicoid with white engraved lettering on black back-ground, inscriptions and lettering sizes shall be as per their standard practice. Suitable plastic sticker labels shall be provided for easy identification of all equipments, 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.

1.8.9 Motors

All electric motors for driving various equipments shall conform to relevant standards viz. IEC, BS or IS as applicable.

The motor rating, torque characteristics, speed etc. shall be selected to suit the duty requirements.

Type of starter for motors shall be duly approved by the purchaser during detailed engineering. The detailed design calculation for selection of type of starters is to be submitted for approval. The priority for type of starters shall be in the following order:

1. Variable frequency drive
2. Soft starter
3. Star delta/ auto –transformer
4. Direct on-line starter

The enclosure of each motor shall be of the type best suited for the service conditions of the motor

The motor insulation shall be resistant to moisture, oil or oil vapor and the motors in general shall be so designed as to suit the tropical climate. Varnished cambric or glass insulation class F shall be used for connection from the windings to the terminals.

The terminal box shall be closed conduit box type conveniently located, and shall have means for terminating the external wiring for outdoor use. The motor terminals shall be of the stud type totally enclosed. Eye bolts or lugs shall be provided for lifting.

Space heaters to avoid condensation shall also be provided.

Special type of motors, not adequately covered by these specifications, shall be offered for any special application, but these shall be subject to the approval of purchaser.

1.8.12 Space heaters

Space heater shall be provided in the Distribution Boards, Control & Protection panels, Motor Control panels etc. The space heaters shall be suitable for continuous operation on 240V AC, 50 HZ single phase supply, and shall be automatically controlled by thermostats. Necessary isolating switches and fuses shall also be provided.

1.8.13 Auxiliary relay, contacts and devices

All relays and timers in protective circuits shall be flush mounted on panel front with connections from the inside. They shall have transparent dust tight covers removable from the front. All protective relays shall have a draw out construction for easy replacement from the front. They shall either have built-in test facilities, or shall be provided with necessary test blocks and test switches located immediately below each relay. The auxiliary relays and timers may be furnished in non-draw out cases.

All AC auxiliary relays shall be suitable for operation with VTs and CTs secondaries.

DC auxiliary relays shall be designed for 220V DC unless otherwise specified and shall operate satisfactorily between 80% and 110% of the rated voltage. Relays shall have adequate thermal capacity for continuous operation in circuits in which they are used.

All protective relays and timers shall have at least two potentially free output contacts. Relays shall have contacts as required for protection schemes. Contacts of relays and timers shall be silver faced and shall have a spring action. Adequate number of terminals shall be available on the relay cases for applicable relaying schemes.

Suitable number of auxiliary contacts or auxiliary relays shall be provided with each VCB's / ACB's for indication, remote indication, annunciation and automatic

changeover and interlocking scheme.

All protective relays, auxiliary relays and timers shall be provided with hand reset operation indicators (flag) for analyzing the cause of operation.

1.9. Mechanical Works

1.9.1 Materials selection

Materials shall be new and of high-grade quality, suitable for the purpose, free from defects and imperfections, and of the classifications and grade listed herein, or their equivalents subject to acceptance by the Owner. Material specifications, including grade or class shall be shown on the appropriate Contractor's detail drawings submitted for review. Materials not listed herein but equivalent in their basic properties may be used subject to the Owner's review of their acceptability.

S. No.	Material	Specification
1	Carbon-steel castings	DIN-1681, Steel castings for general use: quality specifications, grade GS-45 / GS-60 ASTM A27 Grade 65-35 GS-45/ GS-60
2	Iron castings	DIN-1691, Gray iron castings for general use: quality specifications, grade GG-22 and GG-26.
3	Corrosion-resistant steel castings	DIN-17445, Stainless quality specifications type G-X 8 Cr Ni 13 (1.4008) and G-X 6 Cr Ni 18 9 (1.4308), For runners EN Grade:X4 CrNiMo 16-5-1 (Number 1.4418), EN Grade GX4 CrNIMo 16-5-1 (Number 1.4405)
4	Corrosion-resistant steel plate, bars, pipes	DIN-17440, Stainless steel: quality specifications: X 2 Cr Ni Mo 1810(1.4404) X2 Cr Ni Ti 1810 (1.4541) X10 Cr Ni Mo Ti 1810(1.4571) X22 Cr Ni 17 (1. 4057) DIN 2462 Seamless stainless steel pipes.
5	Hardened	DIN-17440, Stainless steel: quality

	corrosion resistant steel	specifications X 10 Cr 13 (1.4006) hardened condition.
6	Carbon steel forging (turbine/ generator shaft, important parts)	DIN-17200, Quenched and tempered steels, Ck 35/Ck 45 ASTM A 668 Grade D.
7	Carbon steel forging (pipe flanges, fittings etc.)	DIN-17100, Steels for general structural purposes: quality specifications grade RSt 37-2 / St 52-3.
8	Carbon steel plates (for low-stressed parts and piping)	DIN-17100, Steels for general structural purposes: quality specifications, grade St 37-2 (1.0116). ASTM A 283 Grade B.
9	Carbon steel plates (for important stress carrying parts)	DIN-17100, Steels for general structural purposes: quality specifications, grade ST52-3 (1.0841), normalized. ASTM A 287 Grade B.
10	Intermediate and high strength steels (for important stress carrying parts and structures under hydraulic pressure)	DIN-17102, weldable fine grain steels, normalized, grades TTStE. ASTM 514.
11	Bronze casting	DIN-1705, Bronze castings: quality specifications.
12	Bronze (for bolting)	DIN-17672, Rod, bar of wrought copper and copper alloys: mech. Properties non-leaded copper-zinc alloys with min. U.T.S of 370 N/mm^2
13	Copper Tube	DIN-1754, Tube of copper: seamless

		drawn, material type SFCu F30 according to DIN-17671.
14	Steel pipes	DIN-2448, Seamless steel tubes: dimensions and weights. DIN-2458, Welded steel tubes dimensions and weights. ASTM A53, API 5L , ASTM A 106
15	Steel pipe flanges and flanged fittings	Applicable DIN-standards for weld neck and slip-on flanges.
16	Bolts and fasteners	DIN-13, ISO metric screw threads from 1 to 300 mm diameter: selection for diameters and pitches. DIN-267, Fasteners and similar parts: technical specifications complete. Other applicable DIN standards.

All materials or parts used in the equipment shall be tested in conformity with the standards specified herein or other applicable standards approved by the Owner.

Certified Material Test Report for the materials of major/important components and/or materials for special application shall be furnished to the Owner as soon as possible after the tests are performed. Each test certificate shall identify the components for which the materials are used and shall contain all information necessary to verify compliance with the Contract Documents.

1.9.2 Welding & NDT

1.9.2.1 Preparation of base material

Members to be joined by welding may be cut to shape and size by mechanical means such as shearing, machining, grinding, or by gas or arc cutting, to suit the conditions. Edges shall be shaped according to ASME requirements. Design of welded joints and selection of weld filler metal shall be in accordance with approved standards and shall allow thorough penetration and good fusion of the weld with the base metal. The edges of surfaces to be welded shall be sound metal free of visible defects such as laminations or defects caused by cutting operation at least 30 mm back from the edge of the weld, and free from rust, oil, grease, and other foreign matter.

1.9.2.2 WPS & WPQR

The establishment of welding procedures, welder's qualifications shall conform to the requirements of the ASME Boiler and Pressure Vessel Code Section VIII and IX. The approved copy of the WPS & WPQR in accordance with the ASME requirements shall be submitted to the purchaser for review and record..

1.9.2.3 Welded construction and stress relieving

Weld-fabricated pressure-containing parts shall be designed, fabricated, stress relieved inspected and tested, unless otherwise specified, in accordance with ASME-VIII.

1.9.2.4 Non-Destructive Testing

Examination of Welds

Combination of NDT techniques i.e RT, UT, MPI, DPT shall be used to ensure the soundness of the weldments depending upon the requirement and geometry of the welds in accordance with the provisions of the ASME. The acceptance criteria for various NDT, NDT personnel shall be as per ASME-V/VIII/IX.

The Contractor's Drawings shall indicate the type and extent of non-destructive examination as it applies to each component or weld. Distinct notations shall be used on the drawings to differentiate shop and site welding.

Examination of Casting

All cast material including Turbine Runner etc. shall be given complete non-destructive examination including radiographic examination of the most critical areas. The Contractor shall submit Quality Sheets (Specification for inspection of steel casting for hydraulic machines), with his recommendation and specify special precautions to be taken of the casting of the turbine runner and other important casting components. The Quality Sheets submitted shall define the area and extent of the various non-destructive examinations to be performed on castings. The examination of castings shall be in accordance with the provisions of CCH-70.

Examination of Forging

Shafts, stems and coupling bolts made of forgings shall be given complete ultrasonic examination and other applicable non-destructive test, to determine that they are sound. Non-destructive examination of other forgings shall be in accordance with accepted good practice to assure their soundness. The structure of forgings shall be homogeneous and free from excessive non-metallic inclusions. An excessive concentration of impurities or separation of alloying elements at critical points in a forging will be a cause for its rejection.

1.9.2.5 Field welding

Filler material required for field-welded joints shall be furnished by the Contractor. The Contractor shall perform all welding work at site in accordance with the applicable WPS. Only qualified welders shall be used for undertaking welding as per the applicable WPS.NDT shall be performed as per the approved drawings.

Preparation for field welding

All cutting, chamfering, and other shaping of metals necessary for the field connection shall be done as far as possible in the shop. Adequate temporary bolted field connections shall be provided to hold the assemblies rigidly and in proper alignment during shop and field assembly.

To ensure proper alignment during field erection, a minimum of two dowels shall be provided for each field connection between subassemblies. The holes shall be drilled and the dowels fitted at shop assembly after the subassemblies have been satisfactorily aligned. All stipulations for welding, structural work and other, shall be applied to fieldwork as well as to shop work, except where otherwise stated.

1.9.3 Painting

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 required number of coats. The Contractor shall perform all painting work in the shop, before shipment, followed by a final coat of paint at site after installation as per the standard procedure.

All materials, supplies, and articles furnished shall be the standard products of recognized reputable manufacturers.

Colour schedule of equipment supplied shall be finalized during detailed design stage.

1.9.4 Galvanization

All materials to be galvanized shall be of the full dimensions shown or specified and all punching, cutting, drilling, screw tapping and the removal of burrs shall be completed before the galvanizing process commences. All galvanizing shall be done by the hot dip process with smelter, not less than ninety eight percent (98%) of which must be pure zinc. No alternative process shall be used without the approval of the purchaser. No components shall be galvanized which are likely to come into subsequent contact with oil. Bolts shall be completely galvanized

including the threads, but the threads shall be left uncoated in the case of nuts. The zinc coating shall be uniform, clean, smooth and as free from spangle as possible. In the case of component parts the zinc coating shall weigh not less than 0.6 kg/m2 over the area covered and be not less than 0.09mm in thickness. All galvanizing shall comply with the requirements of the relevant ASTM standards/Indian Standards. All galvanized parts shall be protected from injury to the zinc coating due to differential aeration and abrasion during the period of transit, storage and erection. Damaged areas of the coating shall be touched up with an approved zinc dust paint or other approved flake metallic compound.

1.9.5 Pumps

All pumps forming part of the generating units and other plant and equipment shall be of high performance requisite type (viz. centrifugal, rotary etc.) and rating, of reputed make, and shall be directly coupled to their driving motors. The pumps shall be of self priming type and with proper sealing systems and protection.

The materials of construction of pumps in general shall suit the service conditions. The materials of construction of the pumps handling water, such as drainage & dewatering pumps, turbine top cover drainage pumps etc. shall be resistant to abrasive effects of silt in such water. The pumps shall operate quietly without undue noise and vibration in their full operating range of head and flow. They shall be easy to maintain.

1.9.6 Embedded parts, Anchor Bolts and Fasteners

All embedded anchor bolts, rods, pipes, welding plates and support plates shall be provided by contractor. Anchor bolts shall consist of a threaded steel rod installed inside a pipe sleeve to provide lateral adjustment after the sleeve is embedded. 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.

1.9.7 Pipes, valves, Bends, Flanges

Connections to penstock shall be kept to the minimum. All penstock and tail water connections shall be double valve. The penstock and tail water connections shall be embedded wherever possible. The material used for pipe connections to the penstock and draft tube shall have proven ductility with Charpy impact values of not less than 35 J at – 20 ºC.

Piping, tubing and pipeline materials and equipment forming part of the generating units & other plant and equipment shall be of appropriate materials, size and type to suit the function and shall conform to the relevant & applicable standards. The piping shall be complete with requisite valves, automatic valves, drain plugs or cocks, test plugs or cocks, sight flow indicators, flow meters, flow relays, thermometers, pressure switches and other necessary instrumentation and devices to provide desired function and operation with ease and flexibility and easy maintenance. Valves to be kept normally locked in open or closed position shall be provided with suitable locking arrangement.

Piping, tubing and pipeline materials and equipment forming part of the generating units & other plant and equipment shall be of appropriate materials, size and type to suit the function and shall conform to the relevant & applicable standards. The piping shall be complete with requisite valves, automatic valves, drain plugs or cocks, test plugs or cocks, sight flow indicators, flow meters, flow relays, thermometers, pressure switches and other necessary instrumentation and devices to provide desired function and operation with ease and flexibility and easy maintenance. Valves to be kept normally locked in open or closed position shall be provided with suitable locking arrangement wherever necessary.

Suitable support system for the piping and valves comprising hangers, brackets, hooks, pedestal etc. shall be designed and provided.

Pipelines may undergo expansion or contraction under service conditions and adequate allowance shall be made for the same.
Spare branch connections provided for any future extension of piping shall be provided with isolating valves whose open ends shall be protected with blank flanges or caps as the case may be. Dismantling pieces with flanges, or unions shall be provided for ease of disconnection of piping for servicing.

Connections with equipment or apparatus may be by flexible pipe to enable easy connection and disconnection.

All items of pipe lines shall be thoroughly cleaned individually before installation and after erection, in stages, on completion, using proper method. It shall be ensured that they are perfectly clean inside before putting into use.

The layout shall be such that valves, gauges/indicating instruments, are conveniently located to enable easy access for operation and reading. Piping shall be installed in trenches/ducts/openings along floors, walls or ceiling as necessary. The layout shall be such as would not interfere with movement of Operation and Maintenance (O&M) personnel.

Lagging of piping runs, wherever necessary e.g. Cooling Water System, Drainage Dewatering System, Flood Protection System etc. shall be provided.

The support system shall be rigid enough to prevent piping vibration when in operation.

For ready identification of different piping system functions, each piping system shall be painted near all operating points and also on each separate section, with two bands of colour, the wide band twice the width of the narrow one. An arrow showing the direction of flow shall also be marked. Generally, the narrow band shall be in the direction of flow. The colour coding for the ground colour, the wide band and the narrow band on different pipes shall be as recommended in Indian or International standards.

All operating valves on a piping shall be painted with the colour mentioned above. Each valve shall have, suitably fitted to it, a name plate indicating the function of the valve.

The gaskets shall be of requisite material and thickness to suit service conditions.

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

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

Rust Prevention and Protection during Transit:-

Bright steel parts including all machined surfaces shall be given a thick coat of tar or tallow or any other approved rust resisting paint in plain colour to prevent rusting during shipment and transport.

1.10. Civil Works

Civil foundations for equipment of the generating units and other plant and equipment will be prepared by the Purchaser in accordance with the basic design data to be supplied by the Contractor.

The Contractor shall provide design for foundations and install the concrete inserts/embedment; support steels and/or components for foundation /supports purpose, shall do any chipping / leveling works, denting / painting etc.

1.14 Erection, Testing, Commissioning and performance of Guarantee Tests

1.14.1 Testing and inspection

Materials used for construction of major & important sub-assemblies shall be thoroughly shop tested and inspected by the Contractor at his own expense prior to dispatch. Shop test shall comprise of routine test & type tests.

The shop tests and inspections shall be as spelt out in individual equipment specifications as dealt in succeeding sections but shall not be limited to the same. Any other tests and inspection not specifically listed but are otherwise considered essential and advisable shall also be conducted.

The Bidders shall furnish schedule of the shop tests and inspections on materials and equipment.

Important tests/inspections shall be subject to witness by the purchaser for which the Contractor shall give sufficient advance notice. In case purchaser is unable to witness shop tests/inspections, the Contractor shall be so intimated and the tests/inspections may then be carried out in the absence of the Purchaser.

Equipment on which tests and inspections have been duly witnessed and approved by the Purchaser may be dispatched by the Contractor.

Equipment on which tests and inspections have not been witnessed by the purchaser shall be dispatched only after the shop tests and inspection Certificates have been approved by the Purchaser.

Pressure Tests

Unless specifically mentioned otherwise 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 design pressure of the respective equipment, vessel or tank.

The test pressure shall be applied for appropriate duration according to standards without showing leaks or drop in pressure.

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.

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.

1.14.2 ~~Erection, commissioning~~ & field tests

The Contractor has to do all the work related to assembly, ~~erection,~~ testing and ~~commissioning~~ complete in all respects. All necessary tools, plants, labour, materials including consumables for performing installation, testing and pre-commissioning shall be provided by the Contractor.

The Contractor shall submit the necessary data/information, layout and foundation/support drawings well in advance.

The Contractor shall provide and install the concrete inserts/embedment, support steels and/or components for foundation/supports purpose as per approved erection drawings and coordinate the activities with civil contractors to keep his activities in synchronism with civil work. All installation for foundation shall be verified and accepted by the Engineer.

The Contractor shall use anchor fasteners for installation of piping, fixtures, mountings, conduits, cabling, panels etc. Minor Chipping of concrete is permitted. However, taking support from reinforcement bars shall not be allowed.

1.14.3 Installation procedure

The Contractor shall submit six copies of all detailed programs and the procedures to be adopted for erection / installation, testing and commissioning well in advance, before start of erection activities/ installation.
The installation procedure shall also have a section "site quality assurance plan" containing erection data sheets / site protocols for various components. These sheets should specify site measurements/ inspections required to be made for ensuring proper installation.

1.14.4 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 Engineer 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 by either 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 and appropriate intermediate locations as per Standard.

1.14.5 Field inspection

The Contractor shall permit Engineer to perform inspections of the assembly which will include a complete verification of the assembly of all parts as to their levels, clearances, pertinent fits, alignments and quality of workmanship. The field supervisor of the Contractor shall provide Engineer with three (3) copies of all the clearances, tolerances and data of all pertinent fits, alignments and levels, so that the latter may repeat the Contractor's measurement, if desired.

Unless otherwise specified, any rejection based on the inspection will be reported to

Contractor within fifteen (15) days.

1.14.6 Field tests

All field tests including tests during installation, pre-commissioning, commissioning, performance and field acceptance tests shall be conducted by the Contractor, in the presence of representative of the Employer. Procedure to be adopted for conducting these tests shall be submitted well in advance, before start of relevant testing, for approval of the Employer.

The equipment / system shall be deemed to be commissioned and ready for trial run only after successful operation for a test service period specified in sub clause "Performance Testing". In the event of any failure this period shall be repeated for any number of times till the successful operation as described above is achieved.

All test equipment and instruments shall be furnished by the Contractor and will remain the Contractor's property after the fulfillment of all field tests.

Any defects or leaks disclosed in the tests shall be duly mended/ repaired to meet the desired function and retested

All necessary materials and labour for performing all the above tests shall be provided by the Contractor.

The Contractor shall prepare written test certificates in a form agreed upon by the Contractor and Employer of all tests results and hand them over to the Employer in due time.

The design, location and approval tests of anchoring rings for the fixing of lifting apparatus necessary for assembly and dismantling of equipment and plant accessories shall be the responsibility of the Contractor.

1.14.7 Taking over of facilities

"Taking over" means that the Facilities (or a specific part thereof where specified) have been completed operationally and structurally and put in a tight and clean condition, and that all work in respect of pre-commissioning of the Facilities or such specific part thereof has been completed and commissioning has been attained as per Technical Specifications. The contractor shall make formal request for taking over the facility to the EIC.

1.14.8 Operation acceptance

The operational acceptance by the Employer of the Facilities (or any part of the Facilities where the Contract provides for acceptance of the Facilities in parts), which certifies the Contractor's fulfillment of the Contract in respect of Functional Guarantees of the

Facilities (or the relevant part thereof) in accordance with the provisions of GCC / SCC.

1.15. Consumables, oils and Lubricant

The Contractor shall deliver to the Owner all equipment complete with initial fill of fluids, grease or lubricants, transformer oil, Nitrogen, SF6 gas and other used gases in non returnable drums / containers and replace any quantity used up or lost during installation and testing.

The oil used for the lubrication and oil pressure systems for the turbine, governor, shutoff valve and generator shall be preferably of the same type.

Supply

The Contractor shall furnish the following:

(i) All oil for initial filling of all equipment supplied, plus additional oil equivalent to the first filling requirement of one unit.

(ii) Grease if required for initial filling of all of the equipment, plus 10% additional.

(iii) Gases for initial filling of all equipment supplied, plus 10 % additional quantity.

(iv) Flushing fluids to flush and clean all systems.

1.16. Type tests:

Type tests have been divided into following two categories:

(a) Category-I

The contractor shall carry out type tests listed under Category -I for the respective equipment. The charges for each of these type tests shall be indicated separatelyin the respective price schedules and the same shall be considered for the evaluation of the bids. The owner reserves the right to waive conducting of any or all of the specified type tests on submission of type test certificates from Govt. approved labs/ accredited laboratories conducted on similar equipment during last five (5) years from the date of bid opening, in which case the type test charges shall not be payable for the type tests which are waived. The type test charges shall be paid only for the test(s) actually conducted successfully under this contract.

(b) Category-II

The contractor shall only submit the certificates from Govt. approved labs/ accredited laboratories of the type tests listed under Category -II for the respective equipment which

should have been carried out within last five (5) years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. In case the contractor is not able to submit report of the type test(s) conducted within last five years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct the test without any financial implication to purchaser.

1.17. Interface Management

The Bidder shall ensure the functional and physical compatibility of supply at each physical interface among various Sub-bidders/ Manufacturers/ Vendors / other third party interface such as Civil, Hydro Mechanical etc. in order to ensure efficient, reliable and safe operation of the whole system/ Scheme.

- List of critical Interfaces:

1. Turbine shaft & Generator DE shaft
2. Bus Duct & Generator Phase Terminals
3. Bus Duct & Generator Transformer
4. GT & GIS
5. ACSR conductor & GIS SF6 to Air Bushing
6. MIV Dismantling Pipe to Spiral Inlet
7. MIV Inlet Pipe to Penstock
8. PPV inlet/outlet pipes to Penstock
9. Pot Head Yard Gantry to incoming/outgoing towers

The Bidder shall ensure co-ordination among various sub-bidders, to verify the continuity and the coherence between themselves. The Bidder shall also resolve all interfacing requirements among various sub-bidders for execution of the work as per scope of contract. Engineer-in-Charge shall provide necessary help for such co-ordinations with different sub-bidders (if chosen by Owner including penstock contractor).

The contractor shall provide compliance certification of interface management at design / engineering level of the concerned interface unit while submitting drawing / document of above interface activities.

1.19. Submission of Drawings, Documents, Manual, software, Calculations, Safety Margin Details etc.

All drawings and documents shall be submitted to purchaser in hard form as well as in editable soft form. Bidder shall submit Ten (10) number hard copies of the documents & drawings to purchaser for reference / review / approval. A comprehensive list of all such drawings/documents planned to be submitted for reference/approval shall be provided beforehand to the purchaser.

1.19.1 Design memorandum

The Bidder shall prepare and submit to purchaser a "Design Memorandum" of the proposed equipment/ system for each section fulfilling the contract specification/ requirement for approval prior to submission of drawings and documents. The memorandum shall include the design philosophy, methodology, system description, input parameters for design, standard and codes, design and selection criteria, equipment data, material specification, major technical features, basic arrangement/ layout etc.

1.19.2 Plant Designation System

The Bidder shall submit the plant designation system such as KKS, RDS-PP etc. to be followed within six (6) months from the date of Letter of award.

1.19.3 Drawings

Loading drawings

For all larger pieces of Works which, due to their dimensions and/or weight and transport limitations, will require special means for their transportation, the Contractor shall submit binding loading drawings indicating dimensions, weights, etc., of the respective pieces of Works and the necessary trailer for its transportation to the site.

Foundation drawings

If a piece of works requires its own foundation or needs a special area for installation, the contractor shall submit drawings indicating all pertinent dimensions, static and dynamic loads, etc. They shall include all essential details required for proper design and construction of the foundations and/or buildings.

In addition, they shall include openings, sleeves, slopes and the arrangement of any supporting structure, i.e. base-frames or other steel constructions for permanent fixing or erection purposes.

If conduits are to be installed in the foundations, the relevant information such as diameter, length, and purpose shall be indicated on the drawings.

Arrangement drawings

All arrangement drawings shall be drawn to scale. The General Arrangement Drawings shall show the physical arrangement of Works (constructions, machines, complete switchgears, control panels, instrument cubicles, etc.), civil constructions (buildings, rooms, foundations, ducts, etc.) and reserved areas (for pipes, cables, lines, etc.) in relation to each other and to agreed co-ordinates and boundaries. Such drawings shall be prepared for the whole plot, for separate plots and for each building (building, hall, room, ducts and trenches, etc.).

Outline drawings

The Outline Drawing shall show all elements and the main dimensions of individual components where necessary in plan view, cross-section, side and top views. If reasonably possible such dimensions can be shown on Arrangement Drawings.

Design drawings

The Design Drawings shall include the shop drawings, assembly drawings, erection drawings, piping diagrams and piping arrangement drawings, etc., showing the dimensions, design and data of all constructions, apparatus and Works to be furnished under this Contract. The drawings shall - where applicable - substantially conform to the Contract Drawings and shall show:

- 3-D Assembly drawings for major components in hard and soft form.
- Details of manufacturing and treatment of major single work pieces specially manufactured for this Contract
- Assembly of the Works in plan and elevation with main dimensions

- Sub-assembly of the principal components of the Works with overall dimensions, adjustment and clearance tolerances, numbers of corresponding detail drawings
- Sub-assemblies in which the Contractor proposes to ship the Works
- All necessary details of the parts connecting to the Works supplied by others
- Location and sizes of auxiliary connections for oil, grease, water, air, electrical power etc.
- Location and size of the instruments and accessories provided
- Methods of lubrication and sealing
- Instructions for heat treatment, pressure tests, surface preparation and anti-corrosive protection
- Full details of parts for which adjustment is provided or which are subject to wear
- Method and sequence of installation, field joints, erection and lifting devices, jacks, grout plugs, anchoring details, etc., if not shown on foundation drawings.

Installation drawings

The construction, mechanical, electrical and I & C Installation Drawings shall provide detailed information on the disposition of the various items of a system (e.g. lighting fixtures, socket outlets, connection boxes, transmitters, actuators, loudspeakers, telephones, pipes, valves, pumps, compressors, etc.) and of the piping and wiring respectively included in the installation or assembly. They shall be based on dimension drawings of cubicles, rooms, buildings or areas containing the Works.

1.19.4 Diagrams

Single-line diagrams

This is a simplified diagram of the essential electrical Works and their interconnections. Each circuit shall be represented by a single line only. It shall contain all required technical information of the Works represented, e.g. voltage, current, capacity, short-circuit level, ratios, voltage variations, positive and zero sequence impedances, measuring transformer and protection relay indices, interlocking, kind of switch drive, code designation, etc. as applicable.

Circuit diagrams

The Circuit Diagrams shall show the power circuits in all the phases with the main apparatus as well as the pilot circuits (measuring and control circuits). It shall show in full the functioning of part or all installations, Works or circuits with all required technical

Block diagrams

The Block Diagrams shall be used to show in a simplified manner the main inter-relationships between the elements of a system by means of symbols, block symbols and pictures without necessarily showing all the connections. The symbols used for the individual kinds of components, e.g. servomotors, computing modules, etc., shall clearly be explained on the diagram or on an attached legend.

Logic diagrams

The Logic or Functional Diagrams shall be used for representation of logic and sequence controls and interlocking by showing only binary logic elements and their effect on the various process equipment disregarding their electrical realisation. Logic function elements (AND, OR, NOR, NAND, STORAGE, etc.) shall be used for processing and combining binary signals.

Terminal diagrams

Such diagrams shall be prepared for any type of terminal box, marshalling rack, control cubicle, switchboard, etc., and shall show the terminals (properly numbered) and the internal and/or external conductors (wires or cables) connected to them.

The terminal diagram of each individual switchboard, terminal box, panel, etc., shall contain, but not be limited to the following information:

Protection co-ordination diagrams

These diagrams shall show in a graphical manner separately for each power supply circuit:

- A simplified single-line diagram of the circuit with technical data of all instrument transformers and relays
- Co-ordinated tripping curves of related protection devices
- Setting of the protection devices.

Emergency shutdown diagram

This diagram shall show the sequential steps and interdependencies during emergency closure.

Flow Charts

Flow charts shall be used for representing sequence of events for start / stop / shut down of the machine including associated equipment and auxiliaries.

1.19.5 Manuals

The following manuals covering all equipments of EM works shall be supplied as per the time schedule in both editable soft and hard form:-

Sr. No.	Manual Description	Time Schedule
1.	Storage and preservation manual	Before start of dispatch
2.	Safety manual	Before start of DT Erection of 1st unit
3.	Erection Manual	Before start of DT Erection of 1st unit
4.	Testing and commissioning manual	Before start of Testing & Commissioning of 1st unit
5.	Operation manual	Before Commissioning of 1st unit
6.	Maintenance manual	After commissioning of all units
7.	Long term storage manual for Generator Transformer	After commissioning of all units
8.	Long term storage manual for boxed up component / equipment.	After commissioning of all units
9.	Repair process / procedure manual for equipment / system	After commissioning of all units

1.19.5.A As built drawing to be provided incorporating changes made during erection, testing and commissioning.

1.19.6 Drawing & Document Submission Schedule

Drawings & documents submission schedule of the EM package with the categorization (i.e. Approval / reference) & tentative submission date shall be submitted to purchaser for approval within six (6) months from the date of Letter of award of contract. The list of drawings in the proposed schedule shall not be limited to the drawings/documents/ manual etc. covered under clause 1.19, the list as per Annexure – D of this section & the list covered under head "Drawings, Documents & Design Calculation" of each section.

Preliminary list of drawings under various categories have been prepared and appended at Annexure – D.

1.20 Quality Assurance Requirement for Electro-Mechanical Package

1.20.1 QUALITY ASSURANCE PROGRAMME

The Bidder shall follow Quality Assurance Programme to ensure that the equipment and services under the scope of contract whether manufactured or performed at the Bidder's works or at his sub-vendor's premises or at the SAPDC's site or at any other place of work are in accordance with the technical specifications. Such programme shall be outlined by the Bidder and be submitted along with the bid. The QA programme shall be generally in line with IS/ISO- 9001 and generally cover the following:

- ORGANISATION STRUCTURE FOR THE MANAGEMENT AND IMPLEMENTATION OF THE PROPOSED QUALITY ASSURANCE PROGRAMME
- QUALITY SYSTEM MANUAL
- DESIGN CONTROL SYSTEMS
- DOCUMENTATION AND DATA CONTROL SYSTEMS
- QUALIFICATION/EXPERIENCE OF BIDDER'S KEY PERSONNEL.
- PROCEDURE FOR PURCHASE OF MATERIAL, PARTS, COMPONENTS AND SELECTION OF SUB-VENDOR'S SERVICES INCLUDING VENDOR ANALYSIS, SOURCE INSPECTION, INCOMING RAW-MATERIAL INSPECTION, VERIFICATION OF MATERIALS PURCHASED, ETC.
- SYSTEM FOR SHOP MANUFACTURING AND SITE ERECTION CONTROLS INCLUDING PROCESS, FABRICATION AND ASSEMBLY.
- CONTROL OF NON-CONFORMING ITEMS AND SYSTEM FOR CORRECTIVE ACTIONS AND RESOLUTION OF DEVIATIONS.
- CONTROL OF CALIBRATION AND TESTING OF MEASURING / TESTING EQUIPMENT.
- SYSTEM FOR QUALITY AUDITS.
- SYSTEM FOR IDENTIFICATION AND APPRAISAL OF INSPECTION STATUS.
- SYSTEM FOR AUTHORISING RELEASE OF MANUFACTURED PRODUCT TO THE PURCHASER.
- SYSTEM FOR TRANSPORTATION /DELIVERY, HANDLING, STORAGE AND PRESERVATION.
- SYSTEM FOR MAINTENANCE OF RECORDS.

1.20.2 GENERAL REQUIREMENTS - QUALITY ASSURANCE

1.20.2.1 All materials, components and equipment covered under scope and its technical specifications shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme agreed mutually.

1.20.2.2 Minimum Quality Assurance Test Requirement (QATR) to be followed during Manufacturing and Field erection indicating requirement of various tests / inspections, on major equipment / items, to be carried out as stipulated in technical specification and standards mentioned therein, are attached hereto and are part of bidding documents. Clarification, if any, on these quality assurance test requirement, raised by bidder shall be discussed and resolved during pre-bid meeting.

1.20.2.3 After the award of contract, the contractor shall submit the detailed Manufacturing & Field Quality Assurance Plans for complete equipment / material during detailed engineering in the format attached hereto (format of quality plan F-060-02 issue 2.0 rev. 01, Total 1 Page) for approval and acceptance by SAPDC/Consultant in line with technical specification, Quality Assurance – General & Test Requirements and detailed engineering.

1.20.2.4 Manufacturing Quality Assurance Plans shall detail out for all the components and equipment & various tests/inspection, to be carried out in conformity with relevant latest IEC/IS/ISO etc, quality practices and procedures to be followed by Contractor's / Sub-vendor's Quality Control Organization, the relevant reference documents, standards and acceptance norms etc. during all stages of material procurement, manufacture, assembly and final testing / factory acceptance tests.

1.20.2.5 The Field Quality Assurance Plans shall detail out the various tests/inspection to be carried out in conformity with relevant latest IEC/IS/ISO, quality practices and procedures etc. to be followed by the contractor's / sub-contractor's site Quality Control Organisation during various stages of site activities from receipt of material/equipment at site till final commissioning/ acceptance/handover.

1.20.2.6 All major items/ equipment/ components to be manufactured in house as well as procured from sub-vendors (Bought out Items, BOI) to be listed in the bid. Bidder shall submit Quality Assurance Plan submission schedule in the bid for above listed items in attached Format (duly filled in the format F-060-05 Issue 2.0 Rev. 00, Total 1 Page) in line with L2 Schedule.

1.20.2.7 For components / equipment / Bought out Items procured by the contractor for the purpose of the contract, the Contractor's purchase specifications and inquiries shall call for quality plans to be submitted by the sub-vendors.

The quality plans called for from the sub-vendors shall detail out, during the various stages of manufacture and installation, the quality practices and procedures followed by the sub-vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc. Such quality plans of the successful sub-vendors shall be finalized with the SAPDC/Consultant in line with requirement mentioned at clause no. 1.20.2.3 above and such approved Quality Plans shall form a part of the purchase order/contract between the contractor and his sub-vendor.

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 and other related documents such as data sheet, drawings, quality plans and delivery conditions shall be furnished to the SAPDC/Consultant by contractor along with a report of the Purchase Orders placed, on the monthly basis, so far for the contract.

1.20.2.8 The Quality Plans shall be submitted on electronic media e.g. CD or E-mail in addition to hard copy, for review and approval of SAPDC/Consultant. After approval, the same shall be submitted in compiled form on CD-ROM by contractor.

1.20.2.9 For all spares, replacement items and additional similar items, the quality requirements/Quality Plans as agreed for the main equipment supply shall be applicable.

1.20.2.10 All material of construction shall be as per technical specification / approved drawings / GTP.

1.20.2.11 Contractor's Plant internal standards must be traceable to acceptable International / National standards & salient points of difference (if any) shall be clearly stated with submission of plant standards. The contractor shall furnish copies of reference documents, plant standards, acceptance norms, test and inspection procedure etc. as referred in Quality Plans along with Quality Plan to SAPDC/Consultant. These Quality Plans and reference documents/standards etc. will be subject to approval of SAPDC without which manufacturer shall not proceed. These documents shall form a part of the contract.

Tests on components and sub-assemblies shall be carried out at various stages of manufacturing, till the product undergoes the final tests in conformity with the relevant standards.

1.20.2.12 The Customer Hold Points (CHPs), identified in approved quality plan, i.e. testing checks which shall be carried out in the presence of the SAPDC, beyond which the work will not proceed without written consent of SAPDC's authorized representative.

1.20.2.13 The contractor / sub-vendor shall carry out routine test on 100% items at his works. The quantum of check / test for routine and acceptance test by SAPDC/Consultant 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.

The quantum of check when specified in percentage (%) / sampling basis shall be treated as per lot per sub-vendor. When the quantum of check is indicated to in whole no., then same quantum of check shall be applicable to each sub-vendor supplying the same equipment.

1.20.2.14 For sub-vendors identified during pre-award stage for submission of vendor details / credentials (category "DR"), contractor shall submit documents in format F-060-01 after placement of award in the manner as specified in Clause no. 1.20.2.17 prior to any procurement and within a month after placement of award or a period as agreed at the time of pre-award discussions.

The proposed sub-vendors should be registered vendors of the bidder and must have proven experience for successful operation for similar equipment / items / processes as mentioned elsewhere in technical specification.

1.20.2.15 Before assigning any portion of work to the sub-vendor, other than one specified and duly accepted in the contract, the contractor will take prior approval of SAPDC.

1.20.2.16 While sub-contracting any portion of work, it shall be mandatory to include these quality assurance – general & test requirements along with vendor qualification criteria, if indicated elsewhere in the technical specification, as a part of their bidding document.

1.20.2.17 Normally no request for change of sub-vendors or inclusion shall be entertained by SAPDC. But in exceptional circumstances, if the request for change of sub-vendors or inclusion is found reasonable and justified, then the same shall be entertained and the

decision of SAPDC in this respect shall be final and binding. The time consumed for the change / inclusion of sub-vendors shall not be excluded from the stipulated time of the completion of the contract. This change shall not relieve the contractor from the responsibility to complete the work within stipulated time in any manner.

1.20.2.18 The contractor's proposal shall include sub-vendor's facilities established at the respective works, the process capability, process stabilization, Q.C. system followed, experience list etc. along with his own technical evaluation of sub-vendor. (Format F-060-01 issue 2.0 rev. 01, Supplier / Sub-vendor Assessment Sheet, Total 14 pages). However, whenever felt necessary, sub-vendor assessment will also be carried out by SAPDC/Consultant in accordance with the above procedure and by factory visits; for existing/proposed vendors/sub-vendors. This approval shall not relieve the contractor from any obligation, duty or responsibility under the contract & SAPDC shall not be responsible for any complications arising between the contractor and his sub-contractor(s) / sub-vendor (s) and / or any other liabilities.

1.20.2.19 SAPDC/Consultant reserves the right to carry out quality audit and quality surveillance of the system and procedures of the contractor / or their sub-vendor. The contractor shall provide all necessary assistance to enable SAPDC/Consultant to carry out such details & surveillance including Quality Manuals, if required by SAPDC/Consultant.

1.20.2.20 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirement of ASME section-VIII/IX or other International equivalent standard acceptable to SAPDC/Consultant. All welding/brazing procedures shall be submitted to SAPDC/Consultant for review / verification prior to carrying out the welding/brazing. However, wherever required by the SAPDC/Consultant, tests shall be conducted in presence of SAPDC's authorized representative.

1.20.2.21 All Brazers, Welders and welding operators employed on any part of the contract either in Contractor/his sub-vendor's works or at site or elsewhere shall be qualified as per ASME section-VIII/IX or other equivalent International Standards acceptable to SAPDC/Consultant.

1.20.2.22 Unless otherwise proven and specifically agreed with SAPDC/Consultant, welding of dissimilar material and high alloy materials shall be carried out at shop only.

1.20.2.23 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 or Indian Society of non-destructive examination). NDT

shall be recorded in a report, which include detail 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.

1.20.2.24 All material used for equipment manufacture including castings and forgings, 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.

1.20.2.25 Contractor shall submit Field Welding Schedule for field welding activities like field welding location, numbers, welding procedure to be used, requirements, codes and NDT requirement along with all supporting documents, like welding procedures, heat treatment procedures, NDT procedures, etc. to SAPDC/Consultant for review at least ninety days before schedule start of erection work at site.

1.20.2.26 Any other statutory requirements as applicable for the equipment / systems shall also be complied with.

1.20.2.27 The inspection calls (duly filled in the format F-060-06 Issue 2.0 Rev. 00, total 1 Page) shall be placed at least 06 weeks in advance for overseas inspections excluding India and 15 days in advance for inspections within India and Nepal.

Before submitting the inspection call to SAPDC for witnessing the Customer Hold Points (CHP's) and/or requesting SAPDC for issuance of Material Dispatch Clearance Certificate (MDCC) based on Test Certificate (TC) review / Certificate of Conformance (COC), the contractor shall ensure that all Drawings / documents / GTP / technical data sheet, relevant to respective CHP / MDCC requirement, has been duly approved / accepted / noted by SAPDC.

1.20.2.28 Contractor shall ensure readiness of offered equipment by all means, before raising such call to SAPDC to attend CHP inspections. In case, SAPDC engineer (s) on reaching at a place of inspection found that material is not ready for inspection due to whatsoever reason, the complete inspection expenditure of SAPDC engineer(s) as per actual shall be chargeable to the contractor.

1.20.2.29 Only calibrated testing & measuring instruments shall be used while performing tests during manufacturing and erection, testing & commissioning at site by the contractor.

Copy of the calibration certificates will be submitted to SAPDC/Consultant by the contractor during inspection as an evidence.

1.20.2.30 Non-conformities observed during manufacturing, shop testing, handling, packaging, transportation, storage, preservation, erection, testing & commissioning are required to be intimated by the contractor (Format for reporting, F-060-04 issue 2.0 rev 01, Total 5 pages). The acceptance/rejection of the non-conformities will be at the discretion of SAPDC.

1.20.2.31 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the acceptance of SAPDC. Action taken in accordance with decision of disposal of non-conformity for repair / rework / modification of the item / equipment and to prevent re-occurrence. The corrective and preventive action may involve modification of item / equipment, change in procedure and system etc. to achieve quality improvement at all stages and levels.

1.20.2.32 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the SAPDC 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.

1.20.2.33 No material shall be dispatched from the manufacturer's works before the same is duly accepted, subsequent to pre dispatch/final inspection including verification of records of all previous tests/inspection by SAPDC and duly authorised for Dispatch by issuance of Material Dispatch Clearance Certificate (MDCC).

1.20.2.34 The test reports of type tests conducted as per contract, in line with requirement stipulated in the technical specification / quality plan should be got accepted from SAPDC/Consultant before final inspection / issuance of MDCC.

1.20.2.35 All materials used or supplied shall be accompanied by valid and approved material certificates and tests and inspection reports. These certificates and reports shall indicate the heat numbers or other such acceptable identification numbers of the material. The material certified shall also have the identification details stamped on it to ensure physical correlation and traceability of material vis-a-vis test certificate. Such identification no. shall remain same and verifiable for all stages of manufacturing and installation.

1.20.3 QA DOCUMENTATION

1.20.3.1 The contractor shall be required to submit the QA Documentation in two hard copies and two CD ROMs, as identified in respective quality plan.

1.20.3.2 Each QA Documentation shall have a project specific Cover Sheet bearing name and identification number of equipment including index of its contents with page control on each document. The QA Documentation file shall be progressively completed by the Contractor/sub-vendor 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.

1.20.3.3 Before dispatch / commissioning of any equipment, the Contractor 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 Contractor will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

1.20.3.4 The contractor shall be required to submit copies of the following quality assurance documents in original duly reviewed and accepted by contractor along with the request letter for issuance of MDCC (Material Dispatch Clearance Certificate):

- QUALITY PLAN CHECK LIST.
- MATERIAL MILL TEST REPORTS ON COMPONENTS AS SPECIFIED IN QUALITY PLAN.
- SKETCHES AND DRAWINGS USED FOR INDICATING THE METHOD OF TRACEABILITY OF THE RADIOGRAPHS TO THE LOCATION ON THE EQUIPMENT.
- NON-DESTRUCTIVE EXAMINATION RESULTS REPORTS INCLUDING INTERPRETATION REPORTS.
- CALIBRATION CERTIFICATE OF ALL METERS & MEASURING INSTRUMENTS PROPOSED TO BE SUPPLIED AS PART OF RELEVANT BILLING BREAKUP ITEM.
- ROUTINE TEST REPORTS FOR TESTING REQUIRED AS PER APPLICABLE CODES AND STANDARDS REFERRED IN THE SPECIFICATIONS.

- INSPECTION REPORTS DULY SIGNED BY AUTHORIZED REPRESENTATIVE OF SAPDC AND CONTRACTOR FOR THE AGREED CUSTOMER HOLD POINTS.
- ALL THE ACCEPTED DEVIATIONS SHALL BE INCLUDED WITH COMPLETE TECHNICAL DETAILS.
- LIST OF BALANCE POINTS IF ANY.
- CERTIFICATES IN RESPECT OF CALIBRATION, WELDERS & BRAZERS QUALIFICATION ETC.
- COPY OF ALL REFERENCE DRAWINGS AND REFERENCE TECHNICAL DOCUMENTS
- ACCEPTANCE OF TYPE TEST REPORTS BY SAPDC/CONSULTANT.

1.20.3.5 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, within 2 weeks after commissioning of individual system.

1.20.3.6 On release of QA Documentation by Inspector, one set of quality document shall be forwarded to Consultant and other set to SAPDC. For the particular case of phased deliveries, the complete quality document to the SAPDC/Consultant shall be issued not later than 3 weeks after the date of the last delivery of equipment.

1.20.4 ASSOCIATED DOCUMENTS / FORMATS

- F-060-01 VENDOR / SUB-VENDOR ASSESSMENT SHEET
- F-060-02 QUALITY PLAN SUBMISSION BY CONTRACTOR.
- F-060-04 NON-CONFORMANCE REPORT (NCR)
- F-060-06 INSPECTION CALL REQUEST.

The above formats are attached at Annexure – E.

1.21 Safety

1.21.1 Safety of personnel

All equipment and services provided under this contract shall abide by international standards commonly accepted in the hydroelectric utility industry for safety of personnel whether involved with operation or maintenance.

1.21.2 Safety of operation

All equipment and services provided under this contract shall abide by commonly accepted standards for safety of operation.

The various system and sub-systems supplied under this contract shall be designed to follow and operate under a clear hierarchical structure:

- plant control level,
- unit control level,
- functional control level, functional drive group level,
- Local drive level.

Each hierarchical control level shall perform its specific tasks and always depend on the subordinate lower control levels. In general, should a higher control level failure occur, the lower control level shall not be affected and shall be able to control the power plant with full safety.

The Contractor shall accordingly build into the "Electrical & Mechanical System" adequate levels of autonomy, independence, redundancy and functional distribution to insure that safety is maintained at all times.

1.22 Earthing

Earthing terminals for equipment of these specifications shall form part of equipment supplies. The contractor shall connect the earthing conductors to these terminals as required.

Risers from earthing bus shall be in the scope of purchaser. However, extension from these risers to the equipment shall be in the scope of supplier in the Power House, Transformer Hall, Switchyard and Butterfly Valve House.

However, overall earthing arrangement required for HT panel, LT panel, DG set, motor & motor control panels etc. at isolated location such as Dam Site, TRT Outfall area and Surge Shaft either by pit earthing or counter poise etc. shall be in the scope of supplier including civil works, design, material supply (for main earthing risers, interconnection, charcoal, salt, Bentonite etc.), erection, testing & commissioning etc.

1.23 Completeness of the specification

Any fittings, accessories, equipments or any other things required for successful commissioning of Arun-III Hydro Electric Project, though may not have been specifically mentioned in the specification but are usually necessary for the completeness of the equipment shall be deemed to be included in the specification

and shall be supplied by the contractor without any extra cost to the Employer.

1.24 Packaging and Shipment

The contractor shall wrap, pack and crate all plant included in the work or part thereof, suitable for shipment to a tropical location, facilitating proper handling and protection from damage in rail, truck, ocean or air shipment as applicable. An approved drying agent, such as Silica Gel, shall be packed in containers or packages holding plant which may be adversely affected by moisture or excessive humidity.

All packing crates shall be clearly marked before shipping to indicate the contract number, shipping address, volume, weight, name, number and unit number of the contents, slinging and weight bearing points.

All plant parts shall be marked to facilitate erection. Each packing crate shall contain a packing list in a waterproof envelope. Parts shall be described and also identified by their numbered marking in the packing list.

Three copies of the packing list shall be forwarded to the purchaser prior to dispatch. The ownership of packaging materials shall be of Employer. All wooden packaging crates and steel support structures shall be dumped to the designated area within 5kms of the power house as per the direction of Engineer in charge.

Annexure-C

List of Standards

S.no		Standard name
a)	**Turbine & auxiliaries**	
i.	IEC 60193 storage pumps and pump turbines.	Hydraulic turbines, storage pumps and pump turbines - Model acceptance tests.
ii.	IEC 60609	Cavitation pitting evaluation in hydraulic turbines,
iii.	IEC 60041	Field acceptance tests to determine the hydraulic performance of hydraulic turbines, storage pumps and pump- turbines
iv.	IEC 60545	Guide for commissioning, operation and maintenance of hydraulic turbines.
v.	IEC 60995	Determination of the prototype performance from model acceptance tests of hydraulic machines with the consideration of scale effects.
b) Governor		
i.	IEC 61362	Guide to specification of hydraulic turbine control systems
ii.	2 IEC 60308	International code for testing of speed governing systems for hydraulic turbines
iii.	3. IEEE 125	IEEE recommended practice for preparation of equipment specifications for speed-governing of hydraulic turbines intended to drive electric generators
c)	**Generator**	

i.	4722	Rotating electrical machine- specification
ii.	60034	Rotating electrical machine
d) Static excitation system		
i.	IEC 60034-16	Excitation system for synchronous machine
ii.	IEEE 421-1 to 5	Excitation system
d)	**Busduct**	
i.	IS:8084-1976	Specifications for interconnecting bus bars for AC voltage above 1 KV and up to and including 36 KV.
ii.	ANSI C 37.20 (Std.27)	Standard of switchgear assembly including metal enclosed bus.
iii.	ANSI C 37.23-1987 (Std.298)	Calculating losses in IPB.
iv.	IS 3070-Part-III/IEC99-4	Lightning arrester. Metal oxide without gap.
v.	IS:3156/IEC 186	- Voltage transformers.
vi.	IS:2705/IEC 185	- Current transformers.
vii.	IS:226	- Structural Steel (Standard Quality).
viii.	IS:72	Galvanising of steel structure.
ix.	IS:13947	Degree of Protection provided by enclosures for low voltage and control gears
x.	IEC 60044	Instrument Transformer.
xi.	IEC 60909	Short circuit current in 3 phase AC System.
xii.	IEC 60865	Short circuit current-calculation & effects.
xiii.	IS:5082	Wrought aluminum and alloy bars, rods, tubes and sections for electrical

		purposes.
xiv.	IS:2099	Bushing for alternating Voltage above 1000 V.
xv.	IS:11171	Earthing Transformer.
xvi.	IS:728	Methods for determining coating on galvanised articles.
xvii.	IS: 9921 (Part 1 to V)-1981	A.C. disconnectors(Isolators)and earthing switches for voltage above 1000V.
xviii.	IS: 9431	Porcelain Insulator.
xix.	IS: 11548 IEC: 129	Shunt capacitor for power system. A.C disconnectors & earthing switches
f)	**Butterfly valve & MIV**	
	IS - 7326	Penstock and turbine inlet butterfly valves for hydropower stations and system
g)	**Generator transformer**	
i.	Power Transformer	IS: 2026 (Part I to IV)/ IEC-60076
ii.	Fittings and accessories for power transformers	IS:3639 & IS: 554
iii.	Transformer bushings	IS:2099 & 3347/IEC-60137
iv.	Dimensions for porcelain transformer bushings	IS:3347
v.	Transformer oil	IS:335/IEC-60296
vi.	Gas and oil operated relay	IS:3637
vii.	Heat exchangers	IS:6088
viii.	Motors	IS:325 and 996/IEC-34
ix.	Motor starters	IS:1822

x.	Oil pumps	IS:5120
xi.	Current transformers	IS:2705/IEC-60044-1
h)	**GIS**	
	IEC 694 Common clauses for HV switchgear IEC 517 HV metal-enclosed switchgear above 72.5 kV IEC 56 Parts 1 to 6-AC High voltage circuit breakers IEC 129 AC disconnectors and earthing switches IEC 267 Guide to testing of circuit breakers IEC 185/186 Current and voltage transformers IEC Rec.376 SF6 Gas IEC Publ. Sec. 187, 192 earthquake 50A IEC 99-1 IEC TC 37 WG 4(194) IEC 9.4 Surge arrestor IEC 137 Outdoor bushing IEC 270 Partial discharge measurement IEC 506 Switching impulse test on HV insulators. IEC 1128 – Alternating current disconnectors bus transfer current switching by disconnectors. 17 c (Sec) 121, 17 c (Central Office) IEC 1259 Requirement for switching of bus charging current by disconnectors. IEC 1129 – AC earthing switches induced current switching. IEC-1259 Requirement for switching of bus charging current by disconnectors. IEC-1639 Direct connection between power transformers & SF6 GIS Current Transformers. IS -3156 Voltage Transformers IEC 480 – guide to the checking of SF6 taken for electrical equipments. IEC 427 – Synthetic testing of high voltage A.C. circuit breaker. IS 2705 – Protective Current Transformers for special (Part-IV) purpose application. NSI/IEEE – Guide for safety in A.C. sub-station (Std. 80-1986) grounding. IEC – 71 Insulation coordination.	
i)	**Pothead yard**	
i.	IEC 99-4	Metal Oxide Lighting arrestor without gap for AC System.

ii.	IEC-353	Line Traps.
iii.	IEC-358	Coupling capacitor & capacitor divider.
iv.	IS-3156	Capacitor voltage transformer.
v.	*IS-5561*	*Electric power connectors.*
vi.	IS-335	Insulating oil for transformers & switchgear.
vii.	IS-5621	Hollow insulation for use in electrical installation.
viii.	IS-1364 (Part I to V)	Hexagon head bolts, screw and nuts for product grade A & B.
ix.	IS-2633	Methods for testing uniformity of coating in Zn-coated articles.
x.	IS-802	Code of practice for use of structural steel for over head transmission tower.
xi.	IS-2629	Recommended practice for hot dip galvanising of iron & steel.
xii.	IS-2062	Specification for structural steel standard quality.
xiii.	IS-808	Specification for rolled steel beam, channel & angle section.
xiv.	IS-2016	Specification for plain washers.
xv.	IS-1367	Specification for hot dip galvanizing coating of fasteners.
xvi.	IS-7215	Specification for tolerances for fabrication of steel structures.
xvii.	IS-209	Specification for zinc.
xviii.	IS-6639	Specification for hexagon bolts & other fasteners.
xix.	IS-1573	Specification for galvanizing washers.
xx.	IS-2486	Specification for insulator fittings for overhead power lines.
xxi.	IS-731	Specification for porcelain insulator for overhead power line.
xxii.	IS-2099	Specification for bushings for A.C Voltage above 1000 V.
xxiii.	IEC-68	Environmental testing
xxiv.	IEC-129	AC Disconnectors and Earthing Switches
xxv.	IEC-137	Insulated bushings for alternating voltage above 1000V
xxvi.	IEC-185	Current Transformers
xvii.	IEC-270	High voltage test techniques partial discharge
xviii.	IEC-506	Switching Impulse Test on HV insulators
xxix.	IEC-1128	AC Disconnectors for line charging current switching
xxx.	IEC-1129	AC Earthing Switches induced current switching

xxxi.	IS-1364	Hexagon Head bolts, screw and Nuts for product Grade A and B (Part 1 to V)
xxii.	IS-2705	Current Transformers
j)	**Unit control system**	
i.	IEC 60255	Electrical relays
ii.	IEC 60297	Dimension of mechanical structure of 19 inch series
iii.	IEC 60326	Printed Boards
iv.	IEC 60446	Basic and safety principles for man-machine interface, marking and identification, identification of conductors by colours or numerals
v.	IEC 60478	Stabilized power supplies, DC output
vi.	IEC 60625	Interface system for programmable measuring instruments
vii.	IEC 61000	Electromagnetic compatibility for industrial process – measurement and control equipment
viii.	IEC 61131	Programmable controllers
ix.	IEC 61158	Digital data communications for measurement and control – Field bus for use in industrial control systems
x.	ISO/IEC 8802	Information technology
xi.	IEEE 1046	Application guide for distributed digital control and monitoring for power stations
xii.	IEC 60870-5	Tele-control equipment and systems
xiii.	IEC 60793 Part 1	Optical Fibre- Measurement and test procedures
xiv.	IEC 60793 Part 2	Optical Fibre- Product specifications
k)	**Unit protection system**	
i.	IEC 50(16) International Electro Technical Vocabulary	
ii.	IEC -68-1 Environmental Testing Part I (General & Guidance)	
iii.	IEC-255-1-00 Electrical Relays -All or nothing Electrical Relays	
iv.	IEC -255 Electrical Relays	
v.	Part 3 Single Input Energising Quantity Measuring Relays with Dependent or Independent Time	
vi.	Part 5 Insulation Tests	
vii.	Part 6 Measuring Relays with more then One Input Energising Quantity	
viii.	Part 7 Test and Measurement Procedures for Electromechanical all or nothing Relays	
ix.	Part 8 Thermal Electrical Relays	

x.	Part 10 Application of the IEC Quality Assessment System for Electronic Components for all or nothing Relays
xi.	Part 11 Interruption to and Alternating Component (Ripple) in DC Auxiliary Energising Quantity of Measuring Relays
xii.	Part 12 Directional Relays and Power Relays with Two Input Energising Quantities
xiii.	Part 13 Biased (%)Differential Relays
xiv.	Part 16 Impedance Measuring Relays
xv.	Part 21 Vibration, shock, Bump & Seismic Tests on Measuring Relays & Protection Equipment
xvi.	Part 22 Electrical Disturbance Tests for Measuring Relays & Protection Equipment IEC -255 Electrical Relays - Part 23 Contract Performance
xvii.	IEC -337 Control Switches & Low Voltage Switching Devices for Control & Auxiliary Circuits
xviii.	IEC 529/ DIN 40050 Degree of Protection provided by Enclosures (IP Code)
xix.	IEC 617/BS 3950 Electrical Protective Systems for A.C. Plant
xx.	BS: 4227 (Part-I) Relay Terminology
xxi.	BS 142 Electrical Protection Relays
xxii.	ASA C 5013 Electrical Relays
xxiii.	IS: 1885 Electro Technical Vocabulary
xxiv.	Part-IX Electrical Relays
xxv.	Part-X Electric Power System Protection
xxvi.	Part-XVIII Switch gear and Control Protection
xvii.	IS: 3231 Specification for Electrical Relays for Power System Protection
xviii.	IS: 3842 Application Guide for Electrical Relays for AC System
xxix.	Part-I Over Current Relays for Feeders and Transformers
xxx.	Part-IV Thermal Relays
xxxi.	
xxii.	Part-V Distance Protection Relays

xxiii.	Part- VI	Power Relays	
xxiv.	Part- VII	Frequency Relays	
xxv.	Part-VIII	Voltage Relays	
xxvi.	IS: 8686	Specification for Static Protective Relays	
xvii.	IS: 12083	Special Requirements for Protection Relays	
xviii.	IS:8686	- Static Protective Relays	
xxix.	IS:8686	- Static Protective Relays	
xl.	IEC:255	- Electric Relays	
xli.	(Part 1 to 19)		
xlii.	IS:3231	- Electric relays for power system protection	
xliii.	IS:2208	- HRC fuses	
xliv.	IS:3842	- Applicable guide for electrical relays for A.C.	
xlv.	(Part 1 to 10)	system	
xlvi.	IS:1248	- Direct acting electrical indicating instruments	
xlvii.	IS:2419	- Dimensions for panel mounted indicating recording instruments	
lviii.	IS:5834	- Electric Timer relays	
xlix.	IS:722	- A.C. Electricity meters	
l)	**Cables**		
i.	IS-694		PVC insulated cables for working voltages up to and including 1100V.
ii.	IS-1554 (Part-I)		PVC insulated (heavy duty) electric cables for working voltages up to and including 1100V.
iii.	IS-1554 (Part-II)		PVC insulated (heavy duty) electric cables for working voltages from 3.3kV up to and including 11kV.
iv.	IS-3961		Recommended current ratings for cables
v.	IS-8130		Conductors for insulated electric cables and flexible cords.
vi.	IS-5831		PVC insulation and sheath of electric cables.
vii.	IS-6380		Specification of Elastomeric Insulation & Sheath of Electric Cables.
viii.	IS-7098 (Part-I & II)		Cross linked polyethylene insulated PVC sheathed cables for working voltages up to 33kV.
ix.	IS-3975		Mild steel wires, strips and tapes for armouring cables.
x.	IS-1753		Aluminium conductors for insulated cables.

xi.	IS-10418	Drums for electric cables
xii.	IS-10810 (Part 0 to 63)	Methods of test for cables
xiii.	IS-6474	Polyethylene insulation and sheath of electric cables.
xiv.	IS-5819	Recommended short circuit ratings of high voltage PVC cables.
xv.	IEC-60502	Power Cables with extruded insulation & their accessories for rated voltages 1kV to 30 kV
xvi.	IEC-540 & 540A	Test methods for insulation and sheaths of electric cables and cord.
xvii.	IEC-60332	Test on electric cables under fire conditions.
xviii.	IEC-60754	Test on gases evolved during combustion of electric cables.
xix.	IEC Hand Book for Temperature Index	Cable in fire regarding temperature Index Chapter-6.
m)	EOT Crane	
i.	IS-3177/BS:466	Code of Practice for Electric overhead traveling cranes and gantry cranes other than steel work crane
ii.	IS-807/BS:2573	Code of practice for design, manufacture, erection and testing (Structural portion) of cranes and hoists.
iii.	IS-5749/BS:3017	Forged Ramshorn hook.
iv.	IS-2266/BS:302	Specifications for steel wire ropes for general engineering purposes.
v.	IS-6938	Code of Practice for design of rope drum and chain hoists for hydraulic gates.
vi.	IS-325/BS:2960	Three phase induction motors.
vii.	IS-13947(Part 4/sec 1)	Contactors and motor starters – Electromechanical contactors & motor starter.
viii.	IS-2062	Steel for general structural purposes.
ix.	IS-3815	Point hooks with shanks for general engineering purpose.

x.	IS-1030	Carbon steel castings for general engineering purposes.
xi.	IS-1875	Carbon steel billets, bloom, slabs and bars for forgings.
xii.	IS-210	Grey Iron castings.
xiii.	IS-1363(Part 1,2,3)	Hexagon head bolts, screws & nuts of product grade C.
xiv.	IS-1364(Part 1,2,3,4,5)	Hexagon head holts, screws & nuts of product grade A&B.
xv.	IS-4460 (Part 1,2,3)	Gears – spur & helical gears – calculation of load capacity.
xvi.	IS-800	Code of practice for general construction in steel.
xvii.	IS-2762	Wire rope slings and sling legs.
n)	**DC BATTERY**	
i.	IS-1652	Specification for stationary cells and batteries, Lead Acid type with plante positive plates.
ii.	IS-266	Specification for Sulphuric Acid
iii.	IS-2959	Specification of contactors for voltage not exceeding 1000V AC or 1200 V DC.
iv.	IS-8828	Specification for miniature Air break circuit breakers for voltage not exceeding 1000 volts.
v.	IS-2516 (Part-I & II/ Section-I)	Specification for alternating current circuit breakers.
vi.	IS-3136	Specification for Polycrystalline semi-conductor rectifier equipment.
vii.	IS:3395	Specification for monocrystalline semi-conductor rectifier cells & stakes.
viii.	IS-4540	Specification for monocrystalline semi-conductor rectifier assemblies and equipment.
ix.	IS-6071	Specification for synthetic separators for lead acid batteries.

x.	IS-1069	Specification for water of storage batteries
xi.	IS-1146	Specification for rubber and plastic containers for lead acid storage batteries.
xii.	IS-8320	General requirements and methods of tests for lead acid storage batteries.
xiii.	IS-1885 (Part-VIII)	Electrical Vocabulary – Secondary cells and batteries.
xiv.	IS-3116	Sealing compound for lead acid batteries.
xv.	IS-2147	Degree of protection for Cubicles.
xvi.	IS-1248	Meters and Instruments.
xvii.	IEC:51	Recommendation for direct acting indicating electrical measuring instruments and their accessories.
xviii.	IEC:157-1	Low Voltage Switchgear and Control gear – Contractors
xix.	IEC:158-1	Low Voltage Control gear
xx.	IEC:445	Identification of apparatus terminals and general rules for a uniform system of terminal marking, using an alpha – numeric notation
xxi.	IEC:478	Stabilized power supplies, DC output
xxii.	IEC:529	Classification of degree of protection provided by enclosure
xxiii.	IEC:896	Stationary lead acid batteries-general requirements and methods of Tests.
n)	**MV SYSTEM**	
i.	IEC-56/ IS-13118	High Voltage A.C. Circuit Breakers.
ii.	IEC-376	Specifications and acceptance of new sulphur hexaflouride gas
iii.	IEC-298	High Voltage metal enclosed switchgear and control gear.
iv.	IEC-137	Bushing for alternating Voltage above 1000 Volts.
v.	IEC-71	Insulation co-ordination.
vi.	IEC-694	Common clauses for high voltage switchgear and control gear standards.
vii.	IEC-267	Guide for testing of circuit breakers with respect to out of phase switching.
viii.	IEC-185	Specification for current Transformers.
ix.	IEC-186-1969	Voltage Transformers.
x.	IEC Study. Group DEC.1981 o.IEC-17A.	Sealing of interrupters
xi.	IS-2516	Specification for alternating current circuit breakers.
xii.	IS-2099	High voltages porcelain bushing.

xiii.	IS-3072	Installation and maintenance of switchgear.
xiv.	IS-1554	PVC insulated cables upto and including 1100 volts.
xv.	IS-5	Colors for ready mixed paints.
xvi.	IS-2705	Specification for current (Part-I to IV) Transformers.
xvii.	IS-3156	Specification for voltage Transformers.
xviii.	IS-1985	General Requirement (Part-I).
xix.	IS-1965	Measurement voltage (Part-II) transformers.
xx.	IS-1966	Protection voltage transformer (Part-III) electromagnetic type.
xxi.	IS-4146	Application guide for VT.
xxii.	IS-8714	Electrical protective relays for the use in seismic area
xxiii.	IS-3842 (XXII)	Electrical relays for AC systems (Part-I to application guide)
xxiv.	IS-3231	Electrical relays for power system protection.
xxv.	IS-9124	Electrical relays, guide for Maintenance and field-testing.
xxvi.	IS-5834 (Part-I to III)	Electrical timer relays for industrial purposes.
xvii.	IS-8686	Static protective relays.
xviii.	IS-142	Specification for electrical protective relay
xxix.	IS-722-1977 (Part-I to IX)	A.C. Electricity meters.
xxx.	IS-11426	Alternating current precision kilowatt hour meter clause 0.5 for testing purpose.
xxxi.	IS-1248	Indicating instruments.
xxii.	IS-375	Bus bars, main connection & Aux. wiring marking & arrangement.
xxiii.	IS-6875	Control switches (LV switching devices for control and auxiliary circuit)
xxiv.	IS-9224(Part-II)	HRC cartridge fuse links.
xxv.	IS-2147 IS-3427	Degree of protection provided by enclosures for switchgear cubicles
xxvi.	IS-3202	Climate roofing for Electrical equipment.
xvii.	IS-345	Code for wiring numbers.
xviii.	IS-6005	Code of practice for phosphate Iron and Steel
xxix.	IS-5082	Wrought Aluminum & Aluminum Alloys for electrical purposes
xl.	IS-12729: 1988	Switchgear & control gear for voltages exceeding 1000V General

		Requirements
xli.	IS-2208	Specification for HRC fuses.
o)	**UATs ,SATs & SSTs**	
	IS 2026 (Part I to IV)	Specification for Power Transformer
	IS: 11171	Specification for dry type power transformers.
	IS-1271	Classification if insulating materials for relation to their stability in service
	IS-5	Colours for ready mixed paints and enamels.
	IS-226	Specification for painting of electrical equipments
	IS-144	Specification for PVC insulated unarmoured low voltage power and control cables up-to 1100 V grade
	IS-694 and 1554/IEC-287	Insulation co-ordination application guide
	IS-2165 and IEC-71	Steel casting of high magnetic permeability
	S-4491	Specifications for low voltage disconnectors earthing switches.
	IEC-129 and IEC 1128 &1129	Specifications for electrical cables and current ratings of cables.
	IEC-287	Loading guide of dry type power transformers
		AC earthing induced current switching devices

	IEC-905 IEC-1129 IS-2099 IS-3639 IS-2147 IS-2705 IS-3347 IS-237 NEMA Standard	Specification for HV bushings. Specifications for fittings and accessories for power transformers. Degrees of protection provided by enclosures for LV switchgears and control gears. Specification for current transformers. Dimensions for porcelain transformer bushings Specifications for bushings up to 1kV Average sound level of the transformers.
p)	**415 V system**	
i.	IS-13947-I(Part-I)	General requirement for switchgear and control gear for voltages not exceeding 1000 volts.
ii.	IS-13947(Part-II)	A.C. Circuit Breaker for voltages not exceeding 1000 volts
iii.	IS-13947(Part-IV)	Specification of A.C. contactors of voltages not exceeding 1000V
iv.	IS-8623(Part I to III)	Specification for factory built assemblies of low voltage switchgear and control gear for voltage up to and including 1000 V AC and 1200 V DC.
v.	IS-2147/IEC-529	Degree of protection provided by enclosures for L.V. switchgear and

		control gear.
vi.	IS-2705/IEC-185 (Part I to IV)	Current transformers.
vii.	IS-3156/IEC-186 (Part I to IV)	Voltage transformers.
viii.	IS-3202	Code of practice for climate proofing of electrical equipment
ix.	IS-3231(Part I to III)	Specification for electrical relays.
x.	IS-1554	PVC insulated(heavy duty) electric cables for working voltages up to and including 1100 volts
xi.	IS-1255	Installation and maintenance of power cables up to and including 33kV rating
xii.	IS-1897	Copper strips
xiii.	IS-5	Colour shades
xiv.	IS-6875(Part I to III)	Push buttons & control switches
xv.	IS-4064	Heavy duty air break switches & fuses of voltages not exceeding 1000 volts
xvi.	IS-9224(Part-II)	H.R.C. cartridge fuse links up to 650 volts
xvii.	IS-9385(Part I to IV)	H.R.C. fuses
xviii.	Indian Electricity Rule,1956 (Latest Revision)	For electrical work
xix.	Indian Electricity Act 2003 for electrical works (Latest Revision) Section IV)	
xx.	IS-5578 & IS-11353	Marking and arrangement for switchgear bus bars, main contracts and auxiliary wiring
xxi.	IS-1248(Part I to IX)	Electrical indicating instruments
xxii.	IS-722(Part I to III)	A.C. electricity meters
xxiii.	IS-3072	Code of practice for installation and maintenance of switchgear
xxiv.	IS-10118	Code of practice for selection, installation and maintenance of switchgear and control gear
xxv.	IS-3043	Code of practice for earthing
xxvi.	IS-947-2	Low voltage switchgear and control gear and circuit breaker

xvii.	IS-947-3	Low voltage switchgear and control gear – Load break switches, switch dis-connector and fuse combination units
xviii.	IEC-947-4-1	Low voltage switchgear and control gear- Contractors and motor starters
xxix.	IEC-947-5-1	Low voltage switchgear and control gear - Electromechanical control devices (control switches)
xxx.	IEC-947-5-2	Low voltage switchgear and control gear- Proximity switches
xxxi.	IEC-947-6-1	Low voltage switchgear and control gear - Automatic system selector switches
xxii.	IEC-439(I to III)	Low voltage switchgear and control gear assemblies and Requirement for type tested and partially type tested assemblies
xxiii.	DG sets	
xxiv.	IEC 60034	Rotating electrical machines
xxv.	IEC 60364-3	Electrical installation of buildings – Assessment of general characteristics
xxvi.	BS 5514	Reciprocating internal combustion engines
xvii.	IS 8183	Bonded mineral wool
xviii.	ISO 8528	Reciprocating IC engine driven alternating current generating sets
xxix.	DIN 6270	Internal Combustion Engines, Definitions of Output
xl.	IS 4722	Rotating Electrical Machines
xli.	IS: 8623	Panels
xlii.	IS: 13497	Panels
xliii.	IS: 10118	Panels
xliv.	IS: 5	Color for supply ready mixed paints and enamels
xlv.	IS: 1248	Specifications for Direct Acting Indicating Instruments and their purposes.
xlvi.	IS: 10000	Methods for tests for internal combustion engine
xlvii.	IS: 10002	Specification for performance requirements for constant speed compression ignition (diesel) engine for general purposes (above 20 KW).
xlviii	BS: 5000 (Part –III)	Rotating electrical machines of particular type of for particular applications. Generators to be driven by reciprocating internal combustion engine
q)	Ventilation system	
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 ventilation fans
v.	IS 900	Induction motor installation
vi.	IS 659	Safety code for air conditioning.
vii.	IS 660	Safety code Mechanical refrigeration.
viii.	IS 655	Metal Air ducts
ix.	IS 325	Three phase induction motors.
x.	IS 5111	Measurement for testing refrigerant compressor.
xi.	IS 2825	Unfired pressure vessels.
xii.	IS 4503	Shell and tube type heat exchangers.
xiii.	ANSI B9.1	Safety code for mechanical refrigeration.
xiv.	IS 3069	Relating to Insulation material.
xv.	IS 4671	Expanded polystyrene for thermal insulation purposes.
xvi.		ASHRAE Handbook, Data and Guide Book.
xvii.	IS:1822	AC motor Starters of Voltage not exceeding 1000 V
xviii.	IS:4029	Guide for Testing of Three phase Induction Motor
xix.	IS:277	Specification for Galvanized Steel Sheets
xx.	IS:3588	Specification for Electric Axial flow Fans
xxi.	IS:7613	Air filters for Air Conditioners and Ventilation Tests
xxii.	IS:737	Specification for Wrought Aluminium or Aluminium Alloy Sheets and Strips
xxiii.	IS:661	Code of Practice for Insulation
xxiv.	IS - 2831	Methods of Test for Air Filters used in Air Conditioning and General Ventilation
xxv.	IS:3928	Sodium Flame Test for Air Filters (other than for air supply to IC Engines and compressors)
r)	Fire fighting system	
i)	General	

	NFPA 851 -	Recommended practice for fire protection for hydroelectric generating plants.
	NFPA 72 -	National Fire Alarm Code
	NFPA 70 -	National Electrical Code
	NFPA 101 -	Life Safety Code
	IS 1648 -	Code of Practice for fire safety of buildings (General) fire fighting equipment and its maintenance
	IS 5571 -	Selection of equipment in hazardous area
ii)	**Fire Alarm & Detection System**	
	IS 2189 -	Code & Practice for Automatic fire alarm system
	IS 11360 -	Specification for smoke detectors for use in Automatic electrical fire alarm system
	IS 2176 -	Heat sensitive fire detectors
	IS 2148 -	Specification for flame proof enclosure of electrical apparatus
	IS 694 -	Copper conductor PVC insulated cables
	IS 3700 -	Essential ratings & characteristics of semi-conductor devices
	IS 4237 -	General requirement for switchgear & control gear
iii)	**Water based fire protection system**	
	NFPA 14 -	Installation of standpipe and hose systems
	NFPA 15 -	Water spray fixed system

	TAC document -	Recommendation for fire protection of transformers
	IS 3034 -	Code of practice for fire safety of industrial buildings electrical generator & distributing station
	IS 1239 -	M.S. tubular & other wrought steel Part I & II fittings
	IS 3589 -	Specification for electrically welded steel pipes
	IS 952 -	Fog nozzles for fire brigade use
	IS 3844 -	Code of practice for installation of internal fire hydrants in multi-storeyed buildings
	IS 325 -	3 phase Induction motors
	IS 780 -	Sluice valves for water work purposes
	IS 3512 -	Specifications for spring check type reflux (non return) valve for water works purposes
	IS 903 -	Specification for fire hose deliver couplings, branch pipes, nozzles
	IS 7760 -	Specification for steel glass front cabinet
	IS 901 -	Specifications for couplings double male and double female instantaneous pattern for fire fighting purpose
	IS 5290 -	Specification for landing valve (internal hydrant)
	IS 4927 -	Specification for unlined flax canvas hose for fire fighting
	IS 884 -	Specification for first aid hose reel for fire fighting for fixed installation

	IS 902 - Suction hose compling for fire fighting purpose. IS 554 - Dimensions for pipe threads where pressure fight points are required on the treads. IS 638 - Sheet rubber jointing and rubber insertion jointing IS 778 - Gun- metal gate, globe and cheek valves for general purpose IS 1822 - Starter IS 2379 - Colour code for identification of pipe lines. IS 2643 - Dimensions of pipe threads for fastening purposes IS 816 - Code of practice for use of metal arc welding for general construction in mild steel. IS 822 - Code of practice for inspection of welds. IS 5306 - Code of practice for fire extinguishing installations and equipment on premises.
iv)	**Portable Fire Extinguishers**
	NFPA 10 - Portable fire extinguishers IS 2190 - Code of practice for selection & maintenance of portable first aid fire extinguishers IS 933 - Specification for portable chemical fire extinguisher - Foam type IS 2878 - Specification for fire extinguisher - Carbon dioxide type NFPA 2001 - Standard on inert gas fire extinguishing system
s)	**Illumination system**

i)	**Lighting fixtures and accessories**	
	IS: 1913	General and safety requirements for electric lighting fittings.
	IS: 4012	Dust proof electric lighting fittings.
	IS: 4013	Dust tight electric lighting fittings.
	IS: 1947	Specification for flood lights.
	IS: 1777	Industrial lighting fittings with metal reflectors.
	IS: 3287	Industrial lighting fittings with plastic reflectors.
	IS: 5077	Specification for decorative lighting outfits.
	IS: 2418	Tubular fluorescent lamps.
	IS: 1258	Specification for Bayonet lamp holder.
	IS: 3323	Bi-pin lamp holders for tubular fluorescent lamps.
	IS: 3324	Holder for starters for tubular fluorescent lamps.
	IS: 1534	Ballasts for use in fluorescent lighting fittings.
	IS: 13021	Electronic Ballasts for use in fluorescent lighting fittings.
	IS: 1569	Capacitors for tubular fluorescent, HPMV & HPSV lighting circuits.
	IS: 2215	Starter for fluorescent lamps.
	IS: 418	Tungsten filament general service electric lamps.
	IS: 3553	Watertight electric fittings.
	IS: 9974	HPSV Lamps specification.
	IS: 9900	HPMV Lamps specification.
	IS: 12948	Tungsten Halogen Lamps Specification. (Non-vehicle)
	IS: 6616	Ballasts for HPM lamps.
	IS: 6665	Code of Practice for Industrial Lights.
	IS: 10322	Luminaries requirements (Part 1 to 5) (Sections 1 to 5).
ii)	**Conduits and its accessories and junction boxes**	
	IS: 1653	Rigid steel conduits for electrical wiring.
	IS: 3480	Flexible steel conduit for electrical wiring.
	IS: 2667	Fittings for rigid steel conduits for electrical wiring.
	IS: 3837	Accessories for steel conduits for electrical wiring.

	IS: 4649	Adaptors for flexible steel conduits.
	IS: 5133	Steel and cast iron boxes as enclosure for electrical accessories.
	IS: 2629	Hot dip galvanizing of iron and steel.
iii)	**Lighting Panels**	
	IS: 13947 (Part-I -1193)	Specification for low voltage switchgear and control gear.
	IEC: 947-I	Degree of protection of enclosed equipments (Annexure-C).
	IS: 8828	Miniature air-break circuit breakers for voltages not exceeding 1000 Volts.
	IS: 2959	AC Contactors of voltage not exceeding 1000 Volts.
	IS: 5	Colors for ready mixed paints and enamels.
	IS: 2551	Danger notice plates.
	IS: 9924 (Part-2)	HRC cartridge links for voltage above 650V.
	IS: 5082	Wrought aluminum and aluminum alloys hard rods, tubes and sections for electrical purposes.
	IS: 8623	Factory built assemblies of switchgear and control gear for voltage upto and including 1000V AC and 1200V AC.
	IS: 13947	AC circuit breaker of voltage not exceeding 1000 volts.
	IEC: 947-2	Low voltage switchgear & control-gear & circuit breaker.
iv)	**Electrical Installation**	
	IS: 1293	3 pin plugs.
	IS: 371	Ceiling roses.
	IS: 3854	Switches for domestic and other similar purposes.
	IS: 5216	Guide for safety procedures and practices in electrical works.
	IS: 732	Code of practice for Electrical wiring installations. (System voltage not exceeding 650 Volts)
	IS: 3043	Code of practice for earthing.
	IS: 1944	Code of practice for lighting of public thoroughfares.
	IS: 5571	Guide for selection of electrical equipment for hazardous areas.
	IS: 800	Code of practice for use of structural steel in general building construction.
	IS: 2633	Methods of testing uniformity of coating on zinc coated articles.

	IS: 6005	Code of practice for phosphating iron and steel.
	IS: 3646	Code of practice for Interior Illumination part I, II and III
t)PA & Communication system		
i.	IEC 60065	Audio, video and similar electronic apparatus- Safety requirements.
ii.	IS 10426	Specification for public address amplifier
iii.	IS 9304	Characteristics and method of measurement for sound system equipment.
u) Elevators		
i.	IS 14665 Electric traction lifts : Part 1	Guidelines for outline dimensions of passenger, goods, service and hospital lifts.
ii.	Part 2	Code of practice for installation, operation and maintenance
iii.	Section 1	Passenger and goods lifts.
iv.	Section 2	Service lifts.
v.	Part 3	Safety rules
vi.	Section 1	Passenger and goods lifts.
vii.	Section 2	Service lifts.
viii.	Part 4	Components
ix.	Section 1	Lift buffers
x.	Section 2	Lift guide rails and guide shoes
xi.	Section 3	Lift car frame, car, counter weight and suspension.
xii.	Section 4	Lift safety gears and governors.
xiii.	Section 5	Lift retiring cam
xiv.	Section 6	Lifts doors and locking devices and contacts.
xv.	Section 7	Lift machines and brakes.
xvi.	Section 8 Lift wire ropes.	Controller and operating devices for lifts.
xvii.	Section 9	
xviii.	Part 5	Inspection Manual
xix.	IS - 4691	Protection of motors from moisture
xx.	IS-325-1978	Specification for Three Phase Induction Motors (Rev IV)

xxi.	IS-732-1982	Code of practice for Electrical Wiring Installation (Revised)
xxii	IS-2365	Steel wire Suspension Ropes for Lifts & Hoists
xxiii	IS-3734	Dimensions of Worm Gearing
v)Security system		
i.	IEC 600065	Audio, video and similar electronic apparatus-Safety requirements.
ii.	IEC 60326	Printed Boards
iii.	IEC 60446	Basic and safety principles for man-machine interface, marking and identification, identification of conductors by colours or numerals.
iv.	IEC 60478	Stabilized power supplies, DC output.
v.	IEC 60870-5	Tele-control equipment and systems.

ANNEXURE - D

HVAC System			
SR. NO.	**TITLE OF DRAWING / DOCUMENT**	**Category (Approval / Reference)**	**Tentative Date of Submission**
1	**2**	**3**	**4**
1	Design Memorandum	Ref	
2	Design Calculation		
2.1	Calculation for fresh air requirement for ventilated area including sizing of motor, blower, ventilation duct etc.	App	
2.2	Tonnage calculation for Air Conditioning System	App	
2.3	Exhaust requirement calculation including sizing of motor, blower, ventilation duct etc.	App	
2.4	Coordination of fuse, MCCB, Power contactors	App	
2.5	Water requirement calculation (if any) for ventilation / air conditioning	App	
3	Loading on foundation	App	
4	OGA/Layout Drawings	App	

5	Ventilation Duct (Supply & Exhaust) Plan & Section - Elevation wise at Power House, Transformer Hall, Switchyard & TRT	App	
6	Foundation Drawings for blowers, motors etc.	App	
7	Sub assembly drawing for pneumatic system of fire dampers	App	
8	Sub assembly drawing for booster blowers (common / localized)	App	
9	Sub assembly drawing for bracket, clamp, insert, frame etc.	App	
10	Methodology for duct formation.	Ref	
11	Component wise weight schedule, lifting arrangement & safety arrangement	Ref	
12	Earthing arrangement drawings of panels / electrical installations etc.	Ref	
13	All Electrical & Control Drawings such as Electrical Panels OGA, Cable Block & Termination Diagram, Schematic Diagram, JB/MB/Kiosk Diagram etc. in respect of HVAC System	App	
14	Erection Procedure documents along with all the drawings pertaining to this section	Ref	
15	Technical Datasheet & Catalogue of every component used under this chapter	App	
16	GTP as in Schedule-II	App	

Annexure –E

QA&I Formats

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VENDOR / SUB-VENDOR ASSESSMENT SHEET

TO BE FILLED-IN BY SUPPLIER / SUB-VENDOR

NAME OF SUPPLIER / SUB-VENDOR IN FULL		
	REGISTERED OFFICE	FACTORY / WORKS
ADDRESS		
TELEPHONE NO.		
FAX NO.		
EMAIL ID		
PERSON(S) TO BE CONTACTED (NAME & DESIGNATION & MOBILE NO.)		
WEEKLY OFF		

SHIFT WORKING		Type of Company (Pl. Tick)		Type of Industry (Pl. Tick)	
OFFICE	WORKS	Pvt. Ltd	Public Ltd.	MSME	Large Scale
ONE ☐	ONE ☐	Proprietary ☐	Partnership ☐	Govt. ☐	Contractor ☐
TWO ☐	TWO ☐	Public Sector ☐			
THREE ☐	THREE ☐				

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Sr. No.	Items / Services / Process for which Approval is desired for	Rating / Size & Type	Applicable Standards IS/DIN/BS/IEC Etc.

REGISTRATION DETAILS #

PAN / TAN NO.	CENTRAL SALES TAX REG. NO.	STATE SALES TAX / TIN NO.	EXCISE DUTY REGISTRATION NO.

EXCISE CONTROL CODE NO.	SERVICE TAX REG. NO.	CATEGORY OF INDUSTRY	REGSISTRATION NO. & VALIDITY DATE
		Micro ☐ Small ☐ Medium ☐ Large ☐	

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A.	ORGANISATIONAL SOUNDNESS		
SR. NO.	DESCRIPTION	DETAILS TO BE FURNISHED	
1.	Nature of Business (Strike whichever is not applicable)	Manufacturing Unit / Engineering Consultant / Agents / Distributors / Stockists / Dealers / Traders / Indian Subsidiary / EPC contractor / Channel Partner (Attach authorization certificate of principal) / Erection contractor / Other	
2.#	Year of commencement of Business / Factory Establishment		
3.	Year of Commencement of Manufacture / Services		
4.	Total Area/Covered Area in Sq. m.	**Total Area**	**Covered Area**
5.	Electric Power-Connected Load		
6.#	Electric Power Standby Load & System		
7.	Details of Directors		

Sr. No.	Name	Designation	Qualification	Experience

8.	Details of Employees

Pleases attach copy of Company's Organization Chart (For Unit)

Division Status	Graduate		Diploma	Skilled	Un-Skilled	Remarks
	Technical	Non-Technical				
Production						
Engineering & Quality Control						
Administration & Other Supporting activities						

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9.	Brief Details of Product and Manufacturing Capability				
Sr. No.	Item & Material	Description (Type, Size Rating)	Annual Production for Last Three Years		
			I	II	III

10.#	Details of Foreign or Indigenous Collaborator				
Sr. No.	Product	Name & Address of Collaborator	Collaboration		
			Scope	Year	Valid up to

11#	Have your product been type tested by any external agency? If so, give details			
Sr. No.	Product	Test (Size / Type & class	Test Report No.	Next Due date

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12.#	Have you been approved by any Statutory agency / third party agency like LLOYD, ASME, NTPC, PGCIL, EIL, Railways etc. ? If so, indicate details and enclose copies of approval letters				
Sr. No.	Item / Material / Service / Process	Description (Size, Type & Class)	Agency	Date of approval	Next Due date

13.#	Indicate Approval / Certification by National / International Standards / Agencies applicable for the subject product.		
Sr. No.	Product	Codes / Standards	License No. & Date

14.#	Reference List (Experience in Particular Type of Equipment / Service / Process). Please indicate since how many years similar type of item / equipment / service / process provided (please furnish documentary evidence).				
Sr. No.	Item / Material / Service / Process	Type & Capacity / Rating	Customer (End User with Address)	Date of Supply / Service provided	Under Operation since year / Month

#Note: Please furnish the performance feedback certificate for proposed item / equipment / process / service form end user in line with requirement stipulated in Technical Specification.

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15.#	Business Commenced with SAPDC/SJVN in past		
Sr. No.	Year	Name of Department / Project Dealt with	Item Supplied / Services Offered.

16.A#	Machinery, Instrument & other Equipment Specific to Process & Product Facilities / service				
Sr. No.	Description of Machine	Capacity & Nos.	Location Shop	Make	Year of Manufg.

16.B#	Other General Facilities				
Sr. No.	Description of Machine	Capacity & Nos.	Location Shop	Make	Year of Manufg.
i	Material Handling Mobile Crane Fork Lift Over Head Cranes				
ii	Metal Cutting &				

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	Bending				
iii	Casting				
iv	Forging				
v	Fabrication				
vi	Welding				
vii	Machining				
viii	Heat Treatment				
ix	Sheet Metal				
x	Fettling & Cleaning, Sand Blasting, Shot Blasting & Pickling				
xi	Painting				
xii	Metal Coating				
xiii	Protection before packing				
xiv	Packing				
xv	Other				

17.#	If In-House Manufacturing Facilities not available, inform source of manufacturing details along with their facilities and experience			
Sr. No.	Process outsourced	Name of the company	Description of machine / Equipment	Remarks

18. A#	Facilities for In-house Testing & Inspection				
Sr. No.	Description	Capacity & Nos.	Make & Year of Mfg.	Calibration Status	Approval Qualification

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18.a#	If In-house testing facilities are not available, indicate source of testing with relevant details.					
Sr. No.	Source of Testing	Description	Capacity & Nos.	Make & Year of Mfg.	Calibration Status	Approval Qualification

Note: In case of outsourcing of major testing such as NDT, Electrical & Mechanical testing, no marks will be awarded. However, material composition testing by chemical method from NABL Lab shall not attract negative marking.

18 C #	Details of any Government Laboratory facility available in area	
	Product related testing facility (type / Performance / Routine / Acceptance Test)	

19	Sources of Raw Material and Bought out Items	
Sr. No.	Description of Raw Material / Bought Out Items	Source

20 #	Storage Area Availability	
	Storage for finished goods (Open / Close)	
	Raw Material storage and identification	

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21 #	Do you have in-house Design / R&D departments?	
22 #	Details of pending legal issues on contractual aspects with customers, if any.	
23 #	Please furnish details of Labour problems in the last three years, if any?	

B.	FINANCIAL SOUNDNESS OF ORGANIZATION			
	Financial Information for last Three Years (Please furnish copy of annual report)			
Sr. No.	Parameters	Year 20	Year 20	Year 20
1#	Please furnish annual turnover of the company.			
	Growth in annual turnover w.r.t. previous years (%)			
2#	Please furnish Profit before tax (PBT) of the company.			
	Growth in PBT w.r.t. previous years (%).			
3#	Please indicate the net worth (Net current assets – Net current liabilities) of the company?			
4#	Whether the vendor has been referred to BIFR / NCLT / any other similar Govt. agency.			
5#	Whether the supplier is a potentially sick company.			
6	Please mention current order book position, as on date in terms of Value and time			

C.	QUALITY SYSTEM	
SR. NO.	DESCRIPTION	Sub-vendor response (along with supporting document)
1*	Are you an ISO 9001 company? If yes, please furnish the certificate and what is your quality policy?	
2*	Is the company an ISO 14000 approved?	
3#	Is the company an OHSAS approved?	
4*	Have your company won any Quality award like Rajeev Gandhi National Quality Award, IMC Ramkrishna Bajaj National Quality Award, Golden Peacock National Quality Award etc? If yes provide documentary evidence.	
5*	Have you received appreciation letter from your customer. Please provide evidence.	
6	To whom your Q.C./Q.A. Chief reports to ? (Please furnish your organization structure)	
7*	If you have a written quality control manual/procedure, then please furnish the same.	

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7 (i)*	Incoming Material Control System (Furnish a copy of system and organization)	
7 (ii)*	Process Control: Are written procedure defining stage wise operations and functions on shop floor established and followed? (Furnish copy of work instruction and record of process control parameter)	
7 (iii)*	Manufacturing/Testing Procedure Qualification & Personnel Qualification (Procedure qualification specification & Record of personnel qualification (PQR) to be submitted).	
7 (IV)*	Are written Quality Control Instruction sheets prepared & properly used? (Please furnish evidence)	
7 (V)#	Are records generated during inspection maintained & available for review? (Please furnish evidence)	
7 (VI)*	Are quality control checks / procedure adequate to maintain desired quality level right from the incoming stage to final stage? Please furnish copy of such control checks / procedure.	
8.#	**Documentation Control**	
8 (i)	Does a system for clear and precise stipulation of responsibilities for documentation issue & change control exists?	
8 (ii)	Are changes made in writing?	
9*	**Control of Inspection, measuring and testing equipment**	
9 (i)	Are necessary gauges, testing and measuring equipment's, available and used?	
9 (ii)	Are testing and measuring equipment properly maintained?	
9 (iii)	Is recorded control on calibration of equipment available?	
10*	System of Identification & Traceability of materials, tools, jigs, fixtures & processed components, etc. (Copy of procedure to be submitted).	
11*	System of Storage / Preservation / Painting and Packing (copy of Procedure to be submitted)	
12*	Do you have written procedure for disposing off the non-conformities? If yes, please furnish the copy of the same also furnish three copies of NCR & CAPA.	
13*	Safety measures (Submit copy of safety system & record of accidents for last two years)	
14#	What type of Sampling Inspection Plan is used in your factory/company? Please furnish details.	
15	How good are you in keeping your dispatch commitments? Please give details of last ten deliveries stating details as below (Provide documentary evidence) Within delivery period:	

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	Delayed but accepted by user: Delayed but accepted with penalty:	
16*	Have you ever been de-listed or put in under temporary suspension by any customer / contractor.	
D.	**AFTER SALES SERVICE**	
SR. NO.	DESCRIPTION	Sub-vendor response (along with supporting document)
1*	For overcoming product deficiencies what are the analytical methods used at Customer's premises?	
2*	What is the strength of your "after-sales service" team?	
3*	What is the response time after receiving complaints from the customers? Provide evidence.	
4*	Customer complaints handling system (Submit list of customer complaints & status for the last three years) Please furnish complete list of complaints attended to during last one year.	
5*	How do you keep your "after-sales service" team updated?	
6*	Provide certificate from 02 customers (end user) for satisfactory after sails services.	

Declaration by Director/ Partner/ Proprietor

I declare that the information furnished above and attached documents are correct to the best of my knowledge, I undertake to inform you at the earliest any change(s) in the details mentioned above.

Signature and Date

Name & Designation

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TO BE FILLED BY MAIN CONTRACTOR FOR SUB-VENDOR (MC)

Sr. No.	Parameters	Supplier response (along with supporting document)
1	Name and address of sub-vendor:	
2 (a)	Type of equipment / item / process / service for which approval is sought:	
2 (b)	Details of equipment / item / process / service for which approval is sought (i.e. Rating, capacity, type, size, weight, etc.):	
3	Experience of main contractor with sub-vendor:	
(a)*	Since how many years sub-vendor is registered with you for proposed type of equipment / item / process / services (furnish documentary evidence):	
4#	Whether sub-vendor is meeting the qualification criteria indicated in the technical specification (furnish documentary evidence).	
5*	Sub-vendor rating as per contractor's internal procedure in the scale 0-10 or 0-100% (furnish documentary evidence).	
6#	Any dispute of main contractor with vendor during execution of last 05 contracts.	
7#	Have you ever de-listed or put in temporary suspension the proposed sub-vendor? If yes, please provide the reason for same.	
8	Please indicate the reason for re-approving / re-listing the sub-vendor.	

I declare that the information furnished by Sub-vendor has been verified and found in order / minor changes which have been marked and initialed on this form itself / observed the following discrepancies.

(Signature & Designation)

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GUIDELINES TO SUPPLIERS FOR FILLING-UP VENDOR/SUPPLIER REGISTRATION FORM

1. All columns are to be filled up properly in the space provided for. Wherever it is not applicable / not available, please mention "Not Applicable" / "Not Available". All pages of the form are to be signed along with seal by the authorized signatory.
2. A separate sheet may be attached if the space provided is insufficient or additional information is to be given, Please put proper identification tag on the separately attached sheet.
3. Any information / clarification required by SAPDC/ Consultant during evaluation must be given expeditiously.
4. Please ensure that all required enclosures are attached with the filled up Vendor Registration Form.
5. Marks shall be awarded on the basis of documentary evidences submitted by Vendor / sub-vendor wherever called in vendor / sub-vendor assessment form.
6. Incomplete or incorrect forms will be rejected.
7. Please fill up the check list given below and send along with the vendor registration forms to SAPDC/Consultant.
8. In case any information found incorrect / false, the vendor shall be rejected / de-listed at any stage.
9. Information with # marks is score able.
10. Accepting or rejecting a vendor is sole discretion of SAPDC.
11. Product catalogue / manual for the proposed item / equipment / process / service, if available, shall be submitted alongwith other documents.

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Furnish following information/Documents:-

Sr. No.	Description	Yes / No	Page No / Annexure
1	Latest audited annual account.		
2	Balance Sheet.		
3	Valid Income Tax Clearance Certificate.		
4	Details of Pending Arbitration cases.		
5	Details of pending disputes with Statutory Authorities.		
6	Organization chart		
7	Copy of Performance certificate (minimum 03)		
8	Copy of minimum three (03) completion certificates of similar work / service.		
9	Letter of approval from ASME / NTPC/ EIL / Railway / Lloyds / Power Grid etc. if any.		
10	ISO: 9001 certificate		
11	Quality Manual		
12	ISO: 14000 certificate		
13	OHSAS, ISO 18000 certificate		
14	Experience list		
15	Type test report & approval certificate		
16	Product Approval certificate from national / international agency.		
17	Quality award certificate		
18	Process and Personnel qualification certificates		
19	Copy of registration / enlistment with reputed / large organizations		
20	Detail of existing clients and details such as address, contact number and mail address.		
21	List of works / projects of similar nature executed with documentary evidences of works executed in last 02 years.		
22	Other documents mentioned elsewhere in vendor / sub-vendor assessment form.		

(Signature & Designation)

	SJVN	FORM NO.: F-060-02 PAGE: 1 of 1 ISSUE: 2.0 REV. 01 DATE: 30/06/2016
	FORM	

PROJECT NAME (MW)	MANUFACTURING / FIELD QUALITY ASSURANCE PLAN				CONTRACTOR NAME, ADDRESS & LOGO
ITEM DESCRIPTION	SUB-ITEM	QAP NO.	REV. NO	ISSUE DATE	SUB-CONTRACTOR NAME, ADDRESS & LOGO

SR. NO.	COMPONENT & OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
					M/C	S				M	C	S	
1	2	3	4	5	6		7	8	9	10			11

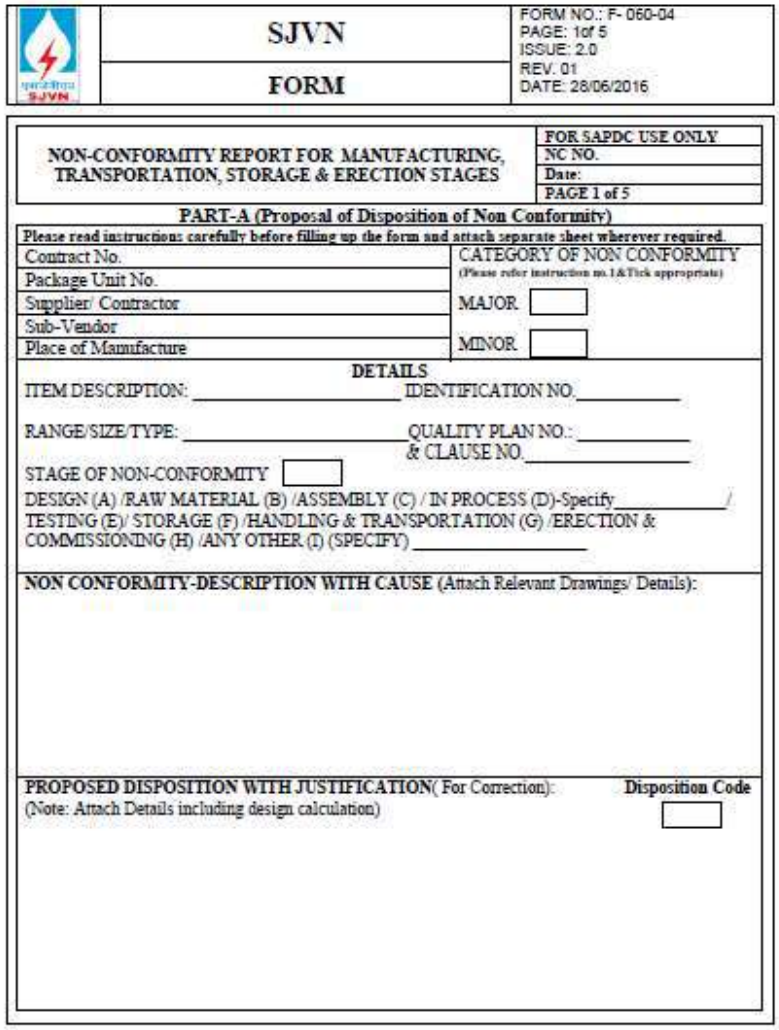
LEGENDS

M	MANUFACTURER	C	CONTRACTOR	S	SAPDC LTD.
P	PERFORM	V	VERIFICATION OF RECORDS	W	WITNESS / CHP
IR	INSPECTION REPORT	DRG	DRAWING	CHP	CUSTOMER HOLD POINT
MA	MAJOR	MN	MINOR	CR	CRITICAL
ME	MEASUREMENT	NDT	NON DESTRUCTIVE TESTING	HT	HEAT TREATMENT
TR1	CERTIFICATE OF COMPLIANCE TO TS/STANDARD REQUIREMENT WITHOUT ANY CHECK LIST OF TESTS CARRIED OUT.	TR2	CERTIFICATE OF COMPLIANCE TO TS/STANDARD REQUIREMENT WITH CHECK LIST OF TESTS CARRIED OUT.	TR3	TEST REPORT/TEST CERTIFICATE WITH TEST RESULTS BASED ON SPECIFIC INSPECTION & TESTING AT MANUFACTURER FACILITY/NABL APPROVED LAB.

NOTE: QAP SHALL BE READ IN CONJUNCTION WITH QUALITY ASSURANCE REQUIREMENT GIVEN AS PART OF TECHNICAL SPECIFICATION

MANUFACTURER / SUB-CONTRACTOR:		CONTRACTOR:	FOR SAPDC USE:	REFERENCE DOC NO. OF SJVN:	
PREPARED BY:	REVIEWED BY	REVIEWED & RECOMMENDED BY	REVIEWED BY	RECOMMENDED BY	APPROVED BY
NAME, DESIGNATION & SIGNATURE	NAME, DESIGNATION & SIGNATURE	NAME, DESIGNATION & SIGNATURE	NAME & SIGNATURE	NAME & SIGNATURE	SIGNATURE & SEAL

Prepared By:	Reviewed By:	Approved By: Process Owner



SJVN	FORM NO.: F- 060-04 PAGE: 1of 5 ISSUE: 2.0 REV. 01 DATE: 28/06/2016
FORM	

NON-CONFORMITY REPORT FOR MANUFACTURING, TRANSPORTATION, STORAGE & ERECTION STAGES	FOR SAPDC USE ONLY NC NO. Date: PAGE 1 of 5

PART-A (Proposal of Disposition of Non Conformity)

Please read instructions carefully before filling up the form and attach separate sheet wherever required.

Contract No.	CATEGORY OF NON CONFORMITY (Please refer instruction no.1&Tick appropriate)
Package Unit No.	
Supplier/ Contractor	MAJOR ☐
Sub-Vendor	
Place of Manufacture	MINOR ☐

DETAILS

ITEM DESCRIPTION: _____ IDENTIFICATION NO._____

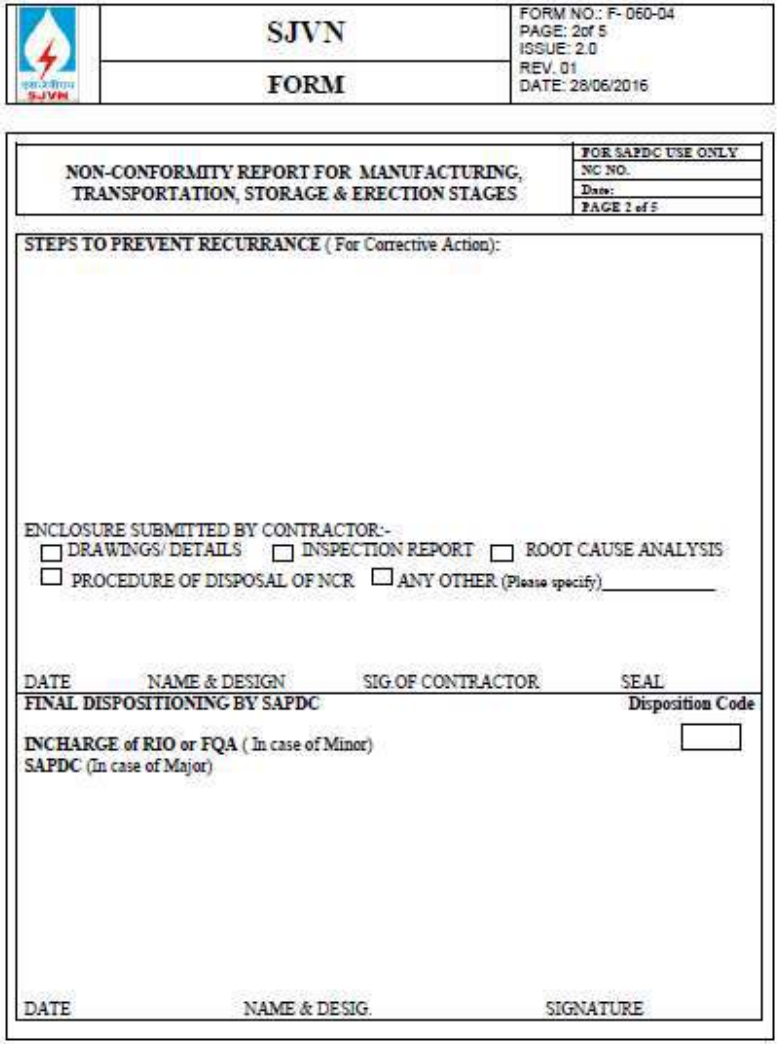
RANGE/SIZE/TYPE: _____ QUALITY PLAN NO.: _____
& CLAUSE NO._____

STAGE OF NON-CONFORMITY ☐

DESIGN (A) /RAW MATERIAL (B) /ASSEMBLY (C) / IN PROCESS (D)-Specify_____/
TESTING (E)/ STORAGE (F) /HANDLING & TRANSPORTATION (G) /ERECTION & COMMISSIONING (H) /ANY OTHER (I) (SPECIFY) _____

NON CONFORMITY-DESCRIPTION WITH CAUSE (Attach Relevant Drawings/ Details):

PROPOSED DISPOSITION WITH JUSTIFICATION(For Correction): **Disposition Code** ☐
(Note: Attach Details including design calculation)



SJVN	FORM NO.: F- 060-04 PAGE: 2of 5 ISSUE: 2.0 REV. 01 DATE: 28/06/2016
FORM	

NON-CONFORMITY REPORT FOR MANUFACTURING, TRANSPORTATION, STORAGE & ERECTION STAGES	FOR SAPDC USE ONLY NC NO. Date: PAGE 2 of 5

STEPS TO PREVENT RECURRANCE (For Corrective Action):

ENCLOSURE SUBMITTED BY CONTRACTOR:-
☐ DRAWINGS/ DETAILS ☐ INSPECTION REPORT ☐ ROOT CAUSE ANALYSIS
☐ PROCEDURE OF DISPOSAL OF NCR ☐ ANY OTHER (Please specify)_____

DATE NAME & DESIGN SIG OF CONTRACTOR SEAL

FINAL DISPOSITIONING BY SAPDC **Disposition Code** ☐

INCHARGE of RIO or FQA (In case of Minor)
SAPDC (In case of Major)

DATE NAME & DESIG. SIGNATURE

SJVN	FORM NO.: F- 060-04 PAGE: 3of 5 ISSUE: 2.0 REV. 01 DATE: 28/06/2016
FORM	

NON-CONFORMITY REPORT FOR MANUFACTURING, TRANSPORTATION, STORAGE & ERECTION STAGES	FOR SAPDC USE ONLY NC NO. Date: PAGE 3 of 5

FOR SAPDC INTERNAL USE ONLY

RECOMMENDATION of INCHARGE of RIO or FQA (In case of Major)/ **CONCERNED SAPDC 's INSPECTION/ SITE ENGINEER** (In case of Minor) — **Disposition Code** [ ]

DATE NAME & DESIG. SIGNATURE

RECOMMENDATION OF SAPDC CONCERNED ENGINEER — **Disposition Code** [ ]

DATE NAME & DESIG. SIGNATURE

GROUP HEAD

DATE NAME & DESIG. SIGNATURE

RECOMMENDATION OF SAPDC (FOR MAJOR CATEGORY)
(Comments of Engineering / Others deptt as applicable to be considered)

DATE NAME & DESIG. SIGNATURE

SJVN	FORM NO.: F- 060-04 PAGE: 4of 5 ISSUE: 2.0 REV. 01 DATE: 28/06/2016
FORM	

NON-CONFORMITY REPORT FOR MANUFACTURING, TRANSPORTATION, STORAGE & ERECTION STAGES	FOR SAPDC USE ONLY NC NO. Date: PAGE 4 of 5

PART B (Verification of Corrections of Non- Conformity)
(Filled after Completion of corrections of Non-Conformity)

ACTION TAKEN BY SUPPLIER/ CONTRACTOR (Attach Report of verification)

DATE NAME & DESIGN SIG OF SUPPLIER/ CONTRACTOR SEAL

VERIFICATION BY SAPDC'S SITE ENGINEER/ INSPECTION ENGINEER

DATE NAME & DESIG. SIGNATURE

IN-CHARGE of RIO/ FQA

DATE NAME & DESIG. SIGNATURE

COMMENTS OF SAPDC ENGINEER

DATE NAME & DESIG. SIGNATURE

GROUP HEAD

DATE NAME & DESIG. SIGNATURE

HOD

DATE NAME & DESIG. SIGNATURE

SJVN	FORM NO.: F- 060-04 PAGE: 5of 5 ISSUE: 2.0 REV. 01 DATE: 28/06/2016
FORM	

NON-CONFORMITY REPORT FOR MANUFACTURING, TRANSPORTATION, STORAGE & ERECTION STAGES	FOR SAPDC USE ONLY NC NO. Date: PAGE 5 of 5

INSTRUCTIONS

1. 'MAJOR' NONCONFORMITY IS DEFINED AS DEPARTURE FROM SPECIFICATION WHICH AFFECTS PERFORMANCE RELIABILITY. SAFETY INTERCHANGEABLITY. ERECTION, COMMISSIONING OR WORKING LIFE ALL OTHER NON-CONFORMITIES SHALL BE TREATED AS CATEGORY 'MINOR'.
2. ACCEPTANCE OF DISPOSITIONED NO N-CONFORMANCE IS WITHOUT PREJUDICE TO SAPDC RIGHT TO CLAIM COMMERCIAL REBATE AND DOES NOT ABSOLVE CONTRACTUAL OBLIGATIONS.
3. OBTAINING APPROVAL OF STATUTORY AUTHORITY IF ANY W.R.T. ABOVE NON CONFORMANCE IS THE RESPONSIBILITY OF SUPPLIER/ CONTRACTOR.
4. DISPOSITIONING OF THIS NON-CONFORMANCE IS FOR THIS SPECIFIC CASE ONLY AND NOT TO BE REGARDED AS PRECEDENCE.
5. **DISPOSITION CODE** THE NON-CONFORMANCE SHALL BE DISPOSITIONED AS UNDER BY SAPDC AND SUPPLIER. (GIVE CODE AT APPROPRIATE BOXES):-
   (01) NC-REJECTED **(02)** NC- CONDITIONALLY ACCEPTED (SPECIFY CONDITION) **(03)** NC-ACCEPTED AS-IT-IS **(04)** NC-ACCEPTED WITH REPAIR.
6. **NC NUMBER** - THIS NO. SHALL BE ALLOTTED BY SAPDC AND SHALL HAVE SAPDC,PROJECT NAME, PACKAGE, FOLLOWED BY RUNNING SERIAL NO. & ENTER TO NC REPORT BY RIO / FQA / CQAI.

RESPONSIBILITIES OF CONTRACTOR

1. ASCERTAIN EXACT NATURE OF NON-CONFORMANCE AND ALONGWITH SUPPORTING DRAWING OF ITEMS/ EQUIPMENT ETC WITH WHICH NON-CONFORMANCE EXISTS.
2. IDENTIFY THE CAUSE OF NON CONFORMITY.
3. DECIDE ON CODE OF DISPOSING.
4. FINALISE THE CAUSE OF NON-CONFORMITYAND PROPOSE CORRECTIVE ACTION.
5. ENSURE AND CERTIFY THAT THE PRODUCT QUALITY PERFORMANCE RELIABILITY AND WORKING LIFE IS NOT AFFECTED FOR MINOR NON-CONFORMITIES AND QUANTIFY THE EXTENT TO WHICH IT IS AFFECTED IN THE CASE OF CATEGORY 'MAJOR' NON-CONFORMITIES.
6. IMPLEMENT AGREED CORRECTIVE ACTION IN A TIME BOUND PROGRAMME AND PROVIDE FEEDBACK AS PER PART-B OF THE FORMAT

RESPONSIBILITIES OF RIO/ FQA

1. IDENTIFY THE PRODUCT APPROPRIATELY.
2. ANALYSE THE CAUSE OF NON-CONFORMITYAND PROPOSE RECOMMENDATION

SJVN	FORM NO.: F-060-06 PAGE: 1 of 1 ISSUE: 2.0 REV. 00 DATE: 30/06/2016
FORM	

INSPECTION CALL REQUEST

Inspection Call No.			Date:			
Project:			Contract No. :			
Contractor/Supplier's Name & Address:			Sub-vendor/Sub-Supplier's Name & Address:			
Contact Person:			Contact Person:			
Telephone/Mobile No.:			Telephone/Mobile No.:			
Fax No.			Fax No.			
email ID:			email ID:			
Details of Equipment with Unit No.:						
Sr. No.	Equipment/Item Description and Sr. No.	Unit No.	BBU Ref.	QAP No. & Rev. No.	Relevant QAP Clause No.	Approved Drawing No. & Rev. No.
Status of Type Tests	Approved / Not Approved / Not Applicable		Place of Inspection:			
Proposed date of Inspection:			Anticipated Working Days Required			
Status of internal inspection by Vendor/sub-vendor			Completed ☐	In-progress ☐	Yet to be done ☐	
Tentative date of completion of internal inspection in case inspection is in-progress/yet to be done:						
Note: Readiness status is to be submitted separately after completion of internal inspection by Manufacturer.						

Date:
Place:

Signature
Name
Designation
Department
Company

Sr. No	Vol. / Section & Clause No.	Original Tender Provision	Amended Tender Provision
		Section-VI, Section-1 GTS	
1.	Clause no. 1.1.3, Page no. 1-175	Climatic Condition Average …… Minimum river water temperature: 10ºC	Climatic Condition Average …….. Minimum river water temperature: 10ºC Standard Design temperature for EM equipments : 40º C* *Wherever specific design temperature is mentioned in different section, those clauses shall prevail.
2.	Clause no. 1.11 (last para), Page no. 33-175	Contractor shall devise the training module for the technicians for operation of EOT cranes	Contractor shall devise the training module for the technicians for operation of EOT cranes during construction at site.
3.	Clause no. 1.19, Page no.47 -175	All …… soft form. Bidder shall submit Ten (10) number hard copies of the documents & drawings to purchaser for reference / review / approval.	All …….. soft form. Bidder shall submit Ten (10) number hard copies of the documents & drawings to purchaser for record after approval / review. However, during approval / review stage, two (2) number hard copies along with editable soft copy shall be submitted.
4.	Clause no. 1.2 (J) (i), page no. 6-175	Size: 62 m (L) x 12 m (W) x 21 m (H)	Size: 83.7 m (L) x 12 m (W) x 21 m (H)
5.	Clause no. 1.2.1, page no. 9-175	Power system study report containing various data on Generator, Governor, Excitation System, Insulation coordination etc. shall be shared with the successful bidder for reference after award of the contract.	Power system study (to be conducted by employer) report containing various data on Generator, Governor, Excitation System, Insulation coordination etc. shall be shared with the successful bidder in due course of time for reference & detail engineering of various EM equipments after award of the contract. However, furnishing of said report by the employer shall not at all to be linked with the various design activities being undertaken by the contractor after award of contract.
6.	Clause no. 1.6, page no. 14-175 & clause no. X.2 (where X is chapter number i.e. 2 to 29 wherever	...The relevant abstract (in soft / hard copy) of all referred standards shall be provided free of cost during engineering stage for facilitating review/ approval of submitted drawing/documents…	…The relevant abstract reproduced in "word/pdf" format (in soft / hard copy) of all referred standards shall be provided during engineering stage for facilitating review/ approval of submitted drawing/documents….

<table>
<tr><th>Sr. No</th><th>Vol. / Section & Clause No.</th><th>Original Tender Provision</th><th>Amended Tender Provision</th></tr>
<tr><td></td><td>applicable)</td><td></td><td></td></tr>
<tr><td>7.</td><td>Clause no. 1.2 (I) (v), page no. 6-175</td><td>Surge Levels<table><tr><td>Load case 100-0-0 (up)</td><td>El. 879.75 m</td></tr><tr><td>33-100-0 (up)</td><td>El. 863.35 m</td></tr><tr><td>100-0-33 (down)</td><td>El. 826.79 m</td></tr><tr><td>0-100-100 (down)</td><td>El. 801.61 m</td></tr></table></td><td>Surge Levels<table><tr><td>Load case 110-0-0 (up)</td><td>El. 886.45 m</td></tr><tr><td>Load case 100-0-0 (up)</td><td>El. 879.75 m</td></tr><tr><td>33-100-0 (up)</td><td>El. 863.35 m</td></tr><tr><td>100-0-33 (down)</td><td>El. 826.79 m</td></tr><tr><td>10-100-100 (down)</td><td>El. 801.61 m</td></tr></table></td></tr>
<tr><td>8.</td><td>Sr. No. 1, Annexure – A, Section-I, GTS, page no. 63 - 175</td><td>Sr. No. 1 (For Turbine):-

Min Accepted Guaranteed Value – 94.5%

Note:- Credit shall be given in evaluation up to 94.8% guaranteed weighted average efficiency only</td><td>Sr. No. 1 (For Turbine):-

Min Accepted Guaranteed Value – 94.3%

Note:- Credit shall be given in evaluation up to 94.6% guaranteed weighted average efficiency only</td></tr>
<tr><td>9.</td><td>Clause no. 1.16 (b), page no. 45&46-175</td><td>…… bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. In case ……..</td><td>…… bid opening. These reports should be for the tests conducted on the equipment similar (i.e. as per IEC / equivalent standards) to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory (NABL approved or equivalent) . In case ……</td></tr>
</table>

	ARUN-3 HYDRO ELECTRIC PROJECT NEPAL (4X225 MW) HVAC SYSTEM PROJECT SPECIFIC GENERAL REQUIREMENTS	SPECIFICATION No: PE-TS-437-571-11000A-A001	
		SECTION : I	
		SUB-SECTION : C3	
		REV. 00	DATE: OCTOBER 2020

SECTION: I

SUB-SECTION: C3

TECHNCIAL SPECIFICATION

(ELECTRICAL PORTION)

TECHNICAL SPECIFICATION

FOR

HVAC

(ELECTRICAL PORTION)

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 this 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.

	ELECTRICAL EQUIPMENT SPECIFICATION FOR HVAC 4 X 225 MW ARUN-3 HEP NEPAL	SPECIFICATION NO. VOLUME NO. : II-B SECTION : C REV NO. : 00 DATE : 19.5.2020 SHEET : 3 OF 3

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.

5.0 The stipulations of specification (in decreasing order) Section-C(customer specification), Datasheet-A, followed by those of Section-D, shall prevail in case of any conflict between the stipulations of specification Section-C (customer specification), Datasheet-A and Section-D.

REV: 00 DATE: 19.5.2020

ANNEXURE – I TO SECTION – C : STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR
PACKAGE: HVAC (CIVIL IN CUSTOMER- SJVN SCOPE)

PROJECT:

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	Vendor	-	1. 415 V AC/240 V AC supply shall be provided by Vendor *
2	Local Push Button Station (for motors)	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	-	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	-	
5	Cable trays, accessories & cable trays supporting system	Vendor	-	
6	Cable glands and lugs for equipments supplied by 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	-	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	-	
9	Equipment grounding & lightning protection	Vendor	-	
10	LT Motors with base plate and foundation hardware	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	-	
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.

REV: 00 DATE: 19.5.2020

ANNEXURE – I TO SECTION – C : STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR
PACKAGE: HVAC (CIVIL IN CUSTOMER- SJVN 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.
3. * BHEL shall provide non cabled feeders for HVAC MCC of Bidder scope. All cable and cabling from BHEL MCC to Bidder MCC is in scope of Bidder

1.6 Standards

The design, manufacture and testing of the various equipment covered under this specification shall comply with the requirements of the latest edition of the relevant IEC/IS/IEEE/ISO standards only. Preference for latest IEC standards for particular equipment / system shall be governed over IEEE/ IS/ ISO standards.

The relevant abstract (in soft / hard copy) of all referred standards shall be provided free of cost during engineering stage for facilitating review/ approval of submitted drawing/documents.

Further rules, guide lines and standard laid down by International/ national agencies shall be applicable in this specification.

List of standards is attached at annexure C.

1.7 Logistics

The Contractor shall establish facilities i.e. office, wireless communication system, internet facilities for smooth and effective monitoring of ongoing activities at site.

1.8 Electrical Works

General Information:-

- Dimensions of Panel, Kiosk, Marshalling Box, Junction Box.
- Weight of above
- Lifting arrangement (All arrangement shall be made through hooks only)
- Baseframe (Suitable for anchoring through anchor bolts in embedded foundation channel)
- Pushbuttons, Indicating lamps, indicating instruments, recording instruments shall be from same supplier throughout the EM Package.
- Numerical relays and Electromagnetic relays shall be from same supplier respectively throughout the EM Package.

1.8.1 Power Supplies

1.8.1.1 AC power

Three-phase system with grounded neutral for feeding three-phase and one-phase consumers (connected between phase and neutral), 415/240V ± 10% and 50Hz ,-5% to +3 %. All motors and other electrical apparatus should be designed to work continuously under,-5% to +3 % frequency variation and ±10% voltage variation.

1.8.1.2 DC power

DC Systems, ungrounded, with earth fault detection 220V plus (+) 10% and minus (-) 20% for the supply of main control circuits for high and medium voltage switchgear, protection circuits and to other larger essentials loads.

Other voltage systems eventually needed, shall be generated from the above systems by means of dc/dc converters, inverters etc.

1.8.2 IP requirement

IP requirement shall be based on applicable National/ international standards and the same shall be finalized during detail engineering. However the minimum requirement shall be as under or as specified in the particular technical specifications of various componenets:

- The cubicles and enclosures shall be of protection class IP 42 or higher according to their location.
- For outside installation and area which are humid, corrosive, and prone to dripping and/ or spray of water, the protection class of cubicles shall be IP 65.
- Cubicles housing electronic cards/modules such as of unit control boards/local control boards, digital governors, static excitation equipments shall be of protection class of IP 52.

1.8.3 Cabling & wiring

Wiring within cubicles and equipment enclosures shall conform to requirements of this section unless otherwise specified. Control wiring shall be single / stranded copper subjected to prior approval by purchaser during detailed engineering and shall not be smaller than 2.5 Sq. mm, except as otherwise agreed by the purchaser.

All Distribution Boards, Control & Protection panels, Motor Control control panels etc. shall be supplied completely wired internally up to the terminal blocks ready to receive purchaser control cable.

All inter cubicle and inter panel wiring and connections between panels of same Distribution Board, Control & Protection panels, Motor Control panels including all bus wiring for AC and DC supplies shall be provided by the tenderer.

Larger size wiring shall be used where needed for the current carrying capacity requirements.

Cables shall have at least 1000 V PVC insulation except for 220V DC and telemetering or communication system equipment for which 650V and 300 V ratings respectively are acceptable.

For current and potential transformer secondary circuits the minimum cross section of the conductors shall not be less than 4.0 Sq. mm.

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 wire ways accessible from the front door.

Engraved core identification ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire.

Each cubical 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.

1.8.4 Power outlets

Power outlet for utilities such as electric drills, welding equipment etc., shall be provided in all floors of the powerhouse to enable repair and maintenance works to be done locally/ in-situ.

1.8.5 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.

Terminal blocks shall be 1100V grade and have continuous rating to carry the maximum expected current on the terminals.

Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short circuiting and earthing facilities.

The terminal shall be such that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally.

The conducting part in contact with cable shall preferably be tinned or silver plated. The terminal blocks shall be of extensible design. The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.

The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.

Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.

All circuits except CT/ PT circuits	Minimum of two of 2.5 sq. mm copper flexible
All CT/ PT circuits	Minimum of 2 nos. of 6 sq. mm copper flexible

The arrangements shall be made in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.

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

At least 20% spare terminals shall be provided on ach panel / cubicle / box and these spare terminals shall be uniformly distributed on all terminals rows.

There shall be minimum clearance of 250 mm between the first / bottom row of terminal block and the associated cable gland plate. Also, the clearance between two rows of terminal blocks shall be a minimum of 150 mm.

1.8.6 Protection requirement

For short circuit and overload protection of power and control circuits, air circuit breakers, moulded case circuit breakers or MCBs shall be used. Outlets from AC (and DC) distribution panels are protected in their respective panels.

1.8.7 Switches, Lamps & Instruments

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 “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 co-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.

Control and Selector switches

The switches and push buttons shall be provided with ample contact ratings, suitable cam or block arrangements necessary for the control functions on 230 V AC or 220 V DC circuits. The control switches used in mimic diagrams shall be of discrepancy type with built in lamp indication.

Control and Selector switches shall be rotary type with escutcheon plates clearly marked to show the function and positions. The switches shall be of sturdy construction suitable for mounting on panel front.

Switches with shrouding of live parts and sealing of contacts against dust ingress shall be provided.

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 (2) contacts closing in close position, and two (2) contacts closing in trip position unless specified otherwise.

Ammeter and voltmeter selector switches shall have four stay out position 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.

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 230V AC and 0.5A 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

Indicating and signaling lamps

Each indicating and signaling lamp shall have a removable cap, which can be

inscribed with wording and shall not be affected with the heat of the lamp.

Indicating lamps are preferably of LED type & low watt consumption and shall be replaceable from the front of the panel. The indicating and signaling lamps shall be of the same size and type.

Lamps shall be provided with series resistors, preferably built-in the lamps assembly. The lamps shall have escutcheon plates marked with its function, wherever necessary.

Lamps shall have translucent lamp-covers of the following colours, as warranted by the application.

Red	:	ACB's/MCCB's close
Green	:	ACB's/MCCB's open
White	:	Auto trip
Amber	:	For all healthy conditions e.g. control supply
Voilet	:	Circuit breaker spring charged
Blue	:	For all alarm conditions (e.g. overload) Also for "SERVICE" & "TEST" positions indicators

Indication lamps should be located just above the associated push buttons/control switches. All indicating lamps shall be suitable for continuous operation at 90% to 110% of their rated voltage.

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 insulated fuse pulling handles shall be supplied with each switchgear.

HRC-Fuse rating shall be chosen by the tenderer depending upon the circuit requirements.

Indicating instruments and Meters

Instruments mounted on panels, shall be of the semi flush type back connected, matching pattern, shape, and of approved finish to present neat and fitting appearance consistent with functional requirements Mechanical quantity measuring instruments which are directly mounted on equipment shall have circular dials and shall be properly supported and guarded against accidental injury/breakage. These shall be placed in convenient locations.

The instruments shall accurately measure and indicate the quantity under all conditions of operation with minimum instrument errors. Changes in ambient temperature within the range prevailing at site shall not affect the accuracy

Contact making instruments shall have contacts suitable for 240 V AC or 220 V DC circuits.

The reading scales on the dials shall be in metric units only and range shall be such that the normal operating values of the quantities are indicated in the middle 3rd of the scale. The dials pointer etc. shall be designed to facilitate accurate reading by minimizing parallax and glare from instrument window and by providing clear bold dial markings. The size of dial and length of the scales of the indicating instruments shall be large enough to suit the requirements. The scale plates of panel mounted indicating instruments shall have a permanent white mat finish with black graduations and the pointer shall also be of the black colour. Instruments mounted on panels shall be of flush type and shall be back connected. All instruments on a switchgear panel shall be of matching pattern, shape and finish so as to present a pleasing appearance consistent with the functional requirements.

All instruments shall conform to relevant International or national applicable standards. These shall be subjected to tests prior to dispatch. The instruments shall be shock, vibration and moisture proof. The electrical instruments shall withstand dielectric test of 2000 V RMS to ground for one (1) minute as per standards.

The coils of electrical instruments shall be designed for continuous operation at 110% of the full load current at instrument potential. The coil rating of the measuring instruments shall be coordinated with those of the associated instrument transformers (i.e. CTs, PTs, etc.) by the supplier. The VA burden of the instruments shall be as low as possible. The meters shall be of the first grade in respect of accuracy

classification.

Energy meter shall be suitable for 3-phase, 4-wire unbalanced system and shall comply generally with the relevant standard. All instruments shall be tested in accordance with the requirements of relevant standards.

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 secondary of potential transformers and from secondary of current transformers, with transformer ratios and connections indicated on the contract drawings.

The meters shall be provided with primary-rated, direct reading registers, with five or more 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 isolation according to IEC Publication 60521. The tolerance ambient temperature range of the meters shall be 0 to 45 degrees C.

The protection class of the Wh meters shall be 0.2 and the VArh meters 0.2 according to IEC Publication 60687.

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 an output signal of 4-20 mA, filtered DC.

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 elements, three-phase.

Accuracy class of the transducers shall be 0.5 or better.

Measuring transformers

All current and voltage transformers shall be completely encapsulated cast resin insulated type suitable for continuous operation at the temperature prevailing inside the switchgear enclosure, when the distribution board is operating at its rated condition and the outside ambient temperature is 40 deg.C.

All instrument transformers shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit and momentary current ratings of the associated switchgear.
All instrument transformer shall have clear indelible polarity markings. All secondary terminals shall be wired to a separate terminal on an accessible terminal block where star-point formation and earthing shall be done.

All VTs shall have readily accessible HRC current limiting fuses on both primary and secondary sides.The class of insulation should be E or better.

The parameter & rating of CTs & PTs are minimum requirement & tentative only. Contactor shall submit the calculations for selection of CT/PT for approval to purchaser.

Potential transformer secondary windings shall be rated 110 / V3 V

Current transformer secondary windings shall have a rated current of 1A / 5A.

1.8.8 Nameplates and Labels

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.

The module identification plate shall clearly give the feeder number and feeder designation wherever applicable. For single front switchboards, similar panel and board identification labels shall be provided at the rear also.

All name plates shall be of non rusting metal or 3-ply lamicoid with white engraved lettering on black back-ground, inscriptions and lettering sizes shall be as per their standard practice. Suitable plastic sticker labels shall be provided for easy identification of all equipments, 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.

1.8.9 Motors

All electric motors for driving various equipments shall conform to relevant standards viz. IEC, BS or IS as applicable.

The motor rating, torque characteristics, speed etc. shall be selected to suit the duty requirements.

Type of starter for motors shall be duly approved by the purchaser during detailed engineering. The detailed design calculation for selection of type of starters is to be submitted for approval. The priority for type of starters shall be in the following order:

1. Variable frequency drive
2. Soft starter
3. Star delta/ auto –transformer
4. Direct on-line starter

The enclosure of each motor shall be of the type best suited for the service conditions of the motor

The motor insulation shall be resistant to moisture, oil or oil vapor and the motors in general shall be so designed as to suit the tropical climate. Varnished cambric or glass insulation class F shall be used for connection from the windings to the terminals.

The terminal box shall be closed conduit box type conveniently located, and shall have means for terminating the external wiring for outdoor use. The motor terminals shall be of the stud type totally enclosed. Eye bolts or lugs shall be provided for lifting.

Space heaters to avoid condensation shall also be provided.

Special type of motors, not adequately covered by these specifications, shall be offered for any special application, but these shall be subject to the approval of purchaser.

1.8.10 Construction power

Contractor shall make arrangement for the construction power for ensuring uninterrupted execution of the works. Suitable no. of DG sets shall be installed at strategic locations for extending uninterrupted power supplies to various sites.

1.8.11 Temporary Power and Lighting

The work relating to all temporary lighting and power facilities required for the installation work shall be carried out by the contractor under this contract and shall be included by the bidders in their offer. These temporary installations shall include cables, outlets, and conduits, supports, insulators, fuses, switches and other required materials.

The materials used for temporary facilities shall not be reused in any permanent installation. The work regarding removal of all temporary facilities from the plant premises, after the same have served the purpose, is also covered under the scope of these specifications.

1.8.12 Space heaters

Space heater shall be provided in the Distribution Boards, Control & Protection panels, Motor Control panels etc. The space heaters shall be suitable for continuous operation on 240V AC, 50 HZ single phase supply, and shall be automatically controlled by thermostats. Necessary isolating switches and fuses shall also be provided.

1.8.13 Auxiliary relay, contacts and devices

All relays and timers in protective circuits shall be flush mounted on panel front with connections from the inside. They shall have transparent dust tight covers removable from the front. All protective relays shall have a draw out construction for easy replacement from the front. They shall either have built-in test facilities, or shall be provided with necessary test blocks and test switches located immediately below each relay. The auxiliary relays and timers may be furnished in non-draw out cases.

All AC auxiliary relays shall be suitable for operation with VTs and CTs secondaries.

DC auxiliary relays shall be designed for 220V DC unless otherwise specified and shall operate satisfactorily between 80% and 110% of the rated voltage. Relays shall have adequate thermal capacity for continuous operation in circuits in which they are used.

All protective relays and timers shall have at least two potentially free output contacts. Relays shall have contacts as required for protection schemes. Contacts of relays and timers shall be silver faced and shall have a spring action. Adequate number of terminals shall be available on the relay cases for applicable relaying schemes.

Suitable number of auxiliary contacts or auxiliary relays shall be provided with each VCB's / ACB's for indication, remote indication, annunciation and automatic

changeover and interlocking scheme.

All protective relays, auxiliary relays and timers shall be provided with hand reset operation indicators (flag) for analyzing the cause of operation.

1.9. Mechanical Works

1.9.1 Materials selection

Materials shall be new and of high-grade quality, suitable for the purpose, free from defects and imperfections, and of the classifications and grade listed herein, or their equivalents subject to acceptance by the Owner. Material specifications, including grade or class shall be shown on the appropriate Contractor's detail drawings submitted for review. Materials not listed herein but equivalent in their basic properties may be used subject to the Owner's review of their acceptability.

S. No.	Material	Specification
1	Carbon-steel castings	DIN-1681, Steel castings for general use: quality specifications, grade GS-45 / GS-60 ASTM A27 Grade 65-35 GS-45/ GS-60
2	Iron castings	DIN-1691, Gray iron castings for general use: quality specifications, grade GG-22 and GG-26.
3	Corrosion-resistant steel castings	DIN-17445, Stainless quality specifications type G-X 8 Cr Ni 13 (1.4008) and G-X 6 Cr Ni 18 9 (1.4308), For runners EN Grade:X4 CrNiMo 16-5-1 (Number 1.4418), EN Grade GX4 CrNIMo 16-5-1 (Number 1.4405)
4	Corrosion-resistant steel plate, bars, pipes	DIN-17440, Stainless steel: quality specifications: X 2 Cr Ni Mo 1810(1.4404) X2 Cr Ni Ti 1810 (1.4541) X10 Cr Ni Mo Ti 1810(1.4571) X22 Cr Ni 17 (1. 4057) DIN 2462 Seamless stainless steel pipes.
5	Hardened	DIN-17440, Stainless steel: quality

1.9.2.5 Field welding

Filler material required for field-welded joints shall be furnished by the Contractor. The Contractor shall perform all welding work at site in accordance with the applicable WPS. Only qualified welders shall be used for undertaking welding as per the applicable WPS.NDT shall be performed as per the approved drawings.

Preparation for field welding

All cutting, chamfering, and other shaping of metals necessary for the field connection shall be done as far as possible in the shop. Adequate temporary bolted field connections shall be provided to hold the assemblies rigidly and in proper alignment during shop and field assembly.

To ensure proper alignment during field erection, a minimum of two dowels shall be provided for each field connection between subassemblies. The holes shall be drilled and the dowels fitted at shop assembly after the subassemblies have been satisfactorily aligned. All stipulations for welding, structural work and other, shall be applied to fieldwork as well as to shop work, except where otherwise stated.

1.9.3 Painting

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 required number of coats. The Contractor shall perform all painting work in the shop, before shipment, followed by a final coat of paint at site after installation as per the standard procedure.

All materials, supplies, and articles furnished shall be the standard products of recognized reputable manufacturers.

Colour schedule of equipment supplied shall be finalized during detailed design stage.

1.9.4 Galvanization

All materials to be galvanized shall be of the full dimensions shown or specified and all punching, cutting, drilling, screw tapping and the removal of burrs shall be completed before the galvanizing process commences. All galvanizing shall be done by the hot dip process with smelter, not less than ninety eight percent (98%) of which must be pure zinc. No alternative process shall be used without the approval of the purchaser. No components shall be galvanized which are likely to come into subsequent contact with oil. Bolts shall be completely galvanized

including the threads, but the threads shall be left uncoated in the case of nuts. The zinc coating shall be uniform, clean, smooth and as free from spangle as possible. In the case of component parts the zinc coating shall weigh not less than 0.6 kg/m2 over the area covered and be not less than 0.09mm in thickness. All galvanizing shall comply with the requirements of the relevant ASTM standards/Indian Standards. All galvanized parts shall be protected from injury to the zinc coating due to differential aeration and abrasion during the period of transit, storage and erection. Damaged areas of the coating shall be touched up with an approved zinc dust paint or other approved flake metallic compound.

1.9.5 Pumps

All pumps forming part of the generating units and other plant and equipment shall be of high performance requisite type (viz. centrifugal, rotary etc.) and rating, of reputed make, and shall be directly coupled to their driving motors. The pumps shall be of self priming type and with proper sealing systems and protection.

The materials of construction of pumps in general shall suit the service conditions. The materials of construction of the pumps handling water, such as drainage & dewatering pumps, turbine top cover drainage pumps etc. shall be resistant to abrasive effects of silt in such water. The pumps shall operate quietly without undue noise and vibration in their full operating range of head and flow. They shall be easy to maintain.

1.9.6 Embedded parts, Anchor Bolts and Fasteners

All embedded anchor bolts, rods, pipes, welding plates and support plates shall be provided by contractor. Anchor bolts shall consist of a threaded steel rod installed inside a pipe sleeve to provide lateral adjustment after the sleeve is embedded. 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.

1.9.7 Pipes, valves, Bends, Flanges

Connections to penstock shall be kept to the minimum. All penstock and tail water connections shall be double valve. The penstock and tail water connections shall be embedded wherever possible. The material used for pipe connections to the penstock and draft tube shall have proven ductility with Charpy impact values of not less than 35 J at – 20 ºC.

A. The Sub-Contractor shall have designed, manufactured, type tested and at least the specified quantity of the all equipments covered under the scope of this contract of at least the rating as specified herein under or higher in last 20 years and supplied equipment should be in successful operation for at least 2 years in last 7 years as on the date of Bid opening in Power Plant or Sub-stations or Industrial Complex etc. Equipment / system wise rating for sub-vendor selection is as below:-

Sr. No.	**Equipment / System**	**Minimum rating required**
1	415V LT SYSTEM	Draw out type LT switchgear 415 V, 4000 Amp. of short time withstand capacity, 63 kA for one sec. (Minimum 50% feeders as per SLD)
3.		
4.	CABLES & Cable Trays	FRLS type control cables, power cables(ac/dc) and cable trays of different sizes of specified voltage for 100MW plant and above
3	400 KV GIS & 400 KV SF6 CGI Bus Ducts	420 kV Class GIS & 420 kV CGI Bus Ducts and auxiliary equipment 400 kV (minimum) 50 Hz, 50% of rated current, 40 kA(min.) short circuit rating, SF6 gas insulated switchgear for indoor/outdoor installation for minimum of 50% bays as per SLD.
4.	POT HEAD YARD	400 kV Pot Head Yard (2 bays)
5.	Computer Based Control, And Monitoring System	Control and Monitoring Systems for minimum of 200 MW power stations and above.
6.	Protection System	IEC 61850 Numerical based protection system for generator, Line and Busbar, HV & LV system.

1.21.2 Safety of operation

All equipment and services provided under this contract shall abide by commonly accepted standards for safety of operation.

The various system and sub-systems supplied under this contract shall be designed to follow and operate under a clear hierarchical structure:

- plant control level,
- unit control level,
- functional control level, functional drive group level,
- Local drive level.

Each hierarchical control level shall perform its specific tasks and always depend on the subordinate lower control levels. In general, should a higher control level failure occur, the lower control level shall not be affected and shall be able to control the power plant with full safety.

The Contractor shall accordingly build into the "Electrical & Mechanical System" adequate levels of autonomy, independence, redundancy and functional distribution to insure that safety is maintained at all times.

1.22 Earthing

Earthing terminals for equipment of these specifications shall form part of equipment supplies. The contractor shall connect the earthing conductors to these terminals as required.

Risers from earthing bus shall be in the scope of purchaser. However, extension from these risers to the equipment shall be in the scope of supplier in the Power House, Transformer Hall, Switchyard and Butterfly Valve House.

However, overall earthing arrangement required for HT panel, LT panel, DG set, motor & motor control panels etc. at isolated location such as Dam Site, TRT Outfall area and Surge Shaft either by pit earthing or counter poise etc. shall be in the scope of supplier including civil works, design, material supply (for main earthing risers, interconnection, charcoal, salt, Bentonite etc.), erection, testing & commissioning etc.

1.23 Completeness of the specification

Any fittings, accessories, equipments or any other things required for successful commissioning of Arun-III Hydro Electric Project, though may not have been specifically mentioned in the specification but are usually necessary for the completeness of the equipment shall be deemed to be included in the specification

and shall be supplied by the contractor without any extra cost to the Employer.

1.24 Packaging and Shipment

The contractor shall wrap, pack and crate all plant included in the work or part thereof, suitable for shipment to a tropical location, facilitating proper handling and protection from damage in rail, truck, ocean or air shipment as applicable. An approved drying agent, such as Silica Gel, shall be packed in containers or packages holding plant which may be adversely affected by moisture or excessive humidity.

All packing crates shall be clearly marked before shipping to indicate the contract number, shipping address, volume, weight, name, number and unit number of the contents, slinging and weight bearing points.

All plant parts shall be marked to facilitate erection. Each packing crate shall contain a packing list in a waterproof envelope. Parts shall be described and also identified by their numbered marking in the packing list.

Three copies of the packing list shall be forwarded to the purchaser prior to dispatch. The ownership of packaging materials shall be of Employer. All wooden packaging crates and steel support structures shall be dumped to the designated area within 5kms of the power house as per the direction of Engineer in charge.

8	**XLPE**	Total Losses (Copper Losses + Dielectric losses etc.) in kW	As quoted by bidder	125000 per kW (corresponding to lowest quoted losses amongst the bidders)	250000 per kW@@	>10% of guaranteed losses quoted by the bidder	At Works	At Works**

N.A.: Not Applicable

****:** The Contractor shall have to make good and meet the guarantees in case of shortfall in test values vis-à-vis guaranteed values. Two month, will be given to the Contractor for the same for rectification and re-demonstration.

##: Rectification process shall be governed according to the relevant clauses given in respective TS section.

@@: Penalty shall be imposed on Total looses which shall be calculated as Total measured length of IPBD / GIS Bus duct / XLPE Cable laid multiplied by per kW loss per meter length respectively.

Annexure-B.1

xxxi.	IS-1364	Hexagon Head bolts, screw and Nuts for product Grade A and B (Part 1 to V)
xxii.	IS-2705	Current Transformers
j)	**Unit control system**	
i.	IEC 60255	Electrical relays
ii.	IEC 60297	Dimension of mechanical structure of 19 inch series
iii.	IEC 60326	Printed Boards
iv.	IEC 60446	Basic and safety principles for man-machine interface, marking and identification, identification of conductors by colours or numerals
v.	IEC 60478	Stabilized power supplies, DC output
vi.	IEC 60625	Interface system for programmable measuring instruments
vii.	IEC 61000	Electromagnetic compatibility for industrial process – measurement and control equipment
viii.	IEC 61131	Programmable controllers
ix.	IEC 61158	Digital data communications for measurement and control – Field bus for use in industrial control systems
x.	ISO/IEC 8802	Information technology
xi.	IEEE 1046	Application guide for distributed digital control and monitoring for power stations
xii.	IEC 60870-5	Tele-control equipment and systems
xiii.	IEC 60793 Part 1	Optical Fibre- Measurement and test procedures
xiv.	IEC 60793 Part 2	Optical Fibre- Product specifications
k)	**Unit protection system**	
i.	IEC 50(16) International Electro Technical Vocabulary	
ii.	IEC -68-1 Environmental Testing Part I (General & Guidance)	
iii.	IEC-255-1-00 Electrical Relays -All or nothing Electrical Relays	
iv.	IEC -255 Electrical Relays	
v.	Part 3 Single Input Energising Quantity Measuring Relays with Dependent or Independent Time	
vi.	Part 5 Insulation Tests	
vii.	Part 6 Measuring Relays with more then One Input Energising Quantity	
viii.	Part 7 Test and Measurement Procedures for Electromechanical all or nothing Relays	
ix.	Part 8 Thermal Electrical Relays	

x.	Part 10 Application of the IEC Quality Assessment System for Electronic Components for all or nothing Relays
xi.	Part 11 Interruption to and Alternating Component (Ripple) in DC Auxiliary Energising Quantity of Measuring Relays
xii.	Part 12 Directional Relays and Power Relays with Two Input Energising Quantities
xiii.	Part 13 Biased (%)Differential Relays
xiv.	Part 16 Impedance Measuring Relays
xv.	Part 21 Vibration, shock, Bump & Seismic Tests on Measuring Relays & Protection Equipment
xvi.	Part 22 Electrical Disturbance Tests for Measuring Relays & Protection Equipment IEC -255 Electrical Relays - Part 23 Contract Performance
xvii.	IEC -337 Control Switches & Low Voltage Switching Devices for Control & Auxiliary Circuits
xviii.	IEC 529/ DIN 40050 Degree of Protection provided by Enclosures (IP Code)
xix.	IEC 617/BS 3950 Electrical Protective Systems for A.C. Plant
xx.	BS: 4227 (Part-I) Relay Terminology
xxi.	BS 142 Electrical Protection Relays
xxii.	ASA C 5013 Electrical Relays
xxiii.	IS: 1885 Electro Technical Vocabulary
xxiv.	Part-IX Electrical Relays
xxv.	Part-X Electric Power System Protection
xxvi.	Part-XVIlI Switch gear and Control Protection
xvii.	IS: 3231 Specification for Electrical Relays for Power System Protection
xviii.	IS: 3842 Application Guide for Electrical Relays for AC System
xxix.	Part-I Over Current Relays for Feeders and Transformers
xxx.	Part-IV Thermal Relays
xxxi.	
xxii.	Part-V Distance Protection Relays

xxiii.	Part- VI	Power Relays	
xxiv.	Part- VII	Frequency Relays	
xxv.	Part-VIII	Voltage Relays	
xxvi.	IS: 8686	Specification for Static Protective Relays	
xvii.	IS: 12083	Special Requirements for Protection Relays	
xviii.	IS:8686	- Static Protective Relays	
xxix.	IS:8686	- Static Protective Relays	
xl.	IEC:255	- Electric Relays	
xli.	(Part 1 to 19)		
xlii.	IS:3231	- Electric relays for power system protection	
xliii.	IS:2208	- HRC fuses	
xliv.	IS:3842	- Applicable guide for electrical relays for A.C.	
xlv.	(Part 1 to 10)	system	
xlvi.	IS:1248	- Direct acting electrical indicating instruments	
xlvii.	IS:2419	- Dimensions for panel mounted indicating recording instruments	
lviii.	IS:5834	- Electric Timer relays	
xlix.	IS:722	- A.C. Electricity meters	
l)	**Cables**		
i.	IS-694	PVC insulated cables for working voltages up to and including 1100V.	
ii.	IS-1554 (Part-I)	PVC insulated (heavy duty) electric cables for working voltages up to and including 1100V.	
iii.	IS-1554 (Part-II)	PVC insulated (heavy duty) electric cables for working voltages from 3.3kV up to and including 11kV.	
iv.	IS-3961	Recommended current ratings for cables	
v.	IS-8130	Conductors for insulated electric cables and flexible cords.	
vi.	IS-5831	PVC insulation and sheath of electric cables.	
vii.	IS-6380	Specification of Elastomeric Insulation & Sheath of Electric Cables.	
viii.	IS-7098 (Part-I & II)	Cross linked polyethylene insulated PVC sheathed cables for working voltages up to 33kV.	
ix.	IS-3975	Mild steel wires, strips and tapes for armouring cables.	
x.	IS-1753	Aluminium conductors for insulated cables.	

xi.	IS-10418	Drums for electric cables
xii.	IS-10810 (Part 0 to 63)	Methods of test for cables
xiii.	IS-6474	Polyethylene insulation and sheath of electric cables.
xiv.	IS-5819	Recommended short circuit ratings of high voltage PVC cables.
xv.	IEC-60502	Power Cables with extruded insulation & their accessories for rated voltages 1kV to 30 kV
xvi.	IEC-540 & 540A	Test methods for insulation and sheaths of electric cables and cord.
xvii.	IEC-60332	Test on electric cables under fire conditions.
xviii.	IEC-60754	Test on gases evolved during combustion of electric cables.
xix.	IEC Hand Book for Temperature Index	Cable in fire regarding temperature Index Chapter-6.
m)	EOT Crane	
i.	IS-3177/BS:466	Code of Practice for Electric overhead traveling cranes and gantry cranes other than steel work crane
ii.	IS-807/BS:2573	Code of practice for design, manufacture, erection and testing (Structural portion) of cranes and hoists.
iii.	IS-5749/BS:3017	Forged Ramshorn hook.
iv.	IS-2266/BS:302	Specifications for steel wire ropes for general engineering purposes.
v.	IS-6938	Code of Practice for design of rope drum and chain hoists for hydraulic gates.
vi.	IS-325/BS:2960	Three phase induction motors.
vii.	IS-13947(Part 4/sec 1)	Contactors and motor starters – Electromechanical contactors & motor starter.
viii.	IS-2062	Steel for general structural purposes.
ix.	IS-3815	Point hooks with shanks for general engineering purpose.

	IEC-905 IEC-1129 IS-2099 IS-3639 IS-2147 IS-2705 IS-3347 IS-237 NEMA Standard	Specification for HV bushings. Specifications for fittings and accessories for power transformers. Degrees of protection provided by enclosures for LV switchgears and control gears. Specification for current transformers. Dimensions for porcelain transformer bushings Specifications for bushings up to 1kV Average sound level of the transformers.
p)	**415 V system**	
i.	IS-13947-I(Part-I)	General requirement for switchgear and control gear for voltages not exceeding 1000 volts.
ii.	IS-13947(Part-II)	A.C. Circuit Breaker for voltages not exceeding 1000 volts
iii.	IS-13947(Part-IV)	Specification of A.C. contactors of voltages not exceeding 1000V
iv.	IS-8623(Part I to III)	Specification for factory built assemblies of low voltage switchgear and control gear for voltage up to and including 1000 V AC and 1200 V DC.
v.	IS-2147/IEC-529	Degree of protection provided by enclosures for L.V. switchgear and

		control gear.
vi.	IS-2705/IEC-185 (Part I to IV)	Current transformers.
vii.	IS-3156/IEC-186 (Part I to IV)	Voltage transformers.
viii.	IS-3202	Code of practice for climate proofing of electrical equipment
ix.	IS-3231(Part I to III)	Specification for electrical relays.
x.	IS-1554	PVC insulated(heavy duty) electric cables for working voltages up to and including 1100 volts
xi.	IS-1255	Installation and maintenance of power cables up to and including 33kV rating
xii.	IS-1897	Copper strips
xiii.	IS-5	Colour shades
xiv.	IS-6875(Part I to III)	Push buttons & control switches
xv.	IS-4064	Heavy duty air break switches & fuses of voltages not exceeding 1000 volts
xvi.	IS-9224(Part-II)	H.R.C. cartridge fuse links up to 650 volts
xvii.	IS-9385(Part I to IV)	H.R.C. fuses
xviii.	Indian Electricity Rule,1956 (Latest Revision)	For electrical work
xix.	Indian Electricity Act 2003 for electrical works (Latest Revision) Section IV)	
xx.	IS-5578 & IS-11353	Marking and arrangement for switchgear bus bars, main contracts and auxiliary wiring
xxi.	IS-1248(Part I to IX)	Electrical indicating instruments
xxii.	IS-722(Part I to III)	A.C. electricity meters
xxiii.	IS-3072	Code of practice for installation and maintenance of switchgear
xxiv.	IS-10118	Code of practice for selection, installation and maintenance of switchgear and control gear
xxv.	IS-3043	Code of practice for earthing
xxvi.	IS-947-2	Low voltage switchgear and control gear and circuit breaker

xvii.	IS-947-3	Low voltage switchgear and control gear – Load break switches, switch dis-connector and fuse combination units
xviii.	IEC-947-4-1	Low voltage switchgear and control gear- Contractors and motor starters
xxix.	IEC-947-5-1	Low voltage switchgear and control gear - Electromechanical control devices (control switches)
xxx.	IEC-947-5-2	Low voltage switchgear and control gear- Proximity switches
xxxi.	IEC-947-6-1	Low voltage switchgear and control gear - Automatic system selector switches
xxii.	IEC-439(I to III)	Low voltage switchgear and control gear assemblies and Requirement for type tested and partially type tested assemblies
xxiii.	DG sets	
xxiv.	IEC 60034	Rotating electrical machines
xxv.	IEC 60364-3	Electrical installation of buildings – Assessment of general characteristics
xxvi.	BS 5514	Reciprocating internal combustion engines
xvii.	IS 8183	Bonded mineral wool
xviii.	ISO 8528	Reciprocating IC engine driven alternating current generating sets
xxix.	DIN 6270	Internal Combustion Engines, Definitions of Output
xl.	IS 4722	Rotating Electrical Machines
xli.	IS: 8623	Panels
xlii.	IS: 13497	Panels
xliii.	IS: 10118	Panels
xliv.	IS: 5	Color for supply ready mixed paints and enamels
xlv.	IS: 1248	Specifications for Direct Acting Indicating Instruments and their purposes.
xlvi.	IS: 10000	Methods for tests for internal combustion engine
xlvii.	IS: 10002	Specification for performance requirements for constant speed compression ignition (diesel) engine for general purposes (above 20 KW).
xlviii	BS: 5000 (Part –III)	Rotating electrical machines of particular type of for particular applications. Generators to be driven by reciprocating internal combustion engine
q)	Ventilation system	
i.	IS 4720	Code of practice for ventilation of surface hydel power stations.
ii.	IS 3103	Installation, operation, testing and maintenance of ventilation system

XLPE

SR. NO.	TITLE OF DRAWING / DOCUMENT	Category (Approval / Reference)	Tentative Date of Submission
1	2	3	4
1	Design Memorandum	Ref	
2	Design Calculation		
2.1	Cable Sizing	App	
2.2	Earthing / sheath voltage limitation study (Voltage Gradient)	App	
2.3	Heat Losses	App	
2.4	Cable Laying Technique criteria (Flat / Trefoil)	App	
2.5	Loading Distribution on Foundation / Bracket	Ref	
2.6	Temperature rise calculations	App	
2.7	Sizing calculation & short circuit withstand capabilities of metallic sheath	App	
3	OGA / Cable Layout (Plan & Section) for Cable installation	App	
4	Foundation / Clamp / Brackets drawings for cable laying	App	
5	Arrangement of XLPE Cable Trench in Cable Tunnel	App	
6	Cable Termination Arrangement	App	
7	Sheath Earthing / Cable Earthing Arrangement including accessories	App	

8	Cable Laying & handling Procedure document	Ref	
9	XLPE Testing Procedure document	Ref	
10	Component wise weight schedule, lifting arrangement & safety arrangement	Ref	
11	All Electrical & Control Drawings such as Electrical Panels OGA, Cable Block & Termination Diagram, Schematic Diagram, JB/MB/Kiosk Diagram etc. in respect of XLPE	App	
12	Erection Procedure documents along with all the drawings pertaining to this section	Ref	
13	Technical Datasheet & Catalogue of every component used under this chapter	Ref	
14	GTP as in Schedule-II	App	
Cable & Cable Trays			
SR. NO.	**TITLE OF DRAWING / DOCUMENT**	**Category (Approval / Reference)**	**Tentative Date of Submission**
1	**2**	**3**	**4**
1	Design Memorandum	Ref	
2	Design Calculation		
2.1	Cable Sizing & selection	App	
2.2	Short Circuit withstand capability & corresponding temperature rise limits	App	

2.3	Loading calculation on cable tray / cable tray frame	App	
3	Cable Trench Drawing	App	
4	Cable Tray Layout Plan (Elevation wise) sub system wise of Power station (Dam, Power House, PPV, TRT, Transformer Hall, Switchyard etc.)	App	
5	Foundation / Clamp / Brackets drawings for cable laying	Ref	
6	Cable Laying & handling Procedure document	App	
7	Earthing arrangement of Electrical installations, if any	Ref	
8	Cable Schedule including termination (system wise, sub system wise etc.) for Control, Power - AC & DC, CT, PT for entire Power Station (Dam, Power House, PPV, TRT, Transformer Hall, Switchyard etc.)	App	
9	All Electrical & Control Drawings such as Electrical Panels OGA, Cable Block & Termination Diagram, Schematic Diagram, JB/MB/Kiosk Diagram etc. in respect of Cable & Cable Trays	Ref	
10	Erection Procedure documents along with all the drawings pertaining to this section	Ref	
11	Technical Datasheet & Catalogue of every component used under this chapter	Ref	
12	Compliance / Approval for handsets and chargers for two way communication system	Ref	
13	GTP as in Schedule-II	App	

LT SYSTEM

SR. NO.	TITLE OF DRAWING / DOCUMENT	Category (Approval / Reference)	Tentative Date of Submission
1	2	3	4
1	Design Memorandum	Ref	
2	Design Calculation		
2.1	Short Circuit withstand capability & corresponding temperature rise limits for LT panel & sandwich bus duct	App	
2.2	Busbar (Main & Tap-off etc.) Sizing calculation of LT boards	App	
~~2.3~~	~~Sandwich Bus duct Sizing calculations~~	App	
2.4	Coordination study of fuse / MCCB / Power Contactor for each feeder of LT Board	App	
3	Loading on foundations	App	
4	Foundation Drawings for LT panels & sandwich bus duct	App	
5	OGA Drawings	App	
6	Front Panel Drawings	App	
7	Earthing arrangement drawing of Panels / electrical installations	Ref	
8	Interlocking scheme	App	
9	Component wise weight schedule, lifting arrangement & safety arrangement	Ref	

10	All Electrical & Control Drawings such as Electrical Panels OGA, Cable Block & Termination Diagram, Schematic Diagram, JB/MB/Kiosk Diagram etc. in respect of LT System	App	
11	Erection Procedure documents along with all the drawings pertaining to this section	Ref	
12	Technical Datasheet & Catalogue of every component used under this chapter	Ref	
13	GTP as in Schedule-II	App	
	MV System		
SR. NO.	**TITLE OF DRAWING / DOCUMENT**	**Category (Approval / Reference)**	**Tentative Date of Submission**
1	**2**	**3**	**4**
1	Design Memorandum	Ref	
2	Design Calculation		
2.1	Short Circuit withstand capability & corresponding temperature rise limits for MV panels	App	
2.2	Busbar (Main & Tap-off etc.) Sizing calculation of MV boards	App	
3	Loading on foundations	App	
4	Foundation Drawings for LT panels & sandwich bus duct	App	

SECTION-20

415 LTAC SYSTEM

20.1 SCOPE OF WORK

Scope of work under this section covers the provision of ~~labour~~, tools, plants, materials and performance of work necessary for the design, engineering, manufacture, quality assurance, quality control, shop assembly, shop testing, packaging & delivery at site including insurance, ~~unloading, site storage and preservation, in plant transportation at site, erection / installation~~, testing supervision, ~~pre commissioning, successful commissioning~~, performance and acceptance testing, handing over to purchaser and warrantee for two years of 415 V switchgear as per the specifications hereunder, complete with all auxiliaries, accessories, spare parts and warranting a trouble free safe operation of the installation. The scope of work covered under this section shall be read in conjunction with General Technical specifications, ~~Chapter-1~~.

20.1.1 Detailed Scope of Work

The scope of work shall be a comprehensive functional system covering all supply and services including but not be limited to following:

20.1.1.1 415 V Switchgear

3-phase, 50 HZ, 415 V switchgear systems consisting of following major items: Number of switchboards shall be as per BOQ / System requirement

i. Four (4) sets of unit auxiliary boards (UABs) of minimum 1000A, 25kA rating having Cu bus bar with 2 nos. Incomer ACBs.
ii. One (1) set of sectionalized station service board (SSBs) of minimum 4000 A, 63kA rating having Cu bus bar with 4 Incomer ACBs.
iii. One (1) set of sectionalized Distribution boards of minimum 1000A, 25kA rating having Cu bus bar with 3 no Incomer ACBs at Dam & Intake loads.
iv. Five (5) sets of Distribution boards of minimum 630A, 12.5kA rating having Cu bus bar with 2 no Incomer ACBs at Transformer Hall, surge shaft , Pothead yard , PPV house, TRT outfall

20.1.1.2

Sandwich bus duct for the following interconnection as per tender drawings enclosed:-

i) Between UAT and UAB

ii) Between SST and SSB

iii) Between UAB and SSB

20.1.1.3 Control, monitoring and related items and services

Co-ordination and provision of necessary contacts and/or ports for integration with plant SCADA system.

20.1.1.4 Common Supplies and services

i. A suitable trolley mounted earthing device shall be provided which, when in circuit, earths the bus bars of feeder side of the breaker.
ii. Drawings, documents and design calculations as per clause 20.6.
iii. Shop, assembly, inspection & tests as per clause no. 20.7.
iv. Packaging, handling and site storage as per clause no. 20.8.
v. Delivery, installation and commissioning as per clause no. 20.9.
vi. Tools and instruments as per clause no. 20.10.
vii. Spare parts as per clause no. 20.11
viii. Field/touch-up painting including all painting materials.

20.1.1.5 Completeness of System

Any other item (s) not mentioned specifically but necessary for the satisfactory completion of scope of work defined above, as per accepted standard (s)/best international practice.

Notes:

i) All the above sets of boards shall be of indoor metal enclosed 415 V switchgear type, complete with cubicles, Circuit breakers , protection, relays metering instruments, bus-bar system, support insulators, cabling, internal wiring and other accessories, to complete the scope ~~as per Singe Line Diagram No SJVN/ARUN-III/EM-2017-02 & SJVN/ARUN-III/EM-2017-03 & detailed in the specifications.~~

20.2 STANDARDS & REGULATIONS

The design, manufacture and testing of the various equipment covered under this specification shall comply with the requirements of the latest edition of the relevant IEC/IS/IEEE/ISO standards only. Preference for latest IEC standards for particular equipment / system shall be governed over IEEE/ IS/ ISO standards. Further rules, guide lines and standard laid down by international/ national agency shall be applicable in this specification.

The relevant abstract (in soft / hard copy) of all referred standards shall be provided free of cost during engineering stage for facilitating review/ approval of submitted drawing/documents.

20.3 PARAMETERS & GUARANTEES

20.3.1 Scheme

The switchgear system is solidly grounded, 3 phases with Neutral (TPN). The voltage level envisaged for Dam will be at two voltage levels i.e. 33KV & 0.415KV and for Power House & Switchyard it will have three voltage levels i.e. 33KV, 11KV and 0.415KV for MV/LV supply scheme.

Unit auxiliaries will be fed from the 630 KVA 15.75kV/415V, UAB/UAT (Unit Auxiliary Board/Unit Auxiliary Transformer) tapped from the bus duct.

Two (02) 15.75/11 kV, 5 MVA SATs will be installed in power house, one on unit -1 generator transformer LV terminals, the other on unit -4 generator transformer LV terminals, by providing a disconnector between generator and generator transformer.

Station auxiliaries will be fed from the 2.5 MVA 11kV/415V, SSBs/SSTs (station service Board/station service Transformer).

Initially when the generating unit is standstill, the power requirement of unit auxiliary board UAB(1-4) shall be met from SSBs. The SSBs are fed following two sources:

1) Two (02) station service transformers (SSTs) being fed from two separate direct feeders from SATs connected through 11 kV Switchgear.

2) Two (02) 415 V,1MVA DG sets will be installed at 400KV switchyard

The units shall be started one at time. After the unit is synchronized the auxiliary power requirement of the generating unit shall be met by the unit auxiliary transformer(UAT).

3 phase, 415 V Distribution boards shall be provided to meet the power requirements of Transformer hall, TRT, Pothead yard, PPV& Surge shaft.

To cater the needs of DAM site, 3 phase, 415 V Distribution boards shall be provided at DAM site.

It shall be the responsibility of the Contractor to complete the work in all respect and to make the scheme functional ~~as per Singe Line Diagram No SJVN/ARUN III/EM-2017-02 & SJVN/ARUN III/EM-2017-03~~

20.3.2 Rating

A	**Common**	
1.	Location	Indoor
2.	No. of bus bars, 3-phase	1
3.	Rated voltage , V	415
4.	Rated frequency, Hz	50, -5% to +3%
7.	Protection class	IP42
8.	Rated power frequency withstand voltage 60s for main circuits	2kV
9.	Rated power frequency withstand voltage 60s for control circuits	2000 V
10.	Control voltage, DC	200 +10 % / -20%V
11.	Auxiliary AC supply, 3 phase	415 ± 10 %
	Current ratio of CTs	As per SLD
12	Accuracy of CT	
	For O/C and E/F	5P10
	For REF	PS
`	For metering	0.2
B	**UAB**	
1.	Rated current of Bus bar & ACBs, A	1000
	Short circuit current rating for 1 sec	25 kA
2.	Material of Bus bar	Copper
C	**SSB**	
1.	Rated current of Bus bar & ACBs, A	4000
	Short circuit current rating for 1 sec	63 kA
2.	Material of Bus bar	Copper
D	**Transformer hall/Pothead yard/TRT / PPV / surge shaft/ Dam site**	
1.	Rated current of Bus bar & ACBs, A	630
	Short circuit current rating for 1 sec	12.5 kA

2.	Material of Bus bar	Copper
E	**Dam & Intake loads**	
1.	Rated current of Bus bar & ACBs, A	1000
2.	Short circuit current rating for 1 sec	25 kA
3.	Material of Bus bar	Copper
F	**Connections**	
1.	B/w SST & SSB	Sandwich Bus duct
2.	B/W UAT & UAB	Sandwich Bus duct
3.	B/W SSB & UAB	Sandwich Bus duct

20.3.3 Performance Guarantee

The 415 V switchgear along with all auxiliaries and accessories shall be capable of performing intended duties under specified conditions. The Contractor shall guarantee the reliability and performance of the individual equipment as well as of the complete system.

20.3.4 Current ratings and short circuit capabilities

The current ratings/ CT/PT ratings mentioned above & in the SLD are indicative only. However, the rated continuous current of any circuit connection or component shall correspond to the maximum current for which that connection or component is designed to carry continuously during operation, under the most unfavorable service conditions which shall be finalized during detailed engineering.

20.3.5 Temperature Rise

The A.C. distribution boards shall be designed to operate satisfactorily under the site conditions and the maximum temperature attained by any part of the equipment wherein service at an ambient temperature of 40 & - 5 deg.C. shall not exceed the limits specified corrected for the site conditions.

20.4 DESIGN AND CONSTRUCTION

20.4.1 AC Distribution Boards

20.4.1.1 General

The 415 V switchgear shall be metal enclosed indoor cubicles free floor standing type.

All Distribution Board frames shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness not less than 2 mm. Frames shall be enclosed in cold rolled sheet steel of thickness not less than 1.6mm. Doors and covers shall also be of cold-rolled sheet steel of thickness not less than 1.6mm. Stiffeners shall be provided wherever necessary.

All Distribution Boards shall be of dust, vermin proof construction and shall be provided with a degree of protection of IP-52.

Hinged doors and removable covers shall be provided wherever necessary to allow access to all equipment. The frame of the cubicles shall be sufficiently sturdy and the metal sheeting of sufficient thickness to ensure safe transport, mounting and operation without deformation or bulging. Natural ventilation as required shall be provided. Distribution Boards shall be easily extendable on both sides, by the addition of the vertical sections after removing the end covers.

The AC distribution board cubicles should comply with the requirement of relevant Indian Standard and Indian Electricity Rules for providing minimum clearance between phases of the bus and live parts from metallic parts.

Continuous lifting hooks shall be provided to facilitate the installation of the transportable cubicles. All identical circuit breakers and module chassis of same size shall be fully interchangeable without having to carryout modifications.

Adopter panels and dummy panels required to meet the various bus bar arrangements and layouts required shall be included in tenderer's scope of work. All sheet work shall be pretreated, in tanks, in accordance with relevant IS.

20.4.1.2 Compartments

Each cubicle shall be divided into sections, or compartments, housing the incoming, interconnecting or outgoing feeder air circuit breaker units and moulded case circuit breaker units respectively.

After isolation of power and control circuits connections it shall be possible to safely carryout maintenance in a compartment with

the bus bar and adjacent circuits live. Necessary shrouding arrangement shall be provided for this purpose over the cable terminations located in cable alley.

Each ACB and MCCB unit shall be mounted on a carriage assembly, constructed so that the unit can be removed and replaced while the buses are energized. The carriage shall have self-engaging definite position stops for disconnected, test and connected positions. All necessary means shall be provided for easy removal and handling of the unit.

20.4.1.3 Cable compartments

All feeders to and from the cubicle assemblies will be cables ~~except from UAT to UAB, SST to SSBs and SSB to UAB~~. The assemblies shall be accessible for the cables from bottom to each feeder circuit breaker via separate cable compartment. Solder less connectors shall be furnished for each power conductor entering the equipment. Provisions shall be made to clamp and fasten cables in the cable. Compartment. Terminals for cable connection will be suitable for Aluminium cables.

20.4.1.4 Derating of Equipments

The current ratings of all equipments as specified in rating clause are the minimum standards current ratings at a reference ambient temperature of 40 deg.C as per relevant Indian Standards.

The Bidder shall indicate clearly the de-rating factors employed for each component and furnish the basis for arriving at these de-rating factors duly considering the specified ambient temperature.

20.4.1.5 Name plates

Each feeder shall be clearly identified with suitably located nameplate(s). Nameplates shall be furnished for all instruments, control switches, etc. Each section of an assembly shall have an identifying name plate placed near the top edge.

20.4.1.6 Wiring

All secondary and control wiring shall be done with stranded copper wires, current transformer secondary leads shall not be less than 4.0

mm2. All control wiring within the assembly housing shall be installed at the manufacturer's premises.

All connections shall be made with solder less lugs. All wires and connections to remote equipment shall be wired to terminal blocks.

20.4.1.7 Bus bars

Bus bar conductors shall be made of copper. All connections shall be in accordance with the best modern practice.

The 415 volts copper 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. and connection of ample size shall be brought to each feeder compartment, for bolted connection of the feeder.

Phase arrangements shall be R-Y-B from top to bottom, from back to front and from left to right when facing the front of the equipment.

All bus bars shall be clearly marked by engraved letters.

Adequate provisions must be made for the expansion and contraction of the bus bars and other bus bar connections with variation in temperature. Bus bars shall be so arranged that they can be extended in length without difficulty. All bus bars shall be adequately supported by Non-hygroscopic, non-combustible, track-resistant and high strength type Polyester fibre glass Moulded Insulators/Epoxy Insulators. Separate supports shall be provided for each phase and neutral bus bar. If a common support is provided anti-tracking barriers shall be provided between the supports.

All field connections shall be bolted. The connections shall be kept as short and straight as possible. Bus bars, connections and their insulating supports shall be of approved construction, mechanically strong and shall withstand all the stresses, which may be imposed upon them under ordinary working conditions due to vibration, temperature fluctuations, short circuit or other reasonable causes. 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 electrolyte copper.

20.4.1.8 Earth Bus

A galvanized steel earthing bus shall be provided at the bottom of each panel and shall extend throughout the length of each distribution board & protruded at the extreme ends suitably for connection with the earthing grid. It shall be bolted to the frame work of each panel and breaker earthing contact point, vertical earth bus shall be provided in each vertical section which shall in turn be bolted to main horizontal ground bus.

The earth bus shall have sufficient cross-section but not less than **size 25x5mm** thick to carry the momentary short circuit and short time fault currents to earth without exceeding the allowable temperature rise. However the **calculations** for arriving at the size of the earth bus shall be furnished with the bid.

All non-current carrying metal work of the distribution board shall be effectively bonded to the earth bus. Electrical conductivity of the whole distribution enclosures frame work and the truck shall be maintained even after painting.

All metallic cases of relays, instruments and other panel mounted equipments shall be connected to earth bus by independent stranded copper wires of size **not less than 2.5 mm.sq.**

VT and CT secondary neutral point earthing shall be at one place only i.e. on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit shall be removed without disturbing the earthing of other circuit.

All hinged doors shall be earthed through flexible earthing braid.

20.4.1.9 Instruments

Control switches and instruments shall be mounted on the circuit breaker compartment doors / front side of the panel.

20.4.2 Air circuit breakers

20.4.2.1 General

The circuit breaker shall be triple pole, horizontal draw out type.

Circuit breakers shall be mounted along with 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 should be free of jerks and shall preferably be on rollers and not on the flat surface. Suitable guides shall be provided to minimize misalignment of the breaker.

There shall be service, test, isolated and maintenance positions for the breakers. 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.

The main contacts should be of appropriate silver alloys. Mere silver plating of the faces shall not be acceptable.

Arcing contacts should be of tungsten base alloy and mere silver plating of the faces shall not be acceptable. Arcing contacts must be separate from main contacts and one piece butt type contacts shall not be acceptable.

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. Inbuilt interlock should be provided to prevent the closed circuit breaker being inserted into the panel.

The ACB shall have provision of locking it in isolated position for keeping personnel and equipment safe during maintenance.

Automatic safety shutters shall be provided to ensure that the cradle terminals are completely covered when the circuit breaker is drawn out. Complete removal of the breaker from the distribution 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". When the cubicle door is open, the breaker should be capable of achieving "MAINTENANCE" position where free access is obtained to all parts of the breakers.

An auxiliary switch with 12 NO and 12 NC contacts shall be provided with each breaker and wired up to terminal block.

A suitable trolley mounted earthing device shall be provided which, when in circuit, earths the bus bars of feeder side of the breaker.

20.4.2.2 Power Operated Mechanism

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.

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% to 110%.

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.

Circuit breaker shall be provided with mechanical indicating devices to show OPEN, CLOSE, TEST and SPRING CHARGED conditions.

Circuit breaker shall be provided with no voltage release as it may be necessary to fulfill operation logic requirement.

Provision shall be made to lock the breaker in "Isolated" position.

Interlocking of the incomer ACB's with the other associated tie ACB's shall also be provided as per the operation logic to be decided during detail engineering stage. In case sufficient number of auxiliary contacts are not available, auxiliary **relay** shall be provided for interlocking.

20.4.3 Moulded Case Circuit Breakers (MCCB)

All the outgoing feeders (except where specifically mentioned) shall be provided with Molded Case Circuit Breakers (MCCB's) having suitably designed for thermal over load and magnetic short circuit protection.

The MCCB's shall be mounted in a trolley which shall be of draw out type. The draw out mechanism for MCCB's 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 MCCB's on the cradle extremely smooth.

MCCB's shall be manually operated. The operating handle should give a clear trip indication.

Alarm Scheme - Audible and visual (Mechanical flag indication) alarm scheme suitable for operation from 220V DC supply shall be provided to indicate tripping of ACB and MCCBs.

The MCCB's shall be quick make/quick break, trip free and independent of manual speed for operation.

MCCB's 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 percentage range of nominal rating in all ranges.

The ratings of the MCCBs shall be finalized during detail engineering stage.

20.5 AUXILIARY SYSTEM AND MISCELLANEOUS COMPONENTS

20.5.1 Refer cl. no. 1.8 of GTS for Instrument Transformers, metering instruments, control and selection switches, push buttons, indicating lamps, HRC fuses, terminal blocks, name plates and labels, space heaters, control & secondary wiring etc.

20.5.2 **415V AC/Copper Sandwich Type Bus Duct And Power Cables Terminations**

LT, sandwich type TPN copper bus-ducts of adequate size and enclosure of non-magnetic aluminum material with shall be provided:

i. B/w SST & SSB
ii. B/W UAT & UAB
iii. B/W SSB & UAB

The length of the AC Bus ducts will depend upon the actual layout of transformers and AC distribution boards. AC bus ducts of high electrolytic copper conductor of suitable cross section connecting these station service transformers and AC distribution board shall also be the part of this bid.

Proper coordination and interfacing of sandwich bus duct with SSTs, SSBs. UATs and UABs shall be ensured for smooth integration at respective terminal points.

LT power cables shall be taken out either from bottom or top of the distribution panels in case of double front distribution boards or either from bottom, rear or top of the distribution panels in case of single front distribution boards. Decision to this effect shall be taken at the final engineering of the drawings. Purchaser reserve the right to alter the cable entries, if required during detail engineering, without any additional commercial implication. End terminations between transformers & boards shall be done with flexible braided Cu.

Cables termination compartment and arrangement for power cables shall be suitable for stranded aluminum conductor, armoured PVC insulated and sheathed, single core/three and half core, 1100V grade power cables.

All necessary cable terminating accessories such as Gland plates, supporting clamps and brackets, power cable lugs, hardware etc. for cables shall be provided by the tenderer, to suit the final cable sizes which would be advised later.

The gland plate shall be of 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 sizes and number which shall be informed to the tenderer later. For all single core cables, gland plates shall be of non magnetic material.

Heat shrinkable sleeve on horizontal bus bars shall be provided but not in vertical bus bars. Necessary supporting structure for Busduct shall be provided by the bidder.

20.5.3 **Control Voltage**

The control voltage of 220 Volts DC supply between the ranges of 80% to 110% of the rated voltage shall be made available at Power House, PPV

House and Dam site only. For other sites i.e. Surge Shaft Area, and Tail Race Outfall area, individual power pack units of sufficient capacity with backup time of 30 mins shall have to be provided by the contractor for control and protection of LT boards/~~DG AMF panel~~ and is to be included in its bid.

20.5.4 Interlocks

Interlocking scheme ~~shall be as per Drg. no. SJVN/ED/Arun-III/EM-2015-03 for tendering purpose which~~ shall be reviewed and finalized during detailed engineering

20.5.5 Automation of LT Switchgear

Necessary contacts / ports of LT Switchgear (e.g. CB on / off / trip, Voltage supervisions etc.) at all locations shall be envisaged for remote interfacing with the plant SCADA. Logic / program for automation of LT Switchgear shall be built in SACDA.

20.5.6 Protection of 415 Switchgear

The minimum protection for the 415 V system shall be ~~as s per Single Line Diagram SJVN/ARUN III/EM-2017-03 and shall be~~ finalized during detail engineering stage . The relays will be installed on 415V switchgear. All the relays shall be of reputed make with proven performance. In accordance of above, the type of protection shall have to be got approved from the Employer before supply / despatch.

The Contractor has to revise/upgrade the system during detailed engineering if the offered system does not meet the entire requirement. The system should be state of art/latest model available at the time of supply. If the protection system mentioned in the awarded contract become obsolete at the time of supply, the Contractor shall offer a latest model without any extra cost to employer.

The relay used in protection system shall be of the numerical, and plug in type arranged in protection cubicles. All relays including all related devices, such as interposing transformers, tripping matrix and relays, test facilities, power supply units, etc. with all circuits shall comply with relevant IEC Recommendation.

20.6 DRAWING , DOCUMENTS & DESIGN CALCULATIONS

After award of contract, the contractor shall furnish all drawings, documents, design calculations, data, manuals & other necessary literature, pertaining to equipment offered by them & so specified under various clauses, in accordance with requirements stipulated in "clause 1.19 of Section – 1 i.e. General Technical Specification (GTS)". A comprehensive list of all such drawings/documents planned to be submitted for reference/approval shall be provided beforehand for approval of the purchaser as already explained in clause no. 1.19.6 of Section – 1 (GTS). The list of drawings & documents to be furnished for approval / reference shall not be limited to the following:-

i) Drawings, documents, design calculations literatures, manuals etc. as per clause no. 1.19 of Section-1 (GTS)

ii) Drawings, documents, design calculations, literatures, manuals as listed in Annexure – D of Section -1 (GTS) referred under clause no. 1.19.6

iii) Detailed quality assurance plan, giving complete specifications of the materials and specifications relating to inspection and testing of materials and finished components.

iv) All drawings having bearing on civil foundations, equipments foundation details and loads

v) Arrangement, installation, foundation, plan, section, detailing of main equipment and sub-assemblies including control & instrumentation system.

vi) All Electrical, Hydraulic & Control Drawings such as Electrical Panels OGA, Cable Block & Termination Diagram, Schematic Diagram, JB/MB/Kiosk Diagram etc. in respect of this section.

vii) All manufacturing drawings not specifically covered under approval/reference category shall be submitted for record and facilitate inspection of the component in the shop and assembly at site.

viii) Any other drawings, documents, design calculations, literatures, manuals etc. not covered anywhere in the specification, but required to be furnished for approval / reference of employer for suitability of design to fulfill the scope of work.

20.7 SHOP ASSEMBLY, INSPECTION & TESTS

20.7.1 Routine tests

Routine tests shall be carried out on all distribution boards and associated equipments; as per relevant standards.

Each switchboard shall be assembled at the manufacturer's works with all apparatus instruments & meters connected up and the various components shall be tested in accordance with the requirements of the relevant Indian Standard.. The following routine tests shall be performed on all the distribution boards, as per the relevant standards, not limited to :

a) For switchgear assembly **as IEC 60439-1**
   i) Inspection of the assembly including inspection of wiring and if necessary electrical operation test.
   ii) Dielectric test.
   iii) Checking of protective measures and of the electrical continuity of the protective circuit.

b) For air circuit breakers and MCCB's **as per IS 13947**
   i) Mechanical operation test.
   ii) Test for verification of calibration of release.
   iii) Dielectric withstand test

c) For TPN non segregated sandwich type LT Bus-duct:
   i) Verification of dimension & cross-section area.
   ii) One minute high potential power frequency voltage without test.

d) PTs **as per IEC 60044**

   i. Verification of terminal markings
   ii. Power frequency withstand test on secondary winding
   iii. Power frequency withstand test between sections
   iv. Power frequency withstand test on primary windings
   v. Partial discharge measurement
   vi. Determination of errors

e) CTs **as per IEC 60044**

   i. Verification of terminal markings
   ii. Power frequency withstand test on secondary winding

iii. Power frequency withstand test between sections
iv. Interturn overvoltage test
v. Power frequency withstand test on primary windings
vi. Partial discharge measurement
vii. Determination of errors

f) Relays, MCBs, switches as per relevant standard.

20.7.2 Type test

Type test of 415 V LT system shall fall under the CAT-II (refer clause no 1.16 of GTS). The type test report of following equipments to be submitted by bidder:

a) Distribution boards- Total assemblies as IEC 60439-1:

i. Temperature rise
ii. Dielectric properties
iii. Short circuit withstand test
iv. Effectiveness of protective circuit
v. Clearance & creepage distance
vi. Mechanical operation
vii. Degree of protection

b) Air circuit breakers/ MCCBs as per IS 13947

i. Temperature rise
ii. Tripping limits and characteristics
iii. Dielectric properties
iv. Operational performance capability
v. Overload performance (where applicable)
vi. Short-circuit breaking capacities
vii. Short-time withstand current

c) For TPN sandwich type LT Bus-duct:

i. High voltage test.
ii. Insulation resistance test.
iii. Short circuit test for a duration and current as specified in the specification.

d) Potential transformers as per IEC 60044

i. Temperature-rise tests
ii. Lightning impulse test
iii. Switching impulse test
iv. Determination of error
v. Short circuit withstand capability test
vi. radio interference voltage measurement (RIV)

e) **Current transformer as per IEC 60044**

i. Temperature-rise tests
ii. Lightning impulse test
iii. Switching impulse test
iv. Determination of error
v. Short circuit withstand capability test
vi. radio interference voltage measurement (RIV)

F) Relays, MCBs, switches as per relevant standard.

20.7.3 **Field Tests**

All field tests including tests during installation, pre-commissioning, commissioning, performance and field acceptance tests shall be conducted by the Contractor, in the presence of representative of the Employer.

Procedure to be adopted for conducting the operational, pre-commissioning, commissioning, performance and field acceptance tests shall be submitted well in advance, at least four (4) months before start of relevant testing, for approval of the Employer.

20.7.3.1 Tests during installation and pre commissioning

At least following inspections/ tests shall be performed during installation and pre commissioning:

- Functional and operational tests,
- Measurement of the insulating resistance of the different power and control circuits, including cables, instruments and apparatus, against earth,
- Adjustment of the protection equipment,

- Calibration of releases,
- Contact resistance measurement of circuit breaker,

- Verification of interlocks: ensure that interlocks are correctly installed and that access is prevented to live portions of the system when interlocks are in place and that access is permitted when interlocks are removed,

20.7.3.2 Commissioning tests

At least following verifications shall be performed before and during energization:

- Insulation resistance measurement of each phase,

- Verification of component temperatures,

- Final adjustment of the protection equipment.

20.7.4 Performance Testing

a) After completion of commissioning tests and commissioning of complete system, If nothing unusual has been observed in load run and load rejection tests, the test service period of 72 hours shall follow. During this test service period, the unit must operate continuously at rated condition without any interruption except of those beyond the control of the Contractor. However, such interrupted period shall not be counted for in the test service period. There should be one month reliability run of the complete unit reckoned from the date of taking over by employer.

b) Remaining Distribution board at all locations shall be kept under charged condition for 72 hrs before taking over. During this test service period, the system / installations must perform satisfactorily & if any defects are observed, same shall be rectified by contractor without any financial implication to employer.

20.8 PACKAGING, ~~HANDLING & SITE STORAGE~~

The contractor shall be liable for all packing, ~~handling and site storage~~ of all the equipment till the installation is handed over to the Engineer in charge.

20.9 **SITE INSTALLATION AND COMMISSIONING**

The Contractor has to do all the work related to assembly, erection, testing and commissioning complete in all respects. All necessary tools, plants, labour, materials including consumables for performing installation, testing and pre-commissioning shall be provided by the Contractor.

The Contractor shall submit the necessary data/information, layout and foundation/support drawings well in advance.

The Contractor shall provide and install the concrete inserts/embedment,support steels and/or components for foundation/supports purpose as per approved erection drawings and coordinate the activities with civil contractors to keep his activities in synchronism with civil work. All installation for foundation shall be verified and accepted by the Engineer.

The Contractor shall use anchor fasteners for installation of fixtures, mountings, conduits, cabling, panels etc. Chipping of concrete and/or taking support from reinforcement bars shall not be allowed.

20.10 TOOLS AND INSTRUMENTS

20.10.1 Tools for erection and Installation.

The Contractor shall bring his own tools, devices, testing instruments / equipments to site in order to erect and install the complete equipment delivered under this section. These shall remain the property of the Contractor unless otherwise agreed to take over any / all of these at mutually agreed conditions.

20.11 SPARE PARTS

The spare parts mentioned here under are meant for use by the Employer during operation and maintenance stage and shall not be used as erection spares required during installation.

20.11.1 Mandatory Spare Parts

The Contractor shall supply the mandatory spare parts as per Schedule-III.

20.11.2 Recommended Spare Parts

The Contractor shall furnish the list of recommended spare parts at Schedule-IV.

SECTION - 18

CABLE AND CABLE TRAYS

18.1 SCOPE OF WORK

Scope of work under this section covers the provision of ~~labour~~, tools, plants, materials and performance of work necessary for the design, engineering, manufacture, quality assurance, quality control, shop assembly, shop testing, packaging & delivery at site including insurance, ~~unloading, site storage and preservation, in plant transportation at site, erection / installation~~, testing supervision, ~~pre commissioning, successful commissioning~~, performance and acceptance testing, handing over to Employer and warrantee for two years of Cable and Cable Trays as per the specifications hereunder, complete with all auxiliaries, accessories, spare parts and warranting a trouble free safe operation of the installation. The scope of work covered under this section shall be read in conjunction with General Technical specifications, ~~Chapter-1.~~

18.1.1 Detail scope of work

The scope of work shall be a comprehensive functional system complete in every respect including but not be limited to following:

18.1.1.1 Power cables

AS PER BOQ / SYSTEM REQUIREMENT

i. ~~One(1) Lot of 11 kV, Aluminium conductor, XLPE, unarmored power cable (High voltage cable) as per SLD Drg. No. SJVN/ED/ARUN-III/EM-2015-03 (Sheet 1 to 3)~~

ii. ~~One(1) Lot of 33kV, Aluminium Conductor, XLPE, unarmoredpower cable(High voltage cable) as per SLD Drg. No.SJVN/ED/ARUN-III/EM-2015-03 (Sheet 1 to 3)~~

iii. One(1) lot of 1.1 kV PVC/XLPE, Aluminium conductor,unarmoredpower cable (Low voltage cable)~~as per SLD Drg. No. SJVN/ED/ARUN-III/EM-2015-03 (Sheet 1 to 3)~~

iv. ~~One (1) Lot of 1.1 kV PVC/XLPE, Copper conductor, unarmored power cable (Low voltage cable) for DC System as per DC SLD Drg. No. SJVN/ED/ARUN-III/EM-2015-10 (Sheet 1 & 2)~~

v. One (1) Lot of power cable, copper conductor connecting the rotor to DC field breaker.

vi. One(1) lot of power cable, Copper conductor, from DCDB to HS pumps including intermediate panels.

vii. One(1) Lot of power cables from LT boards at Power house, Switchyard,Surge Shaft, BFV house, TRT and Dam site, HRT/SFT cavern,to unit auxiliaries and station auxiliaries upto the motor/equipments including intermediate panel/junction box.

viii. One(1) Lot of power cables from LT boards at Power house, Switchyard,Surge Shaft, BFV house, TRT and Dam site, HRT/SFT cavern, to balance of plant items like LP compressor, elevator, EOT cranes, HVAC, illumination, firefighting system, workshop/laboratory etc. upto the motor/equipments including intermediate panel/junction box.

ix. One(1) Lot of power cables from EM panels to third party interface such as Hydro-mechanical equipment, PLCC equipments, civil infra equipments (ejector, water purification plant etc.) etc. at Power house, Switchyard,Surge Shaft, BFV house, TRT and Dam site, HRT/SFT cavern.

18.1.1.2 Control and instrumentation cables AS PER BOQ / SYSTEM REQUIREMENT

i. One (1) Lot of 600/1000 Volt, Copper conductor control cables for Control System (interconnection of various control panels, field equipments, junction box etc.

ii. One (1) Lot of 600/1000 Volt, Copper conductor, Instrumentation cables for connection of various field equipments like RTDs, thermocouple etc. to control panels .

iii. One (1) lot of Coaxial and communication cables for PLCC, time synchronization etc.

iv. One(1) Lot of control cables from EM panels to third party interface such as hydro-mechanical panels

Any other power/control cable not specifically mentioned in the scope ~~of this chapter and other chapters~~ shall be in the scope of contractor at all places.

18.1.1.3 Cable trays and accessories

AS PER BOQ / SYSTEM REQUIREMENT

i. One (1) Lot of perforated/ladder galvanized cable trays including bends, Tees, cross connectors, reducers,hardware of various width as per requirement.

ii. One(1) lot of stainless steel cable trays including bends, Tees, cross connectors, reducers,hardware of various width as per requirement for humid areas prone to water dripping and sprays such as drainage gallery etc.

iii. One (1) lot of Supports including pre-fabricated structures/fixtures strut channels, embedment, hardware (nut, bolts) etc.

iv. One (1) lot of Cable ducts, conduits, channels, joints etc.

v. One(1) lot of Cable terminals, termination kits, cable lugs, cable glands, cable ties, cable sparebutton tape (strap and stud), and cable junction boxes and all other accessories.

vi. Two(2) nos. of automatic tagging guns/ cable marking and tagging equipment with all consumables.

vii. One (1) Lot of GI earth strip & GI wire of various sizes as per requirementfor earthing of cable trays and electrical equipments (motors, panels, marshaling box, junction box etc.) to main riser.

18.1.1.4 Control, monitoring and related items and services

Co-ordination and provision of necessary contacts and/or ports for integration with plant SCADA system.

18.1.1.5 Common Supplies and services

i. Fifteen (15) sets of handsets and chargers for two way communication system including necessary license from the statutory body /concerned Deptt. of GON
ii. Drawings, documents and design calculations as per clause 18.6.
iii. Shop, assembly, inspection & tests as per clause no. 18.7.
iv. Packaging, handling and site storage as per clause no. 18.8.
v. Delivery, installation and commissioning as per clause no. 18.9.
vi. Tools and instruments as per clause no. 18.10.
vii. Spare parts as per clause no. 18.11
viii. Field/touch-up painting including all painting materials.

18.1.1.6 Completeness of System

Any other item (s) not mentioned specifically but necessary for the satisfactory completion of scope of work defined above, as per accepted standard (s)/best international practice.

18.2 STANDARDS & REGULATIONS

The design, manufacture and testing of the various equipment covered under this specification shall comply with the requirements of the latest edition of the relevant IEC/IS/IEEE/ISO standards only. Preference for latest IEC standards for particular equipment / system shall be governed over IEEE/ IS/ ISO standards. Further rules, guide lines and standard laid down by international/ national agency shall be applicable in this specification.

The relevant abstract (in soft / hard copy) of all referred standards shall be provided free of cost during engineering stage for facilitating review/ approval of submitted drawing/documents.

18.3 CABLE PARAMETERS& GUARANTEES

18.3.1 General

All cables shall be designed to cope with:

- The short–circuit conditions,
- The applied protective system in respect to cross-section and number of cores.

The cables shall be capable of satisfactory operation under a power supply system voltage variation of 10% and frequency variation of 5% and a combined frequency voltage variation of 10% (absolute sum). The cables shall have heat and moisture resistant properties. These shall be of type and design, with proven record of hydro power station installation.

18.3.2 Rating and Functional Characteristics

~~**18.3.2.1 Power cables - 33kV &11kV system single/multi-core cables**~~

33kV &11kV power cable shall be of heavy duty, stranded circular aluminium conductor, cross linked polyethylene (XLPE) insulated provided with conductor screening and insulation screening, laid up, extruded PVC inter sheathed, unarmored conforming to relevant IEC/IS. The semi-conducting tape and extrusion of semi-conducting compound shall be suitable for the operating temperature of the cable and compatible with the insulating material. The insulation and screening shall be extruded, semi-conducting and with copper tape screening (with at least 0.075 mm thickness) about it.

The cable shall have the following properties:

- Oxygen index — Min. 29,
- Smoke density — Min. 40% light transmittance,
- Acid gas — Max. 20% by weight,
- Flame propagation — As per relevant IEC

18.3.2.2 Power cables -1100 volt grade

I. Single core cables

These cables shall be at least 1100 volt grade, heavy duty, single core, stranded Aluminium / Copper conductor, FRLS, HR-PVC/XLPE, insulated and PVC sheathed, unarmored and shall conform to the same design and properties as cables conforming torelevantIS/IEC.

II. Multi core cables:

The cable shall be at least 1100 volt grade, heavy duty multi core, stranded Aluminium/Copper conductor, FRLS, HR-PVC/XLPE insulated, color coded, laid up, unarmored, inner sheathed with extruded PVC, 2/3.5 cores, conforming to relevant IS/IEC.

18.3.2.3 Control and instrumentation cables

The control and instrumentation cables shall be multi core, colour coded, unarmored, annealed stranded high conductivity Copper, single conductor, insulated with HR-PVC insulation, PVC sheathed and armoured, conforming to relevant IS/ IEC.

18.3.2.4 Coaxial cable

Coaxial cable shall be offered in accordance with relevant IEC/ISto connect coupling unit installed in the pothead yard to the PLCC terminals, installed in control room of

powerhouse. The cable offered by the Contractor shall be steel armored. The cable shall have braided tinned Copper conductor. The capacitance of the cable shall be low so as to minimize attenuation in the carrier frequency range. The impedance of the cable shall be so as to match with the output impedance of the PLC terminals and secondary impedance of the coupling units. The cable shall be insulated to withstand a test voltage of 4 kV .The Contractor shall supply H.F. cable with following properties:

- Co-axial H.F. cable with 75 ohms characteristic impedance (unbalanced),
- Capacitance per meter – 53-pf approx.,
- Test voltage in kV – 4 kV RMS for 1 minute,
- Size of conductor – 7 strands/0.4mm.

The maximum attenuation at various frequencies shall be as follows:

Frequency in KHZ	Attenuation in db/km
300	1.4
60	3.3
500	4.7

18.3.3 Performance Criteria and Guarantee

The power, control, instrumentation, coaxial communication and other cables along with all auxiliaries and accessories shall be capable of performing intended duties under specified conditions. It is the responsibility of the Contractor to supply the equipment as per guaranteed technical particulars and shall also guarantee the reliability and performance.

18.4 DESIGN AND CONSTRUCTION

18.4.1 Conductor material

All DC,control and instrumentation cables shall be of copper conductor. Power cables shall be of aluminium or copper conductor as defined in the scope.

18.4.2 Conductor shield

The conductor having a semi-conducting screen shall ensure perfectly smooth profile and avoid stress concentration. The conductor screen shall be extruded in the same operation as the insulation. The semi-conducting polymer shall be cross linked (for XLPE cables).

18.4.3 Insulation

The insulation of the cables shall be extruded type and shall be designed and manufactured for the specified system voltage. The manufacturing process shall ensure that insulation is free from voids. The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions. The extrusion method should give very smooth interface between semi-conducting screen and insulation. The insulation of the cable shall be of high standard quality. This should be in accordance with relevant IS and IEC standards.

18.4.4 Insulation shield

In XLPE cables, to confine electrical field to the insulation a non-magnetic semi-conducting shield shall be put over the insulation. The insulation shield shall be extruded in the same operation as the conductor shield and the insulation by triple extrusion process. The XLPE cable insulation shall be strippable. Metallic screening as given in this specification for the various control and power cables and special cables shall be provided

18.4.5 Sheath

The sheath shall be suitable to withstand the site conditions and specified temperature conditions. It shall be of adequate thickness and applied by a continuous process to produce a sheath of consistent quality, free from any defects. The sheath shall be extruded. This should be in accordance with relevant IS and IEC standards.

18.4.6 Service and outer sheath

Extruded PVC servingas specified shall be applied with suitable additives to prevent attack by rodents and termites. All servings must be given anti-termite treatment. The cable should also offer a specially formulated Flame Retardant Low Smoke compound (FRLS) for outer sheat**h**The cable shall have suitable fillers laid up with the conductors, before the sheath is applied and the fillers shall be of substantially circular cross section. Fillers shall be suitable for operating temperature of the insulation and compatible with the insulation.

18.4.7 Size and length of cables

The number of cores and sizes of the cables required for various circuits shall be worked out during detailed engineering.

However, minimum sizes for the following cables conductor shall be taken as:

- 2.5 mm^2 copper for control cable conductor,
- 1.5 mm^2 copper for annunciation and RTD cable conductor,
- 4 core x 6 mm^2 copper for connection between CT junction boxes and panels having red, yellow, blue and black colour cover,
- 4 core x 4 mm^2 copper for connection between PT junction boxes and panels having red, yellow, blue and black colour cover.

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

18.5 AUXILIARY SYSTEMS AND MISCELLANEOUS COMPONENTS

18.5.1 Color scheme and identification

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 relevant IS/ IEC.

All the cables shall carry manufacturer data in a permanent, legible manner at an interval of at least three (3) meter run. The manufacturer's data shall include the name, cable size, and voltage rating together with any other information.

18.5.2 Termination kit

The termination kits required for 11kV& 33kV XLPE cables terminations shall be heat shrinkable type as per relevant IS/IEC.

The Contractor shall supply all hardware consumables such as plumbing metal, sealing compound, tapes and other materials required for the making of these terminal

~~connections of various sizes of cables and should handover the consumables equivalent for two connectionsto the Employer.~~

18.5.3 Cable lugs

The Contractor shall ensure that no bimetallic action takes place, between the conductor of the cable and the cable-connecting lug by filling the lugs with suitable compound. The lugs shall be of standard quality conforming IEC / IS.

18.5.4 Cable accessories

The Contractor shall supply all the required accessories that may be found necessary during actual execution of the job and cost of them shall be included in the contract price. No intermediate joint will be allowed in the run of any cable.

18.5.5 Cable glands

The cable glands shall be made of brass duly electro tinned in order to avoid corrosion and oxidation of the surface. The nipple threads shall be in accordance with relevant IS/IEC. Glands shall provide neat, tight, dust and vermin proof termination. Gland shall be provided with rubber ring to hold the cables firmly when check-nut is slightly tightened. Gland shall be complete with suitable washers etc.

18.5.6 Compression type terminals for control wiring

These terminals are required for copper conductor of control wiring. They shall be crimped to the conductor while other end will provide flat surface for better connections. The connectors shall be made of Copper electro tinned.

18.5.7 Button tape (strap and stud)

This consists of perforated cable strapping with holes conveniently spaced for assembly and moulded studs. The strapping shall be made of NYLON Grade 220 or other elastic material to give proper performance. The studs shall be made of 'NYLON'.

18.5.8 Self-adhesive marker

Self-adhesive marker in the form of strips of any one character, which can be easily peeled from the backing cards and can be applied on the cable, shall be supplied. The strips shall be water- proof duly marked with special formulated ink with specific thermo-setting adhesive to withstand high temperature.

Suitable plastic ring type ferrules marked with engraved indelible ink for control cables and sticker type ferrules for power cables shall be supplied. These shall be marked as per cable schedule such that each core of each cable can be identified easily.

18.5.9 Aluminum strip

Aluminium strip of adequate size for making tags for labels shall be supplied.

PVC tapes, cotton tapes and any other accessory required for laying, termination, testing and commissioning shall be supplied of good quality as per relevant Indian Standards.

18.5.10 Cable trays and support structure

Perforated cable trays made out of 14-gauge mild steel sheet shall be fabricated. The trays shall be of perforated plates with long shape slots for proper ventilation of the cables. The trays shall have minimum 50 mm edge height.

The cable trays shall be fully galvanized as per the relevant IS / IEC

Stainless steel cable trays shall be provided for humid premises and the area prone to water dripping and spraysuch as Drainage and Dewatering and shall be finalized during detailed engineering.

Supports and screws and bolts for cable trays shall be made of the same materials as the cable trays they support.

Tray support system shall be pre-fabricated and bolted type for quick and easy installation.

Trays provided in tiers shall have minimum 300 mm spacing between tiers.

Detailed design of the cable trays and supports shall be approved by the Employer before commencement of fabrication/assembly. The fixing of supports to the walls/ceiling/tunnel/column/ trench etc. is also covered in the scope of supply. Strut channels shall be embedded for fixing of the supports and shall be provided, installed and supervised during concreting for correctness of positioning and alignment by the

Contractor. Anchor fasteners shall be used wherever required to fix the anchors/supports.

In addition to this, ladder type tray with double bends may be used wherever requiredconforming to relevant IEC/IS which shall be finalized during detail engineering. Also, various cable tray accessories such as vertical elbow, horizontal elbow, reducer, horizontal tee, and horizontal cross should be used.

18.5.11 Fire proofing

Cables passing through different fire zones shall be provided with fireproof barriers with the same fire rating as the penetrated walls or partitions.

18.5.12 Cable junction boxes

Junction box shall be constructed of sheet steel of thickness not less than two (2) mm. The door shall be adequately strengthened to ensure rigidity and strength. Sheet steel and sections used in enclosures shall be cut neatly and finished free from burrs. Ample wiring space shall be provided at the sides, and back of the enclosure for incoming and outgoing circuits.

Removable plates with gaskets shall be fitted at the top and bottom of the box to provide the entry for conduit or cable. The door shall be provided with suitable gasket and fitted with a lock type handle. The door shall be hung on hinges having brass bodies and stainless steel pins.

Each cable junction box shall be provided with terminals of adequate rating on the terminal strip of suitable thickness.

18.5.13 Terminal blocks

As per GTS clause 1.8.5 .

18.5.14 Cable markers and cable binding

Suitable cable markers of Aluminium with punch marks shall be provided and suitably tagged to the cable permanently so that cable could be easily identified.

18.5.15 Cable binding/strapping

All control cables after glanding shall be neatly routed and bonded with the help of cable straps and studs inside the panel. Complete routing in panel shall be such that it gives a neat appearance good workmanship.

For L.T. Power cables, suitable holding clamps will be provided in the panel if required.

The Contractor shall do the cable glanding suitable for each cable size at both ends of termination of each cable.

18.5.16 Cable routing

For the main cableways, a system of cable racks and trays as well as cable ducts and trenches shall be provided.

18.6 DRAWINGS, DOCUMENTS AND DESIGN CALCULATIONS

18.6.1 Drawings and documents

After award of contract, the contractor shall furnish all drawings, documents, design calculations, data, manuals & other necessary literature, pertaining to equipment offered by them & so specified under various clauses, in accordance with requirements stipulated in "clause 1.19 of Section – 1 i.e. General Technical Specification (GTS)". A comprehensive list of all such drawings/documents planned to be submitted for reference/approval shall be provided beforehand for approval of the purchaser as already explained in clause no. 1.19.6 of Section – 1 (GTS). The list of drawings & documents to be furnished for approval / reference shall not be limited to the following:-

i) Drawings, documents, design calculations literatures, manuals etc. as per clause no. 1.19 of Section-1 (GTS)

ii) Drawings, documents, design calculations, literatures, manuals as listed in Annexure – D of Section -1 (GTS) referred under clause no. 1.19.6

iii) Detailed quality assurance plan, giving complete specifications of the materials and specifications relating to inspection and testing of materials and finished components.

iv) All drawings having bearing on civil foundations, equipments foundation details and loads

v) Arrangement, installation, foundation, plan, section, detailing of main equipment and sub-assemblies including control & instrumentation system.

vi) All Electrical& Control Drawings such as Electrical Panels OGA, Cable Block & Termination Diagram, Schematic Diagram, JB/MB/Kiosk Diagram etc. in respect of this section.

vii) All manufacturing drawings not specifically covered under approval/reference category shall be submitted for record and facilitate inspection of the component in the shop and assembly at site.

viii) Any other drawings, documents, design calculations, literatures, manuals etc. not covered anywhere in the specification, but required to be furnished for approval / reference of employer for suitability of design to fulfill the scope of work.

18.7 SHOP ASSEMBLY, INSPECTION AND TESTS

18.7.1 Type Test

Type tests which shall fall under Category –I(refer clause 14 of GTS) are to be conducted as per Schedule VI to demonstrate that the cables and accessories offered meet the requirement of specifications.

18.7.2 Routine Tests

The following Routine tests shall be conducted on samples of manufactured cables and on components of accessories in order to verify that the finished products meet the requirements of specifications.

- Conductor resistance test,
- Partial discharge test (for screened cables),
- High voltage test.

In addition to above tests, all other tests mentioned in the relevant IS shall also be performed.
XLPE/PVC/instrumentation cable/coaxial cable shall be tested as per relevant IEC/IS standard.

18.7.3 **Field tests**

Before commissioning of complete system, all cabling system shall be checked as per cable schedule and complete report shall be prepared by Contractor and shall be submitted.

Field test shall include:

- Continuity checking,
- IR testing
- Verification of phase order in power cables
- Visual checking in respect of tagging, laying, dressing, glanding, earthing of complete cable system.

18.7.4 Performance testing

If nothing unusual has been observed in load run and load rejection tests, the test service period of 72 hours shall follow. During this test service period, the unit must operate continuously at rated condition without any interruption except of those beyond the control of the Contractor. However, such interrupted period shall not be counted for in the test service period. There should be one month reliability run of the complete unit reckoned from the date of taking over by employer.

18.8 PACKAGING~~, HANDLING AND SITE STORAGE~~

The Contractor shall pack all the consignment in sea worthy packaging strong enough to withstand rough handling during transit. Machine surface shall be suitably protected against scratches, corrosion, shocks, impact etc. Packages shall be suitably and distinctly identified for type of handling and kind of storage.

All the cables shall be supplied on non-returnable wooden drums with adequate barrel diameter so as to avoid any damage to the cables and to withstand rough handling during transportation and storage. The ends of the cable shall be sealed by means of non-hygroscopic sealing material.

A layer of waterproof paper shall be applied to the surface of the drums and over the outer cable layer. A circular space of at least 40mm shall be left between the cable and the lagging. Each drum shall carry the name of the manufacturer, the name of the Employer, his address, order number, item number, type, size length of cable, net and gross weight duly stenciled thereon. The supplier shall indicate the methods of

storage of cable drums and accessories at site during the detailed design stage.

18.9 SITE INSTALLATION AND COMMISSIONING

18.9.4 Installation procedure

The Contractor shall follow the construction methodology and installation procedure recommended by the cable manufacturer and shall arrange all the necessary erection tools/devices required for installation of cables such as cable rollers, cable pullers, motorized winches, power packs, two-way communications and safety devices etc., as per manufacturer's standard practices for installation of the cables.

Plugging of all cable gland holes left out in the panel after completion of cabling shall be done.

18.10 TOOLS AND INSTRUMENTS

18.10.1 Tools for erection and Installation.

The Contractor shall bring his own tools, devices, testing instruments / equipments to site in order to erect and install the complete equipment delivered under this section. These shall remain the property of the Contractor unless otherwise agreed to take over any / all of these at mutually agreed conditions.

18.10.2 Instruments for testing & commissioning

The list of instruments to be supplied shall be as per Schedule V(A). General requirement of these tools are as below:-

1. The contractor shall provide the highest model of the mentioned make or equivalent.
2. The timeframe to be reckoned the highest model of the mentioned make / equivalent shall be six months prior to the submission of drawings / documents for review / approval of equipment. .
3. The contractor shall submit the duly signed certificate by OEM / dealer certifying that the selected model is the highest model meeting the above timeframe criteria.
4. Supplied equipment's authorized service center shall preferably in India / Nepal.
5. Data sheet needs to be approved during detailed engineering of the finalized model selected from the list of makes. If the contractor proposes to supply the model / make equivalent to the specified list, then data sheet of the

equivalent make along with the data sheet of one of the makes in the list shall be submitted during detailed engineering.

6. The instruments shall be supplied at site before the starting of the testing and commissioning of 1st unit. The contractor may also use the above instruments for testing and commissioning. However, the liability for healthiness, maintenance, consumables etc. shall be in the scope of contractor during this period.
7. The instruments used for testing & commissioning shall be handed over to employer after the final COD of last unit in healthy condition (free from defects and damage). Further, contractor shall ensure the validity of Calibration certificate (as applicable)for at least one year from handing over.
8. Defect liability of tools / instruments used by contractor during testing & commissioning shall commence from the date of handing over & acceptance by the employer.
9. The other instruments shall also be handed over after COD of the last unit along with validity of Calibration certificate (as applicable)for at least one year. The defect liability period will commence from the date of handing over.
10. In case of repetition of tools / instruments in other chapters in addition to the mentioned list, those shall also be part of the scope of supply of contractor.
11. Contractor shall submit product catalogue, brochures, and routine / acceptance tests (if any), guarantee certificate, calibration certificate, instruction manual, O&M manual etc. of each and every instrument.
12. Instruments covered under this schedule shall also be governed by the vendor selection clause no. 1.12 of GTS.

18.11 SPARE PARTS

The spare parts mentioned here under are meant for use by the Employer during operation and maintenance stage and shall not be used as erection spares required during installation.

18.11.1 Mandatory Spare Parts

The Contractor shall supply the mandatory spare parts as per schedule-III.

18.11.2 Recommended Spare Parts

The Contractor shall furnish the list of recommended spare partsat schedule-IV.

SCHEDULE II

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS

SCHEDULE OF TECHNICAL PARTICULARS

The following information shall be given in the tender:-

1. **PANELS**

i) Manufacturer's name & country of manufacture

iii) Rated operational voltage

v) Rated insulation voltage

vi) Rated voltage of auxiliary circuits

viii) Symmetrical Short circuit rating withstand at rated voltage of switchgear cubicle*

ix) Peak short circuit withstand current*

x) Degree of protection

a) Breaker/MCCB's/Distribution cubicles

b) Bus bar chamber

xi) Service conditions i.e. indoor or outdoor

xii) Overall dimensions of panel *

Single front Double front

a) Length(mm) -
b) Breadth(mm) -
c) Height(mm) -

xiii) Shipping dimensions: *

a) Length(mm) -
b) Breadth(mm) -
c) Height(mm) -

xiv) Weight of panel(mm)*

xv) Shipping weight of largest package(kg)

*(Please give information for each type of AC distribution board separately)

2. **AIR CIRCUIT BREAKERS for each type**

i) Name of manufacturer

ii) Model no

iii) Catalogue attached or not

iii) Normal current

iv) Frequency

v) Short circuit performance category

vi) Rated short circuit breaking capacity(kA)

vii) Rated short circuit making capacity(kA)

viii)Rated short circuit withstand current(1 second)kA

ix) Rated insulation voltage

x) a) Normal rating at 40^{o}C ambient temp.(Amps)

b) Derating for 45^{o}C ambient temp.(Amps)

xi) Overload and short circuit release

a) Whether C.T. operated/thermo magnetic type

b) Definite time lag

c) Total operating time for complete clearance of fault

3. **MOULDED CASE CIRCUIT BREAKERS & MINIATURE CIRCUIT BREAKER. for each type**

i) Name of manufacturer and manufacturer's type designation

ii) Model no

iii) Catalogue attached or not

iv) No. of poles

v) Rated operational voltage(V)

vi) Normal current(Amp)

vii) Frequency(Hz)

viii) Short circuit performance category

ix) Rated short circuit breaking capacity(kA)

x) Rated short circuit making capacity(kA)

xi)Rated short circuit withstand current (1 second)kA

xii) Rated insulation voltage(V)

xiii) a) Normal rating at 40°C ambient temp.(Amp)

b) De-rating for 45°C ambient temp.(Amp)

xiv) Overload and short circuit release:

a) Whether thermal overload adjustment provided and its range of adjustment

b) Whether magnetic short circuit protection adjustment provided and its range of
adjustment

c) Definite time lag

d) Total operating time for complete clearance of fault

4. **CURRENT TRANSFORMERS***

a) Name of manufacturer and manufacturer's type designation

b) Model no

c) Catalogue attached or not

* Give details for each type of C.T.

5. **POTENTIAL TRANSFORMERS***

a) Name of manufacturer and manufacturer's type designation

b) Model no

c) Catalogue attached or not

* Give details for each type of P.T.

6. **RELAYS**

a) Name of manufacturer and manufacturer's type designation

b) Model no

c) Catalogue attached or not

* Give details for each type of Relay.

7. **FUSES**

i) Make

ii) Type

iv) Rated voltage

v) Rupturing capacity kA

vi) Peak Cutoff current kA

8. **AUXILIARY CONTACTOR**

i) Make

ii) Type

iii) Coil voltage

iv) Coil Burden

v) Operating time

vi) No. of contacts:

a) Normally open
b) Normally closed

vii) Contact rating

8. **CONTROL/SELECTOR SWITCH**

i) Make

ii) Type designation

iii) Voltage grade

iv) Current rating

Make, carry and break kA

v) Spring return or stay out'

vi) Type of handle

vii) No. of positions

viii) No. of Poles/Ways

ix) Contact materials and plating

9. **VOLTMETER**

i) Make

ii) Type

iii) Accuracy class

iv) Voltage coil rating

v) Voltage coil burden

vi) Case size

vii) Angle of deflection

viii) Scale length

10. **AMMETER**

i) Make

ii) Type

iii) Scale range

iv) Accuracy class

v) Current coil rating

vi) Current coil burden

vii) Case size

11. **INDICATING LAMP**

i) Make

ii) Type

iii) Voltage

iv) Series Resistor - Rating and Value

12. **PUSH BUTTONS**

i) Make

ii) Type designation

iii) Number of contacts (NO + NC)

iv) Contact rating, Amps

13. **SPACE HEATER**

i) Make

ii) Type

iii) Rated voltage

iv) Heater output (W)

v) Thermostat setting range, ^{o}C

14. **WIRING AND TERMINAL BLOCKS**

i) Voltage grade of wires

ii) Insulation of wires

iii) Conductor material

iv) Minimum size of conductor for:

a) Power wiring (mm^2)

b) Control wiring (mm^2)

v) Type of control terminal block on

a) Fixed portion and draw out portion

b) Switchgear and breaker

vi) Make and type of terminal blocks

vii) Minimum current rating of terminal blocks

15. **TIMERS**

i) Manufacturer's name

ii) Type

iii) Standard applicable

iv) Range

v) No. of NO & NC

16. **ENERGY METER**

a) Name of manufacturer and manufacturer's type designation

b) Model no

c) Catalogue attached or not

* Give details for each type of C.T.

17. **POWER PACK UNIT**

i) Manufacturer's Name

ii) Capacity

iii) Capacity of charging unit

iv) No. of feeders in distribution board

18. **PROGRAMMABLE LOGIC CONTROL UNIT**

FOR POWER HOUSE

i) a) Name of manufacturer and manufacturer's type designation

b) Model no

c) Catalogue attached or not

2. For items not listed above but mentioned in the contract required to complete the system, contractor has to submit the performance/ compliance certificate before supply (refer clause no 20.7.5 of TS).

Date:

Place:

Signature of Bidder
Name:
Status:
Whether authorized attorney of tendering company
Name of tendering Company

SCHEDULE III

SCHEDULE OF MANDATORY SPARES

S.No	Description	Quantity
i.	Air circuit breakers	
	630A	3 Nos.
	1000A	1 No.
	1600A	1 No.
	4000A	1 No.
ii.	MCCB of each type used	8 nos. of each used type
iii.	SFU	
	100A	5 Nos.
	200A	5 Nos.
iv.	Portable star delta starters for handling of 100kW motors	6 Nos.
v.	Current transformer of type used	2 nos. of each used type
vi.	Potential transformers (415V/110V)	2 nos.
vii.	Supporting insulator of type used	6 nos. of each used type.
viii.	Bushing of type used	1 no. of each used type
ix.	Arcing chamber assemblies for circuit breaker	`
	630A	6 Nos
	1000A	2 No.
	1600A	2 No.
	4000A	2 No.
x.	Main contacts for three poles, with spring, bolts, nuts etc. for circuit breaker	12 sets of each used type
xi.	Primary isolating contacts used	12 sets of each used type
xii.	Coils for tripping and closing of type used	12 nos. of each used type
xiii.	Complete motor drives of type used	4 nos. of each used type
xiv.	Complete spring closing mechanism for the breakers (If applicable)	2 nos. of each used type
xv.	Sandwich bus duct and associated accessories IF APPLIABLE	
	Bends	5% of installed bends
	Bus duct (straight section)	5% of installed section
xvi.	Relays	2 nos. of each used type
xvii.	Indication lamps used including assemblies	10 nos. of each used type
xviii.	Fuses	10 nos. of each used type
xix.	Control and instrumentation switches	3 nos. of each used type

xx.	Contactors	2 nos. of each used type
xxi.	Indicating instruments	2 nos. of each used type
xxii.	Items for completeness of System as per clause no. 20.1.1.5	10% of installation

Date:

Place:

Signature of bidder
Name:
Status: Whether authorized attorney of tendering company
Name of tendering

SCHEDULE IV

SCHEDULE OF RECOMMENDED SPARES

S.No.	Description	Quantity

Date:

Place:

Signature of bidder
Name:
Status: Whether authorized attorney of tendering company
Name of tendering

SCHEDULE-II

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS

A. **POWER & CONTROL CABLE**

1.0	General:
1.1	Manufacturer's name and address
1.2	Location of factory
2.0	Cable Wire
2.1	Type and size of cable
2.2	Standard applicable
2.3	Voltage rating
2.4	Permissible variation in voltage frequency and combined voltage and frequency
2.5	Suitable for earthed/unearthed system
2.6	No. of cores
3.0	Conductor and its hardness
3.1	Standard applicable

3.2	Material copper/aluminium/grade
3.3	Nominal cross-sectional area
3.4	Form of conductor circular/shaped
3.5	No. of strands
3.6	Nominal dia of each strand
3.7	Whether strands are tinned or not
3.8	Temperature co-efficient of resistance at 20 deg.C.
4.0	Armour/Unarmoured
4.1	Material
4.2	Thickness (minimum)
4.3	Standard applicable
5.0	Conductor Screen
5.1	Standard applicable
5.2	Material
5.3	Minimum thickness
5.4	Whether extruded
6.0	Insulation

6.1	Standard applicable
6.2	Material (mention type)
6.3	Minimum average thickness
6.4	Tolerance on the smallest of the measured values of thickness of insulation
6.5	Dia of core over insulation
6.6	(a) Minimum volume resistivity at 27 deg. C.
	(b) Minimum volume resistivity at 70 deg.C.
6.7	Colour scheme of identification of cores
6.8	Average dielectric strength
6.9	Suitability with regard to moisture ozone, acid, oil and alkaline surroundings
7.0	Insulator Screen
7.1	Standard applicable
7.2	Whether extruded semi-conducting screen is applied
7.3	Material of the semi-conducting screen
7.4	Thickness of the semi-conducting screen

7.5	Whether extruded under triple extrusion process
7.6	Whether copper type screening is applied
7.7	Thickness of the copper tape
7.8	For braided screen material and dia of screen wire and min. percentage coverage
8.0	Inner Sheath
8.1	Standard applicable
8.2	Material thickness of inner sheath
8.3	Whether extruded
8.4	Minimum thickness of inner sheath
8.5	Calculated diameter over stranded cores of the cables
8.6	Whether the inner sheath and the filling material are suitable for the operating temperature of the cable
9.0	Outer Sheath/Overall Covering
9.1	Standard applicable
9.2	Material (mention type if any)
9.3	Whether extruded
9.4	Minimum average thickness

9.5	Tolerance on the smallest of the measured values of thickness of outer sheath
9.6	Calculated dia. under the sheath
9.7	Whether anti-termite treatment has been given in the outer sheath
9.8	Whether flame retardant low smoke compound added in outer sheath
10.0	Electrical Properties
10.1	Conductor resistance at 20 deg. C. per km.
10.2	Maximum permissible conductor temperature: a) Under continuous full load b) Under transient conditions
10.3	Loss tangent at normal frequency
10.4	Reactance at 50 C/S per km.
10.5	Capacitance at 50 C/S per km.
10.6	Current ratings
10.6.1	In air (continuous)
10.6.2	In duct (continuous)
10.6.3	Reference ambient temperature of the above
10.6.4	Short circuit current rating for 1 sec. duration

10.7	Derating factors
10.7.1	For an ambient temperature of 50 deg.C.
10.7.2	For grouping of 6 to 9 cables in cable trench/cable rack trays and in 4 to 6 tiers for different spacings and also touching each other
11.	Mechanical Data
11.1	Overall dia of the cable
11.2	Dia of the cable under the sheath
11.3	Diameter under armouring
11.4	Diameter over the stranded cores
11.5	Weight of cable per km.
11.6	Drum length
11.7	Tolerance on drum length
11.8	Total weight of the drum
11.9	Dimension of the drum
11.10	Recommended minimum installation radius
11.11	Maximum safe pulling force
11.12	Whether identification as per clause 11.14 of the specification is being provided

11.13 Whether packing has been done as per clause 11.13 of the specification

B. CABLE Trays

GENERAL

1.1 Manufacturer's name and address

1.2 Location of factory

1.3 Type and width of

a)Trays

b) Ladders

1.4 Standard applicable

1.5 Thickness

a) Trays

b) Supports

c) Brackets

1.6 Earthing system

1.7 Weight per 1000m

a) Trays

b) Supports

c) Brackets

1.8 Distance between parallel layer of trays

1.9 Galvanization of

a) Trays

b) Supports

c) Brackets

d) Nuts and Bolts

1.10 Painting of support system

1.11 Supporting arrangement system

a) Material & Type

b) Spacing between supporting structures

c) Total weight of supporting steel used

C. CABLE CLAMPS

2.1 Material

2.2 Type

2.3 Thickness

D. CABLE TERMINATION KITS

3. 1 Manufacturer

3.2 Applicable standard

3.3 A.C. withstand voltage (Phase/Ground & Time duration)kV

3.4 Partial Discharge at 1.1 Phase/ground volt

3.5 Impulse withstand 1.2/50 us kV

3.6 Short circuit current 1 sec KA

3.7 Dynamic Short Circuit withstand kV

3.8 Type test report for above tests

a) humidity

b) salt-fog tests furnished (Yes/No)

3.9 Kit particulars:

a) Material of tubing/ moulded part

b) Method of stress control

c) Method of environmental seal

d) List of items included in the kit furnished (Yes/No)

1. For terminations

2. For splices

E. CABLE LUGS

4.1 Make

4.2 Type

4.3 Material

4.4 Applicable Standard

F CABLE GLANDS

5.1 Make

5.2 Type

5.3 Material

5.4 Surface Treatment

5.5 Applicable Standard

G FIRE SEALING SYSTEM

6.1 Type

6.2 Make

6.3 Material of fire stop

6.4 Pressure withstand capacity of fire stop

6.5 Weight of fire stop assembly system

6.6 Shelf life of fire stop material

6.7 Life of fire stop assembly

Note:-

1. **Bidder can supply above information for different types of power & control cables.**

Date:
Place:

Signature of Bidder
Name:
Status
Whether authorized attorney
Of tendering company
Name of Tendering Company

SCHEDULE-III

SCHEDULE OF MANDATORY SPARES

Sr.No.	Description	Quantity
~~1.~~	~~Cable 33 kV~~	~~10% of installed quantity~~
~~2.~~	~~Cable 11 kV~~	~~10% of installed quantity~~
3.	LV power cable of each type	10% of installed quantity
4.	Control cable of each type	10% of installed quantity
5.	Communication cable of each type	10% of installed quantity
~~6.~~	~~Terminals – 11 kV~~ ~~Terminals -33kV~~ ~~Outdoor type~~ ~~Indoor type~~	~~10% of installed quantity~~
7.	Lugs of each size, cable ties	20% of installed quantity
8.	Coaxial cables	10% of installed quantity
9.	Cable glands of each size	20% of installed quantity
10.	Junction boxes of each size	20% of installed quantity
~~11.~~	~~11kV & 33kV Straight Through Joint Kit(Indoor and Outdoor)~~	~~5 No. each~~
12.	Cable Trays along with accessories	10% of Installed quantity of all type
	Crimping Pliers for all sizes of Thimbles	
	a) Ordinary	4(No.)
13.	b) Hydraulic	2(No.)
14.	Wire Cutter for all sizes of cables	3(No.)
15.	Wire Strippers	3(No.)
~~16.~~	~~Electrical operated Concrete, metal & wood drilling machine along with drilling bits of different sizes(Hilti).~~	~~2Sets (each type)~~
17.	~~Heavy duty motorized hot air gun~~	~~2 (Nos.)~~

18.	Gland cutter(all sizes)	2 Sets
19.	Items for completeness of System as per clause no. 18.1.1.6	10% of installation

Date:
Place:

Signature of Bidder
Name:
Status
Whether authorized attorney
Of tendering company
Name of Tendering Company

SCHEDULE-IV

SCHEDULE OF RECOMMENDED SPARES

Sr.No.	Description	Unit	Quantity

Date:
Place:

Signature of Bidder
Name:
Status
Whether authorized attorney
Of tendering company
Name of Tendering Company

SCHEDULE-V

SCHEDULE OF TOOLS

Sr. No.	Description	Qty	Make
1	portable cable fault locator suitable for PVC, PILC, XLPE of rating 400kV, 415V, 33kV, 22kV and 11kV with all necessary auxiliaries, accessories and consumables	One (1) no.	Meggar / Hiptronics/ equivalent
2	Infrared camera suitable upto 400kV with all necessary auxiliaries, accessories and consumables	One (1) no.	Flir / Fluke/ equivalent

Date:
Place:

Signature of Bidder
Name:
Status
Whether authorized attorney
Of tendering company
Name of Tendering Company

SCHEDULE-VI

SCHEDULE OF TYPE TEST

The following type tests shall be conducted as per applicable standards on XLPE and PVC insulated power & control cables:

Sr.No.	Description of Test
1.	Annealing test (for copper)
2.	Tensile test
3.	Wrapping test
4.	Conductor resistance
5.	Partial discharge test
6.	Dielectric power factor test
7.	Bending test followed by partial discharge test
8.	Heating cycle test followed by partial discharge test
9.	Test for thickness of insulation and sheath
10.	Tensile strength and elongation test for insulation and sheath Ageing test for insulation and sheath
11.	Loss of mass tests for insulation and sheath
12.	Shrinkage Test for Insulation and Sheath
13.	Hot Deformation Test for Insulation and Sheath
14.	Cold Bend Test (up to 6mm.sq.) size
15.	Cold Impact Test for Insulation and Sheath
16.	Heat Shock Test for Insulation and Sheath
17.	Thermal Stability Test for Insulation and Sheath
18.	Test for Bleeding and Blooming of pigments for PVC Insulation & Sheath
19.	Fire Resistance Test
20.	Measurement of Insulation Resistance
21.	Impulse withstands Test.
22.	High voltage test (Cable immersed in water)
23.	High voltage test at room temperature
24.	Oxygen Index
25.	Temperature Index
26.	Smoke density test
27.	Flammability test
28.	Swedish Chimney test
29.	Ladder Test.
30.	

Date:
Place:

Signature of Bidder
Name:
Status
Whether authorized attorney
Of tendering company
Name of Tendering Company

TITLE		SPECIFICATION NO.
	LV MOTOR	VOLUME II B
		SECTION D
	DATA SHEET-A	REV NO. 00 DATE
		SHEET 1 OF 1

1.0	Design ambient temperature		:	40 °C
2.0	Maximum acceptable kW rating of LV motor		:	≤200KW
3.0	Installation (Indoors/ Outdoors)		:	As required
4.0	Degree Of Protection		:	IP54 / IP55
5.0	Cooling		:	TEFC / TETV / CACA
6.0	Details of supply system			
	a)	Rated voltage (with variation)	:	415V ± 10%
	b)	Rated frequency (with variation)	:	50 Hz (Variation: -5% to +3%) and
	c)	Combined voltage & freq. variation	:	10% (sum of absolute values)
	d)	System fault level at rated voltage	:	50 kA for 1 sec
	e)	Short time rating for terminal box	:	50 kA for 0.25 sec
	f)	LV System grounding	:	Solidly
7.0	Class of insulation		:	Class 'F', with temp rise limited to class B
8.0	Minimum voltage for starting		:	80% of rated voltage
9.0	Power cables data		:	Shall be given during Detailed engg.
10.0	Earth Conductor Size & Material		:	Shall be given during Detailed engg.
11.0	Space heater supply **(20KW & ABOVE)**		:	240 V, 1Φ , 50 Hz
12.0	TYPE OF STARTER PROVIDED IN MCC		:	DOL
13.0	Locked rotor current			
	a)	Limit as percentage of FLC	:	As per IS 12615
14.0	Additional tests		:	As per QP
15.0	Flame-proof motor			
	a)	Enclosure suitable (As per IS:2148)	:	As per requirement
	b)	Classification of Hazardous area (As per IS: 5572 part-I)	:	As per requirement
	c)	Degree of protection	:	IP65
16.0	Makes		:	AS PER ANNUXURE-I
17.0	Terminal box		:	Suitable to rotate at 90 degrees
18.0	Paint shade		:	Shall be given during Detailed engg.
19.0	Efficiency class		:	As per IS 12615 : 2011

Also detailed Customer spec. for Motors is to be referred as enclosed with technical spec.

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

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

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	Sign & Date	Name		Sign & Date	Name
Prepared by:		HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:		PRAVEEN DUTTA	Reviewed by:		RITESH KUMAR JAISWAL

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

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

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

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

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BHEL	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN	SPEC. NO :	DATE:17.04.2020
		CUSTOMER :	QP NO.: PE-QP-999-Q-007, REV-04	
		PROJECT:	PO NO.:	
		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V)) SYSTEM:	SECTION: II	SHEET 1 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
1.0	RAW MATERIAL & BOUGHT OUT CONTROL													
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	LOG BOOK		P	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	SAMPLE	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TEST REPORT		P/V	-		
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%	-		FREE FROM CRACKS, UN-EVENNESS ETC.	TEST REPORT		P	-	-	
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TC		P/V	-	-	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%	-	MANUFACTURER'S DRG./SPEC	FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK		P/V	-		
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TC		P/V	-		HEAT NO. SHALL BE VERIFIED
		3.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG.	MANUFACTURER'S DRG.	LOG BOOK		P/V	-		
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	LOG BOOK		P/V	-		

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Sign & Date	
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MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	
	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	DATE:17.04.2020
	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 2 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S DRG./ STD.	TC		P/V	-		
		3. DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S DRG.	LOG BOOK		P/V	-		
		4.INTERNAL FLAWS	CR	ULTRASONIC TEST	100%	-	ASTM-A388	MANUFACTURER'S STD.	INSPECTION REPORT	✔	P/W	V	-	FOR DIA OF 55 MM & ABOVE
1.6	SPACE HEATERS, CONNEC-TORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	100%	-	MANUFACTURER'S DRG./STD.	MANUFACTURER'S DRG./STD.	INSPECTION REPORT		P/V	-	-	
		2. PHYSICAL COND.	MA	VISUAL	100%	-	MANUFACTURER'S DRG./STD.	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	INSPECTION REPORT		P/V	-	-	
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG./ STD	MANUFACTURER'S DRG. / STD.	INSPECTION REPORT		P/V	-	-	
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-	MANUFACTURER'S DRG./ STD	MANUFACTURER'S DRG. / STD.	TEST REPORT		P/V	-	-	

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Reviewed by:		PRAVEEN DUTTA	Reviewed by:		R K JAISWAL

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	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN	SPEC. NO :	DATE:17.04.2020
		CUSTOMER :	QP NO.: PE-QP-999-Q-007, REV-04	
		PROJECT:	PO NO.:	
		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V)) SYSTEM:	SECTION: II	SHEET 3 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	-	NO VISUAL DEFECTS	TEST REPORT		P/V	-	-	
		2.DIMENSION(BORE DIA, WALL THICKNESS, BDV AS RECEIVED, BDV AFTER FOLDING AT 180º	MA	TEST	SAMPLE	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK AND OR SUPPLIER'S TC		P/V	-	-	
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK		P	-	-	
		2.DIMENSIONS INCLUDING BURS HEIGHT	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG. .	MANUFACTURER'S DRG.	LOG BOOK		P/V	-	-	
		3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	SAMPLE	-	MANUFACTURER'S DRG./ STD.	MANUFACTURER'S DRG./ STD.	TC		P/V	-	-	
1.9	CONDUCTORS	1. SURFACE FINISH	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		*P/V	-	-	* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY
		2.ELECT. PROP, & MECH. PROP	MA	ELECT. & MECH.TEST	SAMPLES	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S / SPEC.	TC & VENDOR'S TEST REPORTS		P/V	-	-	

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	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 4 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLES	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S / SPEC.	LOG BOOK		P/V	-	-	
1.10	BEARINGS	1.MAKE & TYPE	MA	VISUAL	100%	-	MANUFACTURER'S DRG./ APPROVED DATASHEET	MANUFACTURER'S DRG./ APPROVED DATASHEET	LOG BOOK		P/V	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	APPROVED DATASHEET	APPROVED DATASHEET/ BEARING MANUF'S CATALOGUES	LOG BOOK		P/V	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P/V	-	-	
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	SAMPLE	-	MANUFACTURER'S STD./ APPROVED DATASHEET	MANUFACTURER'S STD./ APPROVED DATASHEET	LOG BOOK		P/V	-	-	
		4.HV/IR	MA	-DO-	100%	-	MANUFACTURER'S STD./ APPROVED DATASHEET	MANUFACTURER'S STD./ APPROVED DATASHEET	LOG BOOK		P/V	-	-	
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	-	MANUFACTURER'S DRG/SPECS	MANUFACTURER'S DRG./ SPECS.	LOG BOOK		P	-	-	
		2.SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	

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	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	DATE:17.04.2020
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	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 5 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
2.0	IN PROCESS													
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-	MANUFACTURER'S DRG	GOOD FINISH	LOG BOOK		P/W	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-	-DO-	GOOD FINISH	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	100%	-	MANUFACTURER'S STD./ ASTM-E165	MANUFACTURER'S STD./ APPROVED DATASHEET.	LOG BOOK	✔	P	V	-	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		3.SHADE	MA	VISUAL	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	

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	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 6 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK		P	-	-	
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK		P	-	-	
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		2.CLEANLINESS	CR	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325//IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT	✔	P	V	-	
		4.RESISTANCE	CR	ELECT. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325//IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT	✔	P	V	-	
		5.INTERTURN INSULATION	CR	ELECT. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325//IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT		P	-	-	
2.6	IMPREGNATION	1.VISCOSCITY	MA	PHY. TEST	AT STARTING	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		3.NO. OF DIPS	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK	✔	P	V	-	THREE DIPS TO BE GIVEN

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	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	DATE:17.04.2020
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	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 7 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
		4.DURATION	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK	✔	P	V	-	
2.7	COMPLETE STATOR ASSEMBLY	1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS	CR	VISUAL	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		2.SOUNDNESS	CR	MALLET TEST & UT	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	TEST/INSPC. REPORT	✔	P	V	-	
		3.HV	MA	ELECT. TEST	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	TEST/INSPC. REPORT	✔	P	V	-	
2.9	COMPLETE ROTOR ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	100%	-	MANUFACTURER'S SPEC./ ISO 1940	MANUFACTURER'S DWG.	LOG BOOK		P	-	-	
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	TEST/INSPC. REPORT	✔	P	V	-	
2.10	ASSEMBLY	1.ALIGNMENT	MA	MEAS.	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		2.WORKMANSHIP	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		3.AXIAL PLAY	MA	MEAS.	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK	✔	P	V	-	
		4.DIMENSIONS	MA	MEAS.	100%	-	MANUFACTURER'S DRG./ MANUFACTURER'S SPEC.	MANUFACTURER'S DRG./ MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		6. RTD, BTD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK	✔	P	V	-	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:		HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:		PRAVEEN DUTTA	Reviewed by:		R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:17.04.2020
	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 8 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS	MA	ELECT.TEST	1/TYPE/SIZE	1/TYPE/SIZE	IS-325//IS-12615/APPROVED DATASHEET	IS-325/IS-12615/APPROVED DATASHEET	TEST REPORT	✔	P	W*	-	* NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST	MA	ELECT.TEST	100%	-	IS-325//IS-12615/APPROVED DATASHEET	IS-325/IS-12615/APPROVED DATASHEET	TEST REPORT	✔	P	V$	- -	$ NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	ELECT.TEST	100%	-	IS: 12075 / IEC 60034-14 & IS-12065	IS: 12075 / IEC 60034-14 & IS-12065	TEST REPORT	✔	P	V$	-	$ NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET &	TEST/INSPC. REPORT	✔	P	W	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	-	IEC 60034-5/IS-12615	APPROVED DATASHEET	TC	✔	P	V	- -	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	ELECT. & MECH. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1/IS: 12802	IS-325/IS-12615/IEC-60034 PART-1/IS: 12802	TC	✔	P	V$	-	$ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	ELECT. & MECH. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325/IS-12615/IEC-60034 PART-1	TC	✔	P	V$	-	$ NOTE - 2
		8. NAME PLATE DETAILS	MA	VISUAL	100%	-	IS-325//IS-12615& DATA SHEET	IS-325//IS-12615 & DATA SHEET	TEST/INSPC. REPORT	✔	P	V$	-	$ NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	-	IS 2148 / IEC 60079-1	IS 2148 / IEC 60079-1	TC	✔	P	V	-	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	SAMPLE	APPROVED DATASHEET	APPROVED DATASHEET	TC	✔	P	W$	-	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY $ NOTE - 2

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:		HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:		PRAVEEN DUTTA	Reviewed by:		R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN	SPEC. NO :	DATE:17.04.2020
		CUSTOMER :	QP NO.: PE-QP-999-Q-007, REV-04	
		PROJECT:	PO NO.:	
		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V)) / SYSTEM:	SECTION: II	SHEET 9 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MANUFACT. STANDARD / (#)	AS PER MANUFACT. STANDARD / (#)	INSPC. REPORT	✔	P	W	-	(#): REFER NOTE-8

NOTES:

1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED.

2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL/CUSTOMER SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON.

3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THE SAME IS VALID FOR 5 YEARS.

4 BHEL RESERVES THE RIGHT TO PERFORM REPEAT TEST, IF REQUIRED.

5 AFTER PACKING AND PRIOR TO ISSUE MDCC, PHOTOGRAPHS OF ITEMS TO BE DESPATCHED SHALL BE SENT TO BHEL PURCHASE GROUP FOR REVIEW.

6 IN CASE , ANY CHANGES IN QP COMMENTED BY CUSTOMER AT CONTRACT STAGE SHALL BE CARRIED OUT BY BIDDER WITHOUT ANY IMPLICATION TO BHEL/ CUSTOMER.

7 PROJECT SPECIFIC QP TO BE DEVELOPED BASED ON CUSTOMER REQUIREMENT.

8 FOR EXPORT JOB, BHEL TECHNICAL SPECIFICATION FOR SEAWORTHY PACKING TO BE FOLLOWED.

9 PACKING SHALL BE SUITABLE FOR STORAGE AT SITE IN TROPICAL CLIMATE CONDITIONS.

10 LATEST REVISION/ YEAR OF ISSUE OF ALL THE STANDARDS (IS/ ASME/ IEC ETC.) INDICATED IN QP SHALL BE REFERRED.

LEGENDS:

*RECORDS, INDENTIFIED WITH "TICK"(√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,

** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, B: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C**: CUSTOMER,

P: PERFORM, **W**: WITNESS, **V:** VERIFICATION, AS APPROPRIATE

MA: MAJOR, **MI**: MINOR, **CR:** CRITICAL

D: DOCUMENT

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:		HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:		PRAVEEN DUTTA	Reviewed by:		R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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

	Manufacturing Quality Assurance Test Requirements		
	Project Name (MW): ARUN-III HEP (4X225 MW)	**Doc. No.:** QAI/A/M/EM/CB/01	**Rev. No.:** 02
	Item Description: Cables (Power, Control, Instrumentation, Coaxial, Cable Tray, Termination Kit & Cable Accessories)	**Issue Date:** 30.05.2017	**Page No.** 2
Sr. No.	**Component, Operation & Characteristics**	**Applicable Standard**	**Remark**
1	2	3	4
A	**Cables (Power, Control, Instrumentation and Coaxial)**		
1	**Incoming Material**		
1.1	**Aluminium Rod/ Copper Rod**		
	Make & Surface Finish, Dimensional Check, Purity, Breaking Load, Conducitvity	IS 8130/ TS/ DRG	V
1.2	**Aluminium Wire/ Copper Wire/Conductor**		
	Diameter, Resistivity or Conductivity at 20C, Mechanical Properties(Tensile, % Elongation/ Wrapping test, Annealing), Surface Finsh, Joints, Chemical properties	IS 8130/ TS/ DRG	V
1.3	**PVC Compound (Insulation)**		
	Make , Specific Gravity, Visual Check for PVC Granules i.e. Foreign Burnt Particle, Elongation Before & After Ageing, Loss of Mass, Thermal Stability	IS 5831/ TS/ DRG	V
1.4	**XLPE Compound (Insulation)**		
	Make , Specific Gravity, Visual Check for PVC Granules i.e. Foreign Burnt Particle, Elongation Before & After Ageing, Loss of Mass, Thermal Stability	IS 7098/ Rel IEC	
1.5	**FRLS PVC Compound**		
	Oxygen Index test, Temperature Index test, HCL Gas Emission test, Smoke Density Rating	ASTMD 2863/ IEC 745(I)	V
1.5	**Amour/ Wire Strip (as applicable)**		
	Tensile Strength, Make, % Elongation, Torsion/ Winding, Mass of Zinc Coating, Resistance, Diameter Size, Uniformity of Zinc Coating	IS 3975/ IS 1554/ TS/ DRG	V
1.6	**Drum**		
	Visual Check, Dimensions, Anti termite/ rodent treatment	IS 10418/ TS/ DRG	V
1.9	**FRLS PVC Compound for Instrumentation/ Coaxial Cables**		
	Oxygen Index test, Temperature Index test, HCL Gas Emission test, Smoke Density Rating	ASTMD 2863/ IEC 745(I)	V
2	**In process Stage**		
2.1	**Conductor**		
	Surface Finish, Lay length constant & nozzing, Resistance/ km at 20C, Dimension, Dia over conductor, Direction of Lay	IS 8130/ TS/ DRG	V
2.2	**PVC Insulated Core Marking**		
	Type of Material, Process Control (Speed, Temperature), Color of Core, Core Identification, Core Numbering, Surface Finish, Thickness of Insulation (Nominal & Minimum), Insulation Resistance, Ovality/ Concentricity, HV Test(Spark Testing), Shrinkage Test, Hot Deformation, Volume Resistivity	IS 1554/ TS/ DRG	V
1.4	**PVC (Sheath) (inner & outer)**		
	Make & Visual Check, Tensile & Elongation Before & After Ageing, Loss of Mass, Thermal Stbility, Specific Gravity, Volumne Resistivity	IS 5831/ TS/ DRG	V
	Oxyegen/ Temperature Index, Smoke Density (Rating) Test, Acid Gas Generation (For Outer Sheath Only)	ASTMD 2863/ IEC 745(I) / TS/ DRG	V
2.3	**Conductor Bunching for instrumentation/ coaxial cables**		
	No of Strands, Size of Wire (Before Stranding), Conductor Resistance, Annealing (Before Stranding) for Copper, Finish	IS 8130	V
2.4	**Pair/ Triad Twisting/ Core Laying for instrumentation/ coaxial cables**		
	Color Sequence, Core/Pair/ Triad Identification, T/M (for pair/triad), HV & CR	DRG/ TS	V
2.5	**Screening (Individual or overall as applicable)**		
	Coverage/ Tape Overlap, Size of wire/ size of tape	DRG/ TS	V
2.6	**Laying of Cores**		
	Construction, Sequence of Laying, Lay length, Laid up diameter, Direction, HV & Continuity	DRG/ TS	V
2.7	**Inner Sheath**		
	Thickness of Inner Sheath, Diameter over inner sheath, Surface Finish, Color	IS 1554/ TS/ DRG	V
2.8	**Amouring**		
	Construction, Dimension, Surface finish, coverage, gap between two wire/ formed wire, Dia over, joint/ cross	IS 1554/ IS 3975/ TS/ DRG	V
2.9	**Outer Sheath**		
	Thickness of sheath (Min/Nom), Surface Finish, Type of Material/Color, Overall dia, Embossing, Progressive Sequence Marking	IS 5831/ TS/ DRG	V
2.10	**Drum Winding**		
	Drum Condition, Cable length, Cable & Sealing before dispatch, Drum marking, Lagging	/ TS/ DRG	V
3	**Final Inspection**		
3.1	**Type Test (as aaplicable for type of cable as per TS)**		

	Annealing test (for Copper), Tensile Strength (for Al), Wrapping test (for Al), Conductor Resistance test, Partial discharge test, dielectric power factor test, bending test followed by partial discharge test, heating cycle test followed by partial discharge test, test for thickness of insulation and sheath, , cold bend test (up to 6mm sq) size, , fire resistance test, measurement of insulation resistance, impulse withstands test, high voltage test (cable immersed in wate), high voltage test at room temperature, oxygen index, smoke density test, flammability test, swedish chimney test, ladder test	TS/ DRG/ Rel Std.	W
3.2	**Type test on Insulation and Sheath**		
	Tensile strength and elongation test, ageing test, loss of mass test, shrinkage test, hot deformation test, Cold impact test, heat shock test, thermal stability test, test for bleeding and blooming of pigments for PVC	TS/ DRG/ Rel Std.	W
3.3	**Routine Tests**		
	Conductor Resistance, HV test, Dimension, Insulation Resistance test, Partial Discharge test for screended cables	IS 1554/ TS/ DRG	W
3.4	**Acceptance Test**		
	Check for cable identification/ marking of cables at 100 meters, Conductor Resistance, Tensile Wrapping,Test for thickness of Insulation & Sheath, Tensile Strength and Elongation Test, Verification of Cable length & Surface Finish, High Voltage test at room temperature, IR test,	IS 1554/ TS/ DRG	W
	(For Outer Sheath Only) Oxygen Index, Temperature Index, Smoke Density Rating, Acid Gas Generation test, Flame Retardant test etc.	ASTMD 2863/ IEC 745(I)/ TS/ DRG	W
3.4	**Additional Tests for Coaxial Cables**		
	Capacitance, Impedance, Voltage Withstand test etc.	REL STD	W
4	**Packing in Drums**		
	Finish & Markings on drums	TS/ DRG/ Rel Std.	V
B	**Optical Fiber Cable**		
1	**Measurement of Dimensions**		
	Diameter of cladding, Non-circularities, Concentricity errors, Diameter of primary coating, Concentricity error of primary coating, Fiber stripping, Thickness of insulation- electrical conductir, thickness of sheath	IEC 60794/ TS/ DRG/ REL STD	V
2	**Measurement of Mechanical Characterisitcs**		
	Tensile performance, crush, impact, torsion, bend, water penetration, abrasion, bending under tension, repeated bending, flexing, kink, cut through resistance, compound flow	IEC 60794/ TS/ DRG/ REL STD	V
3	**Measurement of Electrical Characteristics**		
	Conductor, Resistance, Dielectric strength of insulation, Insulation resistance	IEC 60794/ TS/ DRG/ REL STD	V
4	**Measurement of Transmission & Optical Characteristics**		
	Attenuation, Point Defect, Optical Continuity, Change in optical transmittance during mechanical & Envrionmental condtions, Refractive index profile, Microbending sensitivity & Macrobending sensitivity, Fiber cut-off wavelength, Mode Field diamete	IEC 60794/ TS/ DRG/ REL STD	V
5	**Measurement of Environmental Characterisitcs**		
	Temperature cycling, Ageing, Fire Performance, Sheath integrity, Nuclear Radiation, Pneumatic Resistance, Hydrostatic pressure	IEC 60794/ TS/ DRG/ REL STD	V
C	**Cable Tray**		
1	**Incoming Material**		
1.1	**M.S. Sheet/ Stainless Steel Channels/ Angels**		
	Physical Properties, Chemical Properties, Check for Waiveness, Dimension, Lamination	DRG/ TS	V
2	**In Process Stage**		
2.1	**Fabrication**		
	Surface Defects, Deburring, Dimensions, Welding Quality, DPT	DRG/ ASME Sec IX, ASME Sec VII	V
3	**Final Inspection**		
	Dimesions, Galvanizing test, Mass of Zinc Coating, Thickness and uniformity of Coating, Adhesion test	IS 2629	W
D	**Termination Kit**		
	Routine & Acceptance Test	TS/ DRG/ Rel Std.	V
E	**Cable Accessories (Glands, Termination lugs, Markers, Ties, Tages, Tool for termination, MS Pipe, Marshalling Boxes, MCB, Insulating tapes)**		
	Visual & Dimensional Verification, Finish & Smoothness	DRG	V

LEGENDS

TS: TECHNICAL SPECIFICATIONS	REL. TS/ DRG/ Rel STD.: RELEVENT STANDARD
V: VERIFICATION OF REPORTS/TCs	DRG: DRAWING
W: CUSTOMER HOLD POINT (CHP)	

NOTES

1	Any test at any stage not covered in Quaility Assurance Test Requirement (QATR), but part of technical specification of contract, shall also be carried out by Contractor/ firm.
2	QATR shall be read in conjunction with General Quality Assurance Requirement given as part of Technical Specification
3	This QATR is applicable for all types of cables being supplied under this contract.

106108/2020/PS-PEM-MAX

Manufacturing Quality Assurance Test Requirements

Project Name: Arun- III HEP (4x225 MW)	**Doc. No**. QAI/A/M/EM/EP/04	**Rev. No**. 02
Item Description: LT System (415V AC)	**Issue Date**: 30.05.17	**Pages:** 2

Sr. No.	Component, Operation & Characteristics	Applicable Standard	Remarks
1	2	3	4
I	**415V AC Switchgear**		
A	**Raw Material**		
1	Insulating Material: FRP, SMC & DMC Sheet & components, Insulator		
	a) Visual	DRG & IS9431	V
	b) Dimensional & Creepage distance	-do-	V
	c) 1 Min Dry PF Test (as applicable)	-do-	V
	d) Cantilever Strength (as applicable)	-do-	V
2	**Bus Bar (Copper)**		
	Material test	DRG/ Rel STD/TS	V
	Dimension check, Silver plating on contact surface	DRG/ Rel STD/TS	V
3	**CT, PT & Control Transformer**		
	Routine & Acceptance test	DRG/ Rel STD/TS	V
4	**ACB, MCB, MCCB, Relays, Timer, Auxiliary & Selector Switches, Transducers**		
	Routine & Acceptance test	DRG/ Rel STD/TS	V
5	**Main & Auxiliary Contact- Material test, Silver plated with spring**	DRG/ Rel STD/TS	V
6	**Spring Charging Motor**		
	Routine & Acceptance test	DRG/ Rel STD/TS	V
7	**Closing & Trip Coils**		
	Measurement of Resistance	DRG/ Rel STD/TS	V
8	**Meters (all type) & indicating instruments**		
	Make, Model & Type and Calibration certificate	DRG/ Rel STD/TS	V
	Accuracy test, HV test & routine test	DRG/ Rel STD/TS	V
9	**Indicators**		
	Make, Type & Operation check	DRG/ Rel STD/TS	V
10	**Earthing flat (Galvanized steel)**		
	Dimension & Material test, Galvanization Check	DRG/ Rel STD/TS	V
11	**Gasket**		
	Dimension check, Chemical & Physical properties, Surface finish	DRG/ Rel STD/TS	V
12	**Sheet Steel for fabrication & Steel for structure**		
	Dimension, Chemical & Mechanical properties, Bend test	DRG/ Rel STD/TS	V
B	**Final Inspection**		
1	Dimension check for height, width, depth & sheet thickness of panel	REL. STD/DRG/TS	W
2	Dimension check for bus bar & check phase to phase, phase to earth clearance	REL. STD/DRG/TS	W
3	Visual check as per OGA, DRG & verification of BOM	REL. STD/DRG/TS	W
4	Visual check of alignment of Boards, Operation of Doors, Locks, Shutters, Racking device for ACB & MCCB, Base grouting & gland plates	REL. STD/DRG/TS	W
5	Verification of correct wiring, Ferruling, dressing, routing,, bunching, continuity check, colour coding and earthing	REL. STD/DRG/TS	W
6	Insulation resistance measurement before & after HV test	IEC 60204-1	W
7	Dielectric test on Main, auxiliary & control circuit	IEC 62271-203 $ 7.2	W
8	Functional test on all AC & DC circuit including heating, Lighting, Fan & thermostat	REL. STD/DRG/TS	W
9	Checking interchangeability of Air Circuit Breaker & MCCB of same rating & capacity or as per TS	-do-	W
10	ACB/MCCB		
A	Mechanical Operation test		
i	2 No. Closing Operation of Breaker at rated 110% & 85 % of Auxiliary Voltage	TS/IS 13947-2/ TS	W

Sr. No.	Component, Operation & Characteristics	Applicable Standard	Remarks
1	2	3	4
ii	2 No. Opening Operation of Breaker at rated 110% & 70 % of Auxiliary Voltage	-do-	W
iii	Trip free operation	-do-	W
iv	O-C-O operation of ACB after Power Supply failure	-do-	W
B	Verification of release		
i	Short Circuit & Shunt (if applicable)	IS 13947-2, DRG & TS	V
ii	Under voltage (if applicable)	-do-	W
11	Verification of Mechanical interlock & antipumping features	TS/IS 13947-2/ IEC60694/ IEC62271	W
12	Measurement of Resistance of main circuit	-do-	W
13	Verification of protection against electrical shock	REL. STD/DRG/TS	W
15	Primary/Secondary Current Injection Test	IS 13947-2, DRG & TS	W
16	Operational & functional test, Protection & interlocking check	REL. STD/DRG/TS	W
17	Verification of IP class	REL. STD/DRG/TS	V
18	Surface Protection coating, Paint Shade & Finish, Adhesion test	REL. STD/DRG/TS	W
II	**TPN Non- segregated sandwich type LT Bus-duct**		
1	**Raw Material**		
1.1	Aluminium sheet for enclosure		
1.1.1	Visual, Dimension, Surface Finish, Mechanical Properties, Chemical Composition, Electrical Conductivity & Bend test	REL. STD/DRG/TS	V
1.2	Copper Busbar and flexible braided core		
1.2.1	Visual, Dimension, Surface Finish, Mechanical Properties, Chemical Composition, Electrical Conductivity, Hardness & Bend test	REL. STD/DRG/TS	V
1.3	Gasket		
1.3.1	Dimension check, Chemical & Physical properties, Surface finish	REL. STD/DRG/TS	V
2	**Final Inspection**		
2.1	Make, Model & Labelling	REL. STD/DRG/TS	W
2.2	Overall finish	REL. STD/DRG/TS	W
2.3	Enclosure Dimension, cross-section & thickness	REL. STD/DRG/TS	W
2.4	Bus Bar dimension, cross- section & thickness (all phases & neutral)	REL. STD/DRG/TS	W
2.5	Polarity & continuity check of Busbar	REL. STD/DRG/TS	W
2.6	Milli- volt drop test for joints	REL. STD/DRG/TS	W
2.7	Measurement of resistance of busbar	REL. STD/DRG/TS	W
2.8	IR & HV test	REL. STD/DRG/TS	W
2.9	Creepage distance & clearance	REL. STD/DRG/TS	W
2.10.	Protective Earth test	REL. STD/DRG/TS	W
2.11	Verification of IP class	REL. STD/DRG/TS	V

LEGEND

W: CUSTOMER HOLD POINT(CHP)	DRG: DRAWING
TS: TECHNICAL SPECIFICATION	REL. STD: RELEVANT STANDARD
V: VERIFICATION OF REPORT/TCs	

NOTE:

1	Any test at any stage not covered in Quality Assurance Test Requirement (QATR), but part of Technical Specification of contract, shall also be carried out by Contractor/ firm.
2	QATR shall be read in conjunction with General Quality Assurance Requirement given as part of Technical Specification.
3	Dielectric Test voltage shall be corrected, if installed at an altitude higher than 1000m as per clause no. 4.2.2 of IEC 60071-2.

106108/2020/PS-PEM-MAX

	Manufacturing Quality Assurance Test Requirements		
	Project Name: Arun 3 HEP (4x225 MW)	**Doc. No**. QAI/A/M/EM/EP/05	**Rev. No**. 02
	Item Description: Motor Starter Panel	**Issue Date**: 30.05.17	**Page No**. 2
Sr. No.	**Component, Operation & Characteristics**	**Applicable Standard**	**Remarks**
1	2	3	4
I	**Motor Starter**		
A	**Raw Material**		
1	Insulating Material: FRP, SMC & DMC Sheet & components, Insulator		
	a) Visual	DRG & IS9431	V
	b) Dimensional & Creepage distance	-do-	V
	c) 1 Min Dry PF Test (as applicable)	-do-	V
	d) Cantilever Strength (as applicable)	-do-	V
2	**Bus Bar (Copper)**		
	Material test	DRG/ Rel STD/TS	V
	Dimension check, Silver plating on contact surface	DRG/ Rel STD/TS	V
3	**CT, PT & Control Transformer**		
	Routine & Acceptance test	DRG/ Rel STD/TS	V
4	**Contactors, MCB, MCCB, Relays, Timer, Auxiliary & Selector Switches, Transducers, Variable frequency drive, Soft Starter**		
	Routine & Acceptance test	DRG/ Rel STD/TS	V
8	**Meters (all type) & indicating instruments**		
	Make, Model & Type and Calibration certificate	DRG/ Rel STD/TS	V
	Accuracy test, HV test & routine test	DRG/ Rel STD/TS	V
9	**Indicators**		
	Make, Type & Operation check	DRG/ Rel STD/TS	V
10	**Earthing flat (Galvanized steel)**		
	Dimension & Material test, Galvanization Check	DRG/ Rel STD/TS	V
11	**Gasket**		
	Dimension check, Chemical & Physical properties, Surface finish	DRG/ Rel STD/TS	V
12	**Sheet Steel for fabrication & Steel for structure**		
	Dimension, Chemical & Mechanical properties, Bend test	DRG/ Rel STD/TS	V
B	**Final Inspection**		
1	Dimension check for height, width, depth & sheet thickness of panel	REL. STD/DRG/TS	W
2	Dimension check for bus bar & check phase to phase, phase to earth clearance	REL. STD/DRG/TS	W
3	Visual check as per OGA, DRG & verification of BOM	REL. STD/DRG/TS	W
4	Visual check of alignment of Boards, Operation of Doors, Locks, Shutters, Racking device for ACB & MCCB, Base grouting & gland plates	REL. STD/DRG/TS	W
5	Verification of correct wiring, Ferruling, dressing, routing,, bunching, continuity check, color coding and earthing	REL. STD/DRG/TS	W
6	Insulation resistance measurement before & after HV test	IEC 60204-1	V
7	Dielectric test on Main, auxiliary & control circuit	IEC 62271-203 $ 7.2	W
8	Functional test on all AC & DC circuit including heating, Lighting, Fan & thermostat	REL. STD/DRG/TS	W
9	Checking interchangeability of Air Circuit Breaker & MCCB of same rating & capacity or as per TS	-do-	W
10	MCCB		
A	Mechanical Operation test		
i	2 No. Closing Operation of Breaker at rated 110% & 85 % of Auxiliary Voltage	IS 13947-2/ TS	W
ii	2 No. Opening Operation of Breaker at rated 110% & 70 % of Auxiliary Voltage	-do-	W
iii	Trip free operation	-do-	W
iv	O-C-O operation of MCCB after Power Supply failure	-do-	W
B	Verification of release		

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Sr. No.	Component, Operation & Characteristics	Applicable Standard	Remarks
1	2	3	4
i	Short Circuit & Shunt (if applicable)	IS 13947-2, DRG & TS	V
ii	Under voltage (if applicable)	-do-	W
11	Verification of Mechanical interlock	TS/IS 13947-2/ IEC60694/ IEC62271	W
12	Verification of protection against electrical shock	REL. STD/DRG/TS	W
13	Check for Operation & Operating limit of Contactors & Motor Starter	IEC 60947-4-1, DRG & TS	W
14	Operational & functional test, Protection & interlocking check	REL. STD/DRG/TS	W
15	Setting & Co-ordination of relays with other protective devices in circuit	IEC 60947-4-1, DRG & TS	W
16	Verification of IP class	REL. STD/DRG/TS	V
17	Surface Protection coating, Paint Shade & Finish, Adhesion test	REL. STD/DRG/TS	W

LEGEND

W: CUSTOMER HOLD POINT(CHP)	DRG: DRAWING
TS: TECHNICAL SPECIFICATION	REL. STD: RELEVANT STANDARD
V: VERIFICATION OF REPORTs/TCs	

NOTE:

1. Any test at any stage not covered in Quality Assurance Test Requirement (QATR), but part of Technical Specification of contract, shall also be carried out by Contractor/ firm.
2. QATR shall be read in conjunction with General Quality Assurance Requirement given as part of Technical Specification.
3. Dielectric Test voltage shall be corrected, if installed at an altitude higher than 1000m as per clause no. 4.2.2 of IEC 60071-2.

Field Quality Assurance Test Requirements

	Project Name (MW): ARUN-III HEP (4X225 MW)	**Doc. No.:** QAI/A/F/EM/CB/01	**Rev. No.:** 02
	Item Description: Cables (Power, Control, Instrumentation, Coaxial, Cable Tray, Termination Kit & Cable Accessories)	**Issue Date:** 30.05.2017	**Pages.:** 1

S.No.	Component, Operation & Characteristics	Applicable Standard	Remark
1	2	3	4
A			
1	**Material Received**		
	Visual check of Drum	DRG/ TS/ Rel. Std.	W*
	Check for Transit damage	DRG/ TS/ Rel. Std.	W*
	Cross check with packing list & SJVN's dispatch clearance	DRG/ TS/ Rel. Std.	W*
2	**Storage of Material**		
	Proper Placement of equipment as per the Instruction Manual.	TS/ DRG/ REL STD	W*
	Ensure that no damage or rusting takes place during storage	TS/ DRG/ REL STD	W*
	Ensure that all delicate Equipment are stored in protected area.	TS/ DRG/ REL STD	W*
3	**Erection test of Cable tray**		
	The dimensions of the rack and trays. Support and spacing between tray	DRG/ TS/ Rel. Std.	W*
	Provision and distribution of perforations	DRG/ TS/ Rel. Std.	W*
	Glanding, dressing, clamping and putting address tags of cables	DRG/ TS/ Rel. Std.	W*
	Earthing of racks and trays	DRG/ TS/ Rel. Std.	W*
4	**Pre Erection Checks on Cables**		
	Size of cables/ cable tray erection of cables to be laid are completed	DRG/ TS/ Rel. Std.	W*
	Marking/ Identification of Cable Drums	DRG/ TS/ Rel. Std.	W*
	IR Value of Cables	DRG/ TS/ Rel. Std.	W*
	Ground Roller shall be used every 2 meter interval	DRG/ TS/ Rel. Std.	W*
	Securing of cables	DRG/ TS/ Rel. Std.	W*
	Lying of Control cables and Power cable in different layers of trays	DRG/ TS/ Rel. Std.	W*
	Fire proofing arrangement	DRG/ TS/ Rel. Std.	W*
	Earthing and bonding (Metal sheathing, Metal screening and armour of cable should be earthed at both ends)	DRG/ TS/ Rel. Std.	W*
	Cable Identification tag	DRG/ TS/ Rel. Std.	W*
	GI conduits earthing	DRG/ TS/ Rel. Std.	W*
	Sealing of end of conduits after cable laying	DRG/ TS/ Rel. Std.	W*
	Clearing of cable trench & cover the cable	DRG/ TS/ Rel. Std.	W*
	Laying of sand bricks/ slabs for buried cables	DRG/ TS/ Rel. Std.	W*
5	**Erection Test of Cables**		
	Cable Checking	DRG/ TS/ Rel. Std.	W*
	Continuity Checking	DRG/ TS/ Rel. Std.	W*
	Resistance Checking	DRG/ TS/ Rel. Std.	W*
	IR before and after HV Test	DRG/ TS/ Rel. Std.	W*
	Verification of Phase Orders in power cables	DRG/ TS/ Rel. Std.	W*
	HV tests for Cables	DRG/ TS/ Rel. Std.	W*
	Visual checking in respect of tagging, laying, dressing, glanding, earthing of complete cable system	DRG/ TS/ Rel. Std.	W*
6	**Performance Test as per TS**	TS	W*

LEGENDS

TS: TECHNICAL SPECIFICATIONS	REL. STD.: RELEVENT STANDARD
V: VERIFICATION OF REPORTS/TCs	DRG: DRAWING
W: CUSTOMER HOLD POINT	W*: WITNESS BY SAPDC/ MAIN CONTRACTOR

NOTES

1	Any test at any stage not covered in Quaility Assurance Test Requirement (QATR), but part of technical specification of contract, shall also be carried out by Contractor/ firm.
2	QATR shall be read in conjunction with General Quality Assurance Requirement given as part of Technical Specification
3	Responsibitiy for witnessing (W*) at site shall be decided mutually at the time of finalization of FQAP as per the criticality of test.

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Field Quality Assurance Test Requirements

Project Name : Arun- III HEP (4x225 MW)	**Doc. No**. QAI/A/F/EM/EP/04	**Rev. No**. 02
Item Description: LT System (415 V AC)	**Issue Date**: 30.05.17	**Pages:** 2

Sr. No.	Component, Operation & Characteristics	Applicable Standard	Remarks
1	2	3	4
1	**Material Receipt**		
	External conditions of Equipment free from Damages etc	TS/Instruction Manual/ Reference standard	W*
	Number of packages in each Equipment and physical condition of each package	TS/Instruction Manual/ Reference standard	W*
2	**Storage of Material**		
	Proper Placement of equipment as per the Instruction Manual.	TS/Instruction Manual/ Reference standard	W*
	Ensure that no damage or rusting takes place during storage	TS/Instruction Manual/ Reference standard	W*
	Ensure that all delicate Equipment are stored in protected area.	TS/Instruction Manual/ Reference standard	W*
3	**Embedments**		
3.1	**Installation/fixing of embedments as per drawing**		
	Levelling & alignment before and after concreting	TS/Instruction Manual/ REL.STD	W*
3.2	**Blockout**		
	Check for visual, dimensions & Co-ordinates of blockout	TS/Instruction Manual/ REL.STD	W*
3.3	**Civil Work**		
	Check for all Civil work as per instruction manual	TS/Instruction Manual/ REL.STD	W*
4	**Test during Installation**		
	Check for correct nameplate details	DRG, TS & Relevant STD	W*
	Ensure that the handling tools & tackles like strings, manila ropes, pulleys, etc. are free from damage.	DRG, TS & Relevant STD	W*
	Ensure that proper tying, loading/packing on the vehicle/transport	DRG, TS & Relevant STD	W*
	Ensure for proper unloading, positioning on an even Surface at erection site	DRG, TS & Relevant STD	W*
	Ensure that panels are vertically upright during transport, loading, unloading and erection	DRG, TS & Relevant STD	W*
	Check for foundation frame and its dimensions	DRG, TS & Relevant STD	W*
	Check for layout of Panels	DRG, TS & Relevant STD	W*
	Ensure correct sequence, orientation and alignment of panels	DRG, TS & Relevant STD	W*
	Check for verticality of panels within _+ 5mm	DRG, TS & Relevant STD	W*
	Check for clearances on all sides	DRG, TS & Relevant STD	W*
	Check for proper tightness of base plate bolts, bolts joining panels	DRG, TS & Relevant STD	W*
	Check for tightness of bus bar joints including earth bus bar, all terminals, CTs, PTs, meters and relays	DRG, TS & Relevant STD	W*
	Covering of joints with Compounds (if specified)	DRG, TS & Relevant STD	W*
	Ensure that all unused holes are plugged properly	DRG, TS & Relevant STD	W*
	Ensure that all the unwanted bolts/nuts, wires, hands, tools etc. inside the panels are removed	DRG, TS & Relevant STD	W*
	Check tightness of covers, check for proper laying, dressing, crimping and terminal of all cables	DRG, TS & Relevant STD	W*
	Ensure that proper ear thing is carried out for the panels as per norms and Check for continuity of each bus	DRG, TS & Relevant STD	W*
5	**Pre- Commissioning Test**		
1	**General Test for LT Switchgear**		
	Check for Lubrication of all moving parts like doors etc.	DRG, TS & Relevant STD	W*
	Dimension check of busbar and clearance between phase and phase to earth	DRG, TS & Relevant STD	W*
	Check for alignment of Bus Bars with the Insulators	DRG, TS & Relevant STD	W*
	Check for cleanliness/breakage/chipping of Insulators	DRG, TS & Relevant STD	W*
	IR before & after HV test	DRG, TS & Relevant STD	W*
	HV test on Bus Bars with CTs and breaker/contractor in position	DRG, TS & Relevant STD	W*
	Verification of phase sequence for incoming supply	DRG, TS & Relevant STD	W*
2	**Air Circuit Breaker/MCCB**		
	Check for Proper alignment of Trucks for free movement and correct operation of shutters	DRG, TS & Relevant STD	W*

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Sr. No.	Component, Operation & Characteristics	Applicable Standard	Remarks
1	2	3	4
	Check Control wiring for correctness of connections, continuity and IR values	DRG, TS & Relevant STD	W*
	Contact resistance measurement of Circuit Breaker	DRG, TS & Relevant STD	W*
	Check for manual operation of breakers completely assembled	DRG, TS & Relevant STD	W*
	Check for proper closing and opening operations electrically at extreme conditions of control supply voltage and anti pumping operation	DRG, TS & Relevant STD	W*
	Measurements of IR values, Resistance and minimum pickup voltage of Coils	DRG, TS & Relevant STD	W*
	Checking of mechanical and electrical interlocks	DRG, TS & Relevant STD	W*
	Checking of spring charging motor and recharging time, correct operation of Limits switches	DRG, TS & Relevant STD	W*
	Calibration of release for ACB & MCCB	DRG, TS & Relevant STD	W*
3	**Current Transformer**		
	Insulation Resistance between windings and terminals to body	DRG, TS & Relevant STD	W*
	Measurements of secondary winding resistance	DRG, TS & Relevant STD	W*
	Shorting and earthing of spare CT cores	DRG, TS & Relevant STD	W*
4	**Potential Transformer**		
	IR Test	DRG, TS & Relevant STD	W*
	Ratio and Polarity Test	DRG, TS & Relevant STD	W*
	Checking of line connections as per connection diagram	DRG, TS & Relevant STD	W*
5	**Heating & Lighting**		
	Visual check- Make, Type & Rating	DRG, TS & Relevant STD	W*
	Dielectric test of main, auxiliary & control circuit	DRG, TS & Relevant STD	W*
	Functional Check	DRG, TS & Relevant STD	W*
6	**Cable (Interpanel wiring)**		
	Continuity Check	DRG, TS & Relevant STD	W*
	IR Test	DRG, TS & Relevant STD	W*
	HV Test	DRG, TS & Relevant STD	W*
7	**Cubical Wiring for all cable**		
	IR of all wires with respect to earth	DRG, TS & Relevant STD	W*
	Checking of wiring of control and selector switches and all interconnectors/terminals between panels and fields Transducers/Instruments	DRG, TS & Relevant STD	W*
	Operational and functional checks	DRG, TS & Relevant STD	W*
	Verification of Glanding & Cable Tagging	DRG, TS & Relevant STD	W*
8	**Relays**		
	Checking of IR between all terminals and earth & between AC and DC Terminals	DRG, TS & Relevant STD	W*
	Checking of CT and PT Connection with particulars reference to their polarities as called in Drawing	DRG, TS & Relevant STD	W*
	Checking of operating characteristics by secondary current injection	DRG, TS & Relevant STD	W*
	Relay setting & Co-ordination vis-à-vis other protection relays/ release provided in the entire system including motor-starter/ LT & MV system	DRG, TS & Relevant STD	W*
9	**Measuring, indication and indicating Instrument**		
	IR between all terminal and earth	DRG, TS & Relevant STD	W*
	Checking of CT and PT connection with particular reference to their polarities as called in Drawing	DRG, TS & Relevant STD	W*
10	**Commissioning Test**		
	Function & Operation test including checking of protection and interlocking scheme	DRG, TS & Relevant STD	W*
	Verification of component temperature	DRG, TS & Relevant STD	W*
11	**Performance Test as per Technical Specification**	DRG, TS & Relevant STD	W*

LEGEND

W: CUSTOMER HOLD POINT(CHP)	DRG: DRAWING
TS: TECHNICAL SPECIFICATION	REL. STD: RELEVANT STANDARD
V: VERIFICATION OF REPORT/TCs	W*: WITNESS BY SAPDC / MAIN CONTRACTOR

NOTE:

1	Any test at any stage not covered in Quality Assurance Test Requirement (QATR), but part of Technical Specification of contract, shall also be carried out by Contractor/ firm.
2	QATR shall be read in conjunction with General Quality Assurance Requirement given as part of Technical Specification.
3	Dielectric Test voltage shall be corrected, if installed at an altitude higher than 1000m as per clause no. 4.2.2 of IEC 60071-2.
4	Responsibility for witnessing (W*) at site shall be decided mutually at the time of finalisation of FQAP as per the criticality of test.

Field Quality Assurance Test Requirements

	Project Name: Arun 3 HEP (4x225 MW)	**Doc. No**. QAI/A/F/EM/EP/05	**Rev. No**. 02
	Item Description: Motor Starter Panel	**Issue Date**: 30.05.17	**Page No**. 2
Sr. No.	**Component, Operation & Characteristics**	**Applicable Standard**	**Remarks**
1	2	3	4
1	**Material Receipt**		
	External conditions of Equipment free from Damages etc	TS/Instruction Manual/ Reference standard	W*
	Number of packages in each Equipment and physical condition of each package	TS/Instruction Manual/ Reference standard	W*
2	**Storage of Material**		
	Proper Placement of equipment as per the Instruction Manual.	TS/Instruction Manual/ Reference standard	W*
	Ensure that no damage or rusting takes place during storage	TS/Instruction Manual/ Reference standard	W*
	Ensure that all delicate Equipment are stored in protected area.	TS/Instruction Manual/ Reference standard	W*
3	**Embedments**		
3.1	**Installation/fixing of embedments as per drawing**		
	Leveling & alignment before and after concreting	TS/Instruction Manual/ REL.STD	W*
3.2	**Blockout**		
	Check for visual, dimensions & Co-ordinates of blockout	TS/Instruction Manual/ REL.STD	W*
3.3	**Civil Work**		
	Check for all Civil work as per instruction manual	TS/Instruction Manual/ REL.STD	W*
4	**Test During Installation**		
	Check for correct nameplate details	DRG, TS & Relevant STD	W*
	Ensure that the handling tools & tackles like strings, manila ropes, pulleys, etc. are free from damage.	DRG, TS & Relevant STD	W*
	Ensure that proper tying, loading/packing on the vehicle/transport	DRG, TS & Relevant STD	W*
	Ensure for proper unloading, positioning on an even Surface at erection site	DRG, TS & Relevant STD	W*
	Ensure that panels are vertically upright during transport, loading, unloading and erection	DRG, TS & Relevant STD	W*
	Check for foundation frame and its dimensions	DRG, TS & Relevant STD	W*
	Check for layout of Panels	DRG, TS & Relevant STD	W*
	Ensure correct sequence, orientation and alignment of panels	DRG, TS & Relevant STD	W*
	Check for verticality of panels within _+ 5mm	DRG, TS & Relevant STD	W*
	Check for clearances on all sides	DRG, TS & Relevant STD	W*
	Check for proper tightness of base plate bolts, bolts joining panels	DRG, TS & Relevant STD	W*
	Check for tightness of bus bar joints including earth bus bar, all terminals, CTs, PTs, meters and relays	DRG, TS & Relevant STD	W*
	Covering of joints with Compounds (if specified)	DRG, TS & Relevant STD	W*
	Ensure that all unused holes are plugged properly	DRG, TS & Relevant STD	W*
	Ensure that all the unwanted bolts/nuts, wires, hands tools etc. inside the panels are removed	DRG, TS & Relevant STD	W*
	Check tightness of covers, check for proper laying, dressing, crimping and terminal of all cables	DRG, TS & Relevant STD	W*
	Ensure that proper earthing is carried out for the panels as per norms and Check for continuity of each bus	DRG, TS & Relevant STD	W*
5	**Pre- Commissioning Test**		
1	**General Test for Motor Switchgear**		
	Check for Lubrication of all moving parts like doors etc.	DRG, TS & Relevant STD	W*
	Dimension check of busbar and clearance between phase and phase to earth	DRG, TS & Relevant STD	W*
	Check for alignment of Bus Bars with the Insulators	DRG, TS & Relevant STD	W*
	Check for cleanliness/breakage/chipping of Insulators	DRG, TS & Relevant STD	W*
	IR before & after HV test	DRG, TS & Relevant STD	W*
	HV test on Bus Bars with CTs and breaker/contractor in position	DRG, TS & Relevant STD	W*
	Verification of phase sequence for incoming supply	DRG, TS & Relevant STD	W*
2	**MCCB**		
	Check for Proper alignment of Trucks for free movement and correct operation of shutters	DRG, TS & Relevant STD	W*

Sr. No.	Component, Operation & Characteristics	Applicable Standard	Remarks
1	2	3	4
	Check Control wiring for correctness of connections, continuity and IR values	DRG, TS & Relevant STD	W*
	Contact resistance measurement of Circuit Breaker	DRG, TS & Relevant STD	W*
	Check for manual operation of breakers completely assembled	DRG, TS & Relevant STD	W*
	Check for proper closing and opening operations electrically at extreme conditions of control supply voltage and anti pumping operation	DRG, TS & Relevant STD	W*
	Measurements of IR values, Resistance and minimum pickup voltage of Coils	DRG, TS & Relevant STD	W*
	Checking of mechanical and electrical interlocks	DRG, TS & Relevant STD	W*
	Checking of spring charging motor and recharging time, correct operation of Limits switches	DRG, TS & Relevant STD	W*
	Calibration of release for MCCB	DRG, TS & Relevant STD	W*
3	**Current Transformer**		
	Insulation Resistance between windings and terminals to body	DRG, TS & Relevant STD	W*
	Measurements of secondary winding resistance	DRG, TS & Relevant STD	W*
	Shorting and earthing of spare CT cores	DRG, TS & Relevant STD	W*
4	**Potential Transformer**		
	IR Test	DRG, TS & Relevant STD	W*
	Ratio and Polarity Test	DRG, TS & Relevant STD	W*
	Checking of line connections as per connection diagram	DRG, TS & Relevant STD	W*
5	**Heating & Lighting**		
	Visual check- Make, Type & Rating	DRG, TS & Relevant STD	W*
	Dielectric test of main, auxiliary & control circuit	DRG, TS & Relevant STD	W*
	Functional Check	DRG, TS & Relevant STD	W*
6	**Cable (Interpanel wiring)**		
	Continuity Check	DRG, TS & Relevant STD	W*
	IR Test	DRG, TS & Relevant STD	W*
	HV Test	DRG, TS & Relevant STD	W*
7	**Cubical Wiring for all cable**		
	IR of all wires with respect to earth	DRG, TS & Relevant STD	W*
	Checking of wiring of control and selector switches and all interconnectors/terminals between panels and fields Transducers/Instruments	DRG, TS & Relevant STD	W*
	Operational and functional checks	DRG, TS & Relevant STD	W*
	Verification of Glanding & Cable Tagging	DRG, TS & Relevant STD	W*
8	**Relays**		
	Checking of IR between all terminals and earth & between AC and DC Terminals	DRG, TS & Relevant STD	W*
	Checking of CT and PT Connection with particulars reference to their polarities as called in Drawing	DRG, TS & Relevant STD	W*
	Checking of operating characteristics by secondary current injection	DRG, TS & Relevant STD	W*
	Relay setting & Co-ordination vis-à-vis other protection relays/ release provided in the entire system including Motor-Starter/ LT & MV system	DRG, TS & Relevant STD	W*
9	**Measuring, indication and indicating Instrument**		
	IR between all terminal and earth	DRG, TS & Relevant STD	W*
	Checking of CT and PT connection with particular reference to their polarities as called in Drawing	DRG, TS & Relevant STD	W*
6	**Commissioning Test**		
	Function & Operation test including checking of protection and interlocking scheme	DRG, TS & Relevant STD	W*
	Verification of component temperature	DRG, TS & Relevant STD	W*
7	**Performance Test as per Technical Specification**	DRG, TS & Relevant STD	W*

LEGEND

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TS: TECHNICAL SPECIFICATION	REL. STD: RELEVANT STANDARD
V: VERIFICATION OF REPORT/TCs	W*: WITNESS BY SAPDC / MAIN CONTRACTOR

NOTE:

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2. QATR shall be read in conjunction with General Quality Assurance Requirement given as part of Technical Specification.
3. Dielectric Test voltage shall be corrected, if installed at an altitude higher than 1000m as per clause no. 4.2.2 of IEC 60071-2.
4. Responsibility for witnessing (W*) at site shall be finalized mutually at the time of finalization of FQAP as per the criticality of test.

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.	VERIFICATION FROM MOTOR DATASHEET (Y/N)	KKS NO
	NAME PLATE	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOs						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
																				ANNEXURE-II

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

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

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

LOAD DATA (ELECTRICAL)					
JOB NO.	437	ORIGINATING AGENCY		PEM (ELECTRICAL)	
PROJECT TITLE	4X225MW ARUN-III HEP, NEPAL	NAME		DATA FILLED UP ON	
SYSTEM	HVAC	SIGN.		DATA ENTERED ON	
DEPTT. / SECTION	MAX	SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE	

SUB-VENDOR LIST FOR LT MOTORS

SL NO.	VENDOR NAME	
1	ABB	14, MATHURA ROAD, FARIDABAD, HARYANA-121003
2	BHARAT BIJLEE LTD.	BHARAT BIJLEE LIMITED, 1ST FLOOR, 7-B, RAJINDRA PARK, PUSA ROAD, NEW DELHI - 110 060.
3	CROMPTON GREAVES	3RD FLOOR, EXPRESS BUILDING,9-10, BAHADUR SHAH ZAFAR MARG, NEAR ITO CROSSING,NEW DELHI-110002, INDIA
4	GE-POWER	KAMAK TOWER, 3RD FLOOR, PLOT NO. 12-A, TVK INDUSTRIAL ESTATE, EKKADUTHANGAL, GUINDY, CHENNAI-600032
5	KIRLOSKAR ELECTRIC CO LTD.	P.O. BOX 5555 , MALLESWARAM WEST ,BANGALORE 560055
6	LAXMI HYDRAULICS PVT. LTD	129/130, INDUSTRIAL ESTATE PATIL NAGAR, HOTGI ROAD SOLAPUR-413003, MAHARASHTRA
7	MARATHON	MARATHON ELECTRIC INDIA PRIVATE LTD.SECTOR - 11, MODEL TOWN, FARIDABAD - 121006
8	NGEF	POCKET NO.10, FLAT NO. 37 & 38, EXPANDABLE DDA FLATS, NASIRPUR DWARKA, PHASE-I NEW DELHI-110 045
9	RAJINDRA ELECT INDUSTRIES	14 SHAH IND.ESTATE VEERA DESAI RD,ANDHERI(W) MUMBAI-400053
10	SIEMENS	RC-IN I S NR DEL AREA, JIL BUILDING, TOWER-B, PLOT NO. 78, SECTOR 18, GURGAON-122015, INDIA

SUB-VENDOR LIST FOR GLANDS

1	ALLIED TRADERS & EXPORTERS	C-124 A, SECTOR-2, NOIDA -201 301, UTTAR PRADESH, INDIA
2	ARUP ENGG & FOUNDARY WORKS	391/119,PRINCE ANWAR SHAH ROAD, CALCUTTA-700068
3	BALIGA LIGHTING EQPT.PVT.LTD.	63A,CP RAMASWAMY ROAD, ALWARPET,P.B.No 6910, CHENNAI-600018
4	COMMET BRASS PRODUCTS	NUTAN CHEMICAL COMPOUND, WALBHAT ROAD, GOREGAON, MUMBAI-400063
5	DOWELLS	M/S. DOWELLS ELECTRICALS 47/47A, SATGURU INDUSTRIAL ESTATE. OFF AAREY ROAD, GOREGOAN (EAST). MUMBAI 400 063.
6	ELECTROMAC INDUSTRIES	27/28AF NEW EMPIRE IND.ESTT., R.KRISHNA MANDIR RD.JB NGR ,ANDHERI(E),MUMBAI-400059
7	INCAB	HARE STREET,KOLKATA,WEST BENGAL-700001

SUB-VENDOR LIST FOR LUGS

106108/2020/PS-PEM-MAX

1	DOWELLS	M/S. DOWELLS ELECTRICALS 47/47A, SATGURU INDUSTRIAL ESTATE. OFF AAREY ROAD, GOREGOAN (EAST). MUMBAI 400 063.
2	UNIVERSAL MACHINES LTD.	4,B.B.D.BAG (EAST) 90,STEPHEN HOUSE,5TH FLR CALCUTTA-700001

PACKAGE WISE REGISTERED SUPPLIER LIST

Sl No	Package Name	Supplier Name
1	LT XLPE POWER CABLE	SPECIAL CABLES PVT. LTD.
2	LT XLPE POWER CABLE	ELKAY TELELINKS LTD.
3	LT XLPE POWER CABLE	KEC INTERNATIONAL LIMITED
4	LT XLPE POWER CABLE	SRIRAM CABLES PVT. LTD.
5	LT XLPE POWER CABLE	GUPTA POWER INFRASTRUCTURE LIMITED,
6	LT XLPE POWER CABLE	TIRUPATI PLASTOMATICS PVT. LTD.
7	LT XLPE POWER CABLE	Govind Cable Industries,
8	LT XLPE POWER CABLE	RAVIN CABLES LIMITED
9	LT XLPE POWER CABLE	THERMO CABLES LTD.
10	LT XLPE POWER CABLE	PARAMOUNT COMMUNICATIONS LTD.
11	LT XLPE POWER CABLE	Dynamic Cables Limited
12	LT XLPE POWER CABLE	SUYOG ELECTRICALS LTD.
13	LT XLPE POWER CABLE	GEMSCAB INDUSTRIES LTD.
14	LT XLPE POWER CABLE	APAR INDUSTRIES LTD.
15	LT XLPE POWER CABLE	KEI INDUSTRIES LTD.
16	LT XLPE POWER CABLE	CORDS CABLE INDUSTRIES LTD.
17	LT XLPE POWER CABLE	CHANDRESH CABLES LIMITED
18	LT XLPE POWER CABLE	SBEE CABLES (INDIA) LIMITED
19	LT XLPE POWER CABLE	LASER POWER & INFRA PVT. LTD.
20	LT XLPE POWER CABLE	CMI LTD.
21	LT XLPE POWER CABLE	POLYCAB INDIA LIMITED
22	LT PVC CONTROL CABLE	DELTON CABLES LTD.
23	LT PVC CONTROL CABLE	CORDS CABLE INDUSTRIES LTD.
24	LT PVC CONTROL CABLE	UNIVERSAL CABLES LTD.
25	LT PVC CONTROL CABLE	APAR INDUSTRIES LTD.
26	LT PVC CONTROL CABLE	PARAMOUNT COMMUNICATIONS LTD.
27	LT PVC CONTROL CABLE	TIRUPATI PLASTOMATICS PVT. LTD.
28	LT PVC CONTROL CABLE	LASER POWER & INFRA PVT. LTD.
29	LT PVC CONTROL CABLE	GOVIND CABLE INDUSTRIES
30	LT PVC CONTROL CABLE	GUPTA POWER INFRASTRUCTURE LIMITED,
31	LT PVC CONTROL CABLE	SRIRAM CABLES PVT. LTD.
32	LT PVC CONTROL CABLE	POLYCAB INDIA LIMITED
33	LT PVC CONTROL CABLE	SERVEL INDIA PVT. LTD.
34	LT PVC CONTROL CABLE	SUYOG ELECTRICALS LTD.
35	LT PVC CONTROL CABLE	CHANDRESH CABLES LIMITED
36	LT PVC CONTROL CABLE	GEMSCAB INDUSTRIES LTD.
37	LT PVC CONTROL CABLE	KEI INDUSTRIES LTD.
38	LT PVC CONTROL CABLE	CMI LTD.
39	LT PVC CONTROL CABLE	SBEE CABLES (INDIA) LIMITED
40	LT PVC CONTROL CABLE	Tempsens Instrument (I) Pvt Ltd
41	LT PVC CONTROL CABLE	SPECIAL CABLES PVT. LTD.
42	LT PVC CONTROL CABLE	SVARN INFRATEL PVT. LTD.
43	LT PVC CONTROL CABLE	THERMO CABLES LTD.
44	LT PVC CONTROL CABLE	Dynamic Cables Limited
45	LT PVC CONTROL CABLE	Advance Cable Technologies (P) Ltd.
46	LT PVC CONTROL CABLE	RAVIN CABLES LIMITED
47	LT PVC CONTROL CABLE	ELKAY TELELINKS LTD.
48	LT PVC CONTROL CABLE	KEC INTERNATIONAL LIMITED
49	SCREENED CONTROL CABLES	GUPTA POWER INFRASTRUCTURE LIMITED,

50	SCREENED CONTROL CABLES	CORDS CABLE INDUSTRIES LTD.
51	SCREENED CONTROL CABLES	SPECIAL CABLES PVT. LTD.
52	SCREENED CONTROL CABLES	THERMO CABLES LTD.
53	SCREENED CONTROL CABLES	POLYCAB INDIA LIMITED
54	SCREENED CONTROL CABLES	Advance Cable Technologies (P) Ltd.
55	SCREENED CONTROL CABLES	KEI INDUSTRIES LTD.
56	SCREENED CONTROL CABLES	SUYOG ELECTRICALS LTD.
57	SCREENED CONTROL CABLES	PARAMOUNT COMMUNICATIONS LTD.
58	SCREENED CONTROL CABLES	DELTON CABLES LTD.
59	SCREENED CONTROL CABLES	SERVEL INDIA PVT. LTD.
60	SCREENED CONTROL CABLES	CMI LTD.
61	SCREENED CONTROL CABLES	T C Communication Pvt. Ltd.
62	SCREENED CONTROL CABLES	ELKAY TELELINKS LTD.
63	CABLE TRAYS & ACC.	EROS METAL WORKS (P) LTD.
64	CABLE TRAYS & ACC.	Saral Industries
65	CABLE TRAYS & ACC.	INDIANA GRATINGS PVT. LTD.
66	CABLE TRAYS & ACC.	PARMAR METALS PVT.LTD.
67	CABLE TRAYS & ACC.	Maheshwari Electrical Mfrs. Pvt. Ltd.,
68	CABLE TRAYS & ACC.	RATAN PROJECTS & ENGINEERING CO. PVT.LTD.
69	CABLE TRAYS & ACC.	RABI ENGINEERING WORKS PVT. LTD.
70	CABLE TRAYS & ACC.	ADVANCE POWER PRODUCTS
71	CABLE TRAYS & ACC.	UNITECH FABRICATORS and ENGINEERS PVT LTD
72	CABLE TRAYS & ACC.	PATNY SYSTEMS (P) LTD
73	CABLE TRAYS & ACC.	INDUSTRIAL PERFORATION (I) PVT.LTD.
74	CABLE TRAYS & ACC.	NAMDHARI INDUSTRIAL TRADERS PVT. LTD
75	CABLE TRAYS & ACC.	RUKMANI ELECTRICAL & COMPONENTS PVT LTD
76	CABLE TRAYS & ACC.	VATCO ELEC-POWER PVT. LTD.
77	CABLE TRAYS & ACC.	PENTAX FERRO INCORPORATE
78	CABLE TRAYS & ACC.	INDMARK FORMTECH PVT. LTD.
79	CABLE TRAYS & ACC.	PREMIER POWER PRODUCTS (CAL) PVT. LTD.
80	CABLE TRAYS & ACC.	VINFAB ENGINEERS INDIA PVT. LTD.
81	LT HRPVC POWER CABLES	RAVIN CABLES LIMITED
82	LT HRPVC POWER CABLES	UNIVERSAL CABLES LTD.
83	LT HRPVC POWER CABLES	CMI LTD.
84	LT HRPVC POWER CABLES	SBEE CABLES (INDIA) LIMITED
85	LT HRPVC POWER CABLES	GOYOLENE FIBRES (INDIA) PVT.LTD.
86	LT HRPVC POWER CABLES	KEI INDUSTRIES LTD.
87	LT HRPVC POWER CABLES	Govind Cable Industries,
88	LT HRPVC POWER CABLES	POLYCAB INDIA LIMITED
89	LT HRPVC POWER CABLES	CORDS CABLE INDUSTRIES LTD.
90	LT HRPVC POWER CABLES	CABLE CORPORATION OF INDIA LTD.
91	LT HRPVC POWER CABLES	RADIANT CORPORATION PRIVATE LIMITED
92	LT HRPVC POWER CABLES	PARAMOUNT COMMUNICATIONS LTD.
93	LT HRPVC POWER CABLES	SRIRAM CABLES PVT. LTD.
94	LT HRPVC POWER CABLES	KEC INTERNATIONAL LIMITED
95	LT HRPVC POWER CABLES	SUYOG ELECTRICALS LTD.
96	LT HRPVC POWER CABLES	APAR INDUSTRIES LTD.
97	LT HRPVC POWER CABLES	TORRENT POWER LTD.
98	LT SWITCHGEAR	C and S ELECTRIC LTD.
99	LT SWITCHGEAR	TRICOLITE ELECTRICAL INDUSTRIES LTD
100	LT SWITCHGEAR	SPACEAGE SWITCHGEARS LTD.
101	LT SWITCHGEAR	GE INDIA INDUSTRIAL PVT.LTD.

102	LT SWITCHGEAR	CONTROLS and SCHEMATICS LTD.
103	LT SWITCHGEAR	SCHNEIDER ELECTRIC INDIA PVT. LTD.
104	LT SWITCHGEAR	LARSEN and TOUBRO LTD.
105	LT SWITCHGEAR	ABB India Limited
106	LT SWITCHGEAR	KMG ATOZ SYSTEMS PVT.LTD

NOTE
Galvanising can be done from their own galvanising plant or PEM approved galvanising units

LV SWITCHGEAR
LIST OF MAKES (SUB VENDOR ITEMS)

Vendor shall select the make of components of the switchgear from the list below. However, names of the sub-vendors may be added or deleted from the list without any intimation to the vendor and therefore it is mandatory on the part of the vendor to take approval on the make of components.

Sl. No.	Name of Item / Components	Name of Vendor / Sub-Vendor Make
1	Air Circuit Breaker	C & S Electric
		Schneider
		L & T
		Siemens
		GE-power
		Spaceage-Hundai
		ABB
		BCH-Terasaki
2	AC Contactor/Aux. Contactor	L & T
		Siemens
		Telemechanique
		BCH
		GE-power
		Schneider
		C & S Electric
		Spaceage
		ABB
3	Ammeter(Indicating)	Automatic Electric
		IMP
		Rishabh Industrial(L & T)
		Secure Meters
4	Breaker Control Switch/Selector Switch	Kaycee
		Alstom Ltd.
		GE-Power
		Salzer, L & T
		Switron
5	Bus Bar Material	Hindalco
		Jindal
		Balco
6	Current transformer	Automatic Electric
		Indcoil
		Kappa Electricals
		Pragati Electricals
		PRAYOG
		Silkaans
		C & S Electric
		Precise Electricals
		Southern Electrics
		Siemens
7	Control Transformers	Automatic Electric
		Indcoil
		Kappa Electricals
		Silkaans
		Logicstat
		Southern Electrics
		Precise Electricals
8	Cable Gland	Arup Engg. & Foundry Works
		Commet Brass Products
		Electromac Industries
		Baliga Lighting Eqpt.
		Incab
		Sunil & Co.
		Elexpro Electricals
		Allied Traders
9	Cable Lugs	Dowells
		Universal Machines
10	DC Contactor	BHEL (BHOPAL)
		Electromac Industries
		L & T
		Siemens
		Schneider
		Telemechanique
		GE-power
		C & S Electric
		Spaceage
		ABB
		BCH

Vendor shall select the make of components of the switchgear from the list below. However, names of the sub-vendors may be added or deleted from the list without any intimation to the vendor and therefore it is mandatory on the part of the vendor to take approval on the make of components.

11	DC Switch	Kaycee
		Siemens
		GE-power
		Salzer, L & T
		C & S Electric
12	Diodes	BEL
		Usha Rectifier
		Ruttonshaw
		Hind
13	Earth Leakage CB	Schneider
		Indo Asian
		MDS Switchgear
		S & S Power Switchgear
		C & S Electric
		L & T
		Siemens
		GE-Power
		ABB
14	Earth Leakage Relay[ELR] alongwith CBCT	Areva
		Datar
		Minilec
		Pro'kdevices
15	Electronic Motor Protection Relay (EMPR) including EOCR	ABB
		Areva
		Siemens
		L & T
		GE-power
		Schneider
		C & S Electric
		BCH
16	Energy Meter	BHEL (EDN)
		Simco
		IMP
		Rishabh Industrial(L & T)
		Automatic Electric
		Conzerv
		Secure Meters
17	Ethernet Switches	Ruggedcom
		Moxa
		Delink
		GE-Multilink
18	FUSE Base	GE-power
		L & T
		Alstom Ltd.
		Siemens
		C & S Electric
		Schneider
		Indo Asain
		Spaceage
		ABB
19	FUSES	GE-Power
		Siemens
		Alstom Ltd.
		L & T
		C & S Electric
		Schneider
		Indo Asian
		Spaceage
		ABB

Vendor shall select the make of components of the switchgear from the list below. However, names of the sub-vendors may be added or deleted from the list without any intimation to the vendor and therefore it is mandatory on the part of the vendor to take approval on the make of components.

20	Isolating Switch	Salzer, L & T
		Siemens
		Alstom Ltd.
		GE-power
		Kaycee
		C & S Electric
		Indo Asian
		Flexpro Electricals
		Schneider
		Spaceage
		ABB
21	Interposing Relays	Jyoti
		OEN
		ABB
22	Indicating Lamp(LED)	Siemens
		RASS (C & S Electric)
		Vaishno
		L & T
		Alstom Ltd.
		BCH
		GE-Power
		Schneider
		Concord
		Tecknic Controls
		ABB
		Essen Deinki
23	LPBS(Non-Flame Proof)	C & S Electric
		Tecknic Controls
		BCH
		L & T
		Schneider
		Siemens
		KMG ATOZ
		Jasper Engineers
		Cands
		Unilec Engg.
		Balliga
		Ex-Protecta
		GE- Power
		Sterling Switchgears
		Elexpro
		Vaishno
		Enpro Engg.
		Asiatic
		Evergreen Engg.
		Bose Corporation
		Controls & Schematics
24	LPBS (Flame Proof)	Balliga
		Ex-Protecta
25	Local Motor Starter	KMG ATOZ
		Unilec Engg.
		L & T
		Telemachanique (Schneider)
		C & S Electric
		Spaceage
		Siemens
		ABB
		GE-Power
		BCH
26	MCCB (AC)	L & T
		Crompton Greaves
		GE-power
		Siemens
		C & S Electric
		Schneider
		Spaceage
		ABB
		BCH-Terasaki

Vendor shall select the make of components of the switchgear from the list below. However, names of the sub-vendors may be added or deleted from the list without any intimation to the vendor and therefore it is mandatory on the part of the vendor to take approval on the make of components.

27	MCCB (DC)	Crompton Greaves
		L & T
		GE-power
		Siemens
		C & S Electric
		Schneider
		Spaceage
		ABB
		BCH-Terasaki
28	Multifunction Meter	Conzerve
		Schneider
		Rishabh Industrial(L & T)
		ABB
		Secure meters
29	Miniature Circuit Breaker(MCB)	Schneider
		Indo Asian
		MDS Switchgear
		S & S Power Switchgear
		C & S Electric
		L & T
		Siemens
		GE-Power
		Havells
		ABB
30	Motor Protection Circuit Breaker (MPCB)	Areva
		Siemens
		L & T
		GE-power
		Schneider
		C & S Electric
		ABB
31	Push Button (on swgr)	BCH
		L & T
		Schneider
		Siemens
		Tecknic Control
		Cands
		C & S Electric
		GE- Power
		Vaishno
		ABB
		Essen Deinki
32	Relays (other than interposing relays)	ABB
		Areva
		Siemens
		GE-power
		Schneider
		SEL
		AVK-SEG & Controls
33	Sheet Steel	SAIL
		Jindal
		Essar
		Tisco
34	Synchroscope	Automatic Electric
		GEC-Alsthom
35	Switch & Socket (Industrail Type)	Crompton Greaves
		BCH
		Anchor
		Ellora
		Best and Crompton
		ABB
36	Space Heater	C & S Electric
		Spaceage

Vendor shall select the make of components of the switchgear from the list below. However, names of the sub-vendors may be added or deleted from the list without any intimation to the vendor and therefore it is mandatory on the part of the vendor to take approval on the make of components.

37	Transducer	Southern Transducer
		AE
		Rishabh Industrial(L & T)
		ABB
		Secure meters
38	Thermal Overload Relay	L & T
		Siemens
		Telemechanique
		Schneider
		GE-Power
		C & S Electric
		Spaceage
		BCH
		ABB
39	Timer	BCH
		Alstom
		L & T
		Electronic Automation
		Telemechanique
		Schneider
		Essen Deinki
		ABB
40	Terminals Block(Fixed/Drawout)	Phoenix
		Connect well
		Elemex
		Wago
		Essen Deinki
		Technoplast
41	Thermostat	Automatic Instrumemation
		Anco
		Temptrol
42	Voltmeter(Indicating)	Automatic Electric
		IMP
		Rishabh Industrial(L & T)
		Secure meters
43	Voltage Transformers (VT)	Automatic Electric
		Indcoil
		Kappa Electricals
		Pragati Electricals
		PRAYOG
		Precise Electricals
		Silkaans
		Southern Electrics
		Siemens
44	Winding Heating Transformer	Automatic Electric
		Indcoil
		Kappa Electricals
		Silkaans
		Logicstat
		Southern Electrics
		Precise Electricals
45	ACDB, DCDB, AC/DC Fuse DB	C & S Electric
		Schneider
		L & T
		Siemens
		GE-power
		Spaceage
		ABB
		KMG ATOZ
		Unilec Engg.
		Bose Corporation
		Controls & Schematics
		BCH

106108/2020/PS-PEM-MAX

SECTION: I

SUB-SECTION: C4

TECHNCIAL SPECIFICATION

(C&I PORTION)

	SPECIFIC TECHNICAL REQUIREMENT FOR AIR CONDITIONING & VENTILATION SYSTEM 4X225 MW ARUN-3 HEP	SPECIFICATION NO.
		VOLUME II-B
		SECTION : C
		REV. NO. 00 DATE: 25.10.19
		SHEET OF

C&I TECHNICAL SPECIFICATION FOR HEATING, VENTILATION & AIRCONDITIONING (HVAC SYSTEM)

TABLE OF CONTENTS

A. SPECIFIC TECHNICAL REQUIREMENTS.
B. SPECIFICATION FOR MOTORIZED VALVE ACTUATOR
C. INSTRUMENTATION DATA SHEET.
D. INSTRUMENT CHECK LIST.
E. SPECIFICATION FOR CONTROL PANELS
F. LCP QUALITY PLAN
G. INSTALLATION DIAGRAMS
H. CONTROL & INSTRUMENTATION CABLE
I. LIST OF DELIVERABLES

	SPECIFIC TECHNICAL REQUIREMENT FOR AIR CONDITIONING & VENTILATION SYSTEM 4X225 MW ARUN-3 HEP	SPECIFICATION NO.
		VOLUME **II-B**
		SECTION : **C**
		REV. NO. 00 DATE: 25.10.19
		SHEET OF

SPECIFIC TECHNICAL REQUIREMENTS

	SPECIFIC TECHNICAL REQUIREMENT FOR AIR CONDITIONING & VENTILATION SYSTEM **4X225 MW ARUN-3 HEP**	SPECIFICATION NO. VOLUME **II-B** SECTION : **C** REV. NO. 00 | DATE: 25.10.2019 SHEET 1 OF 3

1. Complete Control & Instrumentation for Air Conditioning & Ventilation System is in bidder scope of supply. Items not specifically mentioned however required for the completeness of the system shall be supplied by bidder.

2. Bidder to include Field instrumentation along with necessary fittings, accessories and valve manifold etc. and Field Junction Box (JB's), in his scope of supply. Each instrument/ equipment shall have a unique KKS Tag No. Field instrument specification and Data Sheet are given elsewhere in this specification. Bidder to provide local control panel wherever required.

3. All fields cabling for instruments/motor/pump/blower to JB is in bidder's scope and details are given elsewhere in the specification. The field I/O s should be grouped together in JBs suitably and a common trunk cable shall be taken to the panel. Cable schedule, cable interconnection details and wiring diagram for the same shall be in bidders' scope.

4. Instrument installation drawings are to be provided by bidder. All instrument fitting and erection hardware/racks as per instrument installation diagram shall be in bidder's scope.

5. The requirements given below are to be read in conjunction with detailed Technical specification enclosed.

6. Every panel-mounted instrument, requiring power supply, shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.

7. Provision for input fire signal from fire alarm system to be ensured for opening/ closing of the motor operated fire dampers.

8. Provision for separate Terminal block/wiring diagram for power and control blocks of control panel to be ensured.

9. Provision for earthing of the panel to be provided by vendor.

10. Vendor to submit GA drawing of control panel indicating layout of instruments, construction details, wiring diagram, class of protection for enclosure, paint type, paint color, thickness and material of enclosure sheet, control scheme during detailed engineering.

11. Layout & space requirement of panel to be specified during detailed engineering.

12. All bidirectional drives (Motor Operated Valves, MOVs) are integral starter type. Typical Hook Up diagram of all types of drives is attached for use (subject to Customer approval).

13. Bidder shall provide Cable Schedule in BHEL excel format. Also, Cable Interconnections details and wiring diagram for Complete System shall be in Bidders' scope.

14. Bidder to provide all control panels, system cabinets, termination & relay cabinets complete with all accessories, wiring and all mounting and erection hardware including junction boxes, canopies, structural steel as required. All instruments/drives shall be terminated on Junction Boxes/Panel in Bidder scope of supply. 20% Spare terminals shall be provided on Junction Boxes.

15. Bidder to delegate/depute their person/experts as per owner/consultant requirements.

16. The make of all the items shall be from approved sub-vendor list.

17. The design, manufacture, inspection, testing, site calibration and installation of all C&I equipment and systems covered under this specification shall conform to the latest editions of applicable codes and standards eg. ANSI, ASME, IEEE, ISO, IEC, IGCI, AWS, NFPA, AISC, IGS, SAMA, UBC, UL, NESC, NEMA, ISA, DIN, VDE, IS etc.

18. Control, monitoring and related items and services

i) Control panel for Air Blowers, exhaust system, motorized damper etc. complete with all necessary accessories.

ii) Necessary instrumentation such as temperature, thermostat, humidity sensor, flow rate sensors in main & booster etc. for the above system.

ii) Coordination and provision of necessary contacts and/ or ports for integration with plant SCADA system.

19. Panels shall be provided at different locations for supply and control of different motors for blower's/ exhaust fans, and motorized dampers, etc. Panel shall include necessary relay, push buttons, indicating lamps and electronic display unit for voltage, current, kW and power factor and electronic energy meter at incomer feeder. Provision for display of flow rate (m3/hr) shall also be made in the control panel of ventilation / booster blower system panel.

	SPECIFICATION NO.	
SPECIFIC TECHNICAL REQUIREMENT FOR AIR CONDITIONING & VENTILATION SYSTEM 4X225 MW ARUN-3 HEP	VOLUME **II-B**	
	SECTION : **C**	
	REV. NO. 00	DATE: 25.10.2019
	SHEET 3	OF 3

Local control panels shall be provided at following locations:

1. Supply and Exhaust Air blower room located at Cable Access Tunnel (CAT)/ Main Access Tunnel (MAT) portal (refer enclosed Ventilation scheme in sub section- 6 of section-II).

2. Exhaust Air Blower Room located at Niche at EL 552. M at connection of branch Adit to Power House (refer enclosed Ventilation scheme in sub section- 6 of section-II).

3. Control block area of Power House.

4. Supply and Exhaust Air Blower room for Butterfly Valve House located at PPV Portal (ADIT 4 portal).

5. Supply Air blower room located inside Auxiliary Dam building.

6. Any other area as per requirement during detailed engineering.

NOTES:

1. All equipment items shall be of latest design with proven on track record from reputed experienced manufacturers of specified type and range of equipment. The make/model of various instruments/items/systems and instrument sub-vendor shall be subject to approval of BHEL/Customer during detailed engineering stage.

2. The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system is to be supplied by bidder without any technical, commercial and delivery implication to BHEL.

3. Documents of C&I System shall be submitted to end user/owner for approval during detail engineering. Changes, if any, shall be accommodated by the bidder without any price/time implication.

	AIR CONDITIONING & VENTILATION SYSTEM **4X225 MW ARUN-3 HEP**	SPECIFICATION NO.
		VOLUME **II-B**
		SECTION : **C**
		REV. NO. 00 DATE: 25.10.19
		SHEET OF

ACTUATOR DATA SHEET

106108/2020/PS-PEM-MAX

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	SPECIFICATION NO.: PE-SS-999-145-I007
		VOLUME II B
		SECTION D
		REV. NO. 04 DATE:15/05/2019
		SHEET 1 OF 4

Data Sheet A & B

	DATA SHEET-A (TO BE FILLED BY PURCHASER)		DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
GENERAL*	* PROJECT			
	OFFER REFERENCE			
	* TAG NO. SERVICE			
	* DUTY	☐ ON / OFF ** ☐ INCHING		
	* LINE SIZE (inlet/outlet): MATERIAL			
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY		
	* OPENING / CLOSING TIME			
	* WORKING PRESSURE			
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF 0-55 DEG C AND RELATIVE HUMIDITY OF 0-95%		
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY		
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY		
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY		
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF, IP:68		
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL		
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.		
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.		
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 85% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. **FOR INCHING SERVICE - 150 STARTS/HR MINIMUM & FOR REGULATING SERVICE - 600 STARTS/HR MINIMUM.**		
HANDWHEEL as per standard EN 12570:2000	* REQUIRED	■ YES ☐ NO		
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED		
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.			
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY		
	MOTOR MAKE / MODEL / TYPE / RATING (KW) (REFER NOTE NO. 6 & 7)	BIDDER TO SPECIFY		
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT-INCLUSIVE OF **I.S.** TOLERANCE		
	ACTUATOR APPLICABLE WIRING DIAGRAM	■ ENCLOSED (BIDDER TO CONFIRM) A: ■ DRG. NO. 3-V-MISC-24227 R00 B: ☐ DRG. NO. 3-V-MISC-24550 R00 C: ☐ DRG. NO. 3-V-MISC-24283 R00 D: ☐ DRG. NO. 4-V-MISC-90271 R11 E: ☐ For Thyristor based Integral starter, Bidder/Vendor to furnish wiring diagram		
	COLOUR SHADE	☐ BLUE (RAL 5012) ☐ …….		
	PAINT TYPE **(## Refer Notes)**	☐ ENAMEL ☐ EPOXY CONFIRMING TO CORROSION CATEGORY C5-I		
	SHAFT RPM	BIDDER TO SPECIFY		
	OLR SET VALUE	BIDDER TO SPECIFY		
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY		
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY		
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC		

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.: PE-SS-999-145-I007	
		VOLUME II B	
		SECTION D	
		REV. NO. 04	DATE:15/05/2019
		SHEET 2 OF 4	

Data Sheet A & B

	DATA SHEET-A (TO BE FILLED BY PURCHASER)		DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☐ 110 V	
	@ ENCLOSURE CLASS OF MOTOR	☐ IP 67 ☐ IP 68 ☐ FLAME PROOF	
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B	
	@ WINDING TEMP PROTECTION	■ THERMOSTAT (3 Nos.,1 IN EACH PHASE) ☐ ----------	
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED (THERMISTOR PTC)	
INTEGRAL STARTER	INTEGRAL STARTER	■ REQUIRED ☐ NOT REQUIRED	
	TYPE OF SWITCHING DEVICE	■ CONTACTORS ☐ THYRISTORS	
	TYPE	■ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)	
	IF SMART (REFER BELOW POINT a – h)		NA
	a) SERIAL LINK INTERFACE	☐ INTEGRAL ☐ FIELD MOUNTED	
	b) SERIAL LINK PROTOCOL	☐ FOUNDATION FIELD-BUS ☐ PROFI-BUS ☐ DEVICE NET ☐……	
	c) SERIAL LINK MEDIA	☐ TWISTED PAIR Cu-CBL ☐ CO-AXIAL Cu-CBL ☐ OFC	
	d) HAND HELD PROGRAMMER	☐ REQUIRED ☐ NOT REQUIRED	
	e) TYPE OF HAND HELD PROGRAMMER	☐ BLUETOOTH ☐ INFRARED ☐.....	
	f) MASTER STATION	☐ REQUIRED ☐ NOT REQUIRED	
	g) MASTER STN INTRFACE WITH DCS	☐ MODBUS ☐ TCP/IP	
	h) DETAILS OF SPECIAL CABLE	☐ ENCLOSED ☐ NOT REQUIRED	
	STEP DOWN CONT. TRANSFORMER	■ REQUIRED	
	OPEN / CLOSE PB	■ REQUIRED ☐ NOT REQUIRED	
	STOP PB	■REQUIRED ☐ NOT REQUIRED	
	INDICATING LAMPS	■ REQUIRED ☐ NOT REQUIRED	
	LOCAL REMOTE S/S	■REQUIRED ☐ NOT REQUIRED	
	STATUS CONTACTS FOR MONITORING	■ REQUIRED ☐ NOT REQUIRED	
	INTEGRAL STARTER DISTURBED SIGNAL(Refer Note 14)	REQUIRED (O/L RELAY OPERATED, CONT./POWER SUPPLY FAILED, S/S IN LOCAL, TORQUE SWITCH OPTD. MID WAY,)	
	ACTION ON LOSS OF EXTERNAL ELECTRIC POWER	☐STAYPUT ☐ FAIL SAFE	
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter) **DATASHEET & WIRING DIAGRAM OF ISOLATION DEVICE TO BE PROVIDED**	TYPE OF ISOLATING DEVICE	■ INTERPOSING RELAY ☐ OPTO COUPLER TO BE DECIDED DURING DETAILED ENGINEERING	
	QUANTITY	■ 2 NOs. ☐ 3 NOs.	
	DRIVING VOLTAGE	■ 20.5 – 24V DC ☐ _____V DC	
	DRIVING CURRENT	■ 125mA MAX ☐ _____mA MAX	
	LOAD RESISTANCE	■ > 192 ohms - <25 k ohms ☐ > _____ohms - < _____ohms	
TORQUE SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN / CLOSE	■1 No. ☐2Nos. / ■1 No. ☐2Nos	
	CONTACT TYPE	2 NO + 2 NC	
	RATING	5A 240V AC AND 0.5A 220V DC	
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE	
	ACCURACY	+3% OF SET VALUE	

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	SPECIFICATION NO.: PE-SS-999-145-I007 VOLUME II B SECTION D REV. NO. 04 DATE:15/05/2019 SHEET 3 OF 4

Data Sheet A & B

DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

LIMIT SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY					
	OPEN : INT : CLOSE	☐1 No ■2 Nos.	2 Nos. (ADJ.)	☐1 No. ■2Nos.			
	CONTACT TYPE	2 NO + 2 NC					
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC					
	ACCURACY	2% OF SET VALUE					

POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications)	■ REQUIRED ☐ NOT REQUIRED	
	MFR & MODEL NO.	BIDDER TO SPECIFY	
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ☐ ELECTRONIC (2 WIRE) CONTACTLESS	
	SUPPLY	■ 24V DC ☐ ……	
	OUTPUT	■ 4-20mA	
	ACCURACY	± 1% FS	
SPACE HEATER	@SPACE HEATER	REQUIRED	
	@ POWER SUPPLY (NON INTEGRAL)	230V AC,1 PH.,50 Hz	
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY	
	@ RATING		
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED	
	ENCL CLASS ACTUATOR/MOTOR T.B.	@☐ IP 68 @☐……	
	@ EARTHING TERMINAL	REQUIRED	
	PLUG & SOCKET	☐ REQUIRED ■ NOT REQUIRED	
	NO. OF PINS REQUIRED(TO BE CHECKED AS PER SIGNALS IN DRIVE CONTROL PHILOSOPHY)		
	NOS. OF PLUG & SOCKET	☐ 1 Nos. for ON/OFF ☐ 2 NOS.(for inching duty) ☐ OTHER (TO BE SPECIFIED INLINE WITH DRIVE CONTROL PHILOSOPHY)	
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:----------	
	@ SPACE HEATER CABLE GLAND	SIZE:----------	
	CONTROL CABLE GLANDS-1	QUANTITY & SIZE :----------	
	CONTROL CABLE GLANDS-2	QUANTITY & SIZE :----------	
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY	_____ Kg.

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.: PE-SS-999-145-I007	
		VOLUME II B	
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Data Sheet A & B

DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

NOTES:

1. **SCOPE**: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY.
2. **CODES & STANDARDS**: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATION STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH:
   IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691, IS-4722, IEC 60947-5-1 AND EN 15714-3 :2010 OR LATEST VERSION.
3. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.
4. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL SHALL BE PROVIDED.
5. THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION.THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE.
6. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING.
7. THE MOTOR SHALL OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY, -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%. **(FOR NTPC PROJECTS)**

   THE MOTOR SHALL BE CAPABLE OF STARTING AT 85 PERCENT OF RATED VOLTAGE RUNNING AT 80 PERCENT OF RATED VOLTAGE AT RATED TORQUE AND 85 PERCENT RATED VOLTAGE AT 33 PERCENT EXCESS RATED TORQUE FOR A PERIOD OF 5 MINUTES EACH. **(FOR NON NTPC PROJECTS)**
8. IN ADDITION TO ABOVE REQUIREMENTS FOR LIMIT/TORQUE SWITCH, **MECHANICAL END STOP** WITH ACCURACY OF 2% SHALL BE SUPPLIED.
9. IT SHOULD BE POSSIBLE TO OPERATE THE ACTUATOR LOCALLY. LOCKABLE LOCAL/REMOTE SELECTION SHALL BE PROVIDED ON THE ACTUATOR.
10. LOCAL POSITION INDICATOR SHALL BE PROVIDED FOR 0 TO 100 % TRAVEL.
11. CONTROL WIRING SHALL BE SUITABLE VOLTAGE GRADE COPPER WIRE 1.5 SQ. MM.
12. ENDURANCE: RATED TORQUE RANGE SHOULD BE BASED ON ISO 5211, ISO5210.
13. TAG PLATE SHALL BE CONFIRMING TO STANDARD BS-15714.
14. INTEGRAL STARTER/ACTUATOR DISTURBED SIGNAL SHALL BE CHECKED AND INCLUDE AS PER DRIVE CONTROL PHILOSOPHY.
15. **** VALVES WITH 10 DEGREE/20DEGREE FEEDBACK REQUIREMENT FOR APPLICATIONS SUCH AS CW/ACW/PLANT WATER SYSTEM ETC SHALL BE CONSIDERED AS INCHING DUTY VALVES. ACCORDINGLY, POSITION FEED BACK TRANSMITTER, PLUG & SOCKET REQUIREMENT SHALL BE CONSIDERED.**

$$ TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE.

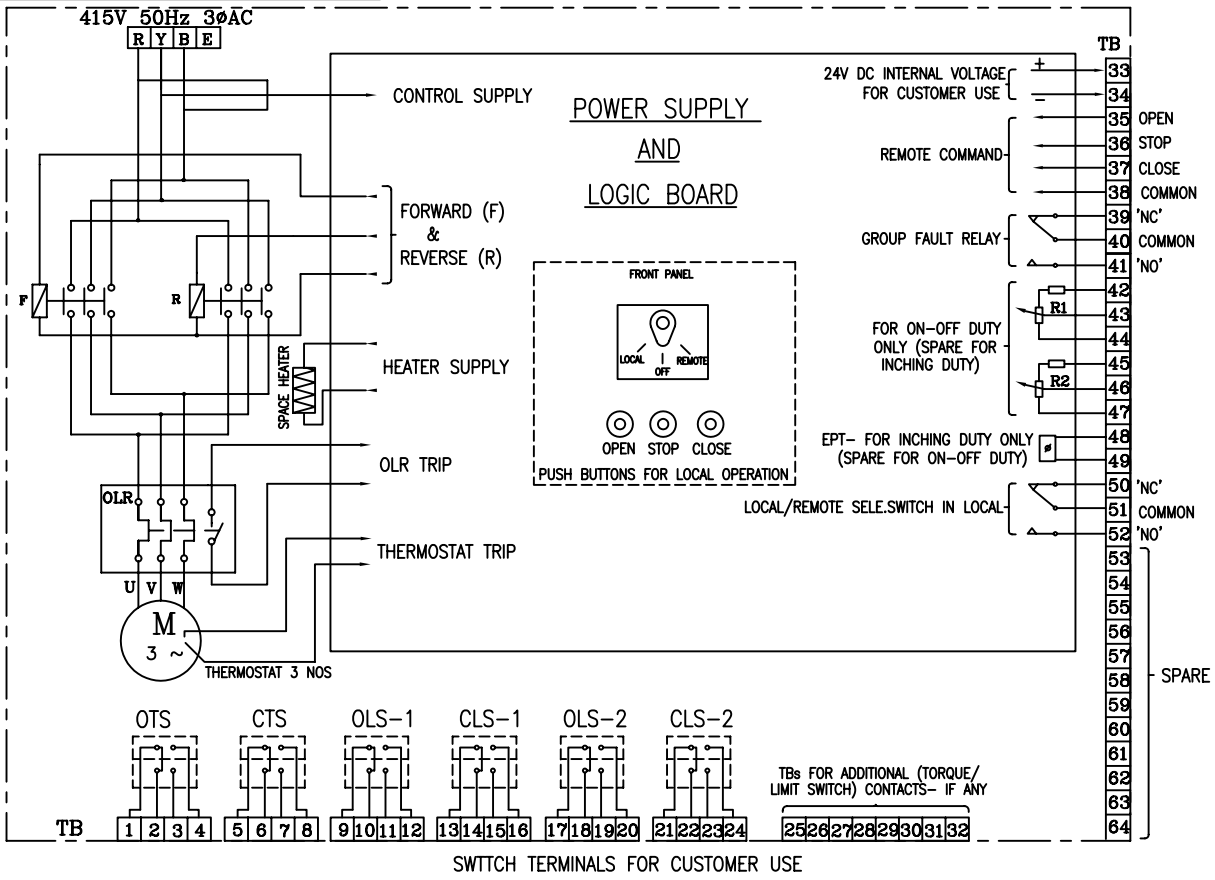
EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS.

	PREPARED BY	CHECKED BY	APPROVED BY	VENDOR COMPANY SEAL
NAME	MADHAV GUPTA	VIPUL KUMAR VERMA	SHIVRAJ SINGH BANSALA	NAME
SIGNATURE				SIGNATURE
DATE	15.05.2019	15.05.2019	15.05.2019	DATE

NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @ BE FILLED BY ES

ALL DIMENSIONS ARE IN MILLIMETRES. FOR TOLERANCES OF UNTOLERANCED DIMENSIONS DURING MANUFACTURE REFER RELEVANT QCP / QP.

DRAWING NO. 3-V-MISC-24227



CONTACT DEVELOPMENT DIAGRAM

OTS	1-2	OPEN AT OVER TORQUE DURING OPENING TRAVEL						
	3-4	CLOSE AT OVER TORQUE DURING OPENING TRAVEL						
CTS	5-6	OPEN AT OVER TORQUE DURING CLOSING TRAVEL						
	7-8	CLOSE AT OVER TORQUE DURING CLOSING TRAVEL						
OLS-1	9-10							
	11-12							
CLS-1	13-14							
	15-16							
OLS-2	17-18							
	19-20							
CLS-2	21-22							
	23-24							
SWITCH	TERMINAL NO.	FULL OPEN	a	INTERMEDIATE		b	FULL CLOSE	
		VALVE POSITION						

INDICATES CONTACT CLOSED

INDICATES CONTACT OPEN

CONTACT RATING: 5A AT 250V AC & 0.5A AT 220V DC

SETTING PROCEDURE OF POSITION LIMIT AND TORQUE SWITCH

VALVES	OPEN		CLOSE	
	MAIN	BACK UP	MAIN	BACK UP
GATE VALVE OF 100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS	OLS	OTS *	CLS	CTS
ALL OTHER GATE & GLOBE VALVES	OLS	OTS *	CTS	#

– CLS NOT TO BE CONNECTED IN TRIP CIRCUIT

* – BYPASS OTS FOR INITIAL 5% OF TRAVEL (FOR GATE VALVES ONLY)

NOTE:–

1. ALL TORQUE AND LIMIT SWITCHES (OTS,CTS,OLS1&2, CLS1&2) ARE WITH 2NO+2NC CONTACTS '1NO+1NC' IS TERMINATED IN TBS 1–24, REMAINING CONTACTS ARE FOR INTERNAL USE. ANY SPARE CONTACTS WHICH ARE NOT USED INTERNALLY ARE TO BE TERMINATED IN TBS 25–32
2. CTS – TORQUE SWITCHES FOR CW ROTATION (CLOSE)
3. OTS – TORQUE SWITCHES FOR CCW ROTATION (OPEN)
4. OLS–1, OLS–2 – LIMITSWITCHES FOR POSITION OPEN
5. CLS–1, CLS–2 – LIMITSWITCHES FOR POSITION CLOSE
6. EPT – ELECTRONIC POSITION TRAMSMITTER (POTENTIOMETRIC TYPE, FOR INCHING DUTY)
7. R1–R2–POTENTIOMETER 2 x 100 OHMS (FOR ON–OFF DUTY)
8. FOR COMMANDS & EPT EITHER INTERNALLY GENERATED 24 VDC OR EXTERNAL SUPPLY OF 24VDC CAN BE USED
9. M – MOTOR 3ø 415V 50 Hz AC SUPPLY

REV	DATE	ALTERED
		CHD & APPD

CAUTION: The information on this document is the property of BHARAT HEAVY ELECTRICALS LTD. It must not be used directly or indirectly in any way detrimental to the interest of the company.

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: ELECTRICAL VALVE ACTUATORS (AC) WITH INTEGRAL STARTERS (DRAWN FOR INTERMEDIATE POSITION OF VALVES)

BHARAT HEAVY ELECTRICALS LTD.,
UNIT: HIGH PRESSURE BOILER PLANT.
TIRUCHIRAPALLI–620014.
365–121

	NAME	SIGN	DATE	NO.OF VAR.
DRN	N.P.ESWAR	N.P	07.10.04	
CHD	D.DINAKARAN	D.D	07.10.04	
APPD	K.ARUNACHALAM	K.A	07.10.04	

DEPT: VL | CODE | SCALE | WEIGHT (KG). | REFERENCE INFORMATIONS | NO. OF ITEMS

TITLE: WIRING DIAGRAM (TERMINAL PLAN) FOR ACTUATOR WITH INTEGRAL STARTER

CARD CODE: U 01

DRAWING NO.: 3–V–MISC–24227

REV: 0

Size A3

	AIR CONDITIONING & VENTILATION SYSTEM 4X225 MW ARUN-3 HEP	SPECIFICATION NO.
		VOLUME **II-B**
		SECTION : **C**
		REV. NO. 00 | DATE: 25.10.2019
		SHEET OF

INSTRUMENTATION DATA SHEET

	SPECIFICATION FOR TEMPERATURE GAUGE	SPECIFICATION NO.: PES – 145 – 027	
		VOLUME II B	
		SECTION D	
		REV. NO. 00	DATE : 23-04-2010
		SHEET 1	OF 3

1.0 SCOPE

This specification covers the Design, Manufacture, Inspection and Testing at the manufacturer's works, proper packing for transportation and delivery to site of Temperature Gauge for use in Utility/Captive Power Station/Combined Cycle Station.

2.0 CODES AND STANDARDS

2.1 All the equipments specified herein shall comply with the requirements of the latest issue of the relevant National and International standards.

2.2 The Design and Materials used for the components shall also comply with the relevant National and International standards.

2.3 As a minimum requirement, the following standards shall be complied with :

Enclosure	-	ISA: RP:8.1
Thermowell	-	ASME : PTC-19.3

3.0 TECHNICAL REQUIREMENTS

3.1 General

The thermometers shall be suitable for an ambient temperature of 0-55°C and relative humidity of 0-95%.

3.2 Bourdon tube and movement

Bourdon shall be made of suitable AISI 316 and the movement shall conform to AISI 304.

3.3 Case

Shall be made of Die cast aluminium and painted with Black stoving enamel paint over a suitable etch primer.

3.4 Bezel Ring

Shall be made of anodised aluminium with anti corrosive finish.

3.5 Dial and Scale

The dial shall be made of suitable material with anti corrosive finish.

The scale shall be concentric and graduated in degrees centigrade. The markings shall be in black on a non-reflective white background.

The pointer deflection angle shall be 270 degrees.

The unit of measurement Deg.C shall also be marked on the dial.

3.6 Pointer

Shall be made of suitable metal with black finish. The pointer shall be provided with suitable mechanism for zero adjustment without opening the case.

3.7 Bulb and Stem

Bulb and stem shall be made of stainless steel AISI 316. The bulb O.D. shall be 12 ±0.1 mm. The process connection shall be adjustable gland type. The immersion length shall be adjustable between 100mm to 300mm. The material of the adjustable gland is AISI 316. The stem shall be flexible suitable for bending.

3.8 Temperature compensation

The thermometer shall be provided with compensating arrangement for ambient temperature changes.

3.9 Capillary

Capillary shall be SS-316 and 1.5mm dia, covered with 4.5mm dia of SS Spiral Sheath.

	SPECIFICATION FOR TEMPERATURE GAUGE	SPECIFICATION NO.: PES – 145 – 027	
		VOLUME II B	
		SECTION D	
		REV. NO. 00	DATE : 23-04-2010
		SHEET 2	OF 3

3.10 Accuracy

± 1% of the full-scale deflection.

3.11 Mounting & Connection

Flush Mounting, back connection, clamp fixing, Direct mounting bottom connection.

3.12 Thermowell

Gauge shall be supplied along with the thermowell. The thermowell shall be of AISI 316 SS/Cr.Mo. Steel and shall be designed to suit the process conditions. For details of the thermowell see enclosed drawings for Thermowell.

4.0 TESTING AND INSPECTION

4.1 The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

4.2 The following test shall be conducted as a minimum requirement.

a) Routine Tests

i) Accuracy test.
ii) Overload test
iii) Response time test

b) Type Tests

i) Ambient temperature compensation test.
ii) Weather proof water tight and dust tight tests.

4.3 Inspection will be conducted by BHEL and/or their authorised representatives as per the agreed inspection schedule. The inspection schedule will be submitted by the bidder for BHEL's approval at contract stage. The cost of all tests and inspections will be deemed to have been included in the bid. For all the type tests covered under 4.3 (b), "Type Test Certificates" as per agreed Quality Plan shall be furnished. In the absence of the same, such Type Tests shall be arranged at the Vendor's works in the presence of BHEL and/or their authorised representatives or in independent Test House / Laboratory approved by BHEL.

4.4 The Standard QP is included in this specification to enable bidder to understand the extent of inspection and testing requirements to execute this job. The successful bidder has to follow the agreed QP, taking care of customer requirements mentioned in Sec-C and submit QP for final approval by BHEL / Customer.

5.0 SPARES AND CONSUMABLES

5.1 Recommended Spares

The bidder shall furnish a list of Recommended Spares alongwith the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation alongwith unit rate against each item to enable BHEL/BHEL's Customer to place a seperate order later, if required.

6.0 DRAWINGS AND DOCUMENTS

6.1 The bidder shall furnish the following documents in required number of copies alongwith the bid :

6.1.1 Data sheet-B, completely filled-up alongwith all enclosures.

6.1.2 Quality Plan.

6.1.3 Catalogs with detailed technical information.

6.1.4 Bar-chart to indicate the time schedule for procurement, manufacture, testing and despatch.

	SPECIFICATION FOR TEMPERATURE GAUGE	SPECIFICATION NO.: PES – 145 – 027	
		VOLUME II B	
		SECTION D	
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6.2 The successful bidder shall furnish the following documents in required number of copies during the contract stage :

6.2.1 For approval

i) Dimensional/Installation drawings.

ii) Data sheet-C, completely filled-up alongwith all the enclosures.

iii) Quality Plan of vendor/sub-vendor.

iv) Test Certificates.

6.2.2 Final/As-built Drawings

Final / As-built drawings / CDs in required number of copies shall be submitted.

6.3 Operation & Maintenance Manuals

O&M Manuals in required number of copies shall be submitted. O&M Manuals shall also contain storage & commissioning instructions.

7.0 MARKING AND PACKING

7.1 Marking

A stainless steel name-plate shall be permanently fixed on each equipment giving its Tag Number and technical specifications.

7.2 Packing

All equipment/materials shall be suitably packed and protected for the entire period of dispatch, storage and erection against impact, abrasion, corrosion, incidental damage due to vermin, sunlight, high temperature, rain, moisture, humidity, dust, sea- water spray (where applicable) as well as rough handling and delays in transit and storage in open.

8.0 APPLICABLE DATA SHEET FORMS

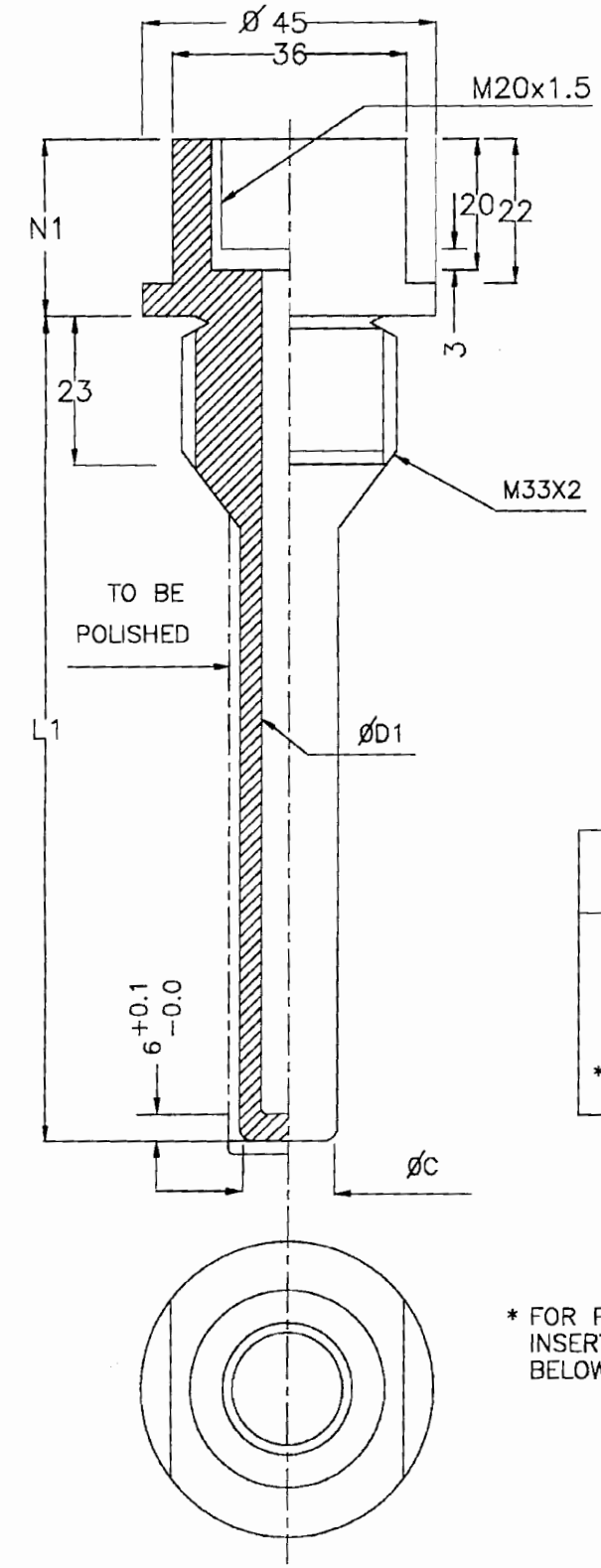
This document shall be read with one or more of the following data sheet forms :

- Data sheet A&B for Temperature Gauge : Data sheet no. PES-145-27-DS1-1
- Data sheet C for Temperature Gauge : Data sheet no. PES-145-27-DS2-1

FORM NO. PEM – 6666–0

THERMOWELL MEDIUM PRESSURE (40 Kgf/Cm2)

SPECIFICATION NO	PES–145–27
VOLUME	IIB
SECTION	D
REV. NO. 02	DATE 16-5-2007
SHEET 4	OF 8



PIPE O.D.	INSERTION LENGTH (L1)
Ø 509 & ABOVE	325
Ø 506 TO 369	250
Ø 368 TO 274	175
*Ø 273 BELOW	150

* FOR PIPE O.Ds UP TO 159mm THE THERMOWELL INSERTION WILL BE STRAIGHT. FOR PIPE O.Ds BELOW 159mm, THE INSERTION SHALL BE SLANT.

Fig.1

FORM NO. PEM – 8666–0

THERMOWELL–HIGH PRESSURE (250 Kgf/Cm2)

SPECIFICATION NO.	PES–145–27
VOLUME	IIB
SECTION	D
REV. NO.	02
DATE	16-5-2007
SHEET	5 OF 8

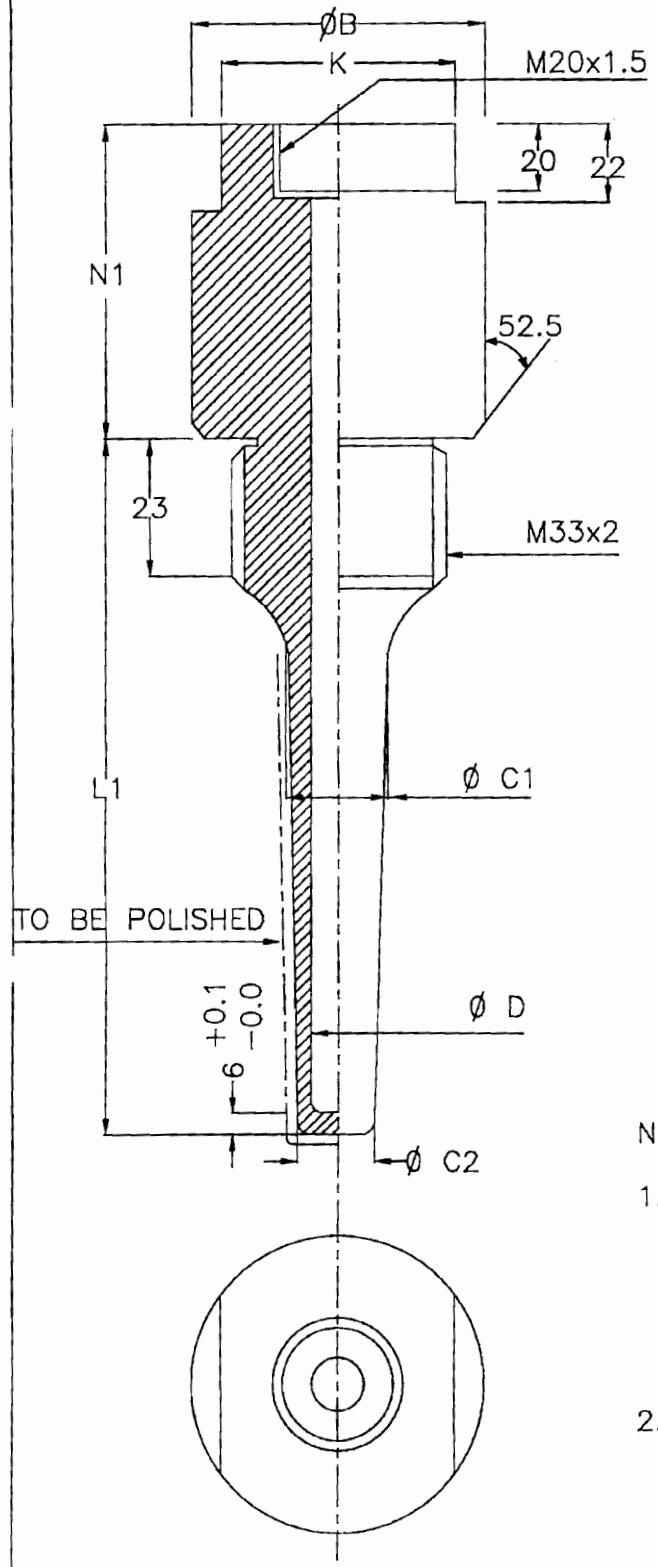


Fig. 2

PIPE O.D.	INSERTION LENGTH L1
Ø 509 & ABOVE	325
Ø 508 TO 368	250
Ø 367 TO Ø274	175
Ø 273 BELOW	150

NOTE :–

1. THE CORRESPONDING ELEMENT ELEMENT LENGTHS ARE GIVEN FOR INFORMATION ONLY. THE ELEMENT LENGTHS ARE WORKOUT AS PER THE FORMULA L=L1+N1–6.
2. FOR PIPE OD'S UPTO 159mm, THE THERMOWELL INSERTION WILL BE STRAIGHT. FOR PIPE OD'S BELOW 159mm, THE INSERTION SHALL BE SLANT.

FORMAT NO. - 6666-0

BHEL	**SPECIFICATION FOR TEMPERATURE GAUGE**	SPECIFICATION NO. : PES - 145 - 27 VOLUME II B SECTION D REV. NO. 02 DATE 16-5-2007 SHEET 6 OF 8

ALL DIMENSIONS IN mm

Instrument stem dia D+0.0 -0.1	DIA D1 +0.2 0	DIA C	Insertion Length L1	Extention element length N1	Corres ponding element length(L)
12	12.5	19	150	27	171
				75	219
				100	244
			175	27	196
				75	244
				100	269
			250	27	271
				75	319
				100	344
			325	27	346
				75	394
				100	419
14	14.5	21	150	27	171
				75	219
				100	244
			175	27	196
				75	244
				100	269
			250	27	271
				75	319
				100	344
			325	27	346
				75	394
				100	419

NOTE: The corresponding element lenghts are given for information only. The elements lengths are worked out as per the formula :

$$L = L1 + N1 - 6$$

FORMAT NO. - 6666-0

	SPECIFICATION FOR TEMPERATURE GAUGE	SPECIFICATION NO. : PES - 145 - 27
		VOLUME II B
		SECTION D
		REV. NO. 02 DATE 16-5-2007
		SHEET 7 OF 8

THERMOWELL-MEDIUM PRESSURE
(40 KG/CM2)

ALL DIMENSIONS IN mm

Instrument stem dia D+0.0 -0.1	DIA D1 +0.2 0	DIA C	Insertion Length L1	Extention element length N1	Corres ponding element length(L)
6	6,5	12.5	150	27	171
				75	219
				100	244
			175	27	196
				75	244
				100	269
			250	27	271
				75	319
				100	344
			325	27	346
				75	394
				100	419
8	8.5	15	150	27	171
				75	219
				100	244
			175	27	196
				75	244
				100	269
			250	27	271
				75	319
				100	344
			325	27	346
				75	394
				100	419

	THERMOWELL HIGH PRESSURE (250 KGf/Cm²)	SPECIFICATION NO. : PES - 145 - 27
		VOLUME II B
		SECTION D
		REV. NO. 02 DATE 16-5-2007
		SHEET 8 OF 8

ALL DIMENSIONS IN mm

Instrument stem dia D (+0.0 -0.1)	DIA D1 (+0.2 0.0)	DIA C1	DIA C2	K	DIA B	Insertion Length L1	Extention Length N1	Corresponding Element Length (L)
6	6.5	19	12.5	36	45	150	27 75 100	171 219 244
						250	27 75 100	271 319 344
8	8.5	21.5	15	36	45	150	27 75 100	171 219 244
						250	27 75 100	271 319 344
12	12.5	25.5	19	36	45	150	27 75 100	171 219 244
						250	27 75 100	271 319 344
14	14.5	27.5	21	36	45	150	27 75 100	171 219 244
						250	27 75 100	271 319 344
16	16.5	29	23	46	55	150	27 75 100	171 219 244
						250	27 75 100	271 319 344

106108/2020/PS-PEM-MAX

FORM NO. PEM-6666-0

	TECHNICAL REQUIREMENT FOR TEMPERATURE GAUGE	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 1 OF 1

TAG No. ……. Qty……. Data Sheet No.: **PE-DC-326-145-I027-1**

Data Sheet A & B

DATA SHEET-A FOR TEMPERATURE GAUGE (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
GENERAL	MANUFACTURER		
	MODEL NUMBER		
	STANDARD TO BE FOLLOWED	■ ISA:RP:8.1 (ENCLOSURE) ■ ASME: PTC-19.3 (THERMOWELL)	
TECHNICAL	TYPE	MERCURRY FILLED (FOR <450 DEG C) INERT GAS ACTUATED (FOR >450 DEG C)	
	PRESSURE ELEMENT	BOURDON	
	MATERIAL	PRESSURE ELEMENT: ■ SS 316 (FOR Hg IN STEEL) CASE: ■ DIE CAST AL ■ SS BULB & CAPILLARY: SS 316 MOVEMENT: SS 304	
	DIAL	SIZE: 150 MM COLOR: WHITE NUMERALS: BLACK SCALE: LINEAR, 270° ARC GRADUATED IN DEG C	
	CASE	COLOUR : BLACK (IN CASE OF DIE CAST AL CASING)	
	ENCLOSURE	CLASS: ■ IP 55 PAINT: ■ EPOXY (IN CASE OF DIE CAST AL CASING)	
	MOUNTING	■ LOCAL ■ PANEL OR RACK	
	ZERO ADJUSTMENT	REQUIRED	
	RANGE SELECTION	SHOULD COVER 125% OF OPERATING PARAMETER	
	OVER RANGE PROTECTION	125% OF FSD FOR RANGE UPTO 400 Deg C 110% OF FSD FOR RANGE BETWEEN 400 TO 500 Deg C	
	COMPENSATION	CASE COMPENSATION TO BE PROVIDED AS PER BS 5235 FOR 0 TO 60 °C.	
	CAPILLARY MATERIAL	SS 316, 1.5 MM DIA COVERED WITH SS SPIRAL SHEATH OF 4.5 MM DIA	
	CAPILLARY LENGTH	5 MTR FOR LOCAL MOUNTED	
PERFORMANCE	ACCURACY	± 0.5% / ± 1% OR BETTER OF FULL SCALE DEFLECTION	
	RESPONSE TIME (WITHOUT THERMOWELL)	AS PER ASME PTC 19.3	
CONNECTION	CONNECTION WITH THERMOWELL	■ M20 x 1.5 (M) ■ 3/4" NPT (M) ■ ½" NPT(M)	
	LOCATION	BOTTOM / BACK	
THERMOWELL	MATERIAL (BAR STOCK)	■ SS 316	
	TYPE	■ SCREWED ■ WELDED ■ FLANGED	
	PROCESS CONNECTION	■ M33X2 ■ 150 RF ■ R 1 ■ R 1½	
	IMMERSION LENGTH (L1)	½ ID OF PIPE SUBJECT TO CONFORMANCE WITH ASME PTC 19.3	
	EXTENSION LENGTH (N1)	INSULATION THICKNESS - STUB HEIGHT + 25 MM	

FORM NO. PEM-6666-0

BHEL	**TECHNICAL REQUIREMENT FOR TEMPERATURE GAUGE**	SPECIFICATION NO.: VOLUME SECTION REV. NO. / DATE: SHEET 2 OF 1

TAG No. ……. Qty……. Data Sheet No.: **PE-DC-326-145-I027-1**

Data Sheet A & B

DATA SHEET-A FOR TEMPERATURE GAUGE (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

ACCESSORIES	NAME PLATE / METAL TAG	ENGRAVED WITH SERVICE LEGEND OR PHINOLIC NAME PLATE		
OTHER REQUIREMENT	1. AMBIENT TEMPERATURE 0-55 DEG C, RH 0-95%. 2. BULB O.D. 12 ± 0.1 MM 3. BEZEL RING SHALL BE OF ANODIZED ALUMINIUM / ABS PLASTIC INCASE OF DIE CAST AL CASING 4. ADJUSTABLE GLAND (BETWEEN 100 MM TO 300 MM) OF SS316 TO BE PROVIDED FOR CONNECTION OF STEM WITH THERMOWELL			
	PREPARED BY	CHECKED BY	APPROVED BY	COMPANY SEAL
NAME				NAME
SIGNATURE/DATE				SIGNATURE /DATE

FORM NO. PEM-6666-0

	SPECIFICATION FOR PRESSURE / DIFFERENTIAL PRESSURE GAUGE	SPECIFICATION NO.: PE-SS-999-145-I026	
		VOLUME II B	
		SECTION D	
		REV. NO. 03	DATE : 16-05-2007
		SHEET 1~~01~~ OF 4~~06~~	

1.0 SCOPE

This specification covers the Design, Manufacture, Inspection and Testing at the manufacturer's works, proper packing for transportation and delivery to site of Pressure/Differential Pressure Gauge for use in Utility/Captive Power Station/Combined Cycle Station.

2.0 CODES AND STANDARDS

2.1 All the equipments specified herein shall comply with the requirements of the latest issue of the relevant National and International standards.

2.2 The Design and Materials used for the components shall also comply with the relevant National and International standards.

2.3 As a minimum requirement, the following standards shall be complied with:

Pressure and vacuum gauges	-	IS-3624
Enclosure	-	IS-12063

3.0 TECHNICAL REQUIREMENTS

3.1 General

The gauges shall be suitable for an ambient temperature of 0-55°C and relative humidity of 0-95%.

3.2 Bourdon tube, Movement & Shank

Bourdon shall be made of stainless steel to AISI 316 and the teeth shall be polished to have frictionless movement without backlash. Movement material shall be AISI 304.l

3.3 Case

Shall be made of die cast ~~aluminium~~aluminum and painted with black stoving enamel paint over a suitable primer. The case shall be provided with a blowout disc, to safeguard the window glass.

3.4 Bezel Ring

Shall be made of anodized ~~aluminium~~aluminum with anti corrosive finish.

3.5 Dial & Scale

The dial shall be made of a suitable material with anti corrosive finish, meeting the requirements of IS-3624.

The scale shall be concentric and graduated in kg/sq.cm. in the pressure gauge. MM of Hg on vacuum side and kg/sq.cm on pressure side in case of vacuum / compound gauges. The marking shall be black on a ~~non-reflecting~~non-reflecting white background. The pointer deflection angle shall be 270 Deg.

The unit of measurement shall also be marked on the dial.

FORM NO. PEM-6666-0

	SPECIFICATION FOR PRESSURE / DIFFERENTIAL PRESSURE GAUGE	SPECIFICATION NO.: PE-SS-999-145-I026	
		VOLUME II B	
		SECTION D	
		REV. NO. 03	DATE : 16-05-2007
		SHEET 2~~02~~ OF 4~~06~~	

3.6 Pointer

Shall be made of suitable metal with black finish. The pointer shall be provided with suitable mechanism for zero adjustment without opening the case.

3.7 Switch device

Switch device shall be snap acting micro switch. The rating of contact shall be 5 A 230 V AC, 0.25 A 220 V DC. Setting range shall be field adjustable over the full range.

3.8 Accuracy

±1% of the full scale deflection.

3.9 Mounting & connection

Flush mounting, back connection, clamp fixing. Direct mounting bottom connection.

4.0 TESTING AND INSPECTION

4.1 The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

4.2 The bidder shall strictly follow the Quality Plan (s) included in Volume-IIB.

4.3 The following tests shall be conducted as a minimum requirement:

a) Routine Tests

i) Accuracy Test.
ii) Overload test.
iii) Hysteresis
iv) Contact Rating (for switch)
v) Repeatability (for switch)
vi) HV / IR (for switch)

b) Type tests

i) Blow out disc
ii) Weatherproof, water tight and Dust tight tests.

4.4 Inspection will be conducted by BHEL and/or their authorised representatives as per the agreed inspection schedule. The inspection schedule will be submitted by the bidder for BHEL's approval at contract stage. The cost of all tests and inspections will be deemed to have been included in the bid. For all the type tests covered under 4.3 (b), "Type Test Certificates" as per Quality Plan shall be furnished. In the absence of the same, such Type Tests shall be arranged at the Vendor's works in the presence of BHEL and/or their authorised representatives or in independent Test House/ Laboratory approved by BHEL.

4.5 The Standard QP is included in this specification to enable bidder to understand the extent of inspection and testing requirements to execute this job. The successful bidder has to follow the agreed QP, taking care of customer requirements mentioned in Sec-C and submit QP for final approval by BHEL / Customer.

FORM NO. PEM-6666-0

	SPECIFICATION FOR PRESSURE / DIFFERENTIAL PRESSURE GAUGE	SPECIFICATION NO.: PE-SS-999-145-I026	
		VOLUME II B	
		SECTION D	
		REV. NO. 03	DATE : 16-05-2007
		SHEET 3~~03~~ OF 4~~06~~	

5.0 SPARES AND CONSUMABLES

5.1 Recommended Spares

The bidder shall furnish a list of Recommended Spares along with the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation along with unit rate against each item to enable BHEL/BHEL's Customer to place a separate order later, if required.

6.0 **DRAWINGS AND DOCUMENTS**

6.1 The bidder shall furnish the following documents in required number of copies along with the bid :

6.1.1 Data sheet-B, completely filled-up along with all enclosures.

6.1.2 Quality Plan.

6.1.3 Catalogues with detailed technical information.

6.1.4 Bar-chart to indicate the time schedule for procurement, manufacture, testing and ~~despatch~~dispatch.

6.2 The successful bidder shall furnish the following documents in required number of copies during the contract stage :

6.2.1 For approval

i) Dimensional/installation drawings.

ii) Data sheet-C, completely filled-up along with all the enclosures.

iii) Quality Plan of vendor/sub-vendor.

iv) Test Certificates.

6.2.2 Final/As-built Drawings

Final / As-built drawings / ~~RTFs~~ CDs in required number of copies shall be submitted.

6.3.0 Operation & Maintenance Manuals

O&M Manuals in required number of copies shall be submitted. O&M Manuals shall also contain storage & commissioning instructions.

FORM NO. PEM-6666-0

	SPECIFICATION FOR PRESSURE / DIFFERENTIAL PRESSURE GAUGE	SPECIFICATION NO.: PE-SS-999-145-I026	
		VOLUME II B	
		SECTION D	
		REV. NO. 03	DATE : 16-05-2007
		SHEET ~~44~~	OF ~~45~~

7.0 MARKING AND PACKING

7.1 Marking

A stainless steel name-~~plate shall~~plate shall be permanently fixed on each equipment giving its Tag Number and technical specifications.

7.2 Packing

All equipment/materials shall be suitably packed and protected for the entire period of ~~despatch~~dispatch, storage and erection against impact, abrasion, corrosion, incidental damage due to vermin, sunlight, high temperature, rain, moisture, humidity, dust, sea- water spray (where applicable) as well as rough handling and delays in transit and storage in open.

8.0 APPLICABLE DATA SHEET FORMS

This document shall be read with one or more of the following data sheet forms :

Data sheet A & B and C for Pressure / Differential Pressure Gauge
(Data sheet no. PE-DC-999-145-I026-1)

FORM NO. PEM-6666-0

	DATA SHEET FOR PRESSURE / DIFFERENTIAL PRESSURE GAUGE	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 1 OF 1

TAG No. ……. Qty..... Data Sheet No.: **PE-DC-999-145-I026-1**

Data Sheet A & B

DATA SHEET-A FOR PRESSURE / DIFFERENTIAL PRESSURE GAUGE (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

GENERAL	MANUFACTURER		
	MODEL NUMBER		
TECHNICAL	PRESSURE ELEMENT	☐ BOURDON ☐ DIAPHRAGM ☐ BELLOW	
	MATERIAL	SENSING ELEMENT – AISI 316 SS MOVEMENT – AISI 304 SS CASING – ■ DIE CAST AL ☐ SS	
	ENCLOSURE	☐ INDOOR MOUNTED IP-55 ☐ OUTDOOR MOUNTED IP-67 ☐ FUEL GAS HAZARDOUS APPL. EXPL. PROOF	
	DIAL	SIZE: ☐ 100MM ■ 150MM COLOR: WHITE NUMERALS: BLACK SCALE: ☐ LINEAR ☐ SQUARE ROOT	
	CASE	COLOUR : BLACK	
	ADJUSTMENT	☐ EXT. MICROMETER SCREW ☐ INT. MICRO SCREW	
	MOUNTING	☐ LOCAL ☐ PANEL OR RACK	
	OVER RANGE PROTECTION	115% ABOVE 150 KG/CM2 FSD 125% ABOVE 150 KG/CM2 FSD	
	BLOW OUT DISC	REQUIRED	
	SWITCHING FACILITY	■ YES ☐ NO	
	TYPE	☐ MICRO SWITCH ☐ OTHER	
	NO. / TYPE OF CONTACTS	2 NOS. SPDT	
	CONTACT RATING	5A 230V AC, 0.25A 220V DC	
	SETTING RANGE	FIELD ADJUSTABLE OVER FULL RANGE	
	REPEATABILITY	± 1% OF FSR	
	POWER SUPPLY	230V AC (if required)	
PERFORMANCE	ACCURACY	± 1% OR BETTER OF FULL SCALE DEFLECTION	
CONNECTION	PROCESS	M20 x 1.5 (M)	
	LOCATION	☐ BACK ☐ BOTTOM	
ACCESSORIES	NAME PLATE / METAL TAG	SS	
	MOUNTING	☐ WALL ☐ PIPE – U CLAMPS & BOLTS ☐ PANEL / RACK	
	OTHER	AS PER ENCLOSED DIAGRAM	

NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

FORM NO. PEM-6666-0

BHEL	**SPECIFICATION FOR PRESSURE / DIFFERENTIAL PRESSURE SWITCH**	SPECIFICATION NO.: PES – 145 – 031	
		VOLUME II B	
		SECTION D	
		REV. NO. 03	DATE : 16-05-2007
		SHEET 1	OF 3

1.0 SCOPE

This specification covers the Design, Manufacture, Inspection and Testing at the manufacturer's works, proper packing for transportation and delivery to site of Pressure/Differential Pressure Switch for use in Utility/Captive Power Station/Combined Cycle Station.

2.0 CODES AND STANDARDS

2.1 All the equipments specified herein shall comply with the requirements of the latest issue of the relevant National and International standards.

2.2 The Design and Materials used for the components shall also comply with the relevant National and International standards.

2.3 As a minimum requirement, the following standards shall be complied with :
Enclosure : ISA:RP:8.1

3.0 TECHNICAL REQUIREMENTS

3.1 General

The pressure switches shall be suitable for an ambient temperature of 0-55°C and Relative Humidity of 0-95%.

3.2 Housing

Weather proof and dust tight housing made of Die-cast aluminium alloy. The external surface of the housing shall have a finish of light grey epoxy enamel.

3.3 Pressure Element

The pressure element shall be seamless hydraulically formed DIAPHRAGM/BELLOWS in Stainless steel/Phosphor Bronze for low pressure applications and stainless steel bourdon/piston for high pressure applications.

3.4 Switching differential

The switching differential shall be adjustable. The set point adjuster for the differential setting shall be inside the housing and shall be adjustable against a calibrated scale.

3.5 Pressure Connection

The pressure connection shall be at bottom. Size shall be 1/4" NPT (F) and material shall be stainless steel.

3.6 Electrical entry

Cable gland with Neoprene gourmet to suit PVC cable up to 17.5mm outside diameter.

3.7 Accuracy

±1% of scale range.

3.8 Micro-switch data

Micro-switch for AC/DC, single pole double throw, contacts having ratings 5 Amps at 230V AC, 0.25 Amps at 220V DC.

3.9 Over pressure range

The pressure switch shall function without any deterioration in the accuracy as specified in clause 3.8 when subjected to an over pressure of 25% above the ranges.

4.0 TESTING AND INSPECTION

4.1 The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

FORM NO. PEM-6666-0

	SPECIFICATION FOR PRESSURE / DIFFERENTIAL PRESSURE SWITCH	SPECIFICATION NO.: PES – 145 – 031	
		VOLUME II B	
		SECTION D	
		REV. NO. 03	DATE : 16-05-2007
		SHEET 2 OF 3	

4.2 The bidder shall furnish the Quality Plan in the format enclosed in volume-III. In case the Quality Plan(s) is/are included in volume-IIB, the bidder shall furnish his Quality Plan strictly in line with the same. The Quality Plan shall be discussed and finalised with the technically accepted bidders before opening the price bid. The stages where the purchaser would like to be associated for witnessing or verification would be indicated by the purchaser in the Quality Plan before approval.

4.3 The following test shall be conducted as a minimum requirement.

a) Routine Tests

i) Repeatability.

ii) Over load.

iii) Contact Rating.

b) Type Tests

i) Enclosure Class (Weatherproof, water tight & dust tight test).

4.4 Inspection will be conducted by BHEL and/or their authorised representatives as per the agreed inspection schedule. The inspection schedule will be submitted by the bidder for BHEL's approval at contract stage. The cost of all tests and inspections will be deemed to have been included in the bid. For all the type tests covered under 4.3 (b), "Type Test Certificates" as per agreed Quality Plan shall be furnished. In the absence of the same, such Type Tests shall be arranged at the Vendor's works in the presence of BHEL and/or their authorised representatives or in independent Test House /Laboratory approved by BHEL.

4.5 The Standard QP is included in this specification to enable bidder to understand the extent of inspection and testing requirements to execute this job. The successful bidder has to follow the agreed QP, taking care of customer requirements mentioned in Sec-C and submit QP for final approval by BHEL / Customer.

5.0 SPARES AND CONSUMABLES

5.1 Recommended Spares

The bidder shall furnish a list of Recommended Spares alongwith the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation alongwith unit rate against each item to enable BHEL/BHEL's Customer to place a separate order later, if required.each item to enable BHEL/BHEL's Customer to place a separate order later, if required.

6.0 DRAWINGS AND DOCUMENTS

6.1 The bidder shall furnish the following documents in required number of copies alongwith the bid :

6.1.1 Data sheet-B, completely filled-up alongwith all enclosures.

6.1.2 Quality Plan.

6.1.3 Catalogs wtih detailed technical information.

6.1.4 Bar-chart to indicate the time schedule for procurement, manufacture, testing and dispatch.

6.2 The successful bidder shall furnish the following documents in required number of copies during the contract stage :

6.2.1 For approval

i) Dimensional/Installation drawings.
ii) Data sheet-C, completely filled-up alongwith all the enclosures.
iii) Quality Plan of vendor/sub-vendor.
iv) Test Certificates.

FORM NO. PEM-6666-0

	SPECIFICATION FOR PRESSURE / DIFFERENTIAL PRESSURE SWITCH	SPECIFICATION NO.: PES – 145 – 031	
		VOLUME II B	
		SECTION D	
		REV. NO. 03	DATE : 16-05-2007
		SHEET 3	OF 3

6.2.2 Final/As-built Drawings

Final / As-built drawings / CD in required number of copies shall be submitted.

6.3 Operation & Maintenance Manuals

O&M Manuals in required number of copies shall be submitted. O&M Manuals shall also contain storage & commissioning instructions.

7.0 MARKING AND PACKING

7.1 Marking

A stainless steel name-plate shall be permanently fixed on each equipment giving its Tag Number and technical specifications.

7.2 Packing

All equipment/materials shall be suitably packed and protected for the entire period of dispatch, storage and erection against impact, abrasion, corrosion, incidental damage due to vermin, sunlight, high temperature, rain, moisture, humidity, dust, sea-water spray (where applicable) as well as rough handling and delays in transit and storage in open.

8.0 APPLICABLE DATA SHEET FORMS

This document shall be read with one or more of the following data sheet forms :

- Data sheet A&B for Pressure/Differential Pressure Switch : Data sheet no. PES-145-31-DS1-0
- Data sheet C Pressure/Differential Pressure Switch : Data sheet no. PES-145-31-DS2-0

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FORM NO. PEM-6666-0

BHEL	**DATA SHEET FOR PRESSURE / DIFFERENTIAL PRESSURE SWITCH**	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 1 OF 1

TAG No. …… Qty..... Data Sheet No.: **PES-145-31-DS1-0**

Data Sheet A & B

DATA SHEET-A FOR PRESSURE / DIFFERENTIAL PRESSURE SWITCH (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

GENERAL	MANUFACTURER		
	MODEL NUMBER		
TECHNICAL	TYPE OF ELEMENT	☐ DIAPHRAGM ☐ BELLOW (for low range) ☐ PISTON ☐ BOURDON (for high range)	
	MATERIAL	ELEMENT: ☒ AISI 316 SS ☐ Ph. Br. CASING : DIE CAST AL	
	ENCLOSURE	☐ INDOOR MOUNTED IP-55 ☐ OUTDOOR MOUNTED IP-65 ☐ IP-67 ☐ FUEL GAS HAZARDOUS APPL. EXPL. PROOF	
	SWITCH TYPE	☐ MICRO ☐ ENCLOSURE HERMETICALLY SEALED	
	SWITCH CONTACT	TWO NOS. SPDT	
	SWITCH RATING	☐ 5A 230V AC ☐ 0.25A 220V DC	
	SETTING & DEAD BAND	ADJUSTABLE	
	MOUNTING	☐ DIRECT ☐ PANEL OR RACK	
	OVER RANGE PROTECTION	115% ABOVE 150 Kg/Cm2 125% BELOW 150 Kg/Cm2	
PERFORMANCE	ACCURACY (SCALE)	± 1%	
	REPEATABILITY	± 0.5%	
CONNECTION	PRESSURE CONNECTION	¼" NPT (F) AT BOTTOM	
	ELECTRICAL	WITH GLAND TO SUIT CABLE OF MAXIMUM O.D. 17.5 MM.	
INSTALLATION ACCESSORIES	AS PER ENCLOSED DRAWING		

	PREPARED BY	**CHECKED BY**	**APPROVED BY**	COMPANY SEAL
NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

FORM NO. PEM-6666-0

	DATA SHEET FOR PRESSURE / DIFFERENTIAL PRESSURE SWITCH	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 1 OF 1

TAG No. ……. Qty..... Data Sheet No.: **PES-145-31-DS2-0**

Data Sheet C

DATA SHEET-C FOR PRESSURE / DIFFERENTIAL PRESSURE SWITCH
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

GENERAL	MANUFACTURER	
	MODEL NUMBER	
TECHNICAL	TYPE OF ELEMENT	
	MATERIAL	
	ENCLOSURE	
	SWITCH TYPE	
	SWITCH CONTACT	
	SWITCH RATING	
	SETTING & DEAD BAND	
	MOUNTING	
	OVER RANGE PROTECTION	
PERFORMANCE	ACCURACY (SCALE)	
	REPEATABILITY	
CONNECTION	PROCESS	
	ELECTRICAL	
INSTALLATION ACCESSORIES	AS PER DRG. ENCLOSED.	

	PREPARED BY	**CHECKED BY**	**APPROVED BY**	COMPANY SEAL
NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

FORM NO. PEM-6666-0

	SPECIFICATION FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER FOR AUX PACKAGES	SPECIFICATION NO.: PES – 145 – 001A
		VOLUME II B
		SECTION D
		REV. NO. 01 DATE : 27.07.94
		SHEET 1 OF 4

1.0 TECHNICAL REQUIREMENTS

1.1 General

The transmitter shall be suitable for ambient temperature 0-55°C. and Relative humidity 0-95%. Transmitters shall be equiped with all accessories required for specific service conditions. Syphons shall be provided for steam service applications. Pulsation dampeners shall be provided for unstable process media such as discharge of pump. Diaphragm seals shall be used where the sensing element comes in contact with corrosive or dirty process fluid. The transmitter measurement for viscous process fluid shall be filled system type with separate Capillary and other required accessories. The transmitters shall be provided with suitable drain & vent points.

1.2 Principle of operation

The electronic differential pressure & pressure transmitters shall be as specified in the data sheet.

1.3 Output Signal

4-20mA DC two wire system unless otherwise specified.

1.4 Material

- Body : Forged Carbon Steel.
- Diaphragm : 316 SS
- Capsule : 316 SS
- Bellow : 316 SS
- Bourdon : 316 SS
- Measurement seal element : Teflon

1.5 Body Rating

Transmitter Body and measuring element (other than electronic housing shall be atleast 1.5 times the maximum process fluid pressure.

1.6 Zero and Span Adjustment

The transmitter zero and span shall be continuously adjustable through a simple field adjustment. The span and zero adjustment shall not interfere with each other. The ratio of maximum span to minimum span shall be atleast five (5) Each transmitter shall be factory callibrated to the range specified in instrument data sheet.

1.7 Zero Elevation or Supression

Zero Elevation or Supression for level measurement shall be provided as standard feature. The continuously adjustable zero elevation device wherever required by the operating range of the transmitter (range specified in data sheet) shall be supplied.

FORM NO. PEM-6666-0

	SPECIFICATION FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER FOR AUX PACKAGES	SPECIFICATION NO.: PES – 145 – 001A	
		VOLUME II B	
		SECTION D	
		REV. NO. 01	DATE : 27.07.94
		SHEET 2	OF 4

1.8 Working temperature of the cell body shall not be less than 100°C.

1.9 Process Connection

The transmitter shall be supplied fitted with 3/5 way valve manifolds having 1/2" NPT (F) connection for Process.

1.10 Mounting

The transmitter shall be suitable both for wall and pipe/stand mounting. Necessary mounting brackets, clamps, bolts and nuts shall be supplied along with transmitter as standard feature. The actual mounting requirement i.e. wall or pipe stand is indicated in the instrument data sheet.

1.11 Power Supply

The transmitter supply shall be 12 to 48V DC (4-20mA/0-20mA output).

1.12 Load Limit

The load limit shall be 500 Ohms at 24V DC and 1500 Ohms at 48V DC.

1.13 Reverse Polarity Protection

For reverse polarity connection of the power supply, there shall cause no damage to transmitter. Reverse current should be limited to 1 mA.

1.14 Signal Grounding

The design of transmitter electronic shall be such that either of the output wires may be grounded, causing no damage to transmitter.

1.15 Cable Entry

Cable gland complete with neoprene gromet suitable for PVC cables with maximum diameter of 17.5mm shall be provided for cable entry. The actual size of the cable shall be indicated during contract stage. Any other satisfactory arrangement for cable entry with proper sealing at entry shall also be acceptable.

1.16 Enclosure

The transmitter enclosure shall be as per NEMA-4 unless otherwise specified. Explosion proof enclosures shall be as per NEMA-7.

1.17 Terminal Box

A terminal unit accessible without exposing the transmitter mechanism shall be provided for signal/supply cable terminations and for test terminals.

FORM NO. PEM-6666-0

	SPECIFICATION FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER FOR AUX PACKAGES	SPECIFICATION NO.: PES – 145 – 001A	
		VOLUME II B	
		SECTION D	
		REV. NO. 01	DATE : 27.07.94
		SHEET 3	OF 4

1.18	Performance Data		
1.18.1	Linearity	:	± 0.1% of span or better.
1.18.2	Hysterisis	:	± 0.1% of span or better.
1.18.3	Dead Band	:	± 0.1% of span or better.
1.18.4	Repeatability	:	± 0.1% of span or better.
1.18.5	Accuracy	:	± 0.5% of span or better.
1.18.6	Sensitivity	:	± 0.05% of span or better.
1.18.7	Stability	:	± 0.25% of span or better for six months.
1.18.8	Supply voltage variation effect	:	± 0.05% of span or better per volt.
1.18.9	Load resistance	:	± 0.0005% of span or better variation per ohm.
1.18.10	Vibration effect	:	Mechanical vibration in 3 mutually perpandicular planes with 0.07 mm amplitude from 10 to 60 Hz and 10m/sec2 acceleration from 60 to 150 Hz. shifts at 50% input shall be <0.01% of span.
1.18.11	Temperature variation effect	:	± 0.5% of span or better per deg.C.
1.18.12	EMI effect	:	DC magnetic field effect at 0% and 100% input upto 50 gauses. - On Zero : Less than 0.1%. - On Span : Less than 0.1%.
1.18.13	RFI effect	:	Radio frequency interference (up to 500 MHz), with field strength of 5 V/M shall not deviate the accuracy by more than 0.1%.
1.18.14	Damping	:	Damping shall be step or continuously adjustable so that time constant varies from 0-3s or 0-6s.
1.18.15	Static pressure	:	Zero shift < 0.5% of span for effect pressure change up to static pressure limit.
1.19	Accessories		
1.19.1	Valve Manifolds		

All differential pressure and pressure transmitters shall be supplied with 5 way and 3 way valve manifold respectively.

FORM NO. PEM-6666-0

	SPECIFICATION FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER FOR AUX PACKAGES	SPECIFICATION NO.: PES – 145 – 001A	
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2.0 TESTING

2.1 The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

2.2 The vendor shall conduct following tests as a minimum requirement and shall furnish test certificate/results thereof, for BHEL approval before despatch of the same.

a) Calibration test to confirm compliance with clauses 1.18.1 to 1.18.5 of this specification.

b) Enclosure as specified in data sheet (Type Test).

c) Over range pressure test to confirm compliance with clause 1.5 of this specification.

3.0 APPLICABLE DATA SHEET FORMS

This document shall be read with one or more of the following data sheet forms :

- Data sheet A&B for Pressure/Differential Pressure Transmitter : Data sheet no. PES-145-01A-DS1-0

- Data sheet C for Pressure/Differential Pressure Transmitter : Data sheet no. PES-145-01A-DS2-0

FORM NO. PEM-6666-0

	DATA SHEET FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 1 OF 2

TAG No. ……. Qty..... Data Sheet No.: **PES-145-01-DS1-0**

Data Sheet A & B

DATA SHEET-A FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

GENERAL	MANUFACTURER		
	MODEL NUMBER		
TECHNICAL	TYPE	☐ INDUCTANCE ☐ CAPACITANCE ☐ STRAIN GAUGE ☐	
	POWER SUPPLY	24V DC	
	TRANSMITTER MEASUREMENT	☐ PRESSURE ☐ DIFF. PRESSURE	
	OUTPUT SIGNAL	4-20MA	
	NO. OF WIRE	TWO	
	ACCURACY	± 0.5% OF SPAN	
	LINEARITY, HYSTERISIS, DEAD BAND AND REPEATABILITY	± 0.1% OF SPAN	
	STABILITY	± 0.25% OF SPAN OR BETTER FOR 6 MONTHS	
	SENSITIVITY	± 0.05% OF SPAN	
	MATERIAL		
	A) BODY	FORGED CARBON STEEL	
	B) ELEMENT	316 SS	
	C) SEAL	TEFLON	
	CONTINUOUSLY ADJUSTABLE SPAN AND ZERO ADJUSTMENT PROVIDED	☐ YES ☐ NO	
	MOUNTING	☐ WALL/PIPE STAND ☐ TRANSMITTER RACK	
	ENCLOSURE	☐ NEMA-4 ☒ NEMA-7	
	TURN DOWN RATIO	TO BE SPECIFIED BY BIDDER	
	INSULATION RESISTANCE	TO BE SPECIFIED BY BIDDER	
	ZERO SUPPRESSION RANGE	TO BE SPECIFIED BY BIDDER	
	ZERO ELEVATION RANGE	TO BE SPECIFIED BY BIDDER	
	INTEGRAL INDICATOR	☐ YES ☐ NO	

FORM NO. PEM-6666-0

	DATA SHEET FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 2 OF 2

TAG No. ……. Qty..... Data Sheet No.: **PES-145-01-DS1-0**

Data Sheet A & B

DATA SHEET-A FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
	TRANSMITTER SHALL BE ABLE TO DRIVE OUTPUT IMPEDANCE OF 500 OHMS.	YES	
	ZERO DRIFT	< 0.1%	
	SPAN DRIFT	< 0.1%	
	MANIFOLD		
	a) PRESSURE MEASUREMENT	3 WAY	
	B) DIFFERENTIAL PRESSURE MEASUREMENT	5 WAY	
	CABLE ENTRY DETAIL	SUITABLE FOR DIA OF 17.5 mm	

	PREPARED BY	**CHECKED BY**	**APPROVED BY**	COMPANY SEAL
NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

FORM NO. PEM-6666-0

	DATA SHEET FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 1 OF 2

TAG No. ……. Qty..... Data Sheet No.: **PES-145-01-DS2-0**

Data Sheet C

DATA SHEET-C FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

GENERAL	MANUFACTURER	
	MODEL NUMBER	
TECHNICAL	TYPE	
	POWER SUPPLY	
	TRANSMITTER MEASUREMENT	
	OUTPUT SIGNAL	
	NO. OF WIRE	
	ACCURACY	
	LINEARITY, HYSTERISIS, DEAD BAND AND REPEATABILITY	
	STABILITY	
	SENSITIVITY	
	MATERIAL	
	A) BODY	
	B) ELEMENT	
	C) SEAL	
	CONTINUOUSLY ADJUSTABLE SPAN AND ZERO ADJUSTMENT PROVIDED	
	MOUNTING	
	ENCLOSURE	
	TURN DOWN RATIO	
	INSULATION RESISTANCE	
	ZERO SUPPRESSION RANGE	
	ZERO ELEVATION RANGE	
	INTEGRAL INDICATOR	

FORM NO. PEM-6666-0

	DATA SHEET FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 2 OF 2

TAG No. ……. Qty..... Data Sheet No.: **PES-145-01-DS2-0**

Data Sheet C

DATA SHEET-C FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

TRANSMITTER SHALL BE ABLE TO DRIVE OUTPUT IMPEDANCE OF 500 OHMS.	
ZERO DRIFT	
SPAN DRIFT	
MANIFOLD	
b) PRESSURE MEASUREMENT	
B) DIFFERENTIAL PRESSURE MEASUREMENT	
CABLE ENTRY DETAIL	

	PREPARED BY	CHECKED BY	APPROVED BY	COMPANY SEAL
NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

FORM NO. PEM-6666-0

	SPECIFICATION FOR TEMPERATURE ELEMENT (WITH THERMOWELL)	SPECIFICATION NO.: PES – 145 - 03	
		VOLUME II B	
		SECTION D	
		REV. NO. 01	DATE : 27.07.94
		SHEET 1 OF 10	

1.0 SCOPE

This specification covers the Design, Manufacture, Inspection and Testing at the manufacturer's works, proper packing for transportation and delivery to site of Temperature Element (with Thermowell) for use in Utility/Captive Power Station/Combined Cycle Station.

2.0 CODES AND STANDARDS

2.1 All the equipments specified herein shall comply with the requirements of the latest issue of the relevant National and International standards.

2.2 The Design and Materials used for the components shall also comply with the relevant National and International standards.

3.0 TECHNICAL REQUIREMENTS

3.1 General

The temperature sensor elements shall be duplex type, either thermocouple (T/C) or resistance temperature detector (RTD). Unless otherwise specified in the data sheet, the type of sensors for different applications shall be as follows:

i) Chromel - Alumel T/C medium temp. range (250°C to 600°C)

ii) Platinum-Rhodium Platinum High temp. range (600°C and above). Type S/R/B.

iii) Platinum RTD Low temperature & high accuracy (-50°C to 250°C).

3.2 Process Parameters

Process parameters such as line size, pressure, temperature, fluid medium are given in the instrument data sheet.

3.3 Thermocouple Wire Size

The thermocouple wire size for a given temperature application shall be as per table – 3.1A of ASME PTC 19.3 – 1974.

3.4 Sensor Grounding

Thermocouple junction shall be generally ungrounded type unless specified otherwise in the data sheet for the thermocouple.

3.5 Sensor Protective Sheath & Wire Insulation

The sensor protective sheath shall be 8mm OD 316 SS seamless tube using compacted magnesium oxide packing/porcelain for insulation.

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	SPECIFICATION FOR TEMPERATURE ELEMENT (WITH THERMOWELL)	SPECIFICATION NO.: PES – 145 - 03	
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3.6 Sensor Characteristics

Thermocouple calibration characteristics i.e. temperature vs. milli volt or resistance shall be as per the applicable Indian Standards (IS-2054 for thermocouple 'K' type, IS-2055 for Pt.Rd.Pt.), RTD type of sensor calibration i.e. temperature vs. resistance shall be as per the applicable Indian Standard (IS-2848).

3.7 Sensor Accuracy Limits

T/C sensor limiting accuracy shall be as per table 3.2A of ASME PTC 19.3 – 1974. RTD sensor accuracy shall be as per table 9.1 of ASME PTC – 19.3 – 74.

3.8 Insulation Resistance

Insulation resistance of RTD leads w.r.t. body shall be more than 5 mega ohms at 100V DC.

3.9 End Connection

The sensor assemblies shall have screwed M33 x 2 end connection. Specific design requirements of pressure, temperature and end connection type for a given application are indicated in the instrument data sheet.

3.10 Terminal Head

Terminal head cover shall be screwed type design having gasket with small flexible chain attached between fixed portion and head cover.

3.10.1 Terminal Head Enclosure

The terminal head enclosure shall be dust, weather proof and water proof as per NEMA-4 classification unless specified otherwise.

3.10.2 Terminals

The terminal head shall have provision of screwed terminal of 1.5 mm^2 size for external connection. The terminals shall be suitably marked '+ve' & '-ve' for thermocouple and 'Lo', 'Hi' and 'C' for three wire RTD.

3.11 Cable Entry

Cable gland complete with neoprene gromet suitable for PVC cable with maximum diameter of 17.5mm shall be provided for cable entry. The actual size of cable shall be indicated during the contract stage. Separate cable entry and cable glands shall be provided for both the elements.

3.12 Thermowell

Temperature element shall be supplied along with the thermowell. The thermowell shall be of tungstion carbide for mill air temperature and for rest of the applications of AISI 316SS forged bar stock shall be designed to suit the process conditions. For detail of the thermowell, see enclosed drawing.

3.12.1 Thermowell Extension Length

Temperature sensor assemblies shall have extension length as specified in tables so that the terminal head clears the pipe line insulation. The extra extension length requirement if any, special applications shall be indicated in the data sheet.

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	SPECIFICATION FOR TEMPERATURE ELEMENT (WITH THERMOWELL)	SPECIFICATION NO.: PES – 145 - 03	
		VOLUME II B	
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		REV. NO. 01	DATE : 27.07.94
		SHEET 3 OF 10	

3.12.2 Material of Thermowell Assemblies

Material of thermowell assemblies as indicated in clause 3.12 unless specified otherwise. The thermowell shall be machined out of solid bar stock. The surface of thermowell over working length portion shall be polished. Thermowell shall be with taper profile. For details of the thermowell see Fig. (1) & Fig. (2).

3.12.3 Internal Construction

Sensor assemblies shall preferably be metal sheathed with spring load on to the thermowell tip for better response. The sheathed sensor assembly shall be replaceable (in-situ) type without removal of thermowell.

3.12.4 Compensating cable should be used for connecting elements to secondary Instruments/Device unless there is specific requirement for cold junction compensation. Field mounted cold junction compensation box as per NEMA-4 shall be provided for all thermocouples. The CJC box shall have automatic temperature control at reference junction temperature of 60 Deg. C. Each CJC box shall be provided with duplex RTD for remote monitoring.

4.0 TESTING AND INSPECTION

4.1 The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

4.2 The bidder shall furnish the Quality Plan in the format enclosed in volume-III. In case the Quality Plan(s) is/are included in volume-IIB, the bidder shall furnish his Quality Plan strictly in line with the same. The Quality Plan shall be discussed and finalised with all the technically accepted bidders before opening the price bid. The stages where the purchaser would like to be associated for witnessing or verification would be indicated by the purchaser in the Quality Plan before approval.

4.3 The following routine tests shall be conducted as a minimum requirement :-

4.3.1 Physical dimension of the sensor assemblies as per approved drawing.

4.3.2 Electrical characteristic of sensor such as continuity of the thermocouple wires, and insulation resistance of the RTD leads w.r.t. body.

4.3.3 Temperature vs. Resistance / milli volt for the sensor assemblies shall be tested with reference to standard resistance thermometer by comparison method. This test may be carried out once for the T/C or RTD sensor wires for each batch production.

4.3.4 Each type of high pressure thermowell assembly with thread end connection shall be tested against hydrostatic test pressure of one & a half times the maximum working pressure for any leakage. However dimensional checks and thread conformity with gauges shall be checked for each sensor assembly.

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	SPECIFICATION FOR TEMPERATURE ELEMENT (WITH THERMOWELL)	SPECIFICATION NO.: PES – 145 - 03	
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4.4 Inspection will be conducted by BHEL and/or their authorised representatives as per the agreed inspection schedule. The inspection schedule will be submitted by the bidder for BHEL's approval at contract stage. The cost of all tests and inspections will be deemed to have been included in the bid. For all the items, "Type Test Certificates" as per agreed Quality Plan shall be furnished. In the absence of the same, such Type Tests shall be arranged at the Vendor's works in the presence of BHEL and/or their authorised representatives or in independent Test House / Laboratory approved by BHEL.

5.0 SPARES AND CONSUMABLES

5.1 Commissioning Spares and consumables

Nil.

5.2 Mandatory Spares

Nil.

5.3 Recommended Spares

The bidder shall furnish a list of Recommended Spares along with the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation along with unit rate against each item to enable BHEL / BHEL's Customer to place a separate order later, if required.

5.4 Special Tools & Tackles

Nil.

6.0 DRAWINGS AND DOCUMENTS

6.1 The bidder shall furnish the following documents in required number of copies along with the bid :

6.1.1 Data sheet-B, completely filled-up along with all enclosures.

6.1.2 Quality Plan of bidder.

6.1.3 Catalogs with detailed technical information.

6.1.4 Bar-chart to indicate the time schedule for manufacture testing and despatch.

6.1.5 Schedule for manufacturing, testing and dispatch (Enclosed in Vol.-II B).

6.2 The successful bidder shall furnish the following documents in required number of copies to BHEL during the contract stage :

6.2.1 For approval

i) Dimensional drawings.

ii) Installation drawings with overall dimensions of the completed equipment and clearances for operation and maintenance.

iii) Data sheet-C, completely filled-up along with all the enclosures.

iv) Quality Plan of vendor/sub-vendor.

v) Test Certificates.

FORM NO. PEM-6666-0

	SPECIFICATION FOR TEMPERATURE ELEMENT (WITH THERMOWELL)	SPECIFICATION NO.: PES – 145 - 03	
		VOLUME II B	
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6.2.2 For information

i) Storage instructions.

ii) Commissioning instructions.

6.2.3 Final/As-built Drawings

Final/As-built drawings/RTFs in required number of copies shall be submitted.

6.3 Operation & Maintenance Manuals

O&M Manuals in required number of copies shall be submitted.

7.0 MARKING AND PACKING

7.1 Marking

A metal name-plate should be permanently fixed on each equipment giving its Tag Number and technical specifications.

7.2 Packing

All equipment / materials shall be suitably packed and protected for the entire period of despatch, storage and erection against impact, abrasion, corrosion, incidental damage due to vermin, sunlight, high temperature, rain moisture, humidity, dust, sea-water spray (where applicable) as well as rough handling and delays in transmit and storage is open.

8.0 APPLICABLE DATA SHEET FORMS

This document shall be read with one or more of the following data sheet forms :

- Data sheet A&B for Temperature Element (With Thermowell) : Data sheet no. PES-145-03-DS1-0

- Data sheet C for Temperature Element (With Thermowell) : Data sheet no. PES-145-03-DS2-0

FORM NO. PEM-6666-0

	DATA SHEET FOR TEMPERATURE TRANSMITTER	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 2 OF 2

TAG No. ……. Qty..... Data Sheet No.: **PES-145-03A-DS1-0**

Data Sheet C

DATA SHEET-C FOR TEMPERATURE ELEMENT (WITH THERMOWELL)
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

GENERAL	MANUFACTURER	
	MODEL NUMBER	
TECHNICAL	ELEMENT TYPE	
	T / C GROUNDED	
	ELEMENT THICKNESS (AWG)	
	LIMIT OF ERROR	
	INSULATION RESISTANCE	
	TIME CONSTANT	
	MOUNTING THREAD SIZE	
	CONDUIT THREAD SIZE	
	EXTENSION WIRE TYPE	
	THERMOWELL	
	THERMOWELL LENGTH	
	LINE SIZE	
	PRESSURE RATING	
	TEMPERATURE RATING	
	FLUID MEDIUM	

NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

	AIR CONDITIONING & VENTILATION SYSTEM **4X225 MW ARUN-3 HEP**	SPECIFICATION NO.
		VOLUME **II-B**
		SECTION : **C**
		REV. NO. 00 | DATE: 25.10.2019
		SHEET OF

INSTRUMENTATION CHECK LIST

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR PRESSURE SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	1.1 MODEL NO/TAG NO						
	1.2 RANGE						
	1.3 END CONN						
	1.4 NO. OF CONTACT						
2	CALIBRATION			P	V	V	
	2.1 REPEATABILITY						
	2.2 SET POINT ADJUSTMENT						
	2.3 DIFFERENTIAL						
3	OVER PR & LEAK TEST			P	V	V	
4	ELECT. INSULATION/HV TEST	ONE		P	V	V	
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V	
	5.1 SENSOR						
	5.2 MOVEMENT						
	5.3 PROCESS CONNECTION						
	5.4 HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	REVIEW OF TC OF MICROSWITCH	FOR LOT		V	V	V	

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL,
P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to carry out ROUTINE TEST on 100 %.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and the same alongwith test certificates to be verified by BHEL

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TRANSMITTER

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECKS FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	VISUAL.						
	MODEL/TAG No						
2	PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	REPEATABILITY			P	W	V	
5	HYSTERESIS			P	W	V	
6	EFFECT OF TEMP VARIATION ON ACCURACY			P	W	V	
7	SPAN / ZERO ADJUSTMENT	ONE / TYPE		P	W	V	
8	EFFECT OF SUPPLY VOLTAGE VARIATION			P	W	V	
9	EFFECT OF LOADING (500 OHM METERS)			P	W	V	
10	HIGH PRESSURE TEST	SEE NOTE-1 BELOW		P	W	V	
11	BURN-IN TEST	ONE / TYPE		P	W	V	
12	DEGREE OF PROTECTION			P	W	V	
13	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. When material corelation are not available manufacturer's compliance to be provided.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR PRESSURE & DP GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	SENSOR TYPE						
	DIAL SIZE						
	MODEL NO/TAG NO						
	RANGE/SCALE						
	SWITCH CONTACT RATING & NOS.						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	SET POINT ADJUSTMENT						
3	OVER PRESSURE & LEAK TEST			P	W	V	
4	OPERATION OF PRESSURE. RELIEF DEVICE	ONE		P	W	V	
5	REVIEW OF TC FOR	FOR LOT		V	V	V	
	MATERIALS OF SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. When material corelation is not available, MFR's compliance to be provided
5. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

	AIR CONDITIONING & VENTILATION SYSTEM 4X225 MW ARUN-3 HEP	SPECIFICATION NO.
		VOLUME **II-B**
		SECTION : **C**
		REV. NO. 00 | DATE: 25.10.2019
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LOCAL CONTROL PANEL SPECIFICATION

	SPECIFICATION FOR LOCAL PANELS	SPECIFICATION NO.: PE-SS –999- 145 –054A	
		VOLUME II B	
		SECTION D	
		REV. NO. 03	DATE : 16-09-2013
		SHEET 1 OF 6	

1.0 SCOPE

This specification covers the Design, Manufacture, Inspection and Testing at the manufacturer's works, proper packing for transportation and delivery to site, supervision, erection, and commissioning at site of Local Panels required for control and monitoring of the Auxiliary Plant & Equipment.

2.0 CODES AND STANDARDS

2.1 All the equipments specified herein shall comply with the requirements of the latest issue of the relevant National and International standards.

2.2 As a minimum requirement, the following standards shall be complied with:

a) IS-6005 : 1998 : Code of practice for phosphating of iron and steel.
b) IS-5 : 2007 : Colors for ready mixed paints and enamels.
c) IS-1248:2003 : Direct Acting Indicating Analog Elec Measuring Instruments.
d) IS/IEC 60947:Part 1:2004 : Low Voltage switchgear & control gear: Part-I (General Rules)
e) IS-8828:1996 : Circuit breaker for household and similar installations.
f) IS-13947 (Part-I):1993 : Low Voltage switchgear & control gear : Part-I (General Rules)
g) ISA-18.1:1979 : Annunciator Sequences and Specification
h) NFPA-496:2003 : Purged & Pressurised Enclosure for Electrical Equipment in Hazardous Locations.

3.0 TECH NICAL REQUIREMENTS

3.1 Panel Construction

3.1.1 The local panels shall house the secondary instruments, annunciation system, Single loop controller, Control switches / push buttons, indicating lamps/LED cluster, relays, timers and other devices required for operation and monitoring of the equipment locally.

3.1.2 The panels shall be of free standing type either welded construction on angle iron (minimum section of 50 x 50 x 4 mm) structure or folded construction by sheet metal formation depending upon the equipments to be mounted on it. The panels shall be robustly built and stiffeners as necessary shall be provided.

3.1.3 The panel shall be suitably reinforced to ensure adequate support for all instruments mounted thereon. All welds on exposed panel surfaces shall be ground smooth.

3.1.4 The salient features of construction shall be:

Sheet material: Cold rolled sheet steel
Frame thickness: Not less than 3.0mm
Enclosure thickness: Not less than 2.5 mm for load bearing sections (Mounted with instruments)
1.6 mm for doors and Not less than 2.0 mm for others

Gland plate thickness: 3.0mm
Base channel: ISMC 100 with anti-vibration mounting & foundation bolts.

3.1.5 The panel shall be provided with rear doors with integral lockable handle. The door when locked shall be held at minimum three places. The door width shall not be more than 550mm.The doors shall be provided with suitable stiffeners to prevent buckling. The handle shall be on the right side of the door. The door shall be removable type with concealed hinges to facilitate maintenance work. Suitable pocket inside the door shall be provided for keeping the drawings / documents. Double door shall be provided with suitable glass windows, as per the requirement.

3.1.6 Suitable neoprene gasket shall be provided on all doors and removable covers. Suitable ventilation system along with louvers shall be provided at bottom and top of the doors covered with removable wire mesh.

3.1.7 The class of protection shall be in accordance with IP-42 unless otherwise specified in the data sheet – A (No. PES-145-54A-DS1-0).

3.1.8 All steel surfaces shall be cleaned by sand / pellet blasting, treated for pickling, degreasing and phosphating etc. by seven tank method. The panel shall have a high quality finish and appearance. The panel shall be painted with two coats of primer followed by two coats of epoxy / synthetic enamel based final paint of color shade and finish as given in data sheet-A (No. PES-145A-DS1-0). Minimum thickness of the paint shall be 85 microns for external paint and 70 microns for internal paint.

3.1.9 The cable glands of the required size and type as given in data sheet-A (No. PES-145A-DS1-0) shall be supplied alongwith the Panel.

3.1.10 All operable and indicating devices shall be mounted on the front of the panel while aux. Relays / timers MCBs etc. required for realization of control logics shall be mounted on a mounting plate inside the panel. Auxiliary relays and timers etc. shall be grouped according to the control function.
No operable or indicating devices shall be mounted below 750 mm and above 1800 mm (w.r.t. finished ground level). The devices shall be located in such a way so as to ensure easy access for operation / maintenance.

3.1.11 Single / dual control power supply feeders of voltage class as specified in data sheet-A (No. PES-145A-DS1-0) shall be provided by the purchaser. In case redundant power supply feeders are provided then auto changeover unit shall be mounted on the panel are in the panel supplier's scope. Where DC control power supply is specified an additional 240V, 50 Hz AC supply feeder for powering of space heater and lighting shall be provided by the purchaser. Suitable arrangement shall be provided inside the panel to receive and terminate the power supply feeder(s). For this purpose MCBs of suitable current rating shall be provided by the vendor. A supervisory relay along with a pilot lamp to indicate control supply 'ON' shall be provided on the panel. Any other power supply required for the operation of the devices mounted in the panel shall be arranged by the vendor.

3.1.12 The internal wiring shall be carried out with 1100 volt grade PVC insulated copper multi strand wire / flexible of 1.5mm2 size. AC & DC wires shall be kept separate from each other. Separate coloured wires to be used for AC and DC circuits. All wires shall be properly numbered and identified with ferrules as per the Control scheme / wiring diagram. Wires shall be routed and run through PVC troughs.

3.1.13 Terminal blocks shall be clip on type, 1100 volts grade. Separate terminal blocks shall be used for AC & DC circuits. The terminals shall be suitable for terminating 0.5 mm2 to 2.5mm2 external cables. The TB points in terminal block shall be cage clamp type / screw type. The terminal for ammeters shall be provided with removable links for shorting CTs. Each terminal strip shall be provided with identification strip. The terminal shall not be mounted below 250 mm height from finished floor. The panel shall have ten (20) percent spare terminal.

3.1.14 The interior of each panel shall be suitably illuminated through fluorescent lamps / tube lights with shrouded cover of minimum 15W operable on 240V 50 Hz AC power supply through panel door switch. A 15 Amp. 3-pin Power receptacle shall be provided.

3.1.15 Suitable space heaters operable on 240 Volts 50 Hz AC power system shall be provided at the panel bottom. These shall be designed to maintain the panel temperature five (5) deg. C above the ambient temperature during maintenance shutdown. Suitable isolating and control devices comprising of MCB, thermostat etc. shall be provided for the space heater.

3.1.16 The panel shall be provided with a copper earth bus of 25 x 6 mm size running throughout the width of the panel. It shall be terminated internally with 10 mm bolts at extreme ends for connection to; main station earth. The panel mounted equipments / devices shall be connected to earth bus through green coloured PVC insulated stranded copper conductor of 2.5 mm2 size.

3.1.17 Local Panel shall be provided with main name plate of 150 mm x 40 mm size having inscription of 20 mm height. The individual devices on the panels shall be as provided with separate name plate with inscription of 3 mm height. The instrument / devices shall be provided with stick on label plates inside the panel. The material of the main and individual labels shall be three (3) ply 3 mm thick Traffolyte

Sheet / 2 mm Anodised Aluminium Plate. The inscription shall be with white letters on black background on traffolyte sheet. The labels shall be fixed by self tapping non-rusting screws.

3.1.18 Vendor shall furnish electric load and heat load list (in case panel is to be placed in ac environment) of each panel.

3.2 Hazardous Area Panel Requirement

3.2.1 The Local Panel located in hazardous area shall be pressurized as per NFPA-496 requirements to render it non-hazardous. Alarms shall be provided for local and remote annunciation when pressurisation falls below 2.5 mm of water column. Protection shall be of type Z of NFPA-496. It shall not be possible to switch ON the power of purged section unless it is purged as per the recommendation of NFPA-496. Vendor must provide a protective device on the panel to protect the panel from over pressurisation.

3.2.2 Vendor shall supply pressurisation kit consisting of valves, restriction orifices, dual filter regulation, pressure gauges, pressure switches, rotameter etc. Pressurisation kit shall be surface mounting on a metal board and located outside the local panel. Pressurisation kit shall further consist of solenoid valve flow switch, timer blow off safety device etc., so as to make purging fully automatic. However final start shall be manual. Panel protection against over pressure to be provided as per NFPA-496.

3.2.3 Pressurised local control panel pressurization kit assembly design shall provide minimum leakage flow through the Local Control Panel. Panel venting shall be as per NFPA-496.

3.2.4 All components in the local panel like indicating instruments, push buttons switches, lamps etc., which are required to be energized without panel pressurization or before completion of purge cycle shall be explosion proof as per NEMA-7 & suitable for area classification.

3.2.5 All push buttons etc. requiring frequent operation during machine running shall have good positive sealing. Weatherproof housing or cover to be provided wherever necessary. Vendor shall provide pressurisation bypass switch outside explosion proof enclosure of pressurized panel with lamp indication. This shall be used only during maintenance. All hinges, screws, other non-painted metallic parts shall be of stainless steel material.

3.2.6 Provision to switch off manually all types of power shall be provided in the panel. In addition, it shall also be possible to switch off power circuits / components which are powered from motor control centre or control room manually in case of pressurization failure. All such cables from MCC and main control room shall be terminated in explosion proof boxes (NEMA-7).

3.3 Control & Monitoring devices

3.3.1 Instruments like Indicators, recorders, single loop controllers etc. as applicable and specified elsewhere for the plant / equipment shall be supplied and mounted on the panel.

3.3.2 Alarm Annunciator System

It shall be solid state discrete facia type having a sequence of ISA-S18.1A or as specified, opaque facia windows of 70 mm x 50 mm size, having two (2) lamps per window, and hooter of 10W, and provision for repeat group alarm at remote. The annunciator shall be provided with ten (10) percent spare windows or minimum two (2) windows along with electronics.

3.3.3 Relays

The relays shall be electromagnetic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable. There shall be ten (10) percent spare contacts.

3.3.4 Timers

The timers shall be electronic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However, minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable.

3.3.5 Control / Selector Switches

Switches shall be Rotary Cam type with minimum of 5 Amps AC & 2 Amp DC continuous current rating. Selector switches shall be stay put type while control switches shall be spring-return-to-neutral type. Contact configuration and rating shall be as per the control function requirement. The switches shall be lockable type wherever specified. Each switch shall be provided with engraved plates indicating the switch position / functions.

3.3.6 Push Buttons / Indicating Lights

The push buttons shall be momentary action self-resetting type, however stop P.B. for unidirectional drives shall be provided with manual reset facility. Its contact configuration & rating shall be as required for the control function but minimum 2 NO + 2 NC of 5 Amp. AC rating. It shall have round coloured projecting tab and engraved escutcheon plate / inscription plate. Colour coding of push buttons shall be as under:

RED	Motor OFF / Valve CLOSE	YELLOW	Alarm acknowledge	Left Hand Side
GREEN	Motor ON / Valve OPEN	BLACK	Lamp test	Right Hand Side

Indicating lights shall be suitable for direct connections across specified power supplies. It shall be fitted with built in resistance to prevent circuit tripping on shorting of lamp filament. It shall be fitted with LED cluster type lamp replaceable from front.

GREEN	Motor OFF / Valve CLOSED condition	AMBER	Motor tripped	Left Hand Side
RED	Motor ON / Valve OPEN condition	WHITE	Normal / healthy	Right Hand Side

3.3.7 Ammeters

Ammeter shall be 96 x 96 mm size, 90 deg. deflection, 1.5% accuracy, 1 Amp. CT operated or with 4-20mA input and Flush mounting type as called for in the data sheet-A (No. PES-145-54A-DS1-0). Ammeters for motors shall have six (6) times folded scale at upper end to enable motor starting current indication

3.3.8 Miniature Circuit Breaker (MCB)

These shall be instantaneous magnetic trip type for short circuit in addition to current time inverse delayed thermal trip feature for over current protection. The housing of MCB shall be made of non-ignitable, high impact material. It shall have minimum short circuit rating of 9 KA for AC Voltages and 4 KA for DC Voltages.

3.3.9 Makes of various instruments / devices shall be as given below

1.	Alarm Annunciators	:	Procon / IIC
2.	Ammeters	:	AEP / IMP
3.	Control / Selector Switches	:	Alsthom / Kaycee / Siemens / L&T
4.	Push Buttons / Indicating Lamps	:	Siemens / L&T / Teknic / Alsthom
5.	Auxiliary Relays	:	Jyoti / Siemens / L&T / OEN
6.	Timers	:	L&T / Alsthom / Bhartiya Cutler Hammer
7.	MCBs	:	S&S Power Engg. / Indo Asian / MDS
8.	Terminal Blocks	:	Jyoti / Elmex

4.0 TESTING AND INSPECTION

4.1 The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

4.2 BHEL's standard Quality Plan for LCP is enclosed with the specification. The bidder shall furnish his acceptance to BHEL's QP and submit the signed and stamped copy of QP along with the offer.

	SPECIFICATION FOR LOCAL PANELS	SPECIFICATION NO.: PE-SS –999- 145 –054A	
		VOLUME II B	
		SECTION D	
		REV. NO. 03	DATE : 16-09-2013
		SHEET 5	OF 6

4.3 The vendor shall conduct the following tests as a minimum requirement:

4.3.1 Routine Tests

1. High Voltage (H.V.)
2. Insulation Resistance (I.R.)
3. Functional

4.3.2 Type Tests

1. Enclosure Class Test

5.0 SPARES AND CONSUMABLES

5.1 Commissioning Spares and consumables

The bidder shall supply all commissioning spares and consumables 'as required' during Start-up, as part of the main equipment supply.

5.2. Mandatory Spares

The bidder shall offer alongwith main offer, the Mandatory Spares as specified elsewhere in the specification. The Mandatory Spares offered shall be of the same make and type as the main equipment.

5.3. Recommended Spares

The bidder shall furnish a list of Recommended Spares indicating the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation alongwith unit rate against each item to enable BHEL/BHEL's Customer to place a separate order later, if required.

6.0 D RAWINGS AND DOCUMENTS

6.1 The bidder shall furnish the following documents in required number of copies along with the bid :

1. Data Sheet no. PES-145A-DS1-0
2. General Arrangement Drawing.
3. Catalogue and technical information for instruments and devices.
4. Quality Plan.

6.2 The vendor shall furnish the following documents in required number as agreed after the award of contract:

1. Data Shee No. PES-145A-DS2-0
2. GA Drawing indicating layout of instruments, construction details, foundation details, cable gland plate alongwith cable glands and all details mentioned in this specification.
3. Control Schematic Diagram along with grouping of different terminals for various functions.
4. Catalogue and technical information for instruments and devices with selected options clearly marked.
5. O&M Manuals.
6. "As Built" Drawing.
7. CDs.

7.0 MARKING AND PACKING

7.1 Panel with all instruments / devices mounted on it shall be suitably packed & protected for the entire period of despatch, storage and erection against impact, abrasion, corrossion, incidental damage due to vermin, sunlight, high temperature, rain moisture, humidity, dust, sea-water spray (where applicable) as well as rough handling and delays in Transit and storage in open.

8.0 APPLICABLE DATA SHEET FORMS

This document shall be read with one or more of the following data sheet forms :

- Data sheet A&B for Local Panels : Data sheet no. PES-145A-DS1-0
- Data sheet C for Local Panels : Data sheet no. PES-145A-DS2-0

106108/2020/PS-PEM-MAX

FORM NO. PEM-66-03

BHEL	**DATA SHEET FOR LOCAL PANELS**	SPECIFICATION NO.: PE-SS-999-145-054A	
		VOLUME	
		SECTION	
		REV. NO. 02	DATE: 16.09.2013
		SHEET 1 OF 3	

TAG No. …… Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet A & B

			DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
GENERAL	MANUFACTURER			
	CONSTRUCTION		■ FOLDED ☐ WELDED	
	ENCLOSURE SHEET THICKNESS **(As per Section 8.13,Volume V of contract specification)**	FRONT	☐2.0 mm	
		OTHER	☐ 2.0 mm	
		DOOR	☐ 1.6 mm	
		HEIGHT	☐ 2365 mm for stand alone panels. ☐ Other ……	
		OTHER	☐ Load bearing sheet front shall have 3mm thickness	
TECHNICAL	INPUT POWER SUPPLY * **(As per Electrical specification)** (ANY OTHER POWER REQUIREMENT TO BE DERIVED FROM THIS SUPPLY ONLY)		☐ 240V 50 Hz AC ☐ 220V DC ■ 415V 3 PHASE 3W ☐ 400V 3 PHASE 4W	
	NO. OF FEEDERS **(As per Electrical specification)**		☐ ONE ☐ TWO	
	STARTER WITH MCC		☐ REQUIRED ■ NOT REQUIRED	
	IPR POSITION		■ MCC ☐ RELAY PANEL	
	CONTACT RATING OF RELAY		■ 5 Amp, 230 V AC ■ 0.25 Amp, 220V DC	
	CONTROL SUPPLY		☐ 110V AC ☐ 220V AC ☐ 220V DC ☐ Other. (As per requirement)	
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)		_____NOS. (AS REQUIRED)	
	TEMP SCANNER (IF REQUIRED –NO. OF CHANNELS TO BE SPECIFIED UNDER SEC-C)		☐ REQUIRED ■ NOT REQUIRED	
	PAINT TYPE **(As per Annex-1,Section 7.6,Voulme IV of contract specification)**		☐ EPOXY ENAMEL ☐ EPOXY POWDER COATED	
	MIMIC (TYPE OF MIMIC- MATERAIL, THICKNESS TO BE SPECIFIED DURING DETAILED ENGG.)		■ REQUIRED ☐ NOT REQUIRED	
	PANEL COLOUR (EXTERNAL) **(As per Annex-1,Section 7.6,Voulme IV of contract specification)**		☐ LIGHT GREY ☐ OPALINE GREEN	
	FINISH (EXTERNAL) **(As per Annex-1, Section 7.6,Voulme IV of contract specification)**		☐ MATT ☐ GLOSSY ☐ SEMI GLOSSY	
	PANEL COLOUR (INTERNAL) **(As per Annex-1,Section 7.6,Voulme IV of contract specification)**		☐ WHITE ☐ CREAM ☐ OFF WHITE	
	FINISH (INTERNAL) **(As per Annex-1,Section 7.6,Voulme IV of contract specification)**		☐ MATT ☐ GLOSSY ☐ SEMI GLOSSY	
	CLASS OF PROTECTION		■ IP-55 (FOR INDOOR SERVICE) ■ IP-67 (FOR OUTDOOR SERVICE) ☐ ANY OTHER	
	CONTROL HARDWARE		■ RELAY BASED	
	FOUNDATION ARRANGEMENT		☐ FOUNDATION BOLTS ☐ ANCHOR FASTENERS	
	WEIGHT OF PANEL (Kg.)		……..(Vendor to specify)	

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FORM NO. PEM-66-03

	DATA SHEET FOR LOCAL PANELS	SPECIFICATION NO.: PE-SS-999-145-054A
		VOLUME
		SECTION
		REV. NO. 02 / DATE: 16.09.2013
		SHEET 2 OF 3

TAG No. …… Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet A & B

	DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)		DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
	PANEL TYPE	☐ PRESSURISED ☐ UNPRESSURISED As per Requirement	
	CABLE GLAND	■ DOUBLE COMPRESSION	
	AMMETER (TYPE OF INPUT) *	☐ 1 Amp CT ☐ 4-20 mA	
	SCOPE OF SUPERVISION FOR ERECTION & COMMISSIONING	☐ APPLICABLE ■ NA	
	* TO BE CO-ORDINATED WITH PEM ELECTRICAL		

	PREPARED BY	**CHECKED BY**	**APPROVED BY**	COMPANY SEAL
NAME	AANCHAL CHOUDHARY	SACHIN SRIVASTAVA	MA MANSOORI	NAME:
DESIGNATION	SR.ENGR	DY.MNGR	D. GM	
SIGNATURE				SIGNATURE:
DATE	16.09.2013	16.09.2013	16.09.2013	DATE:

FORM NO. PEM-6666-0

BHEL	**DATA SHEET FOR LOCAL PANELS**	SPECIFICATION NO.: PE-SS-999-145-054A	
		VOLUME	
		SECTION	
		REV. NO. 02	DATE: 16.09.2013
		SHEET 3 OF 3	

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet C

DATA SHEET-C FOR LOCAL PANEL
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

GENERAL	MANUFACTURER			
	CONSTRUCTION		☐ FOLDED ☐ WELDED (As per requirement EDN)	
	ENCLOSURE SHEET THICKNESS	FRONT		
		OTHER		
		DOOR		
		HEIGHT		
		OTHER		
TECHNICAL	INPUT POWER SUPPLY			
	NO. OF FEEDERS			
	CONTACT RATING OF RELAY			
	TEMP SCANNER			
	CONTROL SUPPLY			
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)			
	PAINT TYPE			
	PANEL COLOUR (EXTERNAL)			
	FINISH (EXTERNAL)			
	TYPE OF MIMIC MATERIAL OF MIMC THICKNESS OF MIMIC			
	PANEL COLOUR (INTERNAL)			
	FINISH (INTERNAL)			
	CLASS OF PROTECTION			
	CONTROL HARDWARE			
	FOUNDATION ARRANGEMENT			
	WEIGHT OF PANEL (Kg.)			

FORM NO. PEM-6666-0

	DATA SHEET FOR LOCAL PANELS	SPECIFICATION NO.: PE-SS-999-145-054A
		VOLUME
		SECTION
		REV. NO. 02 DATE: 16.09.2013
		SHEET 3 OF 3

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet C

DATA SHEET-C FOR LOCAL PANEL
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

PANEL TYPE			
CABLE GLAND			
AMMETER (TYPE OF INPUT)			
SCOPE OF SUPERVISION			

	PREPARED BY	**CHECKED BY**	**APPROVED BY**	COMPANY SEAL
NAME	AANCHAL CHOUDHARY	SACHIN SRIVASTYAVA	MA MANSOORI	NAME:
SIGNATURE				SIGNATURE:
DATE	16.09.2013	16.09.2013	16.09.2013	DATE:

	SPECIFIC TECHNICAL REQUIREMENT FOR AIR CONDITIONING & VENTILATION SYSTEM 4X225 MW ARUN-3 HEP	SPECIFICATION NO.
		VOLUME **II-B**
		SECTION : **C**
		REV. NO. 00 DATE:
		SHEET OF

LCP QUALITY PLAN

PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	1 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
	INCOMING											
1.0	Sheet Steel (CRCA & HR)	1. Chemical Composition	MA	Chemical analysis	Sample	Relevant standard	Relevant standard	Test Certificate	3	---	2	
		2. Bend Test	CR	Mech. test	Sample	Relevant standard	Relevant standard	Log Book	2	---	---	
		3. Surface finish	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		4. Waviness	MA	Visual	100%	Factory Standard	No Waviness	Log Book	2	---	---	
		5. Thickness	MA	Measurement	100%	BHEL Spec.	BHEL Spec.	Log Book	2	---	---	
		6. Mill marking	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	1	
2.0	Flats / Angles / Channels	1. Dimensions	MA	Measurement	Sample	Relevant standard	Relevant standard	Log Book	2	---	---	
		2. Surface Defects	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		3. Straightness	MA	Measurement	100%	Factory Std.	Factory Std.	Log Book	2	---	---	
		4. Mill marking	MA	Visual	100%	Relevant standard	Relevant standard	Log Book	2	---	1	
3.0	Cables / Wires	1. Visual / Surface defects	MA	Visual	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---	
		2. IR and HV	MA	Electrical	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics

$ P - Agency Performing the Test.; W - Agency Witnessing the Test.; V - Agency Verifying the Test.

1 - BHEL; 2 - Vendor; 3 - Sub-vendor

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STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	2 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
		3. Conductor a) Resistance b) Size c) Sheet colour	 MA MA MA	 Electrical Measurement Visual	 100% 100% 100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---	
		4. Type / Routine Test Certificates	MA	Verification	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	3	---	2	
4.0	Electrical Components like Annunciator Transformers Lamps Switches PBs Contactors Relays Timers Space Heaters Thermostat Indicating meters etc.	1. Verification at make and Type	CR	Visual	Sample	BHEL Spec. and BOM	BHEL Spec. and BOM	Log Book	2	---	---	
		2. Verification of Test Certificates	CR	Scrutiny of Type / Routine T.Cs.	100%	Relevant standard	Relevant standard	Log Book	2	---	---	
		3. Operation / Functional check	CR	Electrical	Sample+ 100%@	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	+ for relay & contactors only
		4. I.R.	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	@ for all components except relays & contactors.
		5. H.V.	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	
		6. Calibration	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	1	
		7. Pick up / Drop off Voltage	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics

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1 - BHEL 2 - Vendor 3 - Sub-vendor

PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
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REV. NO.	01 DATE: 22-02-2008
SHEET	3 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
5.0	Misc. Components like Gaskets, Terminal Blocks etc.	1. Verification of Type / Make	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
		2. Surface defects	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
		3. IR / HV on Terminal Blocks	MA	Electrical	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
	IN PROCESS											
6.0	Blanking / Bending / Forming	1. Dimensions	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
		2. Surface defects after bending	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	---	
7.0	Nibbling / Punching	1. Cutout Sizes	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
		2. Deburring	MA	Visual	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
	ASSEMBLY											
8.0	Frame Assembly & Sheet fixing	1. Dimensions	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		2. Alignment	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		3. Welding Quality	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		4. Surface defects	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	

LEGEND:
* CR - Critical characteristics
MA - Major characteristics
MI - Minor characteristics

$ P - Agency Performing the Test.
W - Agency Witnessing the Test.
V - Agency Verifying the Test.

1 - BHEL
2 - Vendor
3 - Sub-vendor

PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	4 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
9.0	Pre-treatment and Painting	1. Pretreatment Process	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		2. Process parameters like bath temp. concentration etc.	MA	Measurement	Periodic	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		3. Dipping / Removal Time	MA	Measurement	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		4. Surface quality after every dip	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		5. Primer after phosphating	MA	Visual, Thickness	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		6. Putty Application & Rubbing after primer	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		7. Paint first coat	MA	Visual, Thickness	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		8. Putty Application and Rubbing after first coat of paint	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		9. Paint second coat	MA	Visual, Thickness, Scratch test Colour adhesion	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics

$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.

1 - BHEL; 2 - Vendor; 3 - Sub-vendor

PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.: **PE-QP-999-145-I056**
VOLUME IIB
SECTION D
REV. NO. 01 DATE: 22-02-2008
SHEET 5 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
10.	Panel Wiring	1. Wiring Layout	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		2. Wiring Termination (Crimped Lugs)	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		3. Ferrule numbers	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		4. Colour of wiring	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
		5. Size of Conductor	MA	Measurement	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
11.	Component Mounting	1. Correct components	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
		2. Fixing	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
	FINAL											
12.	Final Inspection	1. Workmanship	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.
		2. Component layout (neatness, accessibility & safety) Mounting / Proper fixing of all components	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		3. Components identification Marking / Name plates	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	

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PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	6 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
		5. Dimensions	MA	Measurement	100%	BHEL approved drg. / Spec., BOM	BHEL approved drg. / Spec., BOM	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.
		6. Door functioning	MA	Functional	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		7. Paint Shade	CR	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		8. Paint Thickness	CR	Measurement	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		9. Workmanship of Gaskets	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	
		10. Wiring Layout	MA	Visual	100%	BHEL approved drg.	BHEL approved drg.	Inspection Report	2	1	1	
		11. Wire Termination	MA	Pulling manually	Sample	-----	Firm termination	Inspection Report	2	1	1	
		12. Continuity	MA	Electrical	100%	-----	Continuity OK	Inspection Report	2	1	1	

LEGEND:
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MI - Minor characteristics

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1 - BHEL
2 - Vendor
3 - Sub-vendor

PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	7 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
13.	TYPE TEST	Degree of Protection	CR	Mech. Protection	Sample	BHEL approved spec., drg relevant IEC-60947, IEC-60079	BHEL approved spec., drg relevant IEC-60947, IEC-60079	Type Test Certificate	3	---	1	
14	ROUTINE TEST	IR before & after HV Test	CR	Electrical	100%	BHEL approved spec., drg., BOM & relevant standard	BHEL approved spec., drg., BOM & relevant standard	Test Report	2	1	1	
15	FUCTIONAL TEST	1. Control Logic Operation	CR	Electrical	100%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1	
		2. Instrument Calibratio	CR	Electrical	10%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1	
		3. Temperature rise	CR	Electrical	100%	BHEL approved spec/drg. & relevant standard	BHEL approved spec/drg & relevant standard	Inspection Report	2	1	1	

LEGEND:
* CR - Critical characteristics
MA - Major characteristics
MI - Minor characteristics

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1 - BHEL
2 - Vendor
3 - Sub-vendor

DRAWING NO. PE-DG-999-145-IXXX

STANDARD

INSTALLATION DIAGRAM

(FOR INSTRUMENTS IN VENDOR SCOPE OF SUPPLY FOR MAUX PACKAGES)

JOB NO.	999								
STATUS	STANDARD								
DISTRIBUTION									
TO									
No. of									
REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD

PROJECT	STANDARD
BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA	DEPT CODE: I
TITLE	INSTALLATION DIAGRAM (FOR MAUX PACKAGES)

	NAME	SIGN	DATE
DESN	KT		05.11.13
CHD	RV		05.11.13
APPD	BS		05.11.13

DEPT.	SCALE	DRAWING NO.	
SIGN		PE-DG-999-145-IXXX	
DATE		SHEET 1 OF 9	REV. 00

NOTES :–

1. IMPULSE PIPES SHALL BE OF SEAMLESS AND ANNEALED CONFORMING TO ANSI B36.10 IN LINE WITH THE MAIN PIPE MATERIAL.
2. PIPE FITTINGS SHALL BE OF FORGED MATERIAL CONFORMING TO ANSI B16.11–1991.
3. SNUBBER SHALL BE PROVIDED FOR PUMP DISCHARGE PRESS MEASUREMENTS.
4. IN CASE OF STEAM SERVICE SYPHON SHALL BE MADE BY BENDING THE TUBE OR PIPE.
5. VALVE MANIFOLDS & SNUBBER SHALL BE OF FORGED SS–316.
6. FOR SEA WATER APPLICATION SS316L FITTINGS TO BE PROVIDED.
7. 25NB x 15NB WELDED REDUCER SHALL BE USED FOR ROOT VALVE OF 25NB SIZE.
8. ROOT VALVES SHALL BE AS FOLLOWS:

   i) FOR PRESS <40 ATA & TEMP <425 DEG C, ONE(1) NO. 15Nb, ROOT VALVE OF SUITABLE CLASS SHALL BE USED.
   ii) FOR PRESS >40 ATA & TEMP <425 DEG C, TWO(2) NO. 15Nb, ROOT VALVE OF SUITABLE CLASS SHALL BE USED.
   iii) FOR PRESS >40 ATA & TEMP >425 DEG C, TWO(2) NO. 25Nb, ROOT VALVES OF SUITABLE CLASS SHALL BE USED.

9. HORIZONTAL PIPE RUNS SHOULD HAVE A SLOPE IN THE DIRECTION  SHOWN OF 1:20 AS MINIMUM.
10. FOR PRESSURISED STEAM & WATER SERVICE THE ASSOCIATED INSTRUMENT SHOULD BE MOUNTED BELOW THE TAPPING POINT. FOR VACUUM/AIR/GAS SERVICE, THE ASSOCIATED INSTRUMENT SHOULD BE MOUNTED ABOVE THE TAPPING POINT.
11. SEAMLESS PIPE/SEAMLESS TUBE/CAPILLARY LENGTH SHALL BE SUCH THAT THE GAUGES/TRANSMITTERS/SWITCHES ARE MOUNTED IN ACCESSIBLE AREA.

LEGEND :–

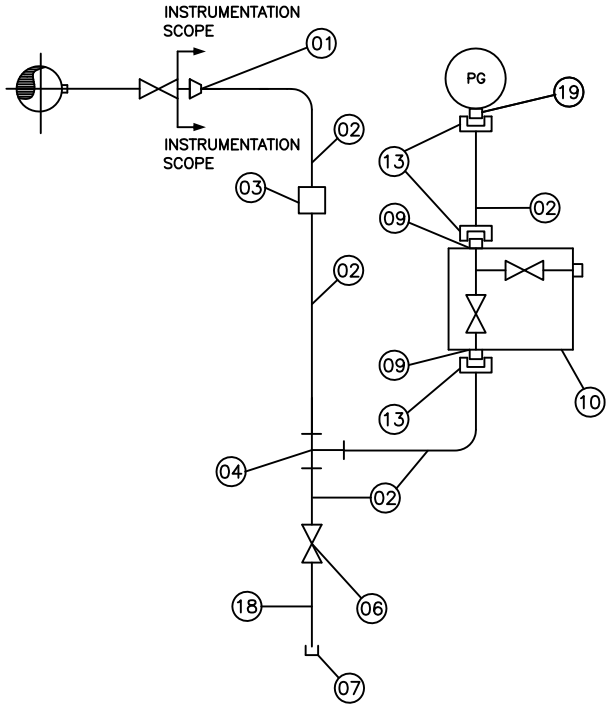
A/R – AS REQUIRED

NPTF – NATIONAL PIPE THREAD FEMALE

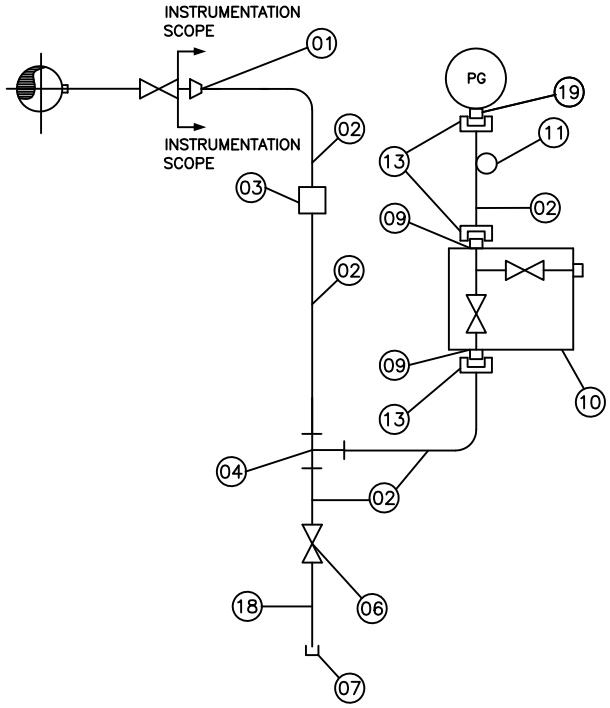
NPTM – NATIONAL PIPE THREAD MALE

SW – SOCKET WELD

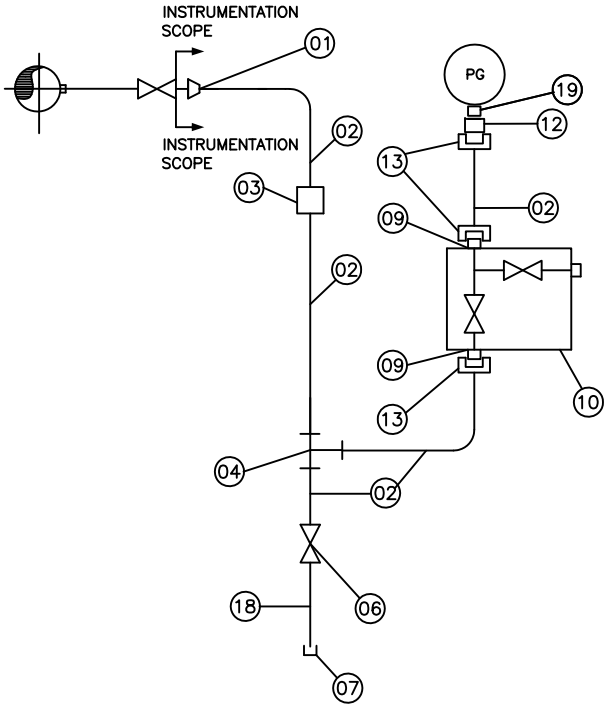
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		REV. NO.	00	DATE 05.11.13
		SHT	2 OF 9	



WATER SERVICE

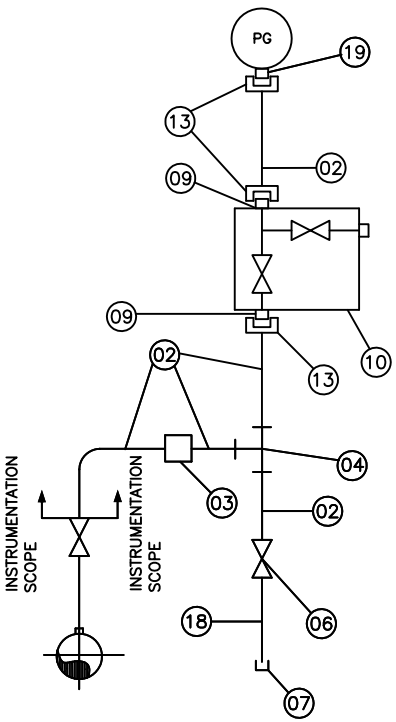


STEAM SERVICE

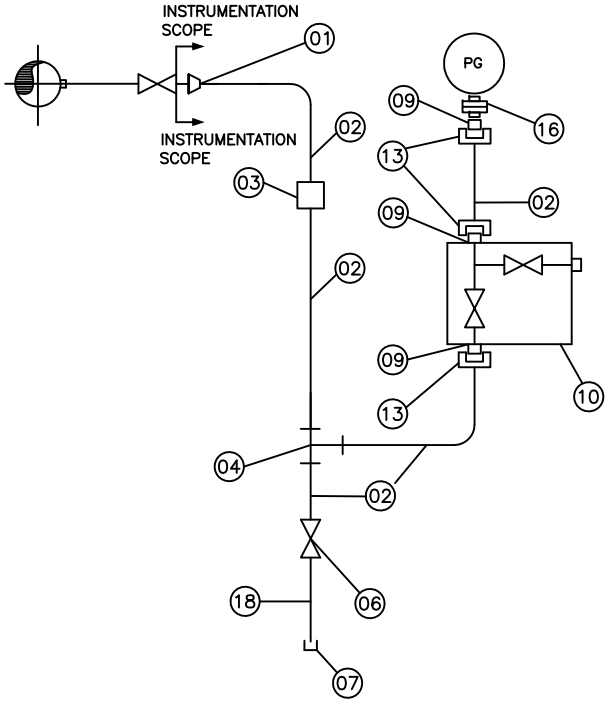


PULSATING SERVICE

TITLE :- INSTRUMENT INSTALLATION DIAGRAM PRESSURE GAUGES	DRG. NO.	PE-DG-999-145-IXXX		
	REV. NO.	00	DATE	05.11.13
	SHT	3 OF 9		



AIR SERVICE

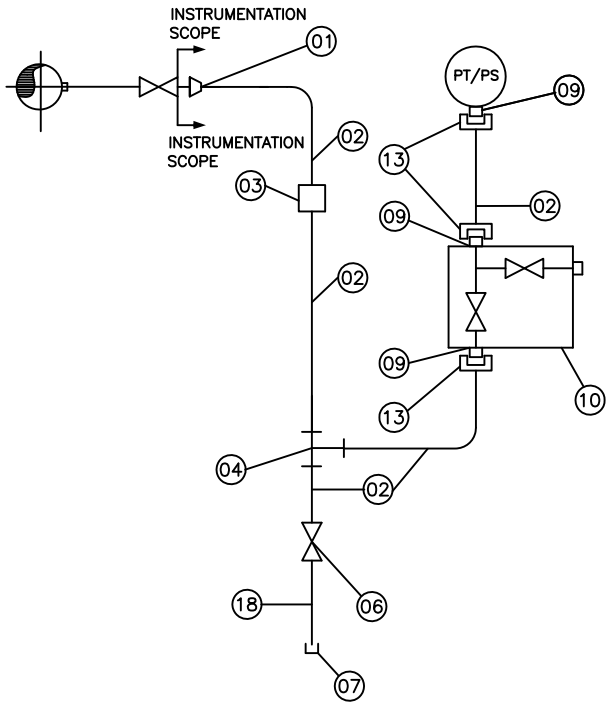


WITH CHEMICAL SEAL

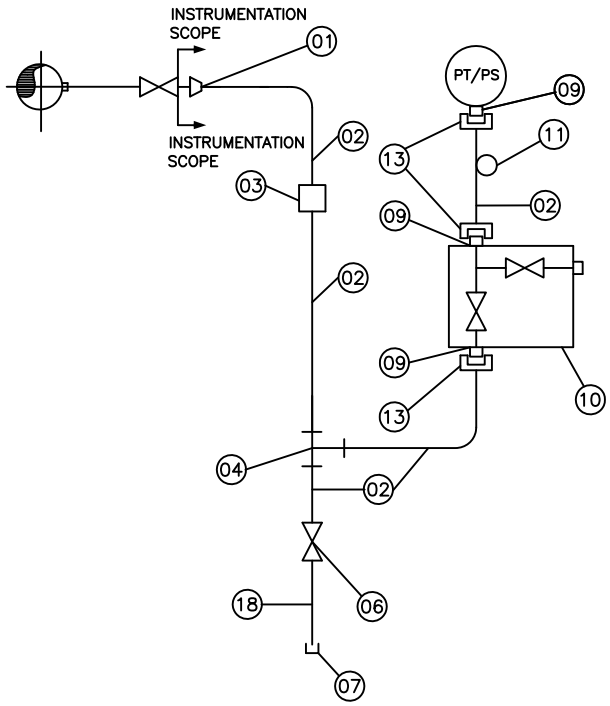
(FOR VISCOUS NON–CORROSIVE FLUID ONLY)

ITEM NO	ITEM/DESCRIPTION	MATERIAL	SIZE	QTY				
				WATER	STEAM	PULSATING	AIR	CHEMICAL
01	REDUCER (IF APPLICABLE)	SAME AS MAIN PIPE	1" X 1/2"SW	01	01	01	00	01
02	SEAMLESS PIPE	SAME AS MAIN PIPE	1/2"	A/R	A/R	A/R	A/R	A/R
03	FORGED COUPLING	SAME AS MAIN PIPE	1/2" SW	A/R	A/R	A/R	A/R	A/R
04	FORGED TEE	SAME AS MAIN PIPE	1/2" SW	01	01	01	01	01
06	FORGED GLOBE VALVE	SAME AS MAIN PIPE	1/2" SW	01	01	01	01	01
07	CAP	SAME AS MAIN PIPE	1/2" NPTF	01	01	01	01	01
09	ADAPTER – M TO M	SS316	M20X1.5M X 1/2" NPTM	02	02	02	02	03
10	TWO VALVE 3 WAY MANIFOLD WITH VENT PLUG	SS316	1/2" NPTF	01	01	01	01	01
11	SYPHON	SS316	1/2" SW	00	01	00	00	00
12	SNUBBER	SS316	M20X1.5M X M20X1.5F	00	00	01	00	00
13	NUT & TAIL PIECE WITH ANNEALED COPPER/SS304 WASHER	SS316	NUT SIZE : M20 X 1.5 WITH 100MM TAIL	03	03	03	03	03
16	CHEMICAL SEAL	SS316	1/2" NPTF X 1/2" NPTF	00	00	00	00	01
18	NIPPLE	SAME AS MAIN PIPE	1/2" NPTM X 1/2" SW	01	01	01	01	01
19	ADAPTER – M TO F	SS316	M20X1.5M X 1/2" NPTF	01	01	01	01	00

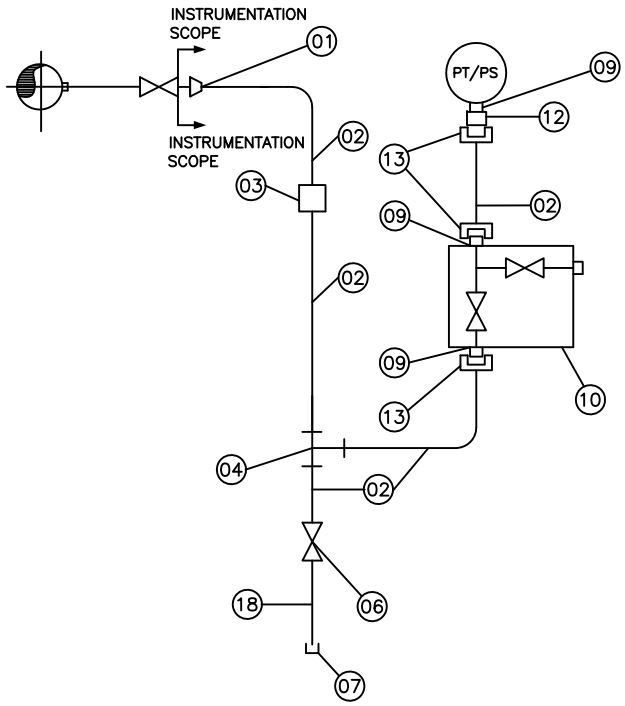
BHEL	TITLE :– INSTRUMENT INSTALLATION DIAGRAM PRESSURE GAUGES	DRG. NO.	PE–DG–999–145–IXXX
		REV. NO.	00 DATE 05.11.13
		SHT	4 OF 9



WATER SERVICE

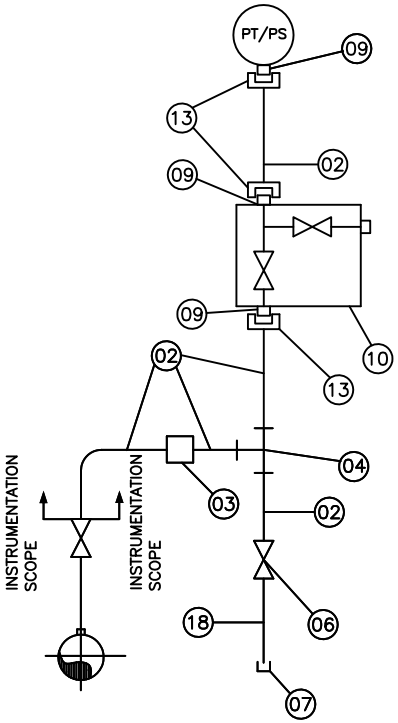


STEAM SERVICE

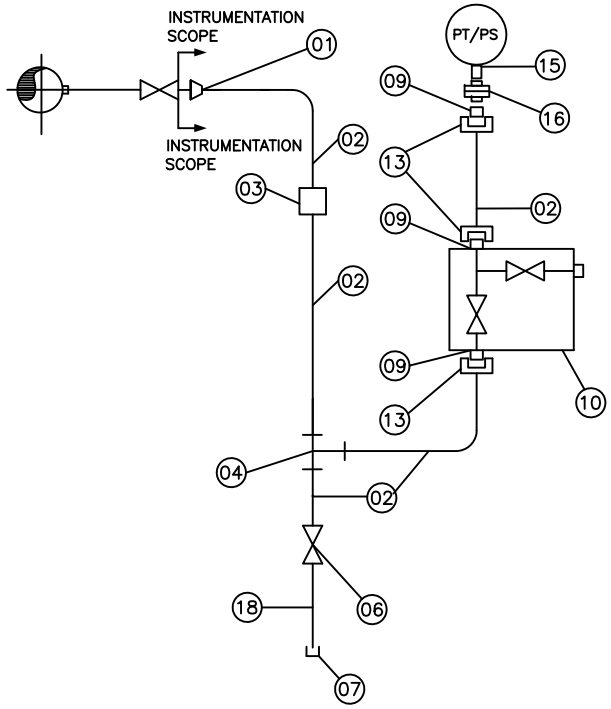


PULSATING SERVICE

BHEL	TITLE :- INSTRUMENT INSTALLATION DIAGRAM PRESSURE SWITCHES/TRANSMITTERS	DRG. NO.	PE-DG-999-145-IXXX	
		REV. NO.	00	DATE 05.11.13
		SHT	5 OF 9	



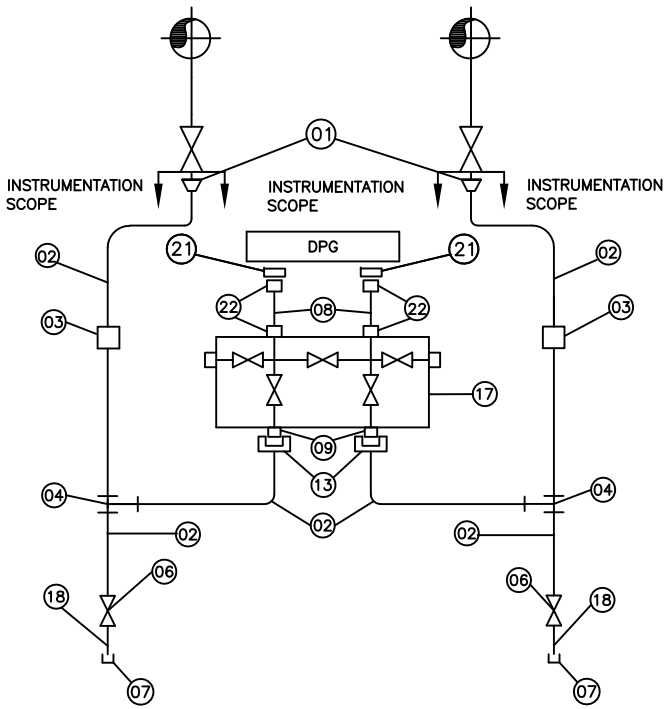
AIR SERVICE



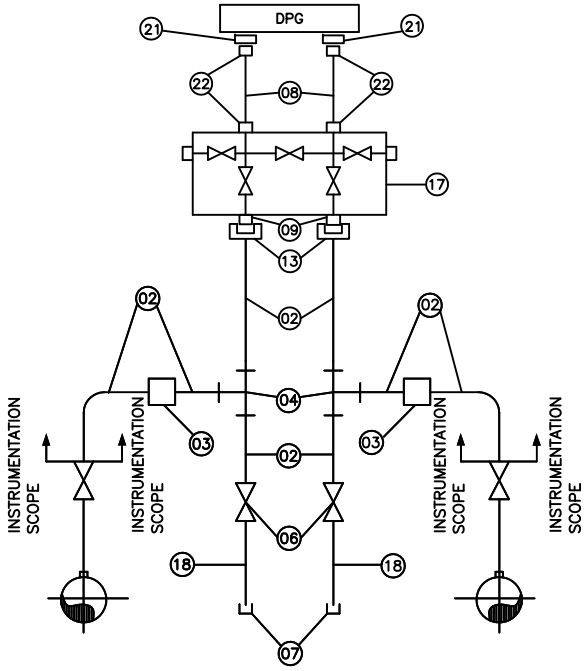
WITH CHEMICAL SEAL
(FOR VISCOUS NON–CORROSIVE FLUID ONLY)

ITEM NO	ITEM/DESCRIPTION	MATERIAL	SIZE	QTY				
				WATER	STEAM	PULSATING	AIR	CHEMICAL
01	REDUCER (IF APPLICABLE)	SAME AS MAIN PIPE	1" X 1/2"SW	01	01	01	00	01
02	SEAMLESS PIPE	SAME AS MAIN PIPE	1/2"	A/R	A/R	A/R	A/R	A/R
03	FORGED COUPLING	SAME AS MAIN PIPE	1/2" SW	A/R	A/R	A/R	A/R	A/R
04	FORGED TEE	SAME AS MAIN PIPE	1/2" SW	01	01	01	01	01
06	FORGED GLOBE VALVE	SAME AS MAIN PIPE	1/2" SW	01	01	01	01	01
07	CAP	SAME AS MAIN PIPE	1/2" NPTF	01	01	01	01	01
09	ADAPTOR – M TO M	SS316	M20X1.5M X 1/2" NPTM	03	03	03	03	03
10	TWO VALVE 3 WAY MANIFOLD WITH VENT PLUG	SS316	1/2" NPTF	01	01	01	01	01
11	SYPHON	CS	1/2" SW	00	01	00	00	00
12	SNUBBER	SS316	M20X1.5M X M20X1.5F	00	00	01	00	00
15	CONNECTOR – M TO M	SS316	1/2" NPTM X 1/2" NPTM	00	00	00	00	01
16	CHEMICAL SEAL	SS316	1/2" NPTF X 1/2" NPTF	00	00	00	00	01
13	NUT & TAIL PIECE WITH ANNEALED COPPER/SS304 WASHER	SS316	NUT SIZE : M20 X 1.5 WITH 100MM TAIL	03	03	03	03	03
18	NIPPLE	SAME AS MAIN PIPE	1/2" NPTM X 1/2" SW	01	01	01	01	01

BHEL	TITLE :– INSTRUMENT INSTALLATION DIAGRAM PRESSURE SWITCHES/TRANSMITTERS	DRG. NO.	PE–DG–999–145–IXXX
		REV. NO.	00 DATE 05.11.13
		SHT	6 OF 9



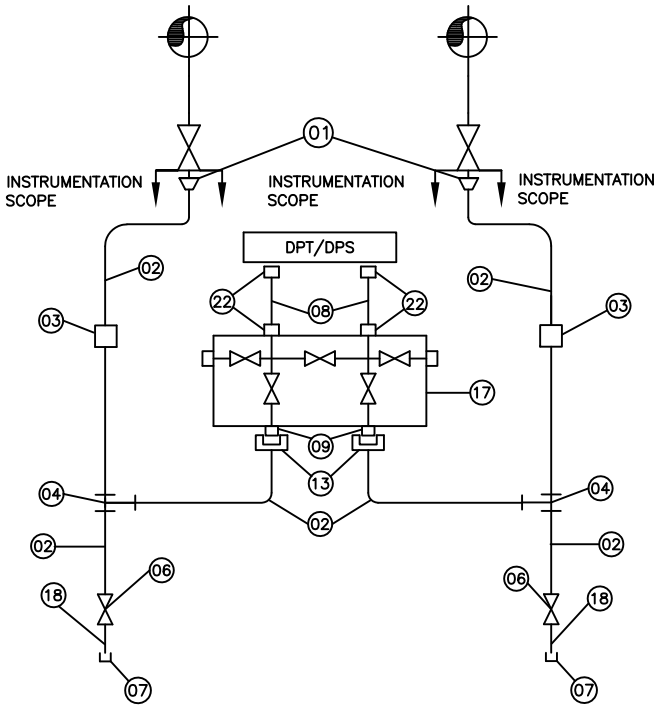
WATER SERVICE



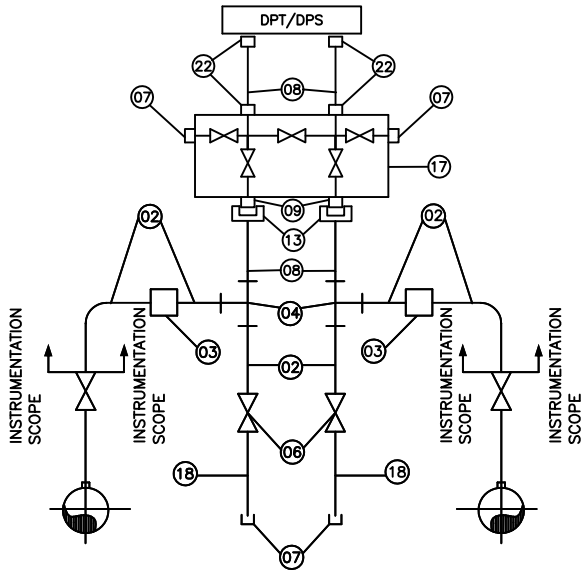
AIR SERVICE

ITEM NO	ITEM/DESCRIPTION	MATERIAL	SIZE	QTY	
				WATER	AIR
01	REDUCER (IF APPLICABLE)	SS316	1" X 1/2"SW	02	00
02	SEAMLESS PIPE	SAME AS MAIN PIPE	1/2"	A/R	A/R
03	FORGED COUPLING	SAME AS MAIN PIPE	1/2" SW	A/R	A/R
04	FORGED TEE	SAME AS MAIN PIPE	1/2" SW	02	02
06	FORGED GLOBE VALVE	SAME AS MAIN PIPE	1/2" SW	02	02
07	CAP	SAME AS MAIN PIPE	1/2" NPTF	02	02
08	SEAMLESS TUBE	SS316	1/2" OD	A/R	A/R
09	ADAPTOR – M TO M	SS316	M20X1.5M X 1/2" NPTM	02	02
17	FIVE VALVE MANIFOLD WITH DRAIN PLUG	SS316	1/2" NPTF	01	01
16	CHEMICAL SEAL	SS316	1/2" NPTF X 1/2" NPTF	00	00
13	NUT & TAIL PIECE WITH ANNEALED COPPER/SS304 WASHER	SS316	NUT SIZE : M20 X 1.5 WITH 100MM TAIL	02	02
18	NIPPLE	SAME AS MAIN PIPE	1/2" NPTM X 1/2" SW	02	02
22	TUBE FITTING DFDC	SS316	1/2" NPTM X 1/2"OD TUBE	04	04
21	CONNECTOR – F TO F	SS316	1/2" NPTF X 1/2" NPTF	02	02

BHEL	TITLE :- INSTRUMENT INSTALLATION DIAGRAM DIFFERENTIAL PRESSURE GAUGES	DRG. NO.	PE-DG-999-145-IXXX	
		REV. NO.	00	DATE 05.11.13
		SHT	7 OF 9	



WATER SERVICE



AIR SERVICE

ITEM NO	ITEM/DESCRIPTION	MATERIAL	SIZE	QTY	
				WATER	AIR
01	REDUCER (IF APPLICABLE)	SS316	1" X 1/2"SW	02	00
02	SEAMLESS PIPE	SAME AS MAIN PIPE	1/2"	A/R	A/R
03	FORGED COUPLING	SAME AS MAIN PIPE	1/2" SW	A/R	A/R
04	FORGED TEE	SS316	1/2" SW	02	02
06	FORGED GLOBE VALVE	SS316	1/2" SW	02	02
07	CAP	CS	1/2" NPTF	02	02
08	SEAMLESS TUBE	SS316	1/2" OD	A/R	A/R
09	ADAPTER – M TO M	SS316	M20X1.5M X 1/2" NPTM	02	02
17	FIVE VALVE MANIFOLD WITH DRAIN PLUG	SS316	1/2" NPTF	01	01
16	CHEMICAL SEAL	SS316	1/2" NPTF X 1/2" NPTF	00	00
15	CONNECTOR – M TO M	SS316	1/2" NPTM X 1/2" NPTM	00	00
13	NUT & TAIL PIECE WITH ANNEALED COPPER/SS304 WASHER	SS316	NUT SIZE : M20 X 1.5 WITH 100MM TAIL	02	02
18	NIPPLE	SAME AS MAIN PIPE	1/2" NPTM X 1/2" SW	02	02
21	CONNECTOR – F TO F	SS316	1/2" NPTF X 1/2" NPTF	00	00
22	TUBE FITTING DFDC	SS316	1/2" NPTM X 1/2"OD TUBE	04	04

BHEL	TITLE :– INSTRUMENT INSTALLATION DIAGRAM DIFFERENTIAL PRESSURE SWITCHES/TRANSMITTERS	DRG. NO.	PE–DG–999–145–IXXX	
		REV. NO.	00	DATE 05.11.13
		SHT	8 OF 9	

BHEL	**CONTROL & INSTRUMENTATION CABLE FOR AIR CONDITIONING & VENTILATION SYSTEM** **4X225 MW ARUN-3 HEP**	SPECIFICATION NO. VOLUME **II-B** SECTION : **C** REV. NO. 00 DATE: 25.10.2019 SHEET 1 OF 8

CONTROL & INSTRUMENTATION CABLE

1) CONTROL & INSTRUMENTATION CABLE

(i) 600/1000 Volt, Copper conductor control cables for Control System (interconnection of various control panels, field equipments, junction box etc.)

(ii) 300/500 Volt, Copper conductor, Instrumentation cables for connection of various field equipment's like RTDs, thermocouple cables (4-20mA, 2-10V signals) etc. to control panels.

(iii) Control cables from EM panels to third party interface such as hydro-mechanical panels

Any other power/control cable not specifically mentioned in the scope of this chapter and other chapters shall be in the scope of contractor at all places

2) Control, monitoring and related items and services

Co-ordination and provision of necessary contacts and/or ports for integration with Plant SCADA system.

3) STANDARDS & REGULATIONS

The design, manufacture and testing of the various equipment covered under this specification shall comply with the requirements of the latest edition of the relevant IEC/IS/IEEE/ISO standards only. Preference for latest IEC standards for particular equipment / system shall be governed over IEEE/ IS/ ISO standards. Further rules, guide lines and standard laid down by international/ national agency shall be applicable in this specification. The relevant abstract (in soft / hard copy) of all referred standards shall be provided free of cost during engineering stage for facilitating review/ approval of submitted drawing/documents.

4) CABLE PARAMETERS & GUARANTEES

(i) General

All cables shall be designed to cope with:

- The short–circuit conditions,
- The applied protective system in respect to cross-section and number of cores.

The cables shall be capable of satisfactory operation under a power supply system voltage variation of 10% and frequency variation of 5% and a combined frequency voltage variation of 10% (absolute sum). The cables shall have heat and moisture resistant properties. These shall be of type and design, with proven record of hydro power station installation.

(ii) Control and instrumentation cables

The control and instrumentation cables shall be multi core, colour coded, unarmoured, annealed stranded high conductivity Copper, single conductor, insulated with HRPVC insulation, PVC sheathed and armoured, conforming to relevant IS/ IEC.

	CONTROL & INSTRUMENTATION CABLE FOR AIR CONDITIONING & VENTILATION SYSTEM 4X225 MW ARUN-3 HEP	SPECIFICATION NO.
		VOLUME **II-B**
		SECTION : **C**
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(ii) Performance Criteria and Guarantee

The control, instrumentation, and other cables along with all auxiliaries and accessories shall be capable of performing intended duties under specified conditions. It is the responsibility of the Contractor to supply the equipment as per guaranteed technical particulars and shall also guarantee the reliability and performance.

5) **DESIGN AND CONSTRUCTION**

i) Conductor material

All control and instrumentation cables shall be of copper conductor.

ii) Conductor shield

The conductor having a semi-conducting screen shall ensure perfectly smooth profile and avoid stress concentration. The conductor screen shall be extruded in the same operation as the insulation. The semi-conducting polymer shall be cross linked (for XLPE cables).

iii) Insulation

The insulation of the cables shall be extruded type and shall be designed and manufactured for the specified system voltage. The manufacturing process shall ensure that insulation is free from voids. The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions. The extrusion method should give very smooth interface between semi-conducting screen and insulation. The insulation of the cable shall be of high standard quality. This should be in accordance with relevant IS and IEC standards. Metallic screening as given in this specification for the various control and power cables and special cables shall be provided

iv) Sheath

The sheath shall be suitable to withstand the site conditions and specified temperature conditions. It shall be of adequate thickness and applied by a continuous process to produce a sheath of consistent quality, free from any defects. The sheath shall be extruded. This should be in accordance with relevant IS and IEC standards.

v) Service and outer sheath

Extruded PVC serving as specified shall be applied with suitable additives to prevent attack by rodents and termites. All servings must be given anti-termite treatment. The cable should also offer a specially formulated Flame Retardant Low Smoke compound (FRLS) for outer sheat**h.** The cable shall have suitable fillers laid up with the conductors, before the sheath is applied and the fillers shall be of substantially circular cross section. Fillers shall be suitable for operating temperature of the insulation and compatible with the insulation.

vi) Size and length of cables

The number of cores and sizes of the cables required for various circuits shall be worked out during detailed engineering.

However, minimum sizes for the following cables conductor shall be taken as:

- 2.5 mm^2/1.5 mm^2 copper for control cable conductor,
- 1.5 mm^2/ 0.75 mm^2 copper for annunciation and RTD cable conductor,

- 4 core x 6 mm2 copper for connection between CT junction boxes and panels having red, yellow, blue and black colour cover,
- 4 core x 4 mm2 copper for connection between PT junction boxes and panels having red, yellow, blue and black colour cover.

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

6) AUXILIARY SYSTEMS AND MISCELLANEOUS COMPONENTS

i) Color scheme and identification

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 relevant IS/ IEC.

All the cables shall carry manufacturer data in a permanent, legible manner at an Interval of at least three (3) meter run. The manufacturer's data shall include the name, cable size, and voltage rating together with any other information.

ii) Cable lugs

The Contractor shall ensure that no bimetallic action takes place, between the conductor of the cable and the cable-connecting lug by filling the lugs with suitable compound. The lugs shall be of standard quality conforming IEC / IS.

iii) Cable accessories

The Contractor shall supply all the required accessories that may be found necessary during actual execution of the job and cost of them shall be included in the contract price. No intermediate joint will be allowed in the run of any cable.

iv) Cable glands

The cable glands shall be made of brass duly electro tinned in order to avoid corrosion and oxidation of the surface. The nipple threads shall be in accordance with relevant IS/IEC. Glands shall provide neat, tight, dust and vermin proof termination. Gland shall be provided with rubber ring to hold the cables firmly when check-nut is slightly tightened. Gland shall be complete with suitable washers etc.

v) Compression type terminals for control wiring

These terminals are required for copper conductor of control wiring. They shall be crimped to the conductor while other end will provide flat surface for better connections. The connectors shall be made of Copper electro tinned.

vi) Button tape (strap and stud)

This consists of perforated cable strapping with holes conveniently spaced for assembly and moulded studs. The strapping shall be made of NYLON Grade 220 or other elastic material to give proper performance. The studs shall be made of 'NYLON'.

vii) Self-adhesive marker

Self-adhesive marker in the form of strips of any one character, which can be easily peeled from the backing cards and can be applied on the cable, shall be supplied. The strips shall be water- proof duly marked with special formulated ink with specific thermo-setting adhesive to withstand high temperature.

Suitable plastic ring type ferrules marked with engraved indelible ink for control cables and sticker type ferrules for power cables shall be supplied. These shall be

marked as per cable schedule such that each core of each cable can be identified easily.

viii) Aluminium strip

Aluminium strip of adequate size for making tags for labels shall be supplied.

PVC tapes, cotton tapes and any other accessory required for laying, termination, testing and commissioning shall be supplied of good quality as per relevant Indian Standards.

ix) Fire proofing

Cables passing through different fire zones shall be provided with fireproof barriers with the same fire rating as the penetrated walls or partitions.

x) Cable junction boxes

Junction box shall be constructed of sheet steel of thickness not less than two (2) mm. The door shall be adequately strengthened to ensure rigidity and strength. Sheet steel and sections used in enclosures shall be cut neatly and finished free from burrs.

Ample wiring space shall be provided at the sides, and back of the enclosure for incoming and outgoing circuits. Removable plates with gaskets shall be fitted at the top and bottom of the box to provide the entry for conduit or cable. The door shall be provided with suitable gasket and fitted with a lock type handle. The door shall be hung on hinges having brass bodies and stainless steel pins.

Each cable junction box shall be provided with terminals of adequate rating on the terminal strip of suitable thickness.

xi) 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. Terminal blocks shall be 1100V grade and have continuous rating to carry the maximum expected current on the terminals.

Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short circuiting and earthing facilities.

The terminal shall be such that maximum contact area is achieved when a cable is Terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally.

The conducting part in contact with cable shall preferably be tinned or silver plated.

The terminal blocks shall be of extensible design. The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.

The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.

Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.

All circuits except CT/ PT circuits	Minimum of two of 2.5 sq. mm copper flexible
All CT/ PT circuits	Minimum of 2 nos. of 6 sq. mm copper flexible

The arrangements shall be made in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live. Wherever duplication of a terminal block is necessary it shall be achieved by solid bonding links.

At least 20% spare terminals shall be provided on ach panel / cubicle / box and these spare terminals shall be uniformly distributed on all terminals rows.

There shall be minimum clearance of 250 mm between the first / bottom row of terminal block and the associated cable gland plate. Also, the clearance between two rows of terminal blocks shall be a minimum of 150 mm.

xii) **Cable markers and cable binding**

Suitable cable markers of Aluminium with punch marks shall be provided and suitably tagged to the cable permanently so that cable could be easily identified.

xiii) Cable binding/strapping

All control cables after glanding shall be neatly routed and bonded with the help of cable straps and studs inside the panel. Complete routing in panel shall be such that it gives a neat appearance good workmanship.

7) **SHOP ASSEMBLY, INSPECTION AND TESTS**

(i) Type Test

Type tests which shall fall under Category –I(refer clause 14 of GTS) are to be conducted as per Schedule VI to demonstrate that the cables and accessories offered meet the requirement of specifications.

(ii) Routine Tests

The following Routine tests shall be conducted on samples of manufactured cables and on components of accessories in order to verify that the finished products meet the requirements of specifications.

- Conductor resistance test,
- Partial discharge test (for screened cables),
- High voltage test.

In addition to above tests, all other tests mentioned in the relevant IS shall also be Performed. Instrumentation cable shall be tested as per relevant IEC/IS standard.

(iii) F**ield tests**

Before commissioning of complete system, all cabling system shall be checked as per cable schedule and complete report shall be prepared by Contractor and shall be submitted.

Field test shall include:

- Continuity checking,

• IR testing
• Verification of phase order in power cables
• Visual checking in respect of tagging, laying, dressing, glanding, earthing of complete cable system.

(iv) Performance testing

If nothing unusual has been observed in load run and load rejection tests, the test service period of 72 hours shall follow. During this test service period, the unit must operate continuously at rated condition without any interruption except of those beyond the control of the Contractor. However, such interrupted period shall not be counted for in the test service period. There should be one-month reliability run of the complete unit reckoned from the date of taking over by employer.

8) PACKAGING, HANDLING AND SITE STORAGE

The Contractor shall pack all the consignment in sea worthy packaging strong enough to withstand rough handling during transit. Machine surface shall be suitably protected against scratches, corrosion, shocks, impact etc. Packages shall be suitably and distinctly identified for type of handling and kind of storage.

All the cables shall be supplied on non-returnable wooden drums with adequate barrel diameter so as to avoid any damage to the cables and to withstand rough handling during transportation and storage. The ends of the cable shall be sealed by means of non-hygroscopic sealing material.

A layer of waterproof paper shall be applied to the surface of the drums and over the outer cable layer. A circular space of at least 40mm shall be left between the cable and the lagging. Each drum shall carry the name of the manufacturer, the name of the Employer, his address, order number, item number, type, size length of cable, net and gross weight duly stencilled thereon. The supplier shall indicate the methods of storage of cable drums and accessories at site during the detailed design stage.

9) INSTALLATION PROCEDURE

The Contractor shall follow the construction methodology and installation procedure recommended by the cable manufacturer and shall arrange all the necessary erection tools/devices required for installation of cables such as cable rollers, cable pullers, motorized winches, power packs, two-way communications and safety devices etc., as per manufacturer's standard practices for installation of the cables.

Plugging of all cable gland holes left out in the panel after completion of cabling shall be done.

10) MANDATORY SPARES

Sr No.	DESCRIPTION	QUANTITY
1.	Control cable of each type	10% of installed quantity
2.	Communication cable of each type	10% of installed quantity

3.	Cable glands of each size	20% of installed quantity
4.	Junction boxes of each size	20% of installed quantity
5.	Items for completeness of System	10% of installation

11) COMPLETENESS OF SYSTEM

Any other item (s) not mentioned specifically but necessary for the satisfactory completion of scope of work defined above, as per accepted standard (s)/best international practice.

SCHEDULE-VI

SCHEDULE OF TYPE TEST

The following type tests shall be conducted as per applicable standards on XLPE and PVC insulated power & control cables:

Sr.No.	Description of Test
1.	Annealing test (for copper)
2.	Tensile test
3.	Wrapping test
4.	Conductor resistance
5.	Partial discharge test
6.	Dielectric power factor test
7.	Bending test followed by partial discharge test
8.	Heating cycle test followed by partial discharge test
9.	Test for thickness of insulation and sheath
10.	Tensile strength and elongation test for insulation and sheath Ageing test for insulation and sheath
11.	Loss of mass tests for insulation and sheath
12.	Shrinkage Test for Insulation and Sheath
13.	Hot Deformation Test for Insulation and Sheath
14.	Cold Bend Test (up to 6mm.sq.) size
15.	Cold Impact Test for Insulation and Sheath
16.	Heat Shock Test for Insulation and Sheath
17.	Thermal Stability Test for Insulation and Sheath
18.	Test for Bleeding and Blooming of pigments for PVC Insulation & Sheath
19.	Fire Resistance Test
20.	Measurement of Insulation Resistance
21.	Impulse withstands Test.
22.	High voltage test (Cable immersed in water)
23.	High voltage test at room temperature
24.	Oxygen Index
25.	Temperature Index
26.	Smoke density test
27.	Flammability test
28.	Swedish Chimney test
29.	Ladder Test.
30.	

Date:
Place:

Signature of Bidder
Name:
Status
Whether authorized attorney
Of tendering company
Name of Tendering Company

Manufacturing Quality Assurance Test Requirements

	Project Name (MW): ARUN-III HEP (4X225 MW)	**Doc. No.:** QAI/A/M/EM/CB/01	**Rev. No.:** 02
	Item Description: Cables (~~Power~~, Control, Instrumentation, Coaxial, Cable Tray, Termination Kit & Cable Accessories)	**Issue Date:** 30.05.2017	**Page No.** 2

Sr. No.	Component, Operation & Characteristics	Applicable Standard	Remark
1	2	3	4
A	**Cables (~~Power~~, Control, Instrumentation and Coaxial)**		
1	**Incoming Material**		
1.1	**Aluminium Rod/ Copper Rod**		
	Make & Surface Finish, Dimensional Check, Purity, Breaking Load, Conducitvity	IS 8130/ TS/ DRG	V
1.2	**Aluminium Wire/ Copper Wire/Conductor**		
	Diameter, Resistivity or Conductivity at 20C, Mechanical Properties(Tensile, % Elongation/ Wrapping test, Annealing), Surface Finsh, Joints, Chemical properties	IS 8130/ TS/ DRG	V
1.3	**PVC Compound (Insulation)**		
	Make , Specific Gravity, Visual Check for PVC Granules i.e. Foreign Burnt Particle, Elongation Before & After Ageing, Loss of Mass, Thermal Stability	IS 5831/ TS/ DRG	V
1.4	**XLPE Compound (Insulation)**		
	Make , Specific Gravity, Visual Check for PVC Granules i.e. Foreign Burnt Particle, Elongation Before & After Ageing, Loss of Mass, Thermal Stability	IS 7098/ Rel IEC	
1.5	**FRLS PVC Compound**		
	Oxygen Index test, Temperature Index test, HCL Gas Emission test, Smoke Density Rating	ASTMD 2863/ IEC 745(I)	V
1.5	**Amour/ Wire Strip (as applicable)**		
	Tensile Strength, Make, % Elongation, Torsion/ Winding, Mass of Zinc Coating, Resistance, Diameter Size, Uniformity of Zinc Coating	IS 3975/ IS 1554/ TS/ DRG	V
1.6	**Drum**		
	Visual Check, Dimensions, Anti termite/ rodent treatment	IS 10418/ TS/ DRG	V
1.9	**FRLS PVC Compound for Instrumentation/ Coaxial Cables**		
	Oxygen Index test, Temperature Index test, HCL Gas Emission test, Smoke Density Rating	ASTMD 2863/ IEC 745(I)	V
2	**In process Stage**		
2.1	**Conductor**		
	Surface Finish, Lay length constant & nozzing, Resistance/ km at 20C, Dimension, Dia over conductor, Direction of Lay	IS 8130/ TS/ DRG	V
2.2	**PVC Insulated Core Marking**		
	Type of Material, Process Control (Speed, Temperature), Color of Core, Core Identification, Core Numbering, Surface Finish, Thickness of Insulation (Nominal & Minimum), Insulation Resistance, Ovality/ Concentricity, HV Test(Spark Testing), Shrinkage Test, Hot Deformation, Volume Resistivity	IS 1554/ TS/ DRG	V
1.4	**PVC (Sheath) (inner & outer)**		
	Make & Visual Check, Tensile & Elongation Before & After Ageing, Loss of Mass, Thermal Stbility, Specific Gravity, Volumne Resistivity	IS 5831/ TS/ DRG	V
	Oxyegen/ Temperature Index, Smoke Density (Rating) Test, Acid Gas Generation (For Outer Sheath Only)	ASTMD 2863/ IEC 745(I) / TS/ DRG	V
2.3	**Conductor Bunching for instrumentation/ coaxial cables**		
	No of Strands, Size of Wire (Before Stranding), Conductor Resistance, Annealing (Before Stranding) for Copper, Finish	IS 8130	V
2.4	**Pair/ Triad Twisting/ Core Laying for instrumentation/ coaxial cables**		
	Color Sequence, Core/Pair/ Triad Identification, T/M (for pair/triad), HV & CR	DRG/ TS	V
2.5	**Screening (Individual or overall as applicable)**		
	Coverage/ Tape Overlap, Size of wire/ size of tape	DRG/ TS	V
2.6	**Laying of Cores**		
	Construction, Sequence of Laying, Lay length, Laid up diameter, Direction, HV & Continuity	DRG/ TS	V
2.7	**Inner Sheath**		
	Thickness of Inner Sheath, Diameter over inner sheath, Surface Finish, Color	IS 1554/ TS/ DRG	V
2.8	**Amouring**		
	Construction, Dimension, Surface finish, coverage, gap between two wire/ formed wire, Dia over, joint/ cross	IS 1554/ IS 3975/ TS/ DRG	V
2.9	**Outer Sheath**		
	Thickness of sheath (Min/Nom), Surface Finish, Type of Material/Color, Overall dia, Embossing, Progressive Sequence Marking	IS 5831/ TS/ DRG	V
2.10	**Drum Winding**		
	Drum Condition, Cable length, Cable & Sealing before dispatch, Drum marking, Lagging	/ TS/ DRG	V
3	**Final Inspection**		
3.1	**Type Test (as aaplicable for type of cable as per TS)**		
	Annealing test (for Copper), Tensile Strength (for Al), Wrapping test (for Al), Conductor Resistance test, Partial discharge test, dielectric power factor test, bending test followed by partial discharge test, heating cycle test followed by partial discharge test, test for thickness of insulation and sheath, , cold bend test (up to 6mm sq) size, , fire resistance test, measurement of insulation resistance, impulse withstands test, high voltage test (cable immersed in wate), high voltage test at room temperature, oxygen index, smoke density test, flammability test, swedish chimney test, ladder test	TS/ DRG/ Rel Std.	W
3.2	**Type test on Insulation and Sheath**		
	Tensile strength and elongation test, ageing test, loss of mass test, shrinkage test, hot deformation test, Cold impact test, heat shock test, thermal stability test, test for bleeding and blooming of pigments for PVC	TS/ DRG/ Rel Std.	W
3.3	**Routine Tests**		

	Conductor Resistance, HV test, Dimension, Insulation Resistance test, Partial Discharge test for screended cables	IS 1554/ TS/ DRG	W
3.4	**Acceptance Test**		
	Check for cable identification/ marking of cables at 100 meters, Conductor Resistance, Tensile Wrapping,Test for thickness of Insulation & Sheath, Tensile Strength and Elongation Test, Verification of Cable length & Surface Finish, High Voltage test at room temperature, IR test.	IS 1554/ TS/ DRG	W
	(For Outer Sheath Only) Oxygen Index, Temperature Index, Smoke Density Rating, Acid Gas Generation test, Flame Retardant test etc.	ASTMD 2863/ IEC 745(I)/ TS/ DRG	W
3.4	**Additional Tests for Coaxial Cables**		
	Capacitance, Impedance, Voltage Withstand test etc.	REL STD	W
4	**Packing in Drums**		
	Finish & Markings on drums	TS/ DRG/ Rel Std.	V
B	**Optical Fiber Cable**		
1	**Measurement of Dimensions**		
	Diameter of cladding, Non-circularities, Concentricity errors, Diameter of primary coating, Concentricity error of primary coating, Fiber stripping, Thickness of insulation-electrical conductir, thickness of sheath	IEC 60794/ TS/ DRG/ REL STD	V
2	**Measurement of Mechanical Characterisitcs**		
	Tensile performance, crush, impact, torsion, bend, water penetration, abrasion, bending under tension, repeated bending, flexing, kink, cut through resistance, compound flow	IEC 60794/ TS/ DRG/ REL STD	V
3	**Measurement of Electrical Characteristics**		
	Conductor, Resistance, Dielectric strength of insulation, Insulation resistance	IEC 60794/ TS/ DRG/ REL STD	V
4	**Measurement of Transmission & Optical Characteristics**		
	Attenuation, Point Defect, Optical Continuity, Change in optical transmittance during mechanical & Envrionmental condtions, Refractive index profile, Microbending sensitivity & Macrobending sensitivity, Fiber cut-off wavelength, Mode Field diameter	IEC 60794/ TS/ DRG/ REL STD	V
5	**Measurement of Environmental Characterisitcs**		
	Temperature cycling, Ageing, Fire Performance, Sheath integrity, Nuclear Radiation, Pneumatic Resistance, Hydrostatic pressure	IEC 60794/ TS/ DRG/ REL STD	V
C	**Cable Tray**		
1	**Incoming Material**		
1.1	**M.S. Sheet/ Stainless Steel Channels/ Angels**		
	Physical Properties, Chemical Properties, Check for Waiveness, Dimension, Lamination	DRG/ TS	V
2	**In Process Stage**		
2.1	**Fabrication**		
	Surface Defects, Deburring, Dimensions, Welding Quality, DPT	DRG/ ASME Sec IX, ASME Sec VII	V
3	**Final Inspection**		
	Dimesions, Galvanizing test, Mass of Zinc Coating, Thickness and uniformity of Coating, Adhesion test	IS 2629	W
D	**Termination Kit**		
	Routine & Acceptance Test	TS/ DRG/ Rel Std.	V
E	**Cable Accessories (Glands, Termination lugs, Markers, Ties, Tages, Tool for termination, MS Pipe, Marshalling Boxes, MCB, Insulating tapes)**		
	Visual & Dimensional Verification, Finish & Smoothness	DRG	V

LEGENDS

TS: TECHNICAL SPECIFICATIONS	REL. TS/ DRG/ Rel STD.: RELEVENT STANDARD
V: VERIFICATION OF REPORTS/TCs	DRG: DRAWING
W: CUSTOMER HOLD POINT (CHP)	

NOTES

1	Any test at any stage not covered in Quaility Assurance Test Requirement (QATR), but part of technical specification of contract, shall also be carried out by Contractor/ firm.
2	QATR shall be read in conjunction with General Quality Assurance Requirement given as part of Technical Specification
3	This QATR is applicable for all types of cables being supplied under this contract.

Cable Schedule format

UnitCableNo	FROM	TO	Purpose	CableSize	REMARKS	PATHCABLENO

	SPECIFIC TECHNICAL REQUIREMENT FOR AIR CONDITIONING & VENTILATION SYSTEM 4X225 MW ARUN-3 HEP	SPECIFICATION NO.
		VOLUME **II-B**
		SECTION : **C**
		REV. NO. 00 | DATE: 03.10.2019
		SHEET OF

LIST OF DELIVERABLES

C&I DELIVERABLES LIST FOR AC & VENTILATION PKG			
Sl.No.	**DRAWING NO.**	**DRAWING/DOCUMENT TITLE**	**CATEGORY**
		INSTRUMENTATION	
1	PE-V9-437-165-I842A	INSTRUMENT DATA SHEETS	A
2	PE-V9-437-165-I902	INSTRUMENT SCHEDULE	I
3	PE-V9-437-165-I879A	INSTRUMENT INSTALLATION/HOOK UP DIAG	I
4	PE-V9-437-165-I852A	FIELD JB TERMINATIONS/ GROUPING DOCUMENT	I
5	PE-V9-437-165-I843A	INSTRUMENT QP / CHECK LIST	A
		LCP	
1	PE-V9-437-165-I898A	CONTROL SCHEME/WIRING DIAGRAM	
2	PE-V9-437-165-I904A	LOCAL CONTROL PANEL DATA SHEET & PANEL EXTERNAL GA DRAWING (INCLUDING FOUNDATION DETAILS & FLOOR CUT-OUT)	A
3	PE-V9-437-165-I901A	CABLE SCHEDULE & CABLE INTERCONNECTION	I
4	PE-V9-437-165-I911A	BILL OF MATERIAL	I
5	PE-V9-437-165-I902A	LOCAL CONTROL PANEL QUALITY PLAN	A
6	PE-V9-437-165-I903A	CABLE QAP	A
NOTE:-			
Any other drawings, documents, design calculations, literatures, manuals etc. not covered anywhere in the specification, but required to be furnished for approval / reference of employer for suitability of design to fulfill the scope of work shall be furnished by Vendor.			

SECTION: I

SUB-SECTION: D

STANDARD TECHNICAL SPECIFICATIONS

	TECHNICAL SPECIFICATION VENTILATION FANS	SPECIFICATION NO. PES-571-11000-A-03	
		VOLUME II B	
		SECTION D	
		REV. 00	DATE: JAN 2020
		SHEET 1 OF 5	

SECTION-D

VENTILATION FANS

	TECHNICAL SPECIFICATION VENTILATION FANS	SPECIFICATION NO. PES-571-11000-A-03	
		VOLUME II B	
		SECTION D	
		REV. 00	DATE: JAN 2020
		SHEET 2 OF 5	

1. GENERAL

This specification covers the design, manufacture, testing of performance at manufacturer's/sub-contractors works, delivery at site, handling at site, erection and commissioning of ventilation fans.

2. CODE AND STANDARDS

The design, manufacture and performance of equipment shall comply with all currently applicable statutes, regulations and safety codes in the locality where it is to be installed. The equipment shall conform to latest edition of applicable Indian Standards or their equivalent standards. Nothing in this specification shall be construed to relieve the vendor of this responsibility. In particular the equipment shall conform to the latest editions of the Following standards.

2.1.1 IS:4894 -Centrifugal fans

2.1.2 IS:3588 -Electric Axial Flow fans

2.1.3 IS:2312 -Propeller type A.C. ventilation fans

2.1.4 IS-3963 -Roof extractor units

2.1.5 BS:848 -Method of performance test for fans.

2.1.6 AMCA publication 99 standards handbook

2.1.7 AMCA standard 210, Test code for air moving devices.

3. DESIGN AND CONSTRUCTION

3.1 THE ENCLOSED DATA SHEET A GIVES THE NECESSARY DETAILS FOR CENTRIFUGAL/AXIAL/ROOF EXTRACTOR UNITS ETC.

3.2 WELDING PROCESS AND WELDERS EMPLOYED FOR FABRICATION SHALL BE QUALIFIED AS PER ASME SEC. IX

3.3 CASING

3.3.1 The centrifugal fans casing shall be of welded construction fabricated with heavy gauge material (min 3 mm) with flanges (min. 5 mm) on inlet and out let side for direct connection and shall be rigidly reinforced and supported by structural angles. The seams shall be permanently sealed airtight. Horizontal Split casings shall be provided on large size fans. Casing drain (at bottom) with threaded plug/ with valve shall be provided, as required. All mounting/ connecting holes shall be drilled off centre.

3.3.2 The axial flow casing for supply fans/roof extractors shall be of heavy gauge construction (min 3 mm) properly reinforced for rigidity and shall be complete with suitable supports. Access doors with suitable locking arrangement shall be provided in the casing for easy access to the motor and impeller. External junction box/ Terminal box on casing with IP-55 protection shall be provided, if required. Wiring for motor from external junction box/ Terminal box shall be through flexible conduit.

3.3.3 Suitable motor brackets designed for rigid mounting of motors, shall be provided for roof extractors and wall mounted exhaust/ supply fans.

3.4 IMPELLER

3.4.1 Centrifugal fan impeller shall have die formed, aerofoil or laminar blades welded to the rim and back plate and shall have non-overloading, self cleaning characteristics. Rim shall be spun to have smooth contour. If required, intermediate stiffening rings

shall be provided. Shaft sleeves shall be furnished, if specified. The impeller, pulley and shaft sleeve shall be secured to the shaft by key and/or nuts (threaded opposite to direction of rotation of impeller). The impeller shall be statically and dynamically balanced.

~~3.4.2~~ The axial fan impeller shall be of high efficiency aerofoil design. The blades shall be mounted on a streamlined hub and the impeller shall be mounted directly on the motor shaft. Impeller shall be in one piece however; fabricated blades will be acceptable up to 450 mm impeller diameter.

3.4.3 Roof ventilator impeller may either be centrifugal or axial type. Backward inclined blades shall be provided for centrifugal impellers. Blades may be die-formed or cast. Axial flow impeller shall be directly mounted to motor shaft whereas centrifugal impeller may either be direct-driven or belt-driven. The shaft of belt-driven centrifugal fan shall be solid cold rolled carbon steel, ground and polished. However, direct mounted impellers are preferred.

3.5 BEARINGS:

3.5.1 The centrifugal fan bearing may be ball, roller or sleeve bearings of self-aligning heavy duty type with adequate capacity and life. Make of Bearings to be specified. Bearings shall be oil/grease lubricated and provided with fittings for lubrication from outside and shall be located in easily accessible position to facilitate maintenance.

3.6 INLET CONES AND GUARDS

3.6.1 Centrifugal fans inlet shall be spun to have a smooth contour. Inlet screen, if provided, shall be galvanised wire mesh of 25 mm square with wire thickness of min. 1.5 mm.

3.6.2 Inlet cone, outlet bell and suitably designed guards shall be provided.

3.7 GUIDE VANES:

3.7.1 In case of vane axial fans guide vanes shall be provided on discharge side.

3.8 BASE PLATE AND VIBRATION ISOLATORS

3.8.1 Base plate and vibration isolators, which may be double deflection rubber in shear or rubber in compression type or spring type shall be provided. With each fan rubber bushes, washers wherever needed for vibration isolator in sufficient nos. shall be included, as required, to ensure isolation of foundation from vibration of equipment. For roof ventilators suitable mounting arrangement shall be provided such that there is no ingress of rain water into the building.

3.9 HOOD AND COWL

3.9.1 Roof exhaustors shall be provided with hinge type hood providing easy access to motor and impeller. Weather proof lockable type disconnect switch shall be provided such that hood can open only when the disconnect switch is in'off' position. On larger size of roof ventilators hoods may be of split construction. 15 mm mesh galvanised bird screen shall be provided.

3.9.2 Rain protection cowls shall be designed to suit wall exhausters/supply fans for protecting fans from rain. The cowls shall be provided with bird screen of heavy gauge expanded metal netting.

3.10 SPEED

3.10.1 The speed of axial flow fans/roof ventilators shall not exceed 960 RPM for impeller dia exceeding 450 mm and shall not be greater than 1440 with impeller dia less than 450 mm.

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4. MOTORS

Drive motors shall be of totally enclosed type, suitable for horizontal/vertical mounting as applicable and shall comply with the requirments of the specifications furnished elsewhere for motors.

5. ACCESSORIES

Accessories as specified in Data sheet-A and as required for satisfactory trouble free & safe operation of fans shall be provided.

6. TESTING AND INSPECTION

List of TCs arranged as per Approved Quality Plan shall be furnished along with copy of TCs at the time of inspection by BHEL

- Visual inspection of sheets/plates, angles, channels etc. – Pitting, lamination in sheets/ plates, angles and channels shall be avoided.- visual inspection by main contractor of BHEL.
- Sheets/ Plates - Test certificate shall be furnished for physical and chemical properties for sheets / plates- for review by BHEL
- Shaft: Mechanical and chemical-– review by BHEL
- Motors (of approved make): Routine TC ,FLP TC if applicable
- Workmanship and dimensional check as per manufacturing drg. and approved Drgs.- by main contractor of BHEL.- Shall be checked by BHEL/ Customer during final inspection.
- Balancing of impellers- Dynamic balancing certificates shall be furnished –grade 6.3 or better to ISO-1940. Balancing weights shall be positively locked/ welded to avoid loosening. - witness by manufacturer - TC to be furnished for review by BHEL(consisting of weight of impeller, radius of correction and balancing rpm). For spare impellers Dynamic Balancing shall be witnessed by BHEL.
- Performance test of one Centrifugal fan or Axial Fan /per type/per size as per applicable standard – by BHEL.
- Centrifugal/ Axial fans 100% run tested by main contractor of BHEL. Run test by BHEL/Customer may be at random or 100%- Vibration shall be within satisfactory zone of VDI 2056 (group- G) machines when measured on bearing housing and noise level <85 dbA at 1 metre distance. Max. Temp. on bearing housing- 40 degrees Centigrade + ambient

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7. DRAWINGS/DOCUMENT/DATA REQUIRED AFTER AWARD OF CONTRACT

7.1 GA drawing & data- sheet to be submitted along with technical schedules enclosed in Volume III.

7.2 Drawing including equipment layout, foundation & loading details etc. for civil works. These drawings must cover sufficient details so that design of civil works can be completed.

7.3 Equipment description giving complete design calculations, basis of design, selection criteria etc.

7.4 Test Certificates.

7.5 Performance Test Certificates.

7.6 Final as built documentation i.e. final-version of all drawings, data & information as per the requirement specified elsewhere.

7.7 Installation and erection manual.

7.8 Inspection, operation & Maintenance Manuals.

7.9 Vendor shall also provide soft copy of each drawing in AutoCAD format.

7.10 Vendor shall also provide final-version of all drawings in 3-D as per the requirement specified elsewhere.

TITLE	SPECIFICATION NO. PES-571-11000-A-03	
CENTRIFUGAL FAN	VOLUME II-B	
DATA SHEET - A	SECTION D	
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No.	Particulars	Data
1	**General Information**	
1.1	Fan Designation/application.	Refer schedule of Ventilation system.
1.2	Nos. required/capacity	Refer Section-C of Specific Technical Requirement
1.3	Location	Refer layout drg. Attached.
2.0	**Design Data**	
2.1	Type	DIDW for Ventilation
2.2	Type of blades	backward curved
2.3	Arrangement	To suit application as per layout.
2.4	Discharge direction	To suit application as per layout.
2.5	Duty	Continuous
2.6	Capacity at site (Cubic Meter/hr) & static pressure.	Refer Section-C of Specific Technical Requirement
2.7	Suction pressure (mm Wg)	As per system requirement.
2.8	Fluid	Atmospheric Air.
2.9	Suction Temperature	Refer weather data attached.
2.10	Suction humidity	Refer weather data attached.
3.0	**Materials**	
3.1	Fan Scroll	Heavy Gauge Mild Steet to IS: 2062 with galvanised
3.2	Fan Casing (side plates & stiffeners)	Heavy Gauge Mild Steet to IS: 2062 / IS: 1079 / Eq. Minimum 3 mm thick casing.
3.3	Impeller	Mild Steel/plate to IS: 2062
3.4	Impeller hub	Mild Steet/plate to IS: 2062
3.5	Impeller back plate blade & shroud	Mild Steet to IS: 2062 / IS: 1079 / Eq.
3.6	a) Shaft b) Shaft sleeve	EN-8 or eqv. -do-
3.7	Support frame and structure.	Mild Steet to IS: 2062
3.8	Flexible connection at outlet canvas with MS Flanges and cleats (3mm thick).	Fire resistant type plastic impregnated

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CENTRIFUGAL FAN	VOLUME II-B
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3.9	V Belt	ISI marked (Reinforced rubber section to IS: 4776)
3.10	V Pulley	Cast Iron multi groove to grade FG 20 as per IS: 210. Having taper lock type
3.11	Slide rails	M.S./C.I.
3.12	Connection pieces	G.I. according to supplier's design
3.13	Bolts & nuts	M.S. Galvanized / Epoxy painted.
3.14	Vibration isolating pads, washers and spring if any.	Hard synthetic rubber
4.0	**ACCESSORIES**	
4.1	Common base plate	Required.
4.2	Anchor bolts	-do-
4.3	Vibration Isolators	Hard synthetic rubber
4.4	V-belt pulleys	-do-
4.5	V-belts	Reinforced rubber of appropriate section
4.6	Belt guard	Required.
4.7	Outlet damper	Required(M.S. Heavy Gauge)
4.8	Inlet guard	Required.
4.9	Inlet Vane (variable)	Not required.
4.10	Drain valve	Required.
4.11	Acoustic silencers	Not required.
5.0	**Motor**	
5.1	Motor by	Bidder
5.2	Starter by	BHEL
6.0	Painting of fans including base frame	Galvanized / epoxy painting (as per Section-C & painting specifications)

NOTE:

1) Motors shall have 15 % margin on duty power point.

2) Fan shall be designed to operate with in 9% and 25% of system throttling line.

3) Opposed Multiple louvers damper shall be provided at fan outlet.Louvres shall be of 2 mm thick MS (galvanized). Casing shall be of 3.15 mm thick MS (galvanized).

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Ventilation Fan (Axial Flow Type)	VOLUME II-B	
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No.	Particulars	Data
	General Information	
1)	Designation	Supply/Exhaust Fans.
2)	Nos. required	Refer schedule of Ventilation system in section-C under specific technical requirement.
3)	Service	To exhaust warm air/to supply fresh air.
4)	Location	Wall mounted.
5)	Area	Same as above in 2.
	Design Data	
6)	Type supply	Axial fans suitable for 415V/3 phase for Motor.
7)	Air delivery capacity	As per schedule of ventilation system.
8)	Fluid	Atmospheric Air.
9)	Temperature	Refer Section of specific technical requirement
10)	Static Pressure required	As per Section'C' schedule of ventilation system.
11)	Outlet Air Velocity	Not more than 12 m/sec.
	Materials	
12)	Casing	M.S. (IS-2062)
13)	Impeller	Cast A1uminium. (Alloy A-6M, IS-617)
14)	Hub	Al Alloy.
15)	Support frame and structure. (Galvanized/	M.S. of adequate thickness Painted) IS-2062.
16)	Neoprene rubber pads	As required.
17)	Coned inlet for wall exhausters/supply fans	MS (IS-2062)
18)	Supporting frame for mounting.	Required.
19)	Protective screen at inlet.	Yes (Min 14 SWG Galvanized wire knitted in 1" square mesh.
20)	Rain Protection Cowl	Aluminum or hot dip Galvanized after fabrication from M.S.

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TITLE	SPECIFICATION NO. PES-571-11000-A-03	
Ventilation Fan (Axial Flow Type)	VOLUME II-B	
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Motor

21)	Motor by	Bidder
22)	Starter by	BHEL

NOTE:

1) For Battery Room, motor for fan shall be of flame proof type & fan of spark proof construction with Epoxy painting.

2) Gravity type damper shall be provided at the outlet of axial fan for exhaust application.

3) Motor shall have 15% margin over Duty Point.

	TECHNICAL SPECIFICATION AIR FILTER	SPECIFICATION NO. PES- 571-11000-A-006	
		VOLUME II B	
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SECTION-D

AIR FILTER

	TECHNICAL SPECIFICATION AIR FILTER	SPECIFICATION NO. PES- 571-11000-A006
		VOLUME II B
		SECTION D
		REV. 00 | DATE: JAN 2020
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1. GENERAL

This specification covers the design, manufacture, inspection and testing at manufacturer's work or his sub-contractor's works of Air filters to be used for air-conditioning and ventilation system.

2. CODES AND STANDARDS

This design, manufacture and performance of AIR FILTERS shall comply with all currently applicable statutes, regulation and safety codes in the locality where the equipment will be installed. The equipment shall also conform to latest applicable Indian/British/USA standards. Nothing in this specification shall be construed to relieve the vendor of this responsibility. The following standards, in particular, shall be applicable for certified ratings of filters and for conducting performance test, if required.

a) BS EN - 779 -Methods of test for air filters used in air conditioning and general ventilation.

3. GENERAL

The enclosed Data sheet A gives the type and other particulars of filters required.

3.1 POLY FIBRE AIR FILTERS

Filtering media shall consist of a suitable fibrous material (e.g. polyethylene extruded sections coir etc.) packed into a 20 gauges GSS framework, complete with handles etc. The filter element shall be supported by galvanised steel wire mesh of 10mm. sq. on either side, Velocity across the filters shall not exceed 2.5 M/sec. Average efficiency Em (%) shall be >/= 80 as per BS EN - 779.

3.2 DRY FABRIC AIR FILTERS

Filter element shall be pressed felt filter fabric or suitable material recommended by the manufacturer, stitched on to galvanised wire gauge support and crimped to form deep folds. Suitable aluminium spacers shall be provided to ensure uniform distribution of air flow through filters. Filter casing shall be provided with neoprene sponge rubber sealing, The filter shall have Average efficiency Em (%) of >/= 95 as per BS EN - 779.

3.3 PANEL TYPE METALLIC FILTERS (DRY/VISCOUS)

Filter shall consist of V-fold galvanised wire mesh interspaced with flat layers of galvanised wire mesh. The density of media shall increase in the direction of air flow. Edges of wire mesh shall be suitably hemmed to prevent abrasion during handling. The media shall be supported on either side by galvanised expanded metal casing. The framework shall be at least 18 gauge GSS. Filter shall be either dry or wetted type as per data sheet=A. The oil shall be mineral oil of approved quality and make. As a the filter frame made of Aluminium alloy conforming to IS:737 can be considered unless use of aluminium is prohibited otherwise due to site conditions being saline/corrosive.

All filters shall be capable of being cleaned of their accumulated dust by tap water flushing. The dry metallic filter shall have Average arrestance Am (%) shall be >/= 90. However oil wetted air filters shall have Average Efficiency Em (%) >/= 90 as per BS EN - 779..

3.4 AUTOMATIC CLEANING FILTERS

This shall consist of a filter mat and drop eliminator, driven by a suitably rated geared

motor unit being supported on a steel framework. The filter mat shall consist of an endless steel wire mat insets of steel mesh held between an upper & a lower shall drop eliminator shall consist of an endles steel wire without insets of steel mesh. The unit shall include a suitable oil pump, gladge raking mechanism and sludge container and tensioning device. Pressure drop shall be limited to 0.5 / mm WG when clean & 10 mm when dirty. Air velocity across filter shall not exceed 3 M/sec.

3.5 ABSOLUTE FILTERS

Filters shall be constructed by pleating a continuous sheet of filter medium into closely spaced pleats separated by heavy corrugated aluminium spacers. They shall be individually tested and certified to have an efficiency of not less than 99.97% when tested with 0.3 micron dioctyphalate smoke as per IS:2831. The clean filter initial static pressure drop shall not be greater than 25mm WC at rated capacity. A neoprene sponge rubber sealing shall be provided on either face of filter frame.

3.6 WATER REPELLANT NYLON FILTERS

This shall be constructed of water repellent nylon fabric with continuous water spraying on it from a header for keeping it clean. Efficiency of this filter shall be 85% down to 10 microns. This filter shall be used for unitary air filtration system only.

4. INSPECTION & TESTING

The scope of inspection for air filters shall be as below:

4.1 Dimensional inspection of frame & filter media.

4.2 Witnessing of type tests on one per type per size air filters for the following properties.

a) Gravimetric efficiency.

b) Pressure drop in clean & dirty (choked - %age to be specified) condition.

c) Efficiency as per BS EN - 779.

4.3 Verification of type test certificates for similar type & size of filters for sodium flame test as per BS-3928 (if applicable- refer data sheet).

5. DATA TO BE FURNISHED BY VENDOR AFTER AWARD OF CONTRACT

5.1 GA Drawing.

5.2 Drawing showing material/construction detail

5.3 Installation and\service manual

5.4 Rating curves/charts

5.5 Test certificates

5.6 Elect. diagrams (when automatic cleaning type)

5.7 Vendor shall also provide soft copy of each drawing in AutoCAD format.

5.8 Vendor shall also provide final-version of all drawings in 3-D as per the requirement specified elsewhere.

TITLE	SPECIFICATION NO. PES-571-11000-A-06	
AIR FILTER **DATA SHEET - A**	VOLUME II-B	
	SECTION D	
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DESCRIPTION		**DATA**
1)	**General**	
1.1	Service	: Air Conditioning & Ventilation.
1.2	Location	: Ventilation plant, & Ductable Split AC plant, fresh air fan system. Also for split AC.
1.3	Nos.	: Refer Section 'C' of Specification.
1.4	Total air flow/type	: Refer Section 'C' of Specification.
1.5	Temperature	: As per project information.
1.6	Relative Humidity	: 100%
1.7	Gas Composition	: Atmospheric Air (Dusty) as prevalent in power Station.
1.8	Filter Media	: Synthetic non-woven
1.9	Efficiency filters.	: Average arrestance efficiency of 65-80 % for Dry Panel filter (pre-filters) and average arrestance Efficiency of 80 % down to 20 micron for
1.10	Allowable pressue drop	: 2.5 mm & 6.5 mm in clean and dirty condition respectively for dry panel filters(prefilters). 12 mm in clean condition for fine filters.
1.11	Frame Work	: 18 G, GSS.
1.12	Mounting	: Ladder Type M.S Angles (galvanised)
1.13	Size	: 600 x 600 mm

Note:-

1) Face velocity of air across the filters shall not exceed 2.5 m/sec and for absolute filters velocity shall not exceed 1.5 m/sec.

BHEL	TECHNICAL SPECIFICATION LOW PRESSURE AIR DISTRIBUTION SYSTEM	SPECIFICATION NO. PES- 571-11000-A-007
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SECTION-D

LOW PRESSURE AIR DISTRIBUTION SYSTEM

	TECHNICAL SPECIFICATION LOW PRESSURE AIR DISTRIBUTION SYSTEM	SPECIFICATION NO. PES- 571-11000-A007
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1. GENERAL

1.1 This specification covers the design, manufacture, construction features, installation, inspection testing and air balancing of air distribution system upto a total pressure of 95mm w.g. The specification is intended to cover the air distribution for air conditioning system and ventilation system not involving localised exhaust.

2. CODES AND STANDARDS

2.1 The design, construction and performance of complete system shall conform to all currently applicable stuatues, regulations, safety codes in the locality where the equipment are to installed

2.2 Unless specified otherwise the equipments shall generally conform to latest applicable Indian Standards. Nothing in this specification shall be construed to relieve the vendor of this responsibility. In particular the equipment shall generally conform to latest editions by the following standards:-

a) IS: 655 - Specifications for metal air ducts.

b) IS:277 - Specifications for galvanised steel sheets.

c) IS:737 - Specification for wrought aluminium and aluminium alloy sheet and strip.

3. MATERIAL

3.1 Metal air ducts shall be either of galvanised steel sheets or aluminium sheets, as indicated in data sheet-A.

3.2 The rolled steel sheets before galvanising shall be properly annealed or normalised so as to allow fabrication of ducts without developing cracks. Zinc coating on the steel shall be as per technical requirement refer to Section-C of Specific Technical Requirements.

3.3 The aluminium sheets shall be of grade S1C or NS3 and shall be suitable for duct fabrication work as per IS-737 latest

4. CONSTRUCTION/FABRICATION

4.1 The thickness of sheets, the type of bracing and other fabrication details shall generally conform to requirements given hereunder unless specified otherwise in data sheet A and/or indicated on drawings.

4.2 **RECTANGULAR DUCTS**

4.2.1

S.No.	Max Side	Sheet Thickness		Type of transverse Joint connections	Bracings
		(mm) GI	(mm) Al		
a)	Up to 600	0.63 (24G)	0.80	S-drive, pocket or bar slips or flanged joints on 2.5m centres	None

b)	601 to 750	0.63 (24G)	0.80	S-drive, 25mm pocket or 25mm bar slips or flanged joints on 2.5m centres	25x25x3 mm MS angles, 1.2m from joints
c)	751 to 1000	0.80 (22G)	1.00	S-drive, 25mm pocket or 25mm bar slips or flanged joints on 2.5m centres	25x25x3 mm MS angles, 1.2m from joints
d)	1001 to1500	0.80 (22G)	1.00	40x40x3mm MS angle, flanged connections or 40mm pocket or40mm bar slips with 35x3mm bar reinforcing on 2.5m centres	40x40x3 mm MS angles, 1.2m from joints
e)	1501 to2250	1.00 (20G)	1.50	40x40x3mm MS angle, flanged connections or 40mm pocket or40mm bar slips, 1M maximum centres, with 35x3mm bar reinforcing	40x40x3 mm diagonal angles or 40x40x3mm angles, 600mm from joints
f)	2251 & above	1.25 (18G)	1.80	50x50x3mm MS angles,connections or 40mm pocket or 40 mm bar slips, 1M maximum centres with 35x3mm bar reinforcing.	50x50x3mm diagonal angles or 50x50x3mm angles 600 mm from joints.
g)	No bracing is required if transverse joints are less than 600mm apart				
h)	For ducts larger than 2250mm, special handling and supporting methods shall be provided as per the approval of Purchaser				

4.2.2 All rectangular ducts having either dimension larger than 450mm shall be cross broken except these ducts which are insulated with sand cement plaster. Air outlet connections on ducts need not be cross broken.

4.2.3 The seams on duct cones shall be of Pittsburgh type. Longitudinal seams shall be smooth inside the ducts.

4.2.4 The flanges used for transverse joints shall be joined together with GI bolts (grade 4.6) and nuts spaced at 125mm centres as per following:

a) Upto 1000mm - 6 mm dia GI bolts
b) 1001 to 1500 - 8 mm dia GI bolts
c) 1501 and above - 10mm dia GI bolts

4.2.5 The MS angle flanges shall be connected to ducts with rivets at approx. 100mm centres. The flanged joints shall have 6mm thick felt packing stuck to flanges with shellac varnish. The holes in the felt packing shall be burnt through. The ducts are to be tapped 6mm across the MS flanges.

4.2.6 MS angles used for bracings shall be tack welded to the ducts or rivetted at 125mm centres, as applicable.

4.3 **ROUND DUCTS**

4.3.1

S.No.	Duct dia-mm	Sheet Thickness		Reinforcing
		(mm) GI	(mm) Al	
a)	Up to 150	0.63 (24G)	0.80	None
b)	151 to 600	0.80 (22G)	1.00	None
c)	601 to 1000	1.00 (20G)	1.50	40x40x3mm girth MS
d)	1001 to1250	1.00 (20G)	1.50	40x40x3mm girth MS angles at 2.0 meter centres
e)	1251 & above	1.25 (18G)	1.80	40x40x3mm girth MS angles at 1.2m centres

4.3.2 The seams on round ducts may be continuously welded or grooved longitudinal seam. In case of welding of GI sheet, zinc rich paint shall be applied on the welded zone.

4.3.3 Round ducts shall either be joined by welding or the ducts shall be swedged 40mm from the ends such that larger end will butt against the swedge and is held in place with sheet metal screws.

4.4 **DUCT SUPPORTS**

Unless specified otherwise on drawings, rectangular ducts with larger side of 2250mm or above shall be supported by 15mm MS rods and 50x50x3mm and MS angles while those below 2250 mm shall be supported by 10mm MS rods and all angles shall be given a coat of primer paint. The duct supports shall be at a distance not exceeding 1800mm. The MS rods shall be fixed to MS angle cleats, which in turn are fixed to ceiling slab by suitable anchor fasteners. All anchor fasteners, MS angle cleats, coach screws, hooks and other supporting material required shall be provided by vendor.

However, If ducts are thermally insulated, the MS angles and supports shall not be in direct contact with ducts, for which purpose wooden pieces/ Resin bonded fibre glass sheets (50 mm thick) shall be used in between.

4.5 **FLEXIBLE CONNECTIONS**

Wherever the sheet metal ducts connects to intake or discharge of fan units a flexible connection of at least 150mm width made by closely woven double layer Fire resistant or canvas shall be provided. The same shall be attached to angle iron frames on equipment and to similar frame on duct or casing by means of a steel band 9r (or) collar fitting over the end of the flexible connection and bolted through angle iron frame so as to clamp securely between the band and the angle frame.

4.6 **TRANSFORMATIONS AND BREACHES**

All curves, bends, offsets and other transformations shall be made for easy and noiseless flow of air. The throat of every branch duct shall be sized to have a velocity not exceeding that in the main duct to which the branch is connected.

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4.7 **CAULKING**

Wherever duct passes through wall, the opening between masonary and duct work shall be neatly caulked or sealed to prevent movement of air from one space to adjoin by space with a rated fire resistant material.

4.8 **EASEMENT**

Normally pipe hangers, light fitting rods etc. shall not be allowed to pass through the ducts. Wherever, It becomes absolutely essential to pass these hangers/rods etc. Through the ducts, prior approval of purchaser shall be taken and light streamlines easement around the same shall be provided to maintain smooth air flow.

4.9 **ACCESS DOORS**

Access doors shall be provided in ducts, plenums etc. on both sides to allow access and servicing of equipment viz. pipes, dampers, coils, valves, heaters etc.

All access doors shall be adequately sized and lined suitably with felt to prevent air leakage. The doors shall be of built-up construction, structurally strong and shall have at least two hinges each, and shall be with two rust proof window sash locks of approved type. All doors shall be so set as to flush with outer finish of duct insulation etc.

4.10 **DAMPERS AND SPLITTERS**

4.10.1 Dampers and splitters shall be provided at suitable points for proportional volume control of the system. Splitters and dampers shall be made of minimum 18 gauge GSS of quadrant type with locking device mounted outside the duct at accessible location.

4.10.2 FIRE DAMPERS

Fire dampers shall be provided as specified in Data Sheet -A and shall be installed at locations indicated on drawings and/or as required/approved by purchaser, including all openings in passage of duct work through fire walls and floors etc. The fire damper shall be of electrical type with damper motor actuated by thermal sensor or fusible link type.

4.10.3 VANES

Unless otherwise shown in the drawings all elbows shall be such that the throat radius is 75% of the duct width. In case throat radius is smaller, suitable single thickness vanes of approved details shall be provided.

4.10.4 FLASHING

For the ducts penetrating roofs or outside walls, provision of flashing shall be made by the ducting vendor.

4.11 **DIFFUSERS AND GRILLS**

The type and quantity of diffusers and grills is indicated on enclosed drawings/data sheet A. The size/quantity of diffusers/ grills indicated in the drawing/data sheet is indicative and is for vendor's reference purpose only. Vendor shall ensure that the diffusers/grills offered are of requisite capacity, throw and terminal velocity. The pressure drop and noise levels shall be as per data sheet. A enclosed. The diffusers/grills shall be approved by purchaser.

Unless specified otherwise the diffusers/grills shall be of mild steel land painted with two coats of primer paint. Supply air grills shall be complete with volume control dampers. Supply air grills shall be double deflection type while Return Air grills can be

single deflection type. Ceiling outlets/diffusers shall have volume control dampers, fixed grids and blanking baffles. All volume control dampers shall be operated by a key from the front of grills/diffusers.

Suitable vanes shall be provided in duct collars to have uniform air distribution. Blank-off baffles wherever required, shall also be provided.

4.12 **PLENUMS AND RA BOXING**

All plenum chambers and/or connections to fans, dampers etc. shall be constructed in 18 gauge GI sheet. supported on 40x40x6mm MS angle frames. All vertical angles shall be riveted at appox. 125mm. centres to the casing. Suitable caulking compound (Pecora or equivalent) shall be inserted between the base of the angle and all masonary construction to which angles are fastened.

Return air boxing requirements if any are indicated in data sheet-A and the same shall be provided by vendor. The return air box ~~shall be~~ fabricated out of GI sheets shall be insulated with 25mm thick fibre-glass.

4.13 **ACCOUSTIC LINING**

The ducts shall be lined acoustically from inside as given in data- sheet A and/or section C of the specification.

4.14 **PAINTING**

Wherever specified the ducts shall be painted or lined with suitable anti-corrosive paint/ lining as per approval of purchaser. In particular the ducts coming in contact with acid fumes shall be epoxy coated, inside and outside.

4.15 **THERMAL INSULATION**

Thermal insulation shall be as per data sheet - A and the insulation shall conform to enclosed spec. no. PES-553-08.

5. INSPECTION AND TESTING

5.1 **INSPECTION & TESTING DURING FABRICATION**

5.1.1 Visual inspection of GI sheets and angles, channels etc. – dents, black spots, chipping of zinc coating, white dust on galvanised sheets shall be avoided. Pitting , lamination in angles and channels shall be avoided.

5.1.2 Galvanised sheets - Test certificate shall be furnished for visual check, coating thickness, adhesion test, sheet thickness, uniformity of coating.

5.1.3 Check for dimensions & mass as per latest IS-277.

5.1.4 Check for defect, twists, ungalvanised spots as per IS-2629.

5.1.5 Bend test & wrapping test as per IS-277.

5.1.6 Zinc coating test on samples as per IS-6745.

5.2 **INSPECTION & TESTING AT SITE.**

5.2.1 The duct branches, elbows etc. shall be inspected and the joints and connections etc, are to be checked before they are assembled in position.

5.2.2 After completion, all duct systems shall be checked and tested for air leakage, tightness, velocity, pressure drop, vibration and noise etc.

	TECHNICAL SPECIFICATION LOW PRESSURE AIR DISTRIBUTION SYSTEM	SPECIFICATION NO. PES- 571-11000-A007
		VOLUME II B
		SECTION D
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6. BALANCING

6.1.1 The entire air distribution system shall be balanced by vendor to supply the air quantities as required in various rooms so as to maintain the requisite temperature and air flow in the conditioned spaces. The final balance of air quantities through each grill/diffuser etc. shall be recorded and submitted to purchaser for approval. Proper steps shall be taken to have a uniform temperature in all enclosures, with utmost care for noise level to be within tolerance limit

6.1.2 All instruments required for testing/balancing etc. of the air distribution system shall be provided by vendor.

7. DATA TO BE FURNISHED BY VENDOR AFTER THE AWARD OF CONTRACT

7.1 Fabrication drawings of ducts and grilles, louvers, dampers, etc, including typical details of grilles dampers etc.

7.2 Test certificates in line with scope of inspection.

7.3 Other dimensional drawings & documents as may be required by purchaser for better understanding of the system & for preparation of operation, maintenance & instruction manual**.**

7.4 Installation instruction manual and air balancing manual.

7.5 Duct air leaking test procedure/smoke test procedure.

7.6 Vendor shall also provide soft copy of each drawing in AutoCAD format.

7.7 Vendor shall also provide final-version of all drawings in 3-D as per the requirement specified elsewhere.

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TITLE	SPECIFICATION NO. PES-571-11000-A-07
LOW PRESSURE AIR DISTRIBUTION SYSTEM	VOLUME II-B
DATA SHEET - A	SECTION D
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Description	**Data**
1. General (List of areas)	: As per Specification/Tender drawing.
2. GSS Duct Work a) Type	: GSS as per IS: 277 (Zinc coating as per Section-C of Specific Technical Requirements.)
b) Size	: As per Section-C of Specific Technical Requirements and bill of quantity.
3. Acoustic lining AC Outlet.	: Up to 5m length from Ductable split
4. Special painting	: Galvanised.
5. Thermal Insulation	: Required in supply air duct in AC entire length.
6. Diffusers (Circular/Square) 300 mm size 350 mm size 450 mm size 550 mm size 600 mm size Any other size	: Bidder to estimate as per drawings./specification. All grille frame and louvers shall be manufactured of at least 16 SWG Aluminium
7. SA grilles (for each size)	: To suit air flow as per System requirements / Tender Drawings.
8. RA grilles (for each size)	: -do-

NOTE:

1. Duct sheet thickness shall be as per IS-655
2. Opposed blade type volume control damper shall be provided at each supply air diffusers/grilles.
3. Bidder to provide suitable gasketing at each duct flange.
4. Fire damper shall be motor operated type, when otherwise specified under Section-C.
5. Access door in ducting system shall be provided as required.
6. MS Angle (painted) shall be used for duct supports etc.
7. Velocity thru duct shall normally not exceed 9.0 M/sec for Air conditioning system and 12 M/sec for Ventilation duct. Maximum velocity (outlet) for supply air diffuser shall not exceed 2.5 m/sec.
8. All Grilles & diffusers shall be supported with frame. Frame etc. shall be supplied by bidder.

	TECHNICAL SPECIFICATION THERMAL INSULATION FOR COLD SURFACES	SPECIFICATION NO. PES-571-11000-A-08
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SECTION-D

THERMAL INSULATION FOR COLD SURFACES

	TECHNICAL SPECIFICATION THERMAL INSULATION FOR COLD SURFACES	SPECIFICATION NO.PES-553-08	
		VOLUME II B	
		SECTION D	
		REV. 00	DATE: JAN 2020
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1. SCOPE

This specification covers design, manufacture, testing at manufacturers works, supply, application & finishing of insulation for cold piping, air conditioning ducting & equipment for low temperature service.

2. CODES & STANDARDS

The design, manufacture and performance of materials covered under this specification shall comply with all currently applicable statues, regulations & safety codes in the locality where the equipment/material are to be installed. The material shall also conform to the latest applicable Indian/British/American codes & standards. Nothing in this specification shall be construed to relieve the vendor of his responsibility. In particular, the material shall conform to the latest editions of the following standards :-

2.1 IS:3069 : Glossary of terms & symbols & units relating to thermal insulation materials.

2.2 IS:4671 : Expanded polystyrene for thermal insulation purposes.

2.3 IS:3677 : Mineral wool for thermal insulation.

2.4 IS:8183 : Resin bonded mineral wool.

3. DESIGN REQUIREMENTS

3.1 The insulating material as well as protective covering shall be new & unused, non-corrosive, vermin/rodent proof and shall be guaranteed to withstand continuously & without deterioration the maximum/minimum temperatures to which they may be subjected to, under specified site conditions.

3.2 The insulation material must be light weight, strong, free from shots & coarse fibre & shall provide high insulation efficiency at low weight & coat. It should be non-hygroscopic & should not rot. It shall not settle or shake down even when subjected to prolonged vibrations.

3.3 The insulation material, density and thickness etc. Shall be as specified in DATA SHEET A.

4. APPLICATION DETAILS

4.1 The surface to be insulated shall be thoroughly cleaned and allowed to dry. Pressure / hydrostatic tests, if any, shall be carried out before application of insulation.

4.2 A layer of solvent free, anticorrosive paint shall be applied & allowed to dry.

4.3 Hot industrial bitumen of grade 85/40 or 85/25 conforming to latest IS: 702 shall be uniformly applied @ 1.5 kg/sq.m on the surface to be insulated. A similar layer shall also be applied on the inside surface & edges of the insulation. A suitable cold adhesive compound may also be used in place of bitumen.

4.4 Insulation in the form of pipe sections/rolls slabs of specified density & thickness should be stuck to the coated surface with joints staggered & well butted & secured. The adjoining sections shall be tightly pressed together. All the joints shall be sealed

with bitumen/equivalent adhesive. Voids if any shall be packed with suitably cut pieces of insulation material.

4.5 In case of double layer application both circumferential & longitudinal joints shall be suitably staggered.

5. VAPOR SEALING & INSULATION FINISH

The insulation shall be treated for vapor sealing & weather proofing & finished as specified in DATA SHEET A The acceptable types of finishes are outlined below:-

5.1 FINISHING SYSTEM I: EXTERNAL INSULATION WITH PLASTER FINISH

5.1.1 A thick vapor seal of hot bitumen @ 2.5 kg/Sqm shall be applied on the outer surface of insulation & allowed to dry.

5.1.2 The surface shall then be wrapped with 20mm (3/4"_ hexagonal mesh of 24 SWG GI wire, butting all the joints & laced down with 22 SWG GI lacing wire.

5.1.3 12.5mm (1/2 inch) thick sand cement plaster in the ratio of (1:1) shall be applied in two layers, the second layer being brought to a smooth finish. A water proofing compound shall be added to the cement before its application.

5.2 FINISH SYSTEM II: EXTERNAL INSULATION WITH PLASTER FINISH OVER POLYTHENE.

5.2.1 The insulation shall be covered with 500 g polythene/polythene bonded Hessians (PBH) with 50mm overlap on longitudinal & circumferential joints. Overlaps shall be sealed with synthetic adhesive in case o-f polythene & liberal coat of bitumen in case of PBH:

5.2.2 The surface shall then be wrapped with 20mm (3/4") mesh of 24 SWG GI wire butting all the joints & laced down with 22 SWG GI lacing wire.

5.2.3 12.5mm thick (1/2 inch) sand cement plaster in ratio of(4:1) shall be applied in two layers, the second layer being brought to a smooth & even finish similarly as described above.

5.3 FINISH III: EXTERNAL INSULATION WITH SHEET METAL FINISH

5.3.1 The insulation shall be covered with 500g polythene with 50mm overlaps at joints, which shall be sealed with synthetic adhesive or equivalent compound.

5.3.2 The polythene shall be covered with 24 gauge GI/aluminum sheet

5.3.3 25mm wide x 22 SWG GI/aluminum peripheral straps shall be fixed over the GI/aluminum sheet at 300mm centres to secure.

5.4 FINISH IV: EXTERNAL INSULATION WITH PLASTER & WATER PROOFING COMPOUND

For ducts & piping exposed to atmosphere, the finish shall be as follows:

5.4.1 A thick vapor seal of hot bitumen at 2.05 kg/sq.m shall be applied on the outer surface of insulation & allowed to dry.

5.4.2 The surface shall then be wrapped with 20mm (32/4") hexagonal mesh of 24 SWG GI Wire butting all the joints & laced down with 223 SWG GI lacing wire.

5.4.3 12.5mm thick (1/*2 inch) sand cement plaster in ratio of (4:1) shall be applied in two layers, the second layer being brought to a smooth finish with water proofing compound added to the cement.

5.4.4 3 mm (1/8") thick coat of water proofing compound shall be applied & wrapped with fibre glass RP tissue. A final coat of 3mm thick water proofing compound shall then be applied over the fiberglass RP tissue & allowed to dry. Alternatively, in place of water proofing as desired above, tar felt type 3 grade 1 of IS 1322 with joints overlapped by 75mm shall be fixed & sealed with bitumen & over this 24 SWG. 25mm hexagonal GI mesh shall be fixed with 22 swig. GI lacing wire & finally bitumen paint shall be applied over wire netting.

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6. INSULATION OF PUMPS & VALVES

6.1 For all inspection covers & hatches on equipment, pump casing & valve bodies, flanges etc. the insulation shall be applied such as to facilitate removal with minimum damage to the insulation. This shall be achieved by encasing the insulation in 22 gauge aluminum sheet metal boxes, which shall be bolted together around the equipment to permit easy removal & replacement. Proper care shall be taken to maintain continuity of vapor seal between the static & removable partitions of the insulation.

6.2 The tenderer may offer thickness of insulation & finishes other than that specified in DATA SHEET A. However, calculations/reasons in support of alternative proposal shall be furnished for purchaser's approval.

7. INSPECTION & TESTING (REFER SPEC. NO - PES-553.00)

7.1 All necessary tests, as required to ensure that the material supplied conform to the requirements of applicable codes & standards, shall be carried out at manufacturer's works & test certificates including these for material/accessories shall be furnished for purchasers approval.

8. PAINTING

8.1 Pipe work having insulation & cladding shall be provided with color identification for the fluids handled and for indicating direction of flow.

8.2 Equipment surfaces having insulation and cladding shall also have identification numbers and any other relevant data provided on the insulated surface.

8.3 All painting for insulated surfaces shall conform to the requirement specified elsewhere.

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9. DATA TO BE FURNISHED AFTER AWARD OF CONTRACT

9.1 Final version of data sheet 'B' incorporating changes if any along with design data.

9.2 Test certificates/reports giving result of insulation to ensure conformance to applicable codes & standards & in particular the following:-

a) Thermal conductivity test.

b) Sound absorption coefficient test.

c) Corrosion test.

d) Sulphur content, moisture content, shot content, moisture absorption etc.

e) Compressive strength & cross breaking strength test.

9.3 Sketches / technical literature / sectional drgs. indicating insulation materials finish and method of application etc.

9.4 Manual dealing with safety aspects & instructions for combating fire arising out of insulation work.

9.5 Instructions on erection and maintenance of insulation work.

9.6 Vendor shall also provide soft copy of each drawing in AutoCAD format.

9.7 Vendor shall also provide final-version of all drawings in 3-D as per the requirement specified elsewhere.

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TITLE

INSULATION

DATA SHEET - A

SPECIFICATION NO. PES-571-11000-A-08	
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Insulation Material

Insulation	Code	Thermal Conductivity MW/cm ^{0}C	Density Kg/m^3
Resin bonded mineral wool / glass wool	IS:8183	0.49 at 50 ^{0}C	At least 24 for duct insulation and 48 for acoustic lining.
Mineral Wool Pipe Section (min. Gr.2)	IS:9842	0.43 at 50 ^{0}C	At least 81
Expanded Polystyrene	IS:4671	0.37 at 10 ^{0}C	At least 15
Al foiled face Nitrile rubber / XLPE	EN12667	0.037 at 20 ^{0}C	At least 140

Type of Insulation

S.No.	Surface	Insulation Material	Insulation Form	Thickness (mm)
i)	Supply & Return air duct for air-conditioning system	Resin bonded roll Mineral Wool (IS:8183)	Roll/slab	25
		Or AI foiled face Nitrile rubber/XLPE	Roll/slab	25
ii)	Refrigerant Piping	a) Expanded Polystyrene	Pipe Section	75
		or b) Mineral Wool	Pipe Section	75
iii)	AHU drain pipe	a) Expanded Polystyrene	Pipe Section	25
		or b) Mineral Wool	Pipe Section	25
iv)	AHU drain pan coil section and fan section	a) Expanded Polystyrene	Slabs	25
		or b) Mineral Wool	Slabs	25
v)	Chilled water piping, valves & specialties	a) Expanded Polystyrene	Pipe Section	75
		or b) Mineral Wool	Pipe Section	75
vi)	Chiller	a) Expanded Polystyrene	Slabs	100
		or b) Mineral Wool	Slabs	100
vii)	Chilled Water Pumps	a) Expanded Polystyrene	Slabs	50
		or b) Mineral Wool	Slabs	50
viii)	Expansion tank with pipe	a) Expanded Polystyrene	Slabs/Pipe Section	50
		or b) Mineral Wool	Slabs/Pipe Section	50

Insulation shall be fire retardant class.

SECTION: I

SUB-SECTION: E

LIST OF ANNEXURES

SECTION-I

SUB SECTION E

ANNEXURE-I

LIST OF MAKES-HVAC SYSTEM

HVAC SYSTEM
LIST OF MAKES OF SUB-VENDOR ITEMS-AS APPLIACBLE
(4x225 MW ARUN-3 HYDRO ELECTRIC PROJECT NEPAL)

S.No.	Description	Makes
1.	**CENTRIFUGAL FAN**	FLAKT / KRUGGER / DRAFT AIR / HYDERABAD POLUTION CONTROL / ADVANCE VENTILATION / PATEL AIR / NICOTRA/ SK SYSTEM / MARATHON / CB DOCTOR / SARLA
2.	**AXIAL FLOW FANS/RE UNITS**	HYDERABAD POLLUTION/ SK SYSTEM / ADVANCE VENTILATION / KRUGER / NICOTRA / MARATHON / FLAKT / CB DOCTOR/ PATEL AIR /SITAL
3.	**SPLIT AIR CONDITIONER/ CASSETEE AC**	VOLTAS / BLUE STAR / CARRIER / HITACHI / LG
4.	**INDUCTION MOTORS (LT)**	SIEMENS / ABB / CGL / MARATHON / KEC / BHARAT BIJLEE / NGEF /JYOTI / LHP
5.	**AIR FILTER**	PUROLATOR / FMI / ANFILCO / TENACITY / JOHN FOWLER /SPECTRUM / AIR TECH / PUROMATIC
6.	**INSULTATION MATERIAL**	BEARDSHELL / K-FLEX / PARAMONT/ ARMAFLEX / SUPREME / LLOYDS / UP TWIGA /AEROCELL
7.	**FIRE DAMPER**	TSC / CARRYAIRE / RAVISTAR (SYSTEM AIR)
8.	**STRIP HEATER**	ESCORTS / RACOLD / DASPASS/ ALCO/ HEATCO / HOTSET
9.	**PAN HUMIDIFIER**	RAPID COOL/ HOTSET /ALCO
10.	**BUTTERFLY VALVE**	AUDCO / FOURESS / INTER VALVE / BDK / WEIR BDK / TYCO / CRANE PROCESS / KEYSTONE
11.	**NON RETURN VALVE**	LEADER / H.SARKAR / FLUID LINE / HI -TECH / CRESENT / A V VALVES / BANKIM & COMPANY / SHIVADURGA
12.	**GATE/GLOBE VALVES**	CRESENT / BDK / AUDCO / FOURESS / KIRLOSKAR / SANT / BOMBAY METAL & ALLOYS / BANKIM / LEADER / H SARKAR / AV VALVES / VENUS PUMPS AND ENGG
13.	**RELIEF / PURGE VALVE**	BRASSOMATIC
14.	**PIPING - ERW**	SURYA ROSHNI / TISCO / DADU PIPES / INDUS TUBE / WELSPUN / TATA / BST / JINDAL / SAIL
15.	**GI SHEETS FOR DUCTING**	TISCO / INDIAN IRON & STEEL CO LTD. / RASHITRYA ISPAT NIGAM LTD. / ESSAR/ ISPAT INDUSTRIES / JSW STEEL / LLOYDS STEEL / BHUSHAN / TATA / SAIL / JINDAL
16.	**HUMID STAT**	JHONSON CONTROL / HONEYWELL / PENN
17.	**GRILLES/ DIFFUSERS/VOLUME CONTROL DAMPER**	AIR FLOW/ TSC / AIR MASTER/ CARRYAIRE / RAVI STAR (SYSTEM AIR)
18.	**FLOW METER**	EUREKA / INSTRUMENTATION ENGINEERS PVT LTD / PLACKA /TRAC / FLOW STAR/ SCIENTIFIC DEVICE
19.	**RH SENSOR/TEMP SENSOR**	HONEY WELL /JOHNSON /SIEMENS / GENERAL INSTRUMENTS
20.	**PRESSURE GAUGE**	GENERAL INST CONSORTIUM / BELL / H.GURU INST / WAAREE INSTRUMENTS / H. GURU IND / FORBES MARSHALL / MANOMETER / A.N. INST / GAUGES BOURDON / GLUCK / WIKA / ASHCROFT / BAUMER TECHNOLOGIES/PRECISION MASS PRODUCTS/ BOSE PANDA/ FIEBIG/ JAPSIN/ MICA
21.	**THERMOSTATS**	H.GURU/ FIEBIG/ JAPSIN/ MICA/ PENN/ HONEYWELL

HVAC SYSTEM
LIST OF MAKES OF SUB-VENDOR ITEMS-AS APPLIACBLE
(4x225 MW ARUN-3 HYDRO ELECTRIC PROJECT NEPAL)

22.	**TEMPERATURE GAUGE**	H. GURU IND/ H.GURU INST/ FORBES MARSHALL/DETRIVE INST & ELECTRONICS / PYRO ELECTRIC /TOSHNIWAL BROSS / WAREE INSTRUMENTS / A.N.INST / GOA INSTRUMENTS / WIKA/ ASHCROFT / H GURU (SI)/ BAUMER TECHNOLOGIES/ GAUGE BOURDON/ GOA THERMOSTAT/ BUDENBERG GAUGE/ PRECISION MASS PRODUCTS
23.	**LEVEL GAUGE**	GENERAL INSTRUMENTS / CHEMTROLS / SBEM, PUNE/ AUTOMAT MUMBAI /SIGMA / TOSHNIWAL / TECHNOMATIC / TELACO /LEVCON / D K INSTRUMENTS / PUNE TECHTROL / FLOW STAR/ BLISS ANAND
24.	**PRESSURE SWITCH / DP SWITCHES**	BELLS / DANFOSS / DK INSTRUMENTS/ DRESSER / SOR INC / VASU / SWITZER / INDFOSS / TRAFAG / GIC / ASHCROFT/ KASTURBA UDYOG/ BARKSDALE/ PRECISION MASS/ MITTAL REFRIGERATION
25.	**LEVEL SWITCH**	SBEM / BLISS ANAND / HI TECH / RAMAN INST / SIGMA / SOR INC / WAREE INST / LEVCON / DK INSTURMENT / V AUTOMAT /CHEMTROLS / SIMENS / FLOW STAR / TRAC/ NIVO CONTROLS/ PUNE TECHTROLS/ SAPCON INSTRUMENTS/ BAUMER TECHNOLOGIES/ GIC
26.	**ROTAMETER**	CHEMTROLS SAMIL / EUREKA IND / IL / TRANSDUCERS AND CONTROL
27.	**CONTROL PANEL**	INDUSTRIAL CONTROL & APPLIANCE/ PYROTECH /POSITRONICS / CONTROL & SWITCHGEAR /SIEMENS / L&T /GE POWER /RITTAL / HOFFMAN
28.	**FIBRE OPTIC CABLE**	BIRLA ERICSON / FINOLEX / AKSH FIBRE
29.	**LT ADAPTER BOX FOR AL TO CU CABLE CONVERTOR**	CONTROL DEVICE / SYSTEM POWER CONTROL / JACKSON / UNILEC / ELECTRIC ALLIED PRODUCT
30.	**ANNUNCIATOR FOR PANEL**	ICC / PECON/ PROCON
NOTE		
	1. THE SUB VENDOR LIST ABOVE IS INDICATIVE ONLY AND IS SUBJECT TO BHEL AND CUSTOMER APPROVAL DURING DETAILED ENGINEERING STAGE WITHOUT ANY COMMERCIAL & DELIVERY IMPLICATION TO BHEL. BIDDER TO PROPOSE SUB VENDOR WITHIN 4 WEEKS OF PLACEMENT OF LOI. THEREAFTER NO REQUEST FOR ADDITIONAL SUB-VENDOR SHALL BE ENTERTAINED. 2. THE INSPECTION CATEGORY WILL BE INTIMATED AFTER AWARD OF CONTRACT BY BHEL/CUSTOMER. HOWEVER, THE SAME WILL BE ADHERED BY THE BIDDER WITHOUT ANY COMMERCIAL AND DELIVERY IMPLICATION TO BHEL/ CUSTOMER. 3. PLEASE ALSO REFER RESPECTIVE SUB-SECTION C-3 & C-4 FOR ELECTRICAL AND C&I RELATED EQUIPMENT LIST OF MAKE.	

SECTION-I

SUB SECTION -E

ANNEXURE-II

MANDATORY SPARE LIST

(REFER SUGGESTIVE PRICE FORMAT)

SECTION-I

SUB-SECTION-E

ANNEXURE-III

LIST OF TOOLS & TACKLES
AND
LIST OF COMMISSIONING SPARES

(REFER SUGGESTIVE PRICE FORMAT)

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SECTION-I

SUB-SECTION-E

ANNEXURE-IV

DRAWINGS / DOCUMENTS SUBMISSION PROCEDURE (COVERED UNDER SUB SECTION C2-B)

	ARUN-3 HYDRO ELECTRIC PROJECT NEPAL (4X225 MW) HVAC SYSTEM MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION	SPECIFICATION No: PE-TS-437-571-11000A-A001 SECTION: I SUB-SECTION: E REV 00 / DATE: OCTOBER 2020 SHEET 1 OF 4

SECTION-I

SUB-SECTION-E

ANNEXURE-V

MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION

	ARUN-3 HYDRO ELECTRIC PROJECT NEPAL (4X225 MW) HVAC SYSTEM MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION	SPECIFICATION No: PE-TS-437-571-11000A-A001	
		SECTION: I	
		SUB-SECTION: E	
		REV 00	DATE: OCTOBER 2020
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S. NO.	BHEL DRAWING NO.	DRG./ DOC. TITLE	SCH. WEEK (FROM DATE OF LOI)
1.	PE-V0-437-571-11000-A001	INSPECTION CATEGORIZATION AND SUBVENDOR LIST FOR HVAC SYSTEM	04
2.	PE-V0-437-571-11000-A006	QUALITY PLAN OF CENTRIFUGAL FANS	12
3.	PE-V0-437-571-11000-A007	QUALITY PLAN OF AXIAL FANS	14
4.	PE-V0-437-571-11000-A008	QUALITY PLAN OF MOTOR	18
5.	PE-V0-437-571-11000-A009	QUALITY PLAN OF MCC/SWITCHGEAR	18
6.	PE-V0-437-571-11000-A010	QUALITY PLAN OF CABLES	18
7.	PE-V0-437-571-11000-A101	HEAT LOAD CALCULATION FOR AC AREAS	04
8.	PE-V0-437-571-11000-A102	OPERATION AND CONTROL PHILOSOPHY FOR HVAC SYSTEM	06
9.	PE-V0-437-571-11000-A104	VENTILATION FAN SCHEDULE.	18
10.	PE-V0-437-571-11000-A105	SPLIT AC SCHEDULE	18
11.	PE-V0-437-571-11000-A206	DATA SHEET & GA FOR SPLIT AC	16
12.	PE-V0-437-571-11000-A207	DATA SHEET & GA FOR CENTRIFUGAL FANS	12
13.	PE-V0-437-571-11000-A208	DATA SHEET & GA FOR AXIAL AND PROPELLAR FANS	14
14.	PE-V0-437-571-11000-A212	DATA SHEET FOR INSULATION	10
15.	PE-V0-437-571-11000-A213	DATA SHEET & GA FIRE DAMPER WITH ACTUATOR.	12
16.	PE-V0-437-571-11000-A214	DATA SHEET FOR INSTRUMENTS	16
17.	PE-V0-437-571-11000-A216	DATA SHEET OF GI AND MS SHEET.	9
18.	PE-V0-437-571-11000-A217	DATA SHEET & GA FOR PRE AND FINE FILTERS.	14
19.	PE-V0-437-571-11000-A218	DATA SHEET & GA FOR MOTORS (Fan, Supply and Exhaust axial fans)	19
20.	PE-V0-437-571-11000-A219	DATA SHEET & GA FOR HEATERS	10
21.	PE-V0-437-571-11000-A221	TECHNICAL DATA SHEET & G.A. DRAWING HUMIDIFIER	12
22.	PE-V0-437-571-11000-A222	GA OF AIR TERMINALS LIKE SUPPLY/RETURN AIR DIFFUSER / GRILL / BACK DRAFT DAMPER / INTAKE LOUVER ETC FOR HVAC SYSTEM	18
23.	PE-V0-437-571-11000-A502	SCHEME FOR AIR DISTRIBUTION IN POWER HOUSE AND TRANSFORMER HALL	8
24.	PE-V0-437-571-11000-A503	PID FOR VENTILATION SYSTEM	04

	ARUN-3 HYDRO ELECTRIC PROJECT NEPAL (4X225 MW) HVAC SYSTEM MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION	SPECIFICATION No: PE-TS-437-571-11000A-A001	
		SECTION: I	
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25.	PE-V0-437-571-11000-A504	TYPICAL Details- DUCT FABRICATION DRAWING / SUPPORT / ERECTION. INSULATION OF DUCTING / PIPING & EQUIPMENTS, PIPE ERECTION	10
26.	PE-V0-437-571-11000-A505	AC DUCT LAYOUT FOR CONTROL ROOM AND OTHE APPLICABLE AREAS	18
27.	PE-V0-437-571-11000-A507	VENTILATION ROOM & VENTILATION DUCT LAYOUT FOR ALL THE FLOOR FOR POWER HOUSE AND TRANSFORMER HALL ALONGWITH FOUNDATION DETAIL OF VENTILATION EQUIPMENT	14
28.	PE-V0-437-571-11000-A508	VENT. ARRANGEMENT FOR BATTERY ROOM ALONGWITH FAN FIXING DETAIL.	18
29.	PE-V0-437-571-11000-A509	VENT. ARRANGEMENT FOR VARIOUS AUXILIARY BUILDING ALONGWITH FAN FIXING DETAIL.	20
30.	PE-V0-437-571-11000-A510	VENTILATION ROOM & VENTILATION DUCT LAYOUT FOR BUTTERFLY VALVE HOUSE AREA ALONGWITH FOUNDATION DETAIL OF VENTILATION EQUIPMENT	16
31.	PE-V0-437-571-11000-A511	VENTILATION ROOM & VENTILATION DUCT LAYOUT FOR DAM AREA ALONGWITH FOUNDATION DETAIL OF VENTILATION EQUIPMENT	18
32.	PE-V0-437-571-11000-A512	VENTILATION DUCT FABRICATION DERAWING	22
33.	PE-V0-437-571-11000-A701	ELECTRICAL PANEL DRAWING INCULDING SLD	20
34.	PE-V0-437-571-11000-A703	ELECTRICAL FEEDER LIST.	16
35.	PE-V0-437-571-11000-A704	CABLE SCHEDULE	20
36.	PE-V0-437-571-11000-A705	TDS FOR POWER AND CONTROL CABLES-TYPE TEST CERTIFICATE FOR CALES, TYPE TEST PROCEDUE, CROSS SECTION	22
37.	PE-V0-437-571-11000-A706	TDS AND GA FOR ELECTRICAL PANEL- SCHEME, SLD, BILL OF MATERIAL	22
38.	PE-V0-437-571-11000-A707	TDS FOR CABLING-CABLE TRAY, CABLE SUPPORT, TYPE TEST CERTIFICATE, JOINTING KITS, TRIFOIL CLAMPS, ABOVE GROUND EARTHING	24
39.	PE-V0-437-571-11000-A708	DRIVE LIST FOR HVAC SYSTEM	16
40.	PE-V0-437-571-11000-A709	I/O LIST FOR HVAC SYSTEM	16
41.	PE-V0-437-571-11000-A710	LOGIC DRAWING FOR HVAC SYSTEM	20
42.	PE-V0-437-571-11000-A801	PACKING & SHIPMENT PROCEDURE	20
43.	PE-V0-437-571-11000-A901	PERFORMANCE / DEMONSTRATION TEST PROCEDURE.	20
44.	PE-V0-437-571-11000-A902	O & M MANUAL.	28

	ARUN-3 HYDRO ELECTRIC PROJECT NEPAL (4X225 MW) HVAC SYSTEM MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION	SPECIFICATION No: PE-TS-437-571-11000A-A001	
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		SUB-SECTION: E	
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Notes:

1. The above drawing list is tentative and shall be finalized with the successful bidder after placement of order. While some of the drawings indicated above may not be applicable, some additional drawings may also be required based on scope of work.
2. Drawings shall be prepared in auto-cad latest edition. Required no. of hard and soft copies (editable) of the drawings shall be furnished as per requirement specified elsewhere in the specification.
3. Only manual calculation with authentic supporting literature (e.g. extracts of hand book/ standard/codes) shall be acceptable. All design calculations and drawings shall be in SI system only.
4. All the drawings and documents including general arrangement drawing, data sheet, calculation etc. to be furnished to the customer during detailed engineering stage shall include / indicate the following details for clarity w.r.t. inspection, construction, erection and maintenance etc.: -

a) All drawings and documents shall indicate the list of all reference drawings including general arrangement.
b) All drawings shall include / show plan, elevation, side view, cross - section, skin section, blow - up view; all major self-manufactured and bought out items shall be labelled and included in BOQ / BOM in tabular form.
c) Painting schedule shall also be made as a part of general arrangement drawing of each equipment / items indicating at least 3 trade names.
d) All the drawings required to be furnished to customer during detailed engineering stage shall include technical parameters, details of paints and lubrication, hardness and BOQ / BOM in tabular form indicating all major components including bought out items and their quantity, material of construction indicating its applicable code / standard, weight, make etc.
e) Drawings/ documents to be submitted for purchaser's review/ approval shall be under revision a, b, c… etc. while drawings /documents to be submitted thereafter for customer's approval after purchaser's approval shall be under r-0, 1, 2, 3 …. etc.
f) Drawings and documents not covered above but required to check safety of machines/ system, shall be submitted during detailed engineering stage without any commercial implication.
g) All drawings shall include "B.O.M" and indicate quantity, material of construction, make along with IS/BS no., technical parameters, dimensions, hardness, machining symbol and tolerance, requirement of radiography and hydraulic tests, painting details, elevation, side view, plan, skin section and blow-up view for clarity.
h) All drawings shall be prepared as per BHEL'S title block and shall bear BHEL'S drawing no.
i) Schedule of drawings submissions, comment incorporations & approval shall be as stipulated in the specifications. The successful bidder shall depute his design personnel to BHEL'S/ customer's/ consultant's office for across the table resolution of issues and to get documents approved in the stipulated time.
j) Bidder to follow the following the drawing submission schedule:
k) 1st submission of drawings from date of LOI as per the submission schedule (week).
l) Every revised submission incorporating comments – within 7 days.
m) Bidder to submit revised drawings complete in all respects incorporating all comments. Any incomplete drawing submitted shall be treated as non-submission with delays attributable to bidder's account. For any clarification/ discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL for across the table discussions/ finalizations/ submissions of drawings.

	ARUN-3 HYDRO ELECTRIC PROJECT NEPAL (4X225 MW) HVAC SYSTEM FORMAT FOR OPERATION AND MAINTENANCE MANUAL	SPECIFICATION No: PE-TS-437-571-11000A-A001
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SECTION-I

SUB-SECTION-E

ANNEXURE-VI

FORMAT FOR OPERATION AND MAINTENANCE MANUAL

	ARUN-3 HYDRO ELECTRIC PROJECT NEPAL (4X225 MW) HVAC SYSTEM FORMAT FOR OPERATION AND MAINTENANCE MANUAL	SPECIFICATION No: PE-TS-437-571-11000A-A001	
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Project name :
Project number :
Package Name :
PO reference :
Document number :
Revision number :

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
1.0	**COVER PAGE**				
1.1	Project Name				
1.2	Customer/consultant Name				
1.3	Name of Package				
1.4	Supplier details with phone, FAX ,email address , Emergency Contact number				
1.5	Name and sign of prepared by , checked by & approved by				
1.6	Revision history with approval Details				
2.0	**INDEX**				
2.1	showing the sections & related page nos. All the pages should be numbered section wise				
3.0	**DESCRIPTION OF PLANT/SYSTEM**				
3.1	Description /write up of operating principle of system equipment/ associated sub-systems & accessories/controls system , operating conditions, performance parameters under normal , start up and special cases				
3.2	Equipment list and basic parameter with Tag numbers				
3.3	Data sheets approved by Customer/for information and catalogues provided by original manufacturer				
3.4	Associated other packages and Interface /terminal points				
3.5	P&ID & Process Diagrams				
3.6	GA Layout drawings, As-built drawings , Actual photograph of items/system (Drawings of A2 & bigger sizes are to be attached in the last)				
3.7	Single line/wiring diagrams				

	ARUN-3 HYDRO ELECTRIC PROJECT NEPAL (4X225 MW) HVAC SYSTEM FORMAT FOR OPERATION AND MAINTENANCE MANUAL	SPECIFICATION No: PE-TS-437-571-11000A-A001	
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Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
3.8	Control philosophy /control write-ups				
4.0	**COMMISSIONING ACTIVITIES (IF NOT COVERED IN SEPARATE DOCUMENT I.E. ERECTION MANUAL, COMMISSIONING MANUAL)**				
4.1	Pre-Commissioning Checks				
4.2	handling of items at site				
4.3	Storage at site				
4.4	Unpacking & Installation procedure				
5.0	**OPERATION GUIDELINES FOR PLANT PERSONAL/USER/OPERATOR**				
5. 1	Interlock & Protection logic along with the limiting values of protection settings for the equipment along with brief philosophy behind the logic, drawings etc. to be provided.				
5. 2	Start up, normal operation and shut down procedure for equipment along with the associated systems in step by step mode. Valve sequence chart, step list, interlocks etc. with Equipment isolating procedures to be mentioned.				
5. 3	Do's & Don't of the equipment.				
5. 4	Safety precautions to be taken during normal operation. Safety symbols, Emergency instructions on total power failure condition/lubrication failure/any other condition				
5. 5	Parameters to be monitored with normal values and limiting values				
5. 6	Trouble shooting with causes and remedial measures				
5. 7	Routine operational checks, recommended logs & records				
5. 8	Changeover schedule if more than one auxiliary for the same purpose is given				
5. 9	Painting requirement and schedule				
5. 10	Inspection, repair , Testing and calibration procedures				
6.0	**MAINTENANCE GUIDELINES FOR PLANT**				

	ARUN-3 HYDRO ELECTRIC PROJECT NEPAL (4X225 MW) HVAC SYSTEM FORMAT FOR OPERATION AND MAINTENANCE MANUAL	SPECIFICATION No: PE-TS-437-571-11000A-A001	
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Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
	PERSONAL				
6.1	List of Special Tools and Tackles required for Overhaul/Trouble shooting including special testing equipment required for calibration etc.				
6.2	Stepwise dismantling and re-assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained, clearances etc. to be mentioned. Tolerances for fitment of various components to be given.				
6.3	Preventive Maintenance & Overhauling schedules linked with running hours/calendar period along with checks to be given				
6.4	Long term maintenance schedules especially for structural, foundations etc.				
6.5	Consumable list along with the estimated quantity required during commissioning, normal running and during maintenance like Preventive Maintenances and Overhaul. Storage/handling requirement of consumables/self-life.				
6.6	List of lubricants with their Indian equivalent, Lubrication Schedule, Quantity required for each equipment for complete replacement is to be given				
6.7	List of vendors & Sub-vendors with their latest addresses, service centers ,Telephone Nos., Fax Nos., Mobile Nos., e-mail IDs etc.				
6.8	List of mandatory and recommended spare parts list				
6.9	Tentative Lead time required for ordering of spares from the equipment supplier				
6.10	Guarantee and warranty clauses				
7.0	**Statutory and other specific requirements considerations.**				
8.0	**List of reference documents**				
9.0	**Binding as per requirement**				

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SECTION-I

SUB SECTION E

ANNEXURE-VII

PAINTING SPECIFICATION & COLOUR SCHEME (COVERED UNDER SECTION C2-B)

	ARUN-3 HYDRO ELECTRIC PROJECT NEPAL (4X225 MW) HVAC SYSTEM PACKING PROCEDURE	SPECIFICATION No: PE-TS-437-571-11000A-A001
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		SUB-SECTION : E
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SECTION-I

SUB SECTION E

ANNEXURE-VIII

PACKING PROCEDURE
(COVERED UNDER SECTION C2-B)

SECTION-II

SECTION-II

SUB-SECTION-1

INSPECTION AND TESTING

1.01.00 Inspection and Tests during Manufacture.

1.01.01 The method and techniques to be used by the Bidder for the control of quality during manufacture of all plant and equipment shall be agreed with the Owner.

1.01.02 The Owner's general requirements with respect to quality control and the required shop tests are set out elsewhere in this specification.

1.01.03 Before any item of plant or equipment leaves its place of manufacture the Owner shall be given the option of witnessing inspections and tests for compliance with the specification and related standards.

1.01.04 Advance notice shall be given to the Owner as agreed in the Contract, prior to the stage of manufacture being reached, and the piece of plant must be held at this stage until the Owner has inspected the piece, or has advised in writing that inspection is waived. If having consulted the Owner and given reasonable notice in writing of the date on which the piece of plant will be available for inspection, the Owner does not attend the Bidder may proceed with manufacture having forwarded to the Owner duly certified copies of his own inspection and test results.

The owner's representative shall have at all reasonable times access to bidder's or his sub-vendor's premises and shall have power to inspect/ examine materials and workmanship or equipment under manufacture.

The Bidder shall forthwith forward to the engineer duly certified copies of the Test Certificates in six copies (one to the Purchaser and five to the Consulting Engineer) for approval. Further nine (9) copies of Shop Test Certificates shall be bound with Instruction Manuals referred to elsewhere.

For electrical equipment, routine tests as per relevant IS spec are to be carried out on all equipment. Type tests are also to be carried out on selected equipment as detailed in the specs of concerned electrical equipment.

1.01.05 Under no circumstances any repair or welding of castings be carried out without the consent of the Engineer. Proof of the effectiveness of each repair by radiographic and/or other non-destructive testing technique, shall be provided to the Engineer.

1.01.06 All the individual and assembled rotating parts shall be statically and dynamically balanced in the works.
Where accurate alignment is necessary for component parts of machinery normally assembled on site, the Bidder shall allow for trial assembly prior to dispatch from place of manufacture.

1.01.07 All materials used for the manufacture of equipment covered under this specification shall be of tested quality. Relevant test certificates shall be made available to the Purchaser. The certificates shall include tests for mechanical properties and chemical analysis of representative material. Equipment or parts coming under any statutory

Regulations shall be certified by a Competent Authority under the regulations in the specified format.

1.01.08 All pressure parts connected to pumping main shall be subjected to hydraulic testing at a pressure of 150% of shut-off head for a period not less than one hour. Other parts shall be tested for one and half times the maximum operating pressure, for a period not less than one hour.

1.01.09 All necessary non-destructive examinations shall be performed to meet the applicable code requirements.

1.01.10 All welding procedures adopted for performing welding work shall be qualified in accordance with the requirements of Section-IX of ASME code or IBR as applicable. All welded joints for pressure parts shall be tested by liquid penetrant examination according to the method outlined in ASME Boiler and Pressure Vessel code. Radiography, magnetic particle examination magnuflux and ultrasonic testing shall be employed wherever necessary/ recommended by the applicable code. At least 10% of all major but welding joints shall be radiographed unless otherwise stipulated.

Statutory payments in respect of IBR approvals including inspection shall be made by the bidder. Bidder's scope shall include to preparation of all necessary documents, co-ordination and follow-up for above approval. Owner shall only forward assistance/endorsement of documents /design /drawings /reports/records to be submitted for approval as stipulated/ required by Statutory Authorities till registration of the unit and clearance for commercial operation.

1.02.00 Performance Tests at Site

1.02.01 The full requirements for testing the system shall be agreed between the Owner and the Bidder prior to Award of Contract. The completely erected System shall be tested by the Bidder on site under normal operating conditions. The Bidder shall also ensure the correct performance of the System under abnormal conditions, i.e. the correct working of the various emergency and safety devices, interlocks, etc.

1.02.02 The Bidder shall provide complete details of his normal procedures for testing, for the quality of erection and for the performance of the erected plant. These tests shall include site pressure test on all erected pipe work to demonstrate the quality of the piping and the adequacy of joints made at site.

1.02.03 The Bidder shall furnish the quality procedures to be adopted for assuring quality from the receipt of material at site, during storage, erection, pre-commissioning to tests on completion and commissioning of the complete system/equipment.

1.03.00 For details of specific tests required on individual equipment refer to respective section of this specification.

All Statutory testing / clearance is in Bidder's scope including payment of all fees, etc. as required

	ARUN-3 HYDRO ELECTRIC PROJECT NEPAL (4X225 MW) HVAC SYSTEM INSPECTION AND TESTING	SPECIFICATION No: PE-TS-437-571-11000A-A001 SECTION : II SUB-SECTION : 1 REV 00 | DATE: OCTOBER 2020

QAP FORMAT

BHARAT HEAVY ELECTRICALS LIMITED

CORPORATE QUALITY ASSURANCE

PROJECT: SYSTEM :

VENDOR : ITEM :

SL NO	COMPONENT /OPERATION OPERATIONS	CHARACTERISTICS CHECKED	CATEGORY	TYPE /METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11

Legend: 1. BHEL 2. Vendor 3. Sub-Vendor

QP No	CQS/SQP/31	Signature	Date					
	Rev		Name					
Page No	1 of 1		Party	Customer/Consultant		Bhel		Vendor

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SECTION: II

SUB SECTION: 2

LIST OF DOCUMENTS TO BE SUBMITTED WITH BID

	ARUN-3 HYDRO ELECTRIC PROJECT NEPAL (4X225 MW) HVAC SYSTEM LIST OF DOCUMENTS TO BE SUBMITTED WITH BID	SPECIFICATION No: PE-TS-437-571-11000A-A001 SECTION : II SUB-SECTION : 2 REV: 00 DATE: OCTOBER 2020 SHEET 2 OF 2

BIDDER SHOULD SUBMIT THE SIGNED AND STAMPED COPY OF THE FOLLOWING DOCUMENTS:

1. Compliance cum confirmation certificate.
2. Un priced format for Main Package.
3. Un priced format for Mandatory spare.
4. Complete set of Technical specifications.
5. No deviation certificate.
6. Pre-bid clarification schedule and signed copy of technical corrigenda, if any.

SECTION: II

SUB SECTION: 3

COMPLIANCE CUM CONFIRMATION CERTIFICATE

	ARUN-3 HYDRO ELECTRIC PROJECT NEPAL (4X225 MW) HVAC SYSTEM COMPLIANCE CUM CONFIRMATION CERTIFICATE	SPECIFICATION No: PE-TS-437-571-11000A-A001	
		SECTION : II	
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COMPLIANCE CUM CONFIRMATION CERTIFICATE

The bidder shall confirm compliance with following by signing / stamping this compliance certificate (every sheet) and furnish same with the offer.

a) The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions, other than those mentioned under "exclusion and those resolved as per 'Schedule of Deviations', with regard to same.

b) There are no other deviations w.r.t. specifications other than those furnished in the 'Schedule of Deviations'. Any other deviation, stated or implied, taken elsewhere in the offer stands withdrawn unless specifically brought out in the 'Schedule of Deviations'

c) Bidder shall submit QP in the event of order based on the guidelines given in the specification & QP enclosed therein. QP will be subject to BHEL / CUSTOMER approval & customer hold points for inspection / testing shall be marked in the QP at the contract stage. Inspection / testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc. This is within the contracted price without any extra implications to BHEL after award of the contract.

d) All drawings/ data-sheets / calculations etc. submitted along with the offer shall not be taken cognizance off.

e) The offered materials shall be either equivalent or superior to those specified in the specification & shall meet the specified / intended duty requirements. In case the material specified in the specifications is not compatible for intended duty requirements then same shall be resolved by the bidder with BHEL during the pre-bid discussions, otherwise BHEL / Customer's decision shall be binding on the bidder whenever the deficiency is pointed out.

For components where materials are not specified, same shall be suitable for intended duty, all materials shall be subject to approval in the event of order.

f) The commissioning spares shall be supplied on 'As Required Basis' & prices for same included in the base price itself.

g) All sub vendors shall be subject to BHEL / CUSTOMER approval in the event of order.

h) Guarantee for plant/equipment shall be as per relevant clause of GCC / SCC / Other Commercial Terms & Conditions

i) In the event of order, all the material required for completing the job at site shall be supplied by the bidder within the ordered price even if the same are additional to approved billing break up, approved drawing or approved Bill of quantities within the scope of work as tender specification. This clause will apply in case during site

commissioning, additional requirements emerges due to customer and / or consultant's comments. No extra claims shall be put on this account

j) Schedule of drawings submissions, comment incorporations & approval shall be as stipulated in the specifications. The successful bidder shall depute his design personnel to BHEL's / Customer's / Consultant's office for across the table resolution of issues and to get documents approved in the stipulated time.

k) As built drawings shall be submitted as and when required during the project execution.

l) The bidder has not tempered with this compliance cum confirmation certificate and if at any stage any tempering in the signed copy of this document is noticed then same shall be treated as breach of contract and suitable actions shall be taken against the bidder.

m) Successful bidder shall furnish detailed erection manual for each of the equipment supplied under this contract at least 3 months before the scheduled erection of the concerned equipment / component or along with supply of concerned equipment / component whichever is earlier.

n) Document approval by customer under Approval category or information category shall not absolve the vendor of their contractual obligations of completing the work as per specification requirement. Any deviation from specified requirement shall be reported by the vendor in writing and require written approval. Unless any change in specified requirement has been brought out by the vendor during detail engineering in writing while submitting the document to customer for approval, approved document (with implicit deviation) will not be cited as a reason for not following the specification requirement.

o) In case vendor submits revised drawing after approval of the corresponding drawing, any delay in approval of revised drawing shall be to vendor's account and shall not be used as a reason for extension in contract completion.

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SECTION: II

SUB SECTION: 4

PRE-BID CLARIFICATION SCHEDULE

	ARUN-3 HYDRO ELECTRIC PROJECT NEPAL (4X225 MW) HVAC SYSTEM PRE-BID CLARIFICATION SCHEDULE	SPECIFICATION No: PE-TS-437-571-11000A-A001
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		SUB-SECTION : 4
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PRE-BID CLARIFICATION SCHEDULE

S. NO.	SECTION/CLAUSE/PAGE NO.	STATEMENT OF THE REFERRED CLAUSE	CLARIFICATION REQUIRED

The bidder hereby clarifies that above mentioned are the only clarifications required on the technical specification for the subject package.

Signature: _____

Name: _____

Designation: _____

Company: _____

Date: _____

Company Seal

SECTION: II

SUB SECTION: 5

DEVIATION SHEET (COST OF WITHDRAWAL)

ANNEXURE-II: DEVIATION SHEET (COST OF WITHDRAWAL)

PROJECT:-

PACKAGE:-

TENDER ENQUIRY REFERENCE:-

NAME OF VENDOR:-

SL NO	VOULME/ SECTION	PAGE NO.	CLAUSE NO.	TECHNICAL SPECIFICATION/ TENDER DOCUMENT	COMPLETE DESCRIPTION OF DEVIATION	COST OF WITHDRAWL OF DEVIATION	REFERENCE OF PRICE SCHEDULE ON WHICH COST OF WITHDRAWL OF DEVIATION IS APPLICABLE	NATURE OF COST OF WITHDRAWL OF DEVIATION (POSITIVE/ NEGATIVE)	REASON FOR QUOTING DEVIATION
TECHNICAL DEVIATIONS									
COMMERCIAL DEVIATIONS									
PARTICULARS OF BIDDERS/ AUTHORISED REPRESENTATIVE									
NAME				**DESIGNATIONS**		**SIGN & DATE**			

NOTES:

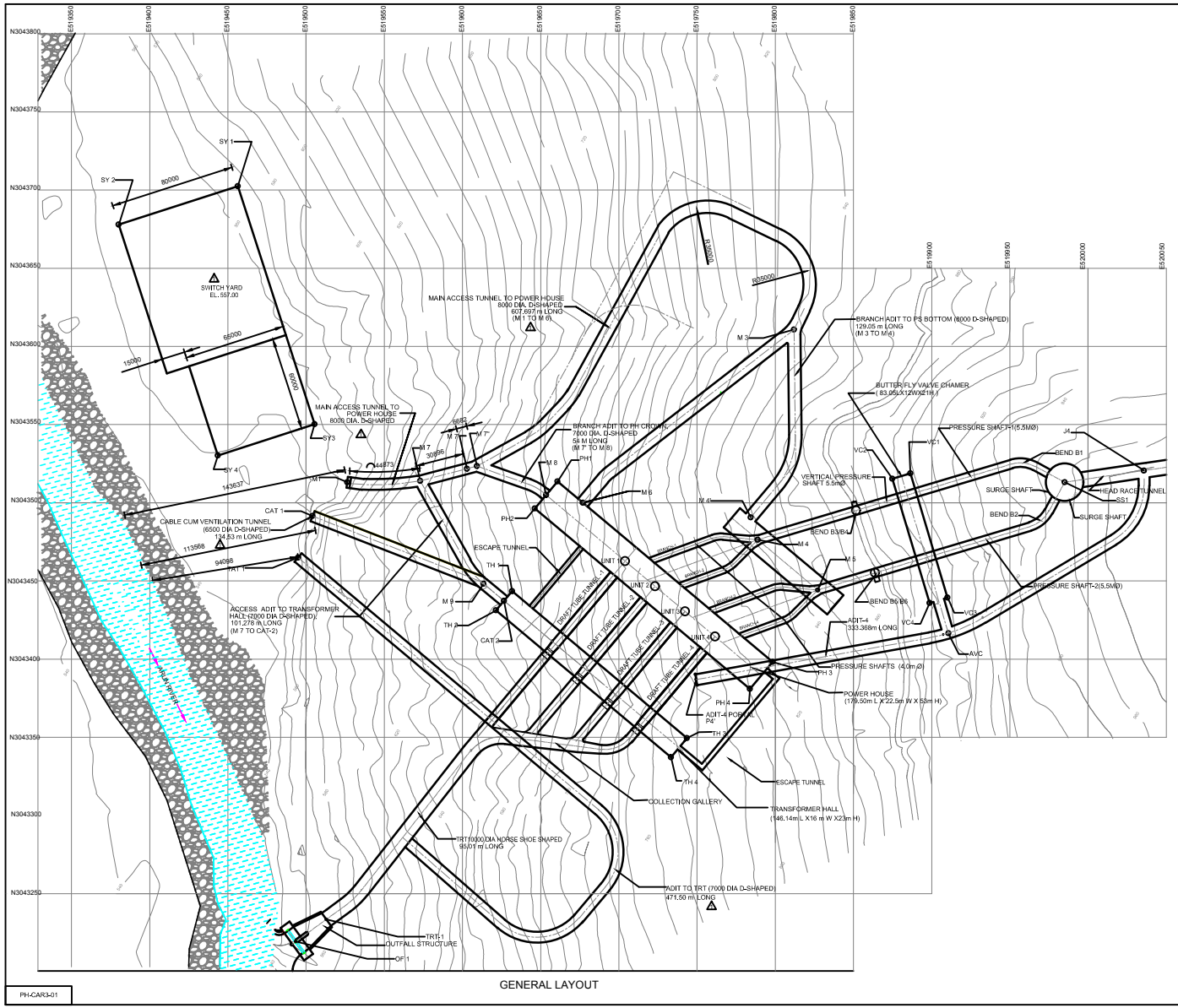
1. Cost of withdrawal of deviation will be applicable on the basic price (i.e. excluding taxes, duties & freight) only.
2. All the bidders have to list out all their Technical & Commercial Deviations (if any) in detail in the above format.
3. Any deviation not mentioned above and shown separately or found hidden in offer, will not be taken cognizance of.
4. Bidder shall submit duly filled unpriced copy of above format indicating "quoted" in "cost of withdrawal of deviation" column of the schedule above along with their Techno-commercial offer, wherever applicable. In the absence of same, such deviation(s) shall not be considered and offer shall be considered in total compliance to NIT.
5. Bidder shall furnish price copy of above format along with price bid.
6. The final decision of acceptance/ rejection of the deviations quoted by the bidder shall be at discretion of the Purchaser.
7. Bidders to note that any deviation (technical/commercial) not listed in above and asked after Part-I opening shall not be considered.
8. For deviations w.r.t. Credit Period, Liquidated damages, Firm prices if a bidder chooses not to give any cost of withdrawal of deviation loading as per Annexure-VII, will apply. For any other deviation mentioned in un-priced copy of this format submitted with Part-I bid but not mentioned in priced copy of this format submitted with Priced bid, the cost of withdrawal of deviation shall be taken as NIL.
9. Any deviation mentioned in priced copy of this format, but not mentioned in the un-priced copy, shall not be considered.
10. All techno-commercial terms and conditions of NIT shall be deemed to have been accepted by the bidder, other than those listed in unpriced copy of this format.
11. Cost of withdrawal is to be given separately for each deviation. In no event bidder should club cost of withdrawal of more than one deviation else cost of withdrawal of such deviations which have been clubbed together shall be considered as NIL.
12. In case nature of cost of withdrawal (positive/negative) is not specified it shall be assumed as positive.
13. In case of discrepancy in the nature of impact (positive/ negative), positive will be considered for evaluation and negative for ordering.

Page 1 of 1

SECTION: II

SUB SECTION: 6

TENDER DRAWINGS



NOTE:-

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS OTHERWISE SPECIFIED .
2. NO DIMENSION SHALL BE SCALED OUT , ONLY WRITTEN DIMENSIONS ARE TO BE TAKEN AS CORRECT.

CO-ORDINATES & ELEVATIONS OF IMPORTANT POINTS

S.No.	DESCRIPTION	POINTS	EASTINGS	NORTHINGS	INVERT ELEVATION	REMARKS
1.	POWER HOUSE COMPLEX	M 1	519526.307	3043513.069	557.00	-
		M 3	519612.010	3043610.784	532.50	-
		M 4	519788.824	3043476.354	522.25	-
		M 4'	519784.229	3043490.657	522.25	-
		M 5	519627.118	3043444.205	522.25	-
		M 6	519676.943	3043500.055	539.00	-
		M 7	519572.920	3043513.994	555.00	-
		M 7'	519602.833	3043521.758	553.26	-
		M 7*	519609.301	3043523.437	553.26	-
		M 8	519653.568	3043504.990	555.00	-
		M 9	519612.060	3043448.577	552.62	-
		CAT 1	519504.154	3043491.430	557.00	-
		CAT 2	519626.521	3043437.278	552.00/568.20	CVT/ACCESS TO TH
		PH 1	519660.801	3043513.606	539.00	SERVICE BAY LEVEL
		PH 2	519646.335	3043498.374	539.00	-DO-
		PH 3	519798.277	3043398.191	539.00	-DO-
		PH 4	519783.810	3043380.958	539.00	-DO-
		TH 1	519631.665	3043443.405	552.00	SERVICE BAY LEVEL
		TH 2	519621.377	3043431.151	552.00	-DO-
		TH 3	519743.591	3043349.440	552.00	-DO-
		TH 4	519733.303	3043337.186	552.00	-DO-
2.	TAIL RACE TUNNEL	TRT 1	519512.882	3043233.455	530.40	-
		TAT 1	519494.897	3043464.927	557.00	-
		TAT 6	519561.779	3043285.948	516.85	-
3.	OUTFALL	OF 1	519493.406	3043219.271	532.44	-
4.	BUTTERFLY VALVE CHAMBER	VC 1	519686.399	3043515.438	780.00	FINISHED FLOOR LEVEL
		VC 2	519674.900	3043515.438	780.00	-DO-
		VC 3	519910.161	3043439.294	780.00	-DO-
		VC 4	519898.663	3043435.860	780.00	-DO-
5.	SURGE SHAFT	SS1	519985.000	3043513.143	940.00	TOP OF SURGE SHAFT
6.	ADIT 4	P4'	519749.445	3043386.880	772.00	ADIT 4 PORTAL
		AVC	519910.717	3043416.463	778.40	-
		J4	520035.722	3043520.603	779.57	FINISHED INVERT LEVEL
7.	SWITCH YARD	SY1	519546.419	3043702.499	557.00	FINISHED LEVEL
		SY2	519380.269	3043677.981	557.00	-DO-
		SY3	519605.452	3043550.197	557.00	-DO-
		SY4	519443.580	3043520.277	557.00	-DO-

REVISION NOTE:-

1. LAYOUT OF MAIN ACCESS TUNNEL (MAT) TO POWER HOUSE SERVICE BAY (EL. 539.00) MODIFIED .
2. LAYOUT OF CABLE CUM VENTILATION TUNNEL TO TRANSFORMER HALL MODIFIED .
3. LAYOUT OF ADIT TO TAIL RACE TUNNEL HAS BEEN MODIFIED .
4. LAYOUT OF SWITCH YARD HAS BEEN MODIFIED .

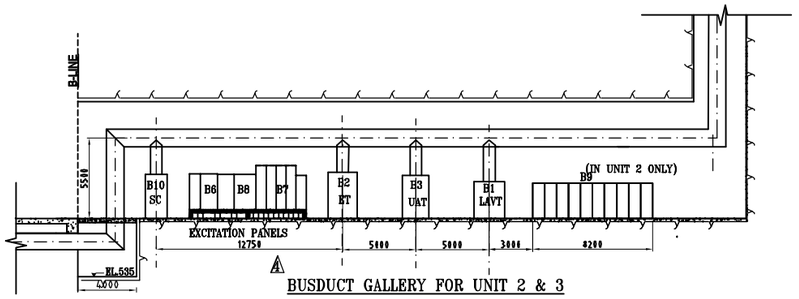
APPD.	CONSULTANT एसजेवीएन लिमिटेड SJVN LIMITED	
SUBM.	एसएपीडीसी प्रा0 लिमिटेड SAPDC (P.) LIMITED	
CHKD.	अरुण 3 जल विद्युत परियोजना नेपाल (900 मेगावाट) ARUN-3 HYDRO ELECTRIC PROJECT NEPAL (900MW)	
DRWN.	POWER HOUSE COMPLEX GENERAL LAYOUT PLAN	
DSGN.	अभिकल्पित DSGN. -sd-	परिचालित CHKD. -sd- / संस्तुत RECM. -sd-
DATE	26.04.19	
REV. NO.	1	ORG.NO. PH-C2-AR3-C01/R1 / APRIL . 2019 / DUKP-AR3-
	तयाकित DRWN. -sd-	प्रस्तुत SUBM. -sd- / अनुमोदित APPD. -sd-

FIRST ANGLE PROJECTION

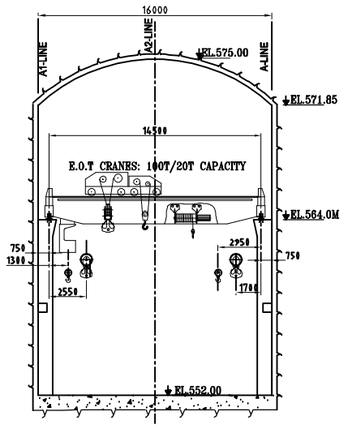
(ALL DIMENSIONS ARE IN "mm")

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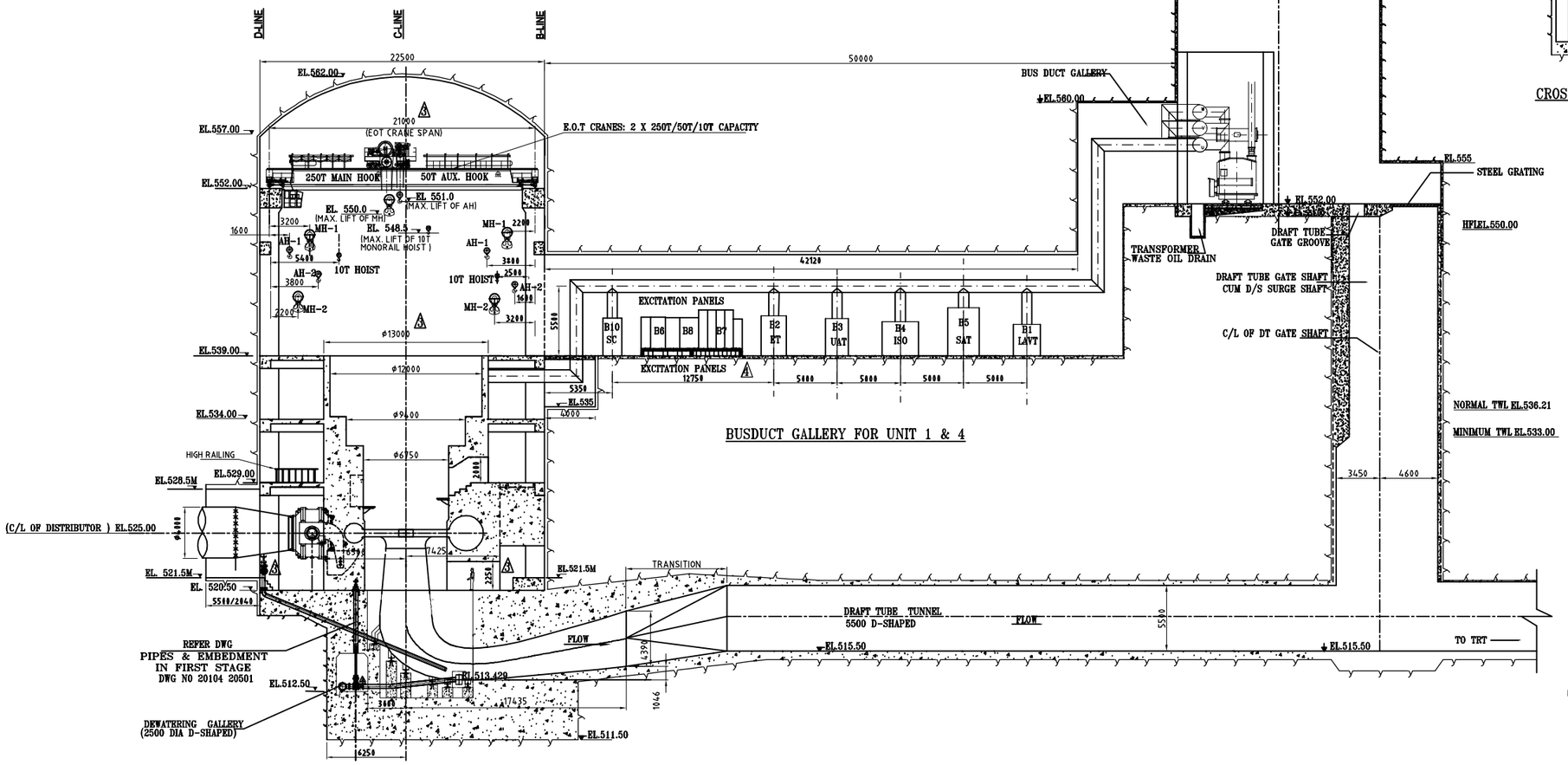
ITEM. No	DESCRIPTION	APPROX. SIZE (mm)		
		LENGTH	WIDTH	HEIGHT
B1	LAVT CUBICLE	3000	2150	2500
B2	EXCITATION TRANSFORMER	3500	2000	3150
B3	UNIT AUXILIARY TRANFORMER	3250	1800	2950
B4	ISOLATOR CUBICLE	2700	2500	2700
B5	STATION AUXILIARY TRANFORMER	3700	2900	3800
B6	REGULATION CUBICLE	1926	1250	2465
B7	THYRISTOR PANEL	3429	1250	3045
B8	FIELD SUPPRESSION PANEL	2651	1250	2465
B9	11 KV SWITCHGEAR	8200	1800	2415
B10	SHORTING CUBICLE	4000	1500	3000



BUSDUCT GALLERY FOR UNIT 2 & 3



CROSS-SECTION THROUGH SERVICE BAY OF TRANSFORMER CAVERN



CROSS-SECTION OF POWER HOUSE THROUGH C.L OF UNIT

NOTES:

01. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES.
02. SIZE OF EQUIPMENTS SHOWN ARE TENTATIVE AND SHALL BE REVIEWED AFTER DETAILED DESIGN.
03. BUSDUCT ROUTING SHOWN IN TENTATIVE AND SHALL BE REVIEWED AFTER DETAILED DESIGN.

REV.	DATE	ALTERED / CHECKED / APPROVED	ZONE	
03	15.03.19	DK / DK / RS	ZONE	REVISED AS PER SJVNL'S COMMENTS DATED 05.02.19 AT PLACES MARKED ⚠3
02	26.12.18	DK / DK / RS	ZONE	REVISED AS PER SJVNL'S COMMENTS DATED 30.11.18 AT PLACES MARKED ⚠2
01	16.10.18	DK / DK / RS	ZONE	REVISED AS PER SJVNL'S COMMENTS DATED 21.09.18 AT PLACES MARKED ⚠1
			ZONE	CONCRETE PEDESTALS ADDED FOR SEE EQUIPMENTS. AT PLACES MARKED ⚠

ADDITIONAL INFORMATION		PROJECT	ARUN-3 HYDRO ELECTRIC PROJECT, NEPAL (4x 225 MW)
STATUS OF DRAWING	U	CUSTOMER	SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)
DISTRIBUTION OF PRINTS		CONSULTANT	SJVN LIMITED (A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF HP)
	NAME / SIGN / DATE / NO. OF VAR.	CONTRACTOR	भारत हेवी इलेक्ट्रिकल्स लिमिटेड, भोपाल Bharat Heavy Electricals Limited, Bhopal
DRWN	DK / 10.9.18		
CHKD	DK / 10.9.18		
APPD	RS / 10.9.18		
SUB-SUPPLIER / VENDOR			

DEPT HSE	UNTOL. DIMS. GR.	ANGLE	SCALE 1:200	WEIGHT(kg)	REF.TO ASSY.DRG.	ITEM NO.	NO.OF ITEMS
CODE 415							

TITLE: POWER HOUSE GENERAL ARRANGEMENT-CROSS SECTION

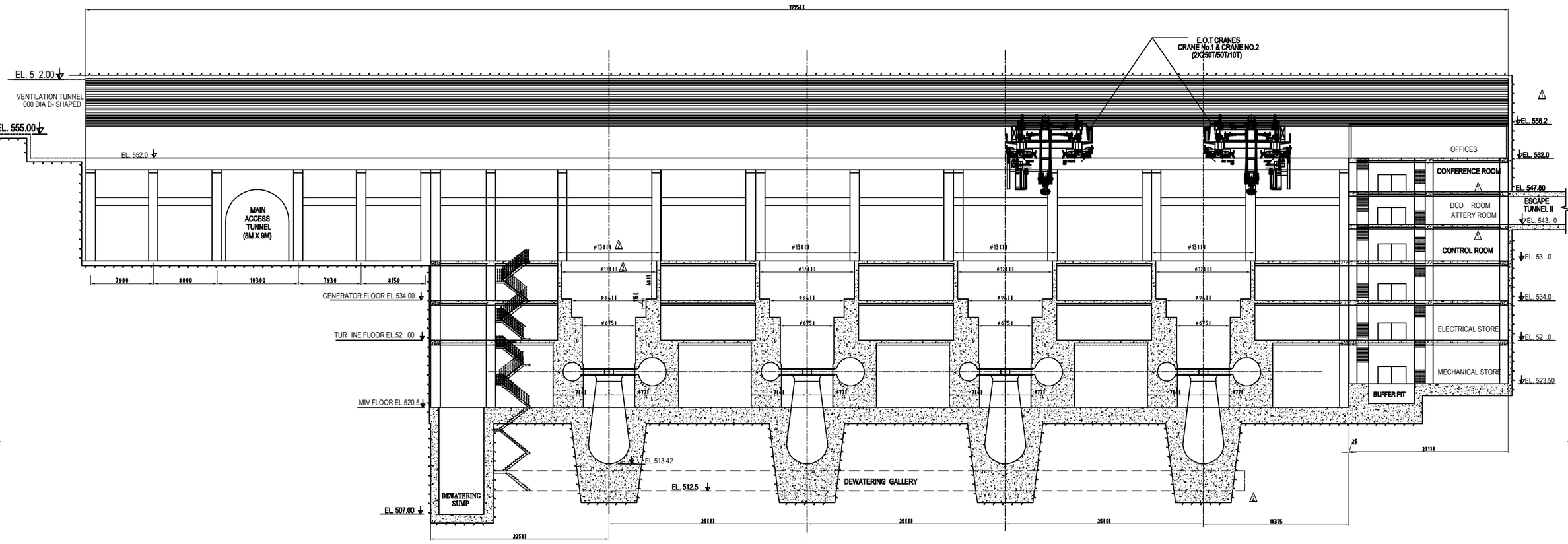
DRAWING NO. 1 200 00 20551 REV. 04

SHEET NO. 01 NO. OF SHEETS. 01

A1 SIZE

REF. DRG. NO. | SIGN. & DATE | INVENTORY NO.

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LONGITUDINAL SECTION THROUGH C-LINE

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES.

REV.	DATE	ALTERED / CHECKED / APPROVED	ZONE
01	23.03.19	DK / DK / RS	REVISED AS PER SJVNL'S COMMENTS DATED 05.02.19 AT PLACES MARKED 2
02	24.12.18	DK / DK / RS	REVISED AS PER SJVNL'S COMMENTS DATED 30.11.18 AT PLACES MARKED 1

	NAME	SIGN	DATE	NO. OF VAR.
DRWN	DK		16.10.18	
CHKD	DK		16.10.18	
APPD	RS		16.10.18	

ADDITIONAL INFORMATION

STATUS OF DRAWING

DISTRIBUTION OF PRINTS

SUB-SUPPLIER / VENDOR

PROJECT	ARUN-3 HYDRO ELECTRIC PROJECT, NEPAL (4x 225 MW)
CUSTOMER	SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)
CONSULTANT	SJVN LIMITED (A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF HP)
CONTRACTOR	भारत हेवी इलेक्ट्रिकल्स लिमिटेड, भोपाल Bharat Heavy Electricals Limited, Bhopal

DEPT	UNTOL. DIMS. GR.	ANGLE	SCALE	WEIGHT(kg)	REF.TO ASSY.DRG.	ITEM NO.	NO.OF ITEMS
CODE			1:250				

TITLE: POWER HOUSE
LONGITUDINAL SECTION THROUGH C-LINE

DRAWING NO. 1 200 00 20558 REV. 02

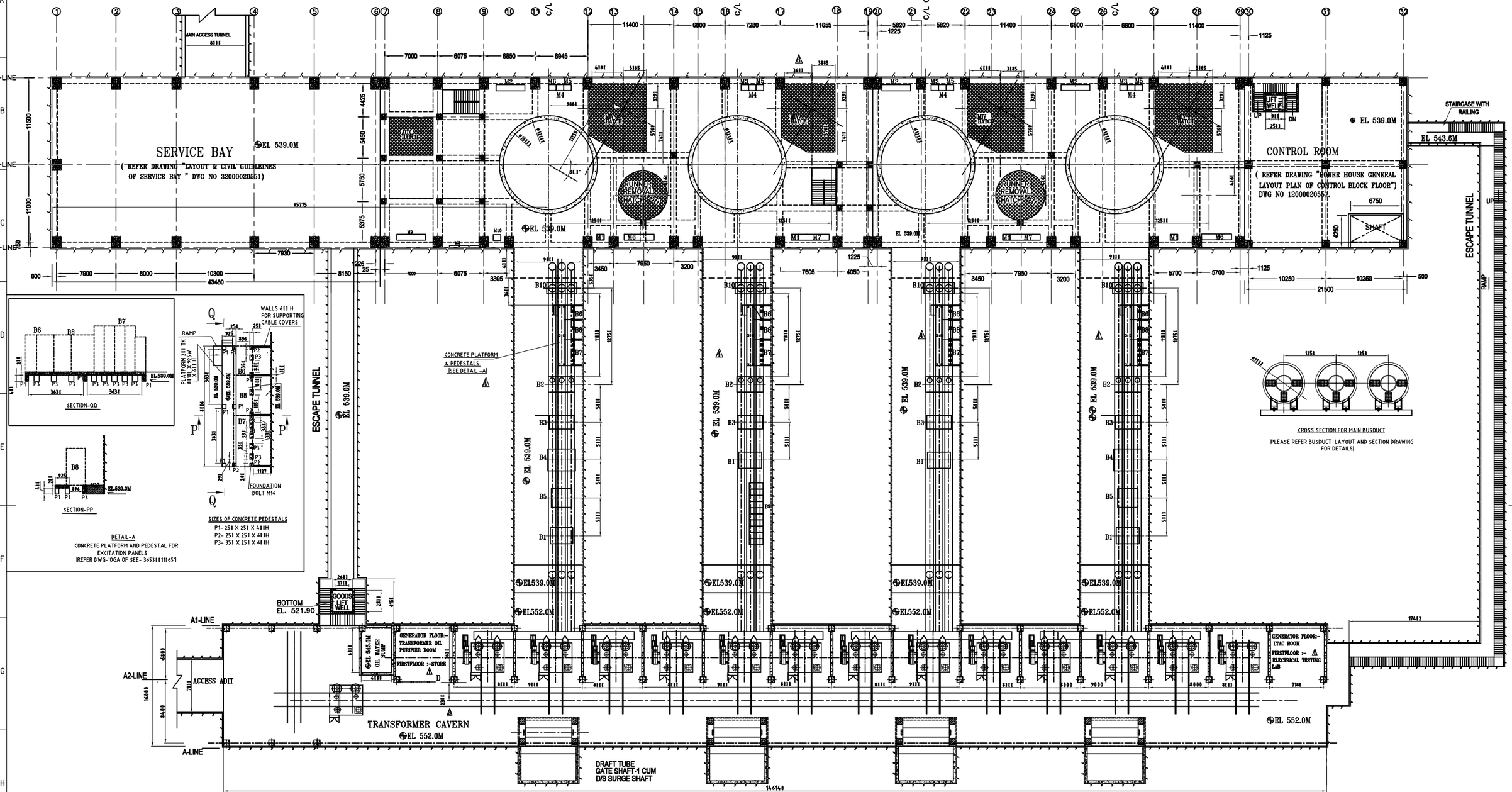
SHEET NO. NO. OF SHEETS.

REF. DRG. NO. SIGN. & DATE INVENTORY NO.

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN "mm")

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DETAIL-A
CONCRETE PLATFORM AND PEDESTAL FOR EXCITATION PANELS
[REFER DWG-'OGA OF SEE- 36531111651]

SIZES OF CONCRETE PEDESTALS
P1- 251 X 251 X 611H
P2- 251 X 251 X 611H
P3- 351 X 251 X 611H

TABLE FOR DIMENSIONS OF EQUIPMENTS-MACHINE ROOM (TENTATIVE): ⚠

ITEM No	DESCRIPTION	APPROX. SIZE (mm) LENGTH	WIDTH	HEIGHT	WEIGHT (kg)	QUANTITY PER UNIT	TOTAL QUANTITY	DIVISION
M1	EHGC	1000	800	2415	-	1	4	EDN
M2	AUTO SEQUENCER EQUIPMENT	3804	800	2415	-	1	4	EDN
M3	GUAGE PANEL	1000	800	2415	-	1	4	EDN
M4	TEMPERATURE MEASUREMENT PANEL	1000	800	2415	-	1	4	EDN
M5	INSTRUMENT PANEL	1000	800	2415	-	1	4	EDN
M6	GENERATOR PROTECTION PANEL U-1 & 4	1000	800	2295	-	4	8	SWE
M7	GENERATOR PROTECTION PANEL U-2 & 3	1000	800	2295	-	4	8	SWE
M8	STARTER PANEL FOR DRAINAGE DEWATERING & FLOOD PROTECTION PUMPS (WALL MOUNTED)	1200	325	1200	-	1	3	HPE
M9	LCB FOR STATION & COMMON AUXILIRIES	3804	800	2415	-	1	3	HPE
M10	FIRE FIGHTING PANEL	1000	800	2409	-	-	1	PESD

TABLE FOR DIMENSIONS OF EQUIPMENTS-BUS DUCT GALLERY (TENTATIVE): ⚠

ITEM. No	DESCRIPTION	APPROX. SIZE (mm) LENGTH	WIDTH	HEIGHT	WEIGHT (kg)	QUANTITY PER UNIT	TOTAL QUANTITY	DIVISION
B1	LAVT CUBICLE	3100	2150	2500		1	4	RUDRAPUR
B2	EXCITATION TRANSFORMER	3500	2100	3150		1	4	EDN
B3	UNIT AUXILIARY TRANFORMER ⚠	3250	1800	2950		1	4	JHANSI
B4	ISOLATOR CUBICLE	2700	2500	2700		1	2	
B5	STATION AUXILIARY TRANFORMER	3700	2900	3800		1	2	JHANSI
B6	REGULATION CUBICLE ⚠	1926	1250	2465	-	1	4	EDN
B7	THYRISTOR PANEL ⚠	3429	1250	3045	-	1	4	EDN
B8	FIELD SUPPRESSION PANEL ⚠	2651	1250	2465	-	1	4	EDN
B9	11 KV SWITCHGEAR	8200	1800	2415	-	-	1	SWE
B10	SHORTING CUBICLE	4000	1500	3000	-	1	4	RUDRAPUR

PLAN AT EL.539.0M & 552.0M

NOTES:

01. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES.
02. SIZE OF EQUIPMENTS SHOWN ARE TENTATIVE AND SHALL BE REVIEWED AFTER DETAILED DESIGN.
03. BUSDUCT ROUTING SHOWN IN TENTATIVE AND SHALL BE REVIEWED AFTER DETAILED DESIGN.
04. BEAM/COLUMN TO BE SUITABLY RELOCATED TO AVOID FOULING FOR HANDLING OF EQUIPMENT.

REV.	DATE	ALTERED	
		CHECKED	
		APPROVED	
ZONE			

REV.	DATE	ALTERED	
		CHECKED	
		APPROVED	
ZONE			

REV.	DATE	ALTERED	
04	15.03.19	CHECKED	DK
		APPROVED	RS
ZONE	CONCRETE PEDESTALS ADDED FOR SEE EQUIPMENTS. AT PLACES MARKED ⚠		

REV.	DATE	ALTERED	
03	15.03.19	CHECKED	DK
		APPROVED	RS
ZONE	REVISED AS PER SJVNL'S COMMENTS DATED 05.02.19 AT PLACES MARKED ⚠		

REV.	DATE	ALTERED	
02	26.12.18	CHECKED	DK
		APPROVED	RS
ZONE	REVISED AS PER SJVNL'S COMMENTS DATED 30.11.18 AT PLACES MARKED ⚠		

REV.	DATE	ALTERED	
01	16.10.18	CHECKED	DK
		APPROVED	RS
ZONE	REVISED AS PER SJVNL'S COMMENTS DATED 21.09.18 AT PLACES MARKED ⚠		

ADDITIONAL INFORMATION	
STATUS OF DRAWING	
DISTRIBUTION OF PRINTS	

	NAME	SIGN	DATE	NO. OF VAR.
DRWN	DK	10.9.18		
CHKD	DK	10.9.18		
APPD	RS	10.9.18		

SUB-SUPPLIER / VENDOR

PROJECT	ARUN-3 HYDRO ELECTRIC PROJECT, NEPAL (4x 225 MW)
CUSTOMER	SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)
CONSULTANT	SJVN LIMITED (A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF HP)
CONTRACTOR	भारत हेवी इलेक्ट्रिकल्स लिमिटेड, भोपाल Bharat Heavy Electricals Limited, Bhopal

DEPT CODE	UNTOL. DIMS. GR.	ANGLE	SCALE 1:250	WEIGHT(kg)	REF.TO ASSY.DRG.	ITEM NO.	NO.OF ITEMS

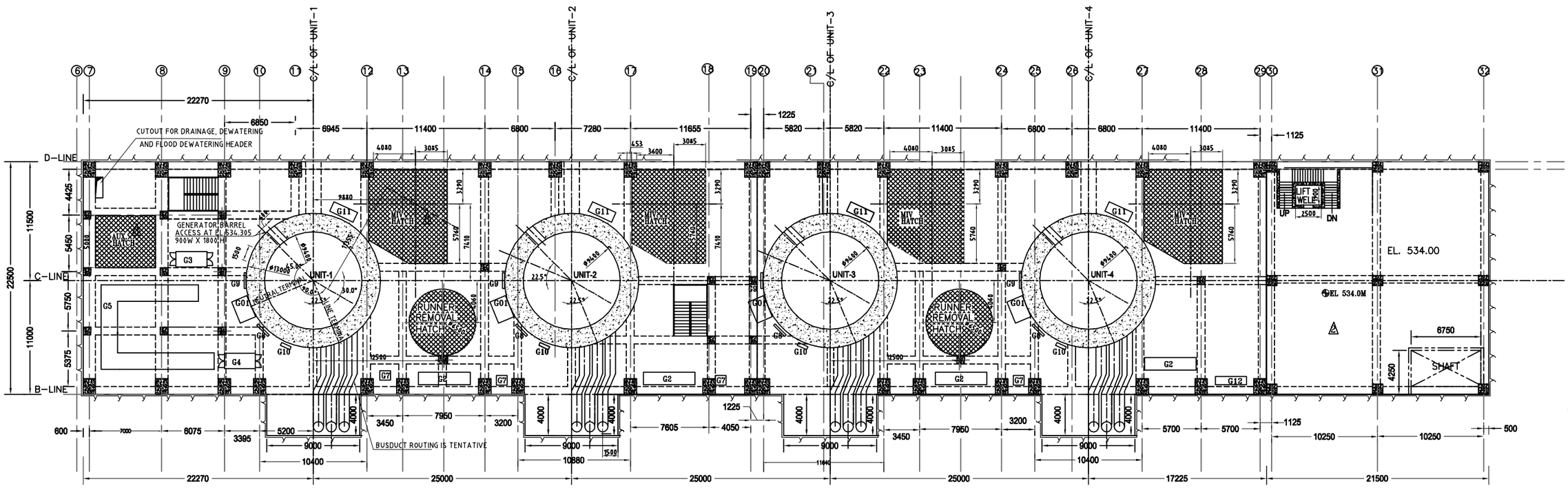
TITLE: POWER HOUSE GENERAL ARGT. PLAN AT EL. 539.0 M

DRAWING NO. 1 200 00 20556 REV. 04

SHEET NO. NO. OF SHEETS.

REF. DRG. NO. | SIGN. & DATE | INVENTORY NO.

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PLAN AT EL.534.0M (GENERATOR FLOOR)

TABLE FOR DIMENSIONS OF EQUIPMENTS-MACHINE ROOM (TENTATIVE):

ITEM. No	DESCRIPTION	APPROX. SIZE (mm) LENGTH	WIDTH	HEIGHT	WEIGHT (kg)	QUANTITY PER UNIT	TOTAL QUANTITY	DIVISION
G1	N G CUBICLE	1600	2200	2465	-	1	4	RUDRAPUR
G2	UNIT AUXILIARY BOARD	5000	1200	2400	-	1	4	HPE
G3	SST-1	3000	1600	3100	-	-	1	JHANSI
G4	SST-2	3000	1600	3100	-	-	1	JHANSI
G5	STATION SERVICE BOARD	22000	1600	2400	-	-	1	HPE
G6								
G7	HMC	1050	700	1850	-	1	4	HPE-GOV
G8	MARSHALING BOX -1 (600 POINTS)	1500	200	1200	-	1	4	HGE
G9	MARSHALING BOX -2 (600 POINTS)	1500	200	1200	-	1	4	HGE
G10	STARTER PANEL FOR SPACE HEATER	1000	300	1200	-	1	4	EDN
G11	WATER SPRINKLER CONTROL PANEL FOR GENERATOR FIRE FIGHTING	2500	1000	2300	-	1	4	HGE
G12	SUB DCDB	3000	800	2400	-	-	1	HPE

NOTES:

01. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES.
02. SIZE OF EQUIPMENTS SHOWN ARE TENTATIVE AND SHALL BE REVIEWED AFTER DETAILED DESIGN.
03. BUSDUCT ROUTING SHOWN IN TENTATIVE AND SHALL BE REVIEWED AFTER DETAILED DESIGN.
04. BEAM/COLUMN TO BE SUITABLY RELOCATED TO AVOID FOULING FOR HANDLING OF EQUIPMENT.

REV.	DATE	ALTERED / CHECKED / APPROVED	DK / RS	ZONE	REMARKS
03	16.03.19	CHECKED DK, APPROVED RS			REVISED AS PER SJVNL'S COMMENTS DATED 05.02.19 AT PLACES MARKED ⚠
02	26.12.18	CHECKED DK, APPROVED RS			REVISED AS PER SJVNL'S COMMENTS DATED 30.11.18 AT PLACES MARKED ⚠
01	16.10.18	CHECKED DK, APPROVED RS			REVISED AS PER SJVNL'S COMMENTS DATED 21.09.18 AT PLACES MARKED ⚠

	NAME	SIGN	DATE	NO. OF VAR.
DRWN	DK		10.9.18	
CHKD	DK		10.9.18	
APPD	RS		10.9.18	

SUB-SUPPLIER / VENDOR

ADDITIONAL INFORMATION	
STATUS OF DRAWING	U
DISTRIBUTION OF PRINTS	
PROJECT	ARUN-3 HYDRO ELECTRIC PROJECT, NEPAL (4x 225 MW)
CUSTOMER	SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)
CONSULTANT	SJVN LIMITED (A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF HP)
CONTRACTOR	भारत हेवी इलेक्ट्रिकल्स लिमिटेड, भोपाल Bharat Heavy Electricals Limited, Bhopal

DEPT	CODE	UNTOL. DIMS. GR.	ANGLE	SCALE	WEIGHT(kg)	REF.TO ASSY.DRG.	ITEM NO.	NO.OF ITEMS
HSE	415			1:200				

TITLE: POWER HOUSE GENERAL ARGT. PLAN AT EL. 534.0 M

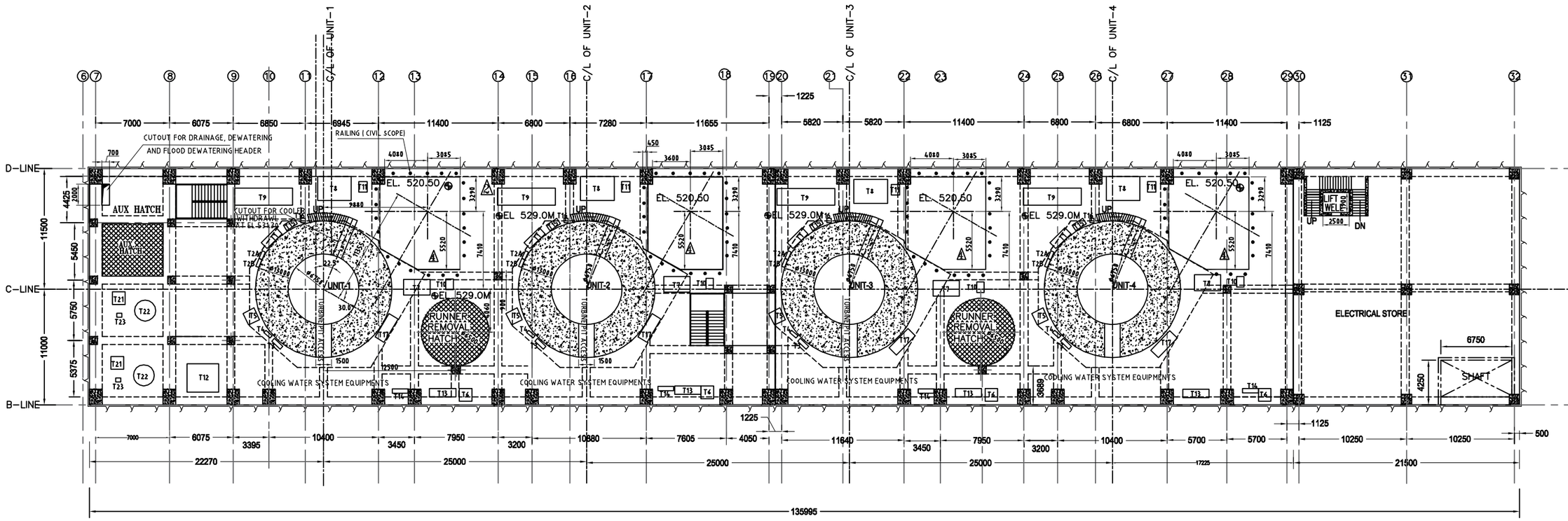
DRAWING NO. 1 200 00 20555 REV. 03

SHEET NO. 01 NO. OF SHEETS. 01

A1 SIZE

INVENTORY NO. | SIGN. & DATE | REF. DRG. NO.

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PLAN AT EL.529.00 (TURBINE FLOOR)

AT TURBINE FLOOR (T) EL 529.0M

ITEM. No	DESCRIPTION	APPROX. SIZE (mm) LENGTH	WIDTH	HEIGHT	WEIGHT (kg)	QUANTITY PER UNIT	TOTAL QUANTITY	DIVISION
T1	HS LUBRICATION SYSTEM	2000	800	800	400	1	4	HGE
T2	A. HS LUBRICATION STARTER PANEL (AC) B. HS LUBRICATION STARTER PANEL (DC)	800	300	1200	-	1	4	HPE
T3	BRAKE JACK CONTROL PANEL	350	1100	1200	350	1	4	HGE
T4	DUCT COLLECTOR STARTER PANEL	800	300	1200	-	1	4	HPE
T5	BRAKE DUST COLLECTOR	1200	1200	2500	500	1	4	HGE
T6	MOTORIZED POWER PACK UNIT	1200	1200	1800	300	1	4	HGE
T7	P P SET FOR GOV & MIV	2500	1500	1100	4000	1	4	HPE-GOV
T8	NITROGEN BOTTLE BANK-GOV & MIV	3200	2300	3800	3500	1	4	HPE-GOV
T9	PISTON ACCUMULATOR	5500	1600	4000	5000	1	4	HPE-GOV
T10	HYDRAULIC CONTROL PANEL FOR MIV	700	1000	2350	400	1	4	HPE-GOV
T11	ELECTRICAL CONTROL PANEL FOR MIV	800	1000	2500	300	1	4	HPE-GOV
T12	LUBRICATION OIL HANDLING SYSTEM	3000	2700	3800	2500	-	1	HPE-GOV
T13	SECONDARY CW PUMP MCP	2500	800	1900	-	1	4	HPE-GOV
T14	PRIMARY CW PUMP MCP	1500	400	1900	-	1	4	HPE-GOV
T15	STARTER PANEL FOR GOV & MIV OPU	1200	600	1200	-	1	4	HPE-GOV
T16	STARTER PANEL FOR OLU	400	400	-	-	1	4	HPE-GOV
T17	STARTER PANEL FOR TOP COVER DRAINAGE PUMPS	1000	400	1000	-	1	4	HPE-GOV
T21	LP AIR COMPRESSOR	1200	1200	2000		-	2	HTE
T22	LP AIR RECEIVER	Φ2000	-	2500		-	2	HTE
T23	LP AIR DRYER	475	360	-		-	2	HTE

REV.	DATE	ALTERED / CHECKED / APPROVED	DK / DK / RS	ZONE	DESCRIPTION
04	10.05.19				MIV HATCH SIZE CHANGED AS MOM DATED 18-19 APRIL 2019 AT PLACES MARKED A
03	15.03.19				REVISED AS PER SJVNL'S COMMENTS DATED 05.02.19 AT PLACES MARKED A
02	26.12.18				REVISED AS PER SJVNL'S COMMENTS DATED 30.11.18 AT PLACES MARKED A
01	16.10.18				REVISED AS PER SJVNL'S COMMENTS DATED 21.09.18 AT PLACES MARKED A

ADDITIONAL INFORMATION

STATUS OF DRAWING: U

DISTRIBUTION OF PRINTS

	NAME	SIGN	DATE	NO. OF VAR.
DRWN	DK		10.9.18	
CHKD	DK		10.9.18	
APPD	RS		10.9.18	

SUB-SUPPLIER / VENDOR

PROJECT: ARUN-3 HYDRO ELECTRIC PROJECT, NEPAL (4x 225 MW)

CUSTOMER: SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)

CONSULTANT: SJVN LIMITED (A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF HP)

CONTRACTOR: भारत हेवी इलेक्ट्रिकल्स लिमिटेड, भोपाल Bharat Heavy Electricals Limited, Bhopal

DEPT	CODE	UNTOL. DIMS. GR.	ANGLE	SCALE	WEIGHT(kg)	REF.TO ASSY.DRG.	ITEM NO.	NO.OF ITEMS
HSE	415			1:200				

TITLE: POWER HOUSE GENERAL ARGT. PLAN AT EL. 529.0 M

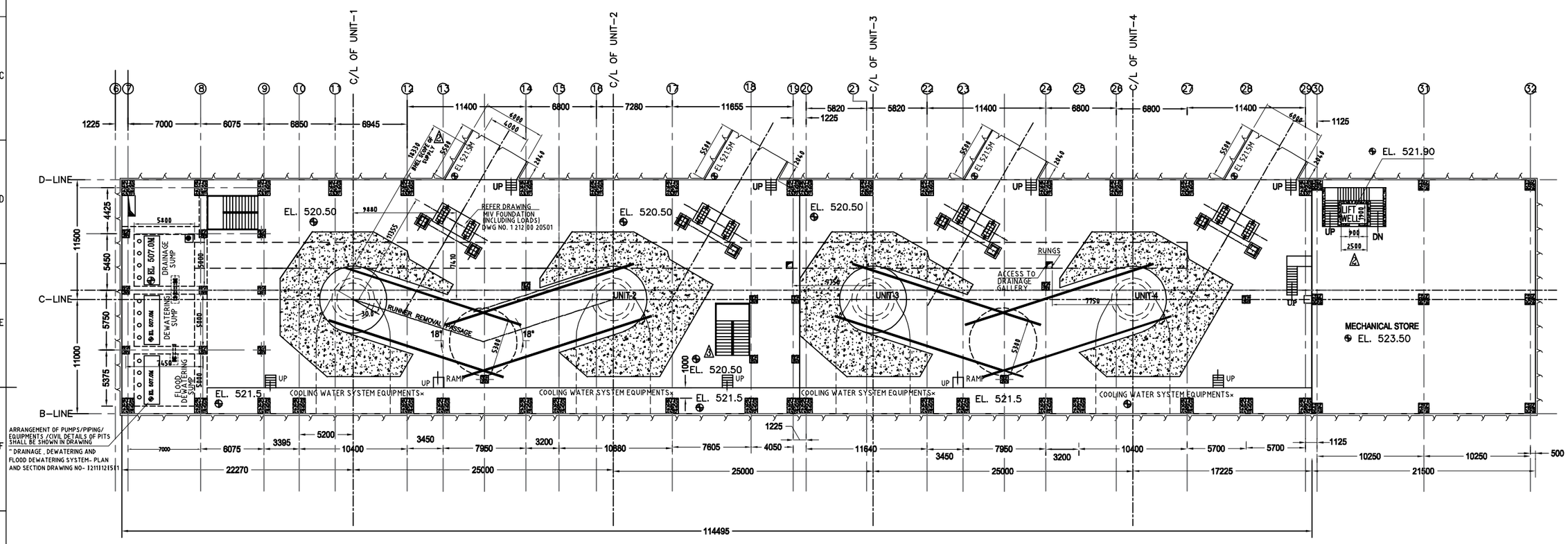
DRAWING NO. 1 200 00 20554 REV. 04

SHEET NO. 01 NO. OF SHEETS. 01

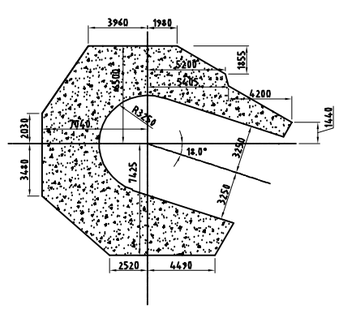
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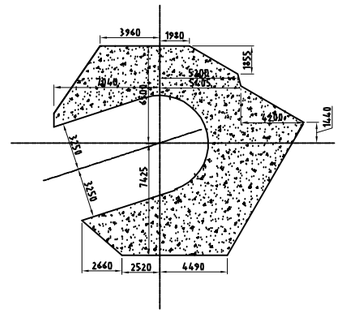
REF. DRG. NO. / SIGN. & DATE / INVENTORY NO.

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PLAN AT EL.520.5 (MIV FLOOR)





NOTE:- 1) FOUNDATIONS/EMBEDMENTS SHOWN IN THE FLOOR ARE FOR REFERENCE ONLY. RESPECTIVE SYSTEM DRAWING IS TO BE REFEREED FOR CONSTRUCTION .

2) EMBEDMENTS/CUTOUTS IN THE BARREL ARE NOT SHOWN IN THE DRAWING. . FOR THE SAME , PLEASE REFER DRAWING "PIPES & EMBEDMENT IN FIRST STAGE DRAWING NO 0 20104 20501.

REV.	DATE	ALTERED / CHECKED / APPROVED	ZONE
03	15.03.19	REVISED AS PER SJVNL'S COMMENTS DATED 05.02.19 AT PLACES MARKED ⚠	
02	26.12.18	IDK / IDK / RKS	
01	16.10.18	DK / DK / RS	

	NAME	SIGN	DATE	NO. OF VAR.
DRWN	DK		26.10.18	
CHKD	DK		26.10.18	
APPD	RS		26.10.18	

ADDITIONAL INFORMATION

STATUS OF DRAWING: U

DISTRIBUTION OF PRINTS

SUB-SUPPLIER / VENDOR

PROJECT	ARUN-3 HYDRO ELECTRIC PROJECT, NEPAL (4x 225 MW)
CUSTOMER	SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)
CONSULTANT	SJVN LIMITED (A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF HP)
CONTRACTOR	भारत हेवी इलेक्ट्रिकल्स लिमिटेड, भोपाल Bharat Heavy Electricals Limited, Bhopal

DEPT	CODE	UNTOL. DIMS. GR.	ANGLE	SCALE	WEIGHT(kg)	REF.TO ASSY.DRG.	ITEM NO.	NO.OF ITEMS
HSE	415			1:200				

TITLE: POWER HOUSE GENERAL ARGT. PLAN AT EL. 520.5 M

DRAWING NO. 1 200 00 20553 REV. 03

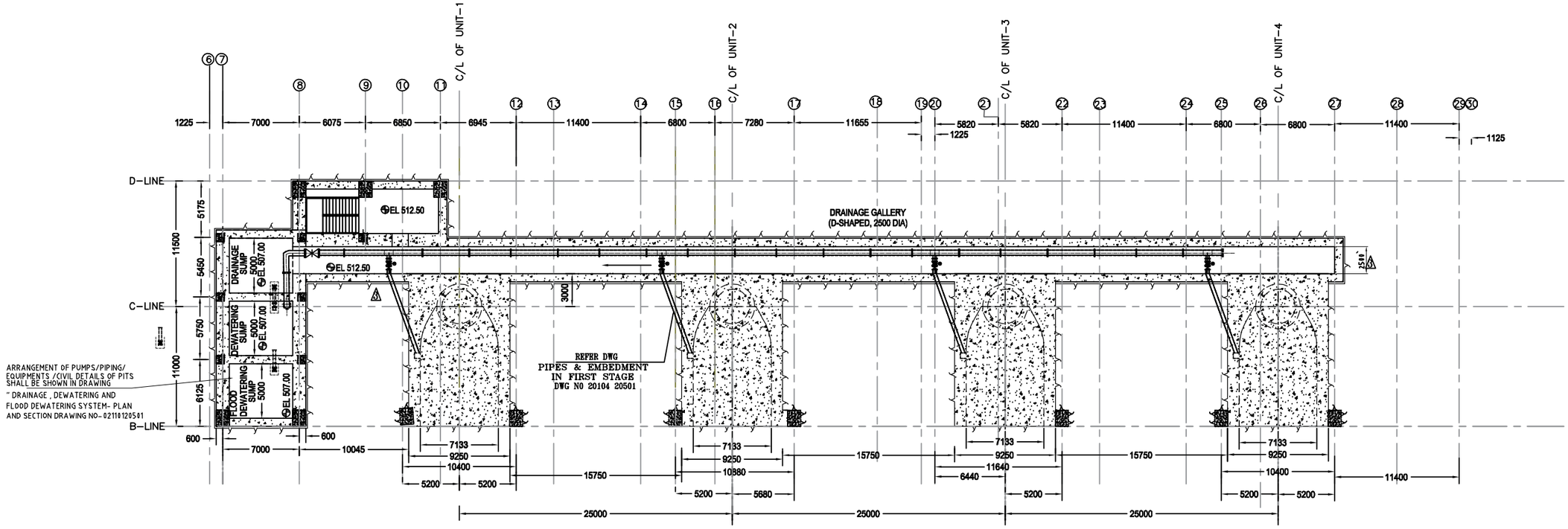
SHEET NO. 01 NO. OF SHEETS. 01

REF. DRG. NO. | SIGN. & DATE | INVENTORY NO.

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN "mm")

THE INFORMATION ON THIS DOCUMENT IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LIMITED.
IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY.



PLAN AT EL.512.50 (BELOW DRAFT TUBE)

ADDITIONAL INFORMATION				PROJECT	ARUN-3 HYDRO ELECTRIC PROJECT, NEPAL (4x 225 MW)
STATUS OF DRAWING	U			CUSTOMER	SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)
DISTRIBUTION OF PRINTS				CONSULTANT	SJVN LIMITED (A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF HP)
	NAME	SIGN	DATE	NO. OF VAR.	CONTRACTOR	भारत हेवी इलेक्ट्रिकल्स लिमिटेड, भोपाल Bharat Heavy Electricals Limited, Bhopal
DRWN	DK		10.9.18		
CHKD	DK		10.9.18		
APPD	RS		10.9.18		

REV.	DATE	ALTERED / CHECKED / APPROVED		ZONE	REVISED AS PER SJVNL'S COMMENTS DATED
03	15.03.19	DK / DK / RS			05.02.19 AT PLACES MARKED 3
02	26.12.18	DK / DK / RS			30.11.18 AT PLACES MARKED 2
01	16.10.18	DK / DK / RS			21.09.18 AT PLACES MARKED 1

SUB-SUPPLIER / VENDOR

DEPT	CODE	UNTOL. DIMS.	GR.	ANGLE	SCALE	WEIGHT(kg)	REF.TO ASSY.DRG.	ITEM NO.	NO.OF ITEMS
HSR	415				1:200				

TITLE: POWER HOUSE GENERAL ARGT. PLAN AT EL. 512.5 M

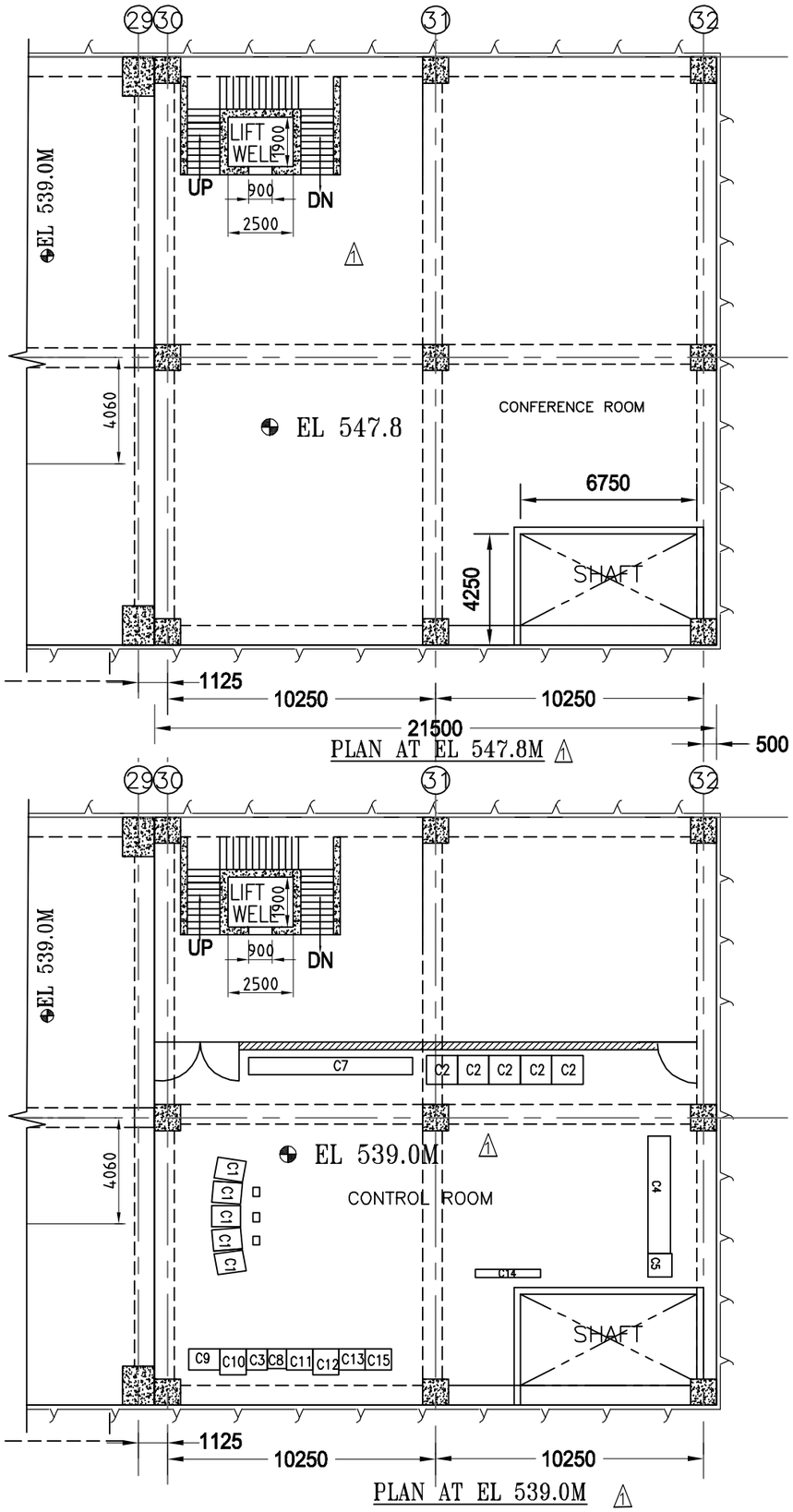
DRAWING NO. 1 200 00 20552 REV. 03

SHEET NO. 01 NO. OF SHEETS. 01

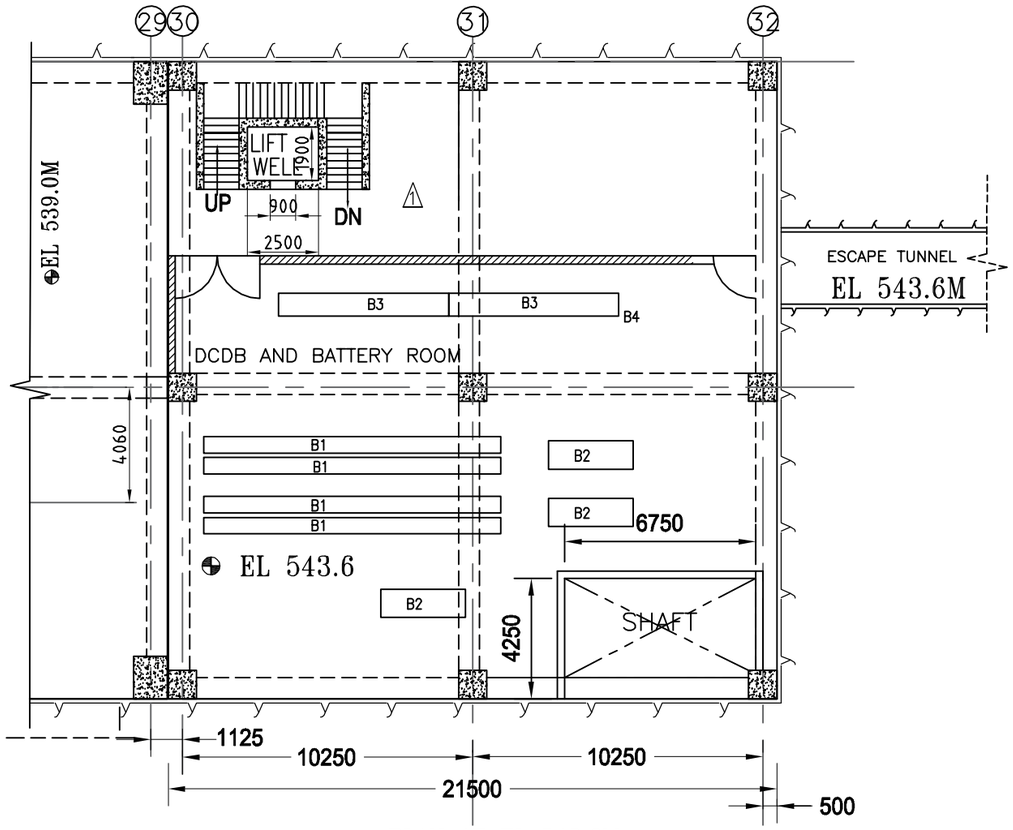
INVENTORY NO. | SIGN. & DATE | REF. DRG. NO.

A1 SIZE

THE INFORMATION ON THIS DOCUMENT IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LIMITED.
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PLAN AT EL 547.8M ⚠1



PLAN AT EL 543.6M ⚠1

PLAN AT EL 539.0M ⚠1

CONTROL ROOM EQUIPMENTS (AT EL 539.0M)

S.NO	DESCRIPTION	APPROX. SIZE (MM)			WEIGHT	QUANTITY PER UNIT	TOTAL QUANTITY	DIVISION
		LENGTH	WIDTH	HEIGHT				
C1	OPERATOR WORK STATION DESK	4500	750	1100		–	1	EDN
C2	COMPUTER TABLES (INCLUDING EWS)	1200	1100	750		–	7	EDN
C3	GPS BASED MASTER CLOCK SYSTEM	800	800	2415				EDN
C4	UPS FOR HMI COMPUTERS	4500	850	2000		–	1	EDN
C5	ACDB FOR UPS	900	900	2000		–	1	EDN
C6	PRINTER TABLE	700	600	750		–	2	EDN
C7	LVS	6280	670	2400		–	1	EDN
C8	NETWORK INTERFACE PANEL	750	750	2415		–	1	EDN
C9	FIRE ALARM PANEL	1200	800	2200		–	1	PESD
C10	FIRE ALARM PRINTER	1000	1000	800		–	1	PESD
C11	SECURITY ACCESS CONTROL PANEL	1000	800	2200		–	1	HPE
C12	CCTV PANEL	1000	1000	500		–	1	HPE
C13	CCTV CONTROLLER PANEL	1000	800	2100		–	1	HPE
C14	EPAPX PANEL	2500	300	–		–	1	HPE
C15	HVAC PANEL	1000	800	2100		–	1	PEM

DCDB AND BATTERY ROOM EQUIPMENTS (AT EL 543.6)

S.NO	DESCRIPTION	APPROX. SIZE (MM)			WEIGHT	QUANTITY PER UNIT	TOTAL QUANTITY	DIVISION
		LENGTH	WIDTH	HEIGHT				
B1	220 V BATTERY BANK	10500	1300	2500		–	2	HPE
B2	220 V BATTERY CHARGER	3000	1000	2400		–	3	HPE
B3	MAIN DCDB (DCDB 1&2)	12000	800	2400		–	1	HPE

LIST & SIZES OF EQIUPMENTS ARE TENTATIVE AND MAY BE REVISED DURING DETAIL DETAIL ENGINEERING OF RESPECTIVE SYSTEM

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES.

REV.	DATE	ALTERED / CHECKED / APPROVED		ZONE
02	15.03.19	CHECKED / APPROVED	DK / RS	REVISED AS PER SJVNL'S COMMENTS DATED 05.02.19 AT PLACES MARKED ⚠2
01	26.12.18	CHECKED / APPROVED	DK / RS	REVISED AS PER SJVNL'S COMMENTS DATED 30.11.18 AT PLACES MARKED ⚠1

	NAME	SIGN	DATE	NO. OF VAR.
DRWN	DK		16.10.18	
CHKD	DK		16.10.18	
APPD	RS		16.10.18	

ADDITIONAL INFORMATION

STATUS OF DRAWING: U

DISTRIBUTION OF PRINTS

SUB-SUPPLIER / VENDOR

PROJECT: ARUN-3 HYDRO ELECTRIC PROJECT, NEPAL (4x 225 MW)

CONSULTANT / CUSTOMER: SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)

CONSULTANT: SJVN LIMITED (A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF HP)

CONTRACTOR: भारत हेवी इलेक्ट्रिकल्स लिमिटेड, भोपाल / Bharat Heavy Electricals Limited, Bhopal

DEPT	CODE	UNTOL. DIMS. GR.	ANGLE	SCALE	WEIGHT(kg)	REF.TO ASSY.DRG.	ITEM NO.	NO.OF ITEMS
HSE	415			1:200				

TITLE: POWER HOUSE-GENERAL LAYOUT PLAN OF CONTROL BLOCK FLOORS

DRAWING NO. 1 200 00 20557 REV. 02

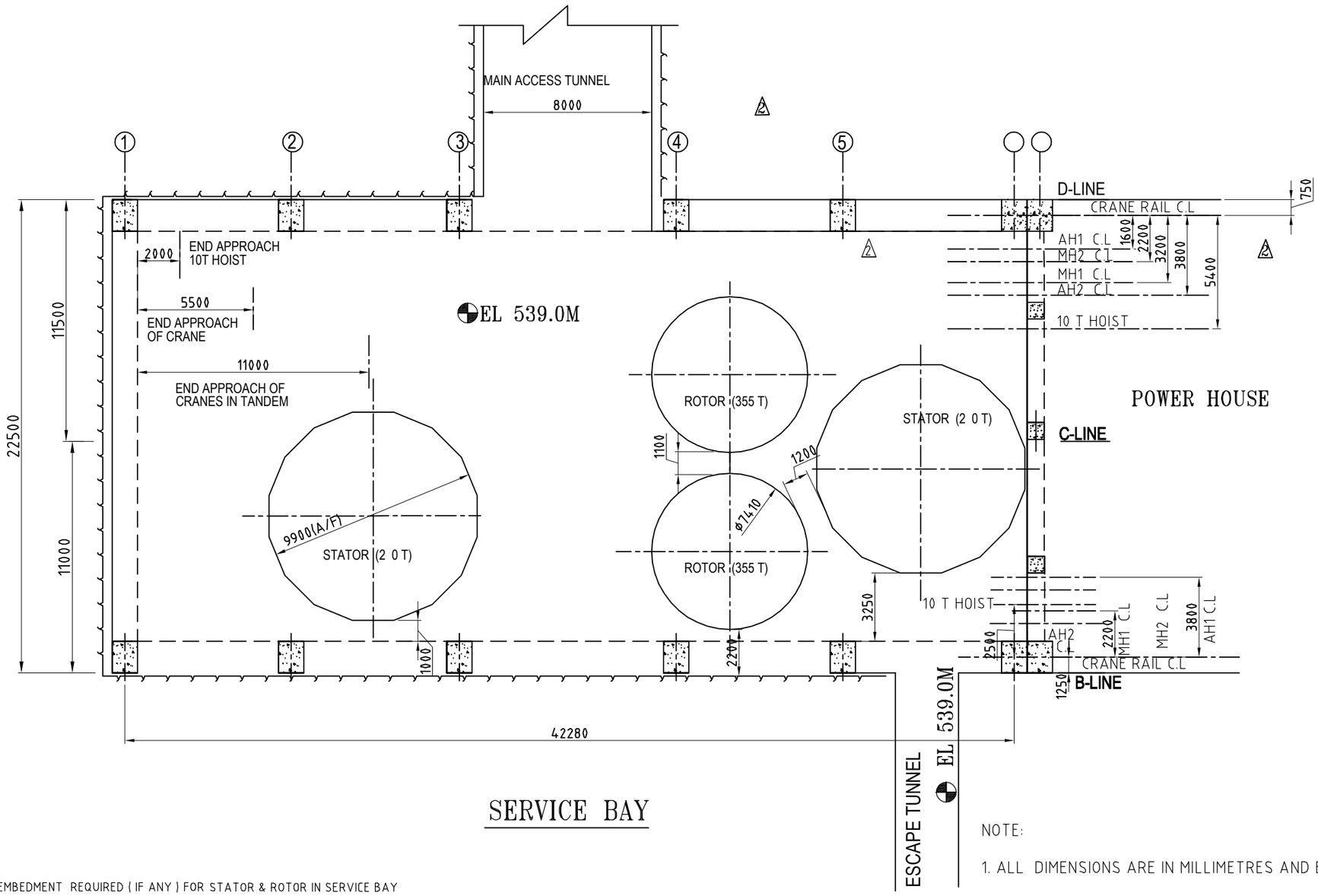
SHEET NO. 01 NO. OF SHEETS. 01

REF. DRG. NO. | SIGN. & DATE | INVENTORY NO.

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN "mm")

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IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY.



SERVICE BAY

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES.

NOTE:- 1) EMBEDMENT REQUIRED (IF ANY) FOR STATOR & ROTOR IN SERVICE BAY SHALL BE SHOWN LATER.

2) REFER DRAWING "LOADING ON SERVICE BAY" FOR DETAILS OF ROTOR AND STATOR PEDESTALS.

REV.	DATE	ALTERED / CHECKED / APPROVED	ZONE	REMARKS
		ALTERED / CHECKED / APPROVED		
02	15.03.19	DK / DK / RS		REVISED AS PER SJVNL'S COMMENTS DATED 05.02.19 AT PLACES MARKED 2
01	26.12.18	DK / DK / RS		REVISED AS PER SJVNL'S COMMENTS DATED 30.11.18 AT PLACES MARKED 1

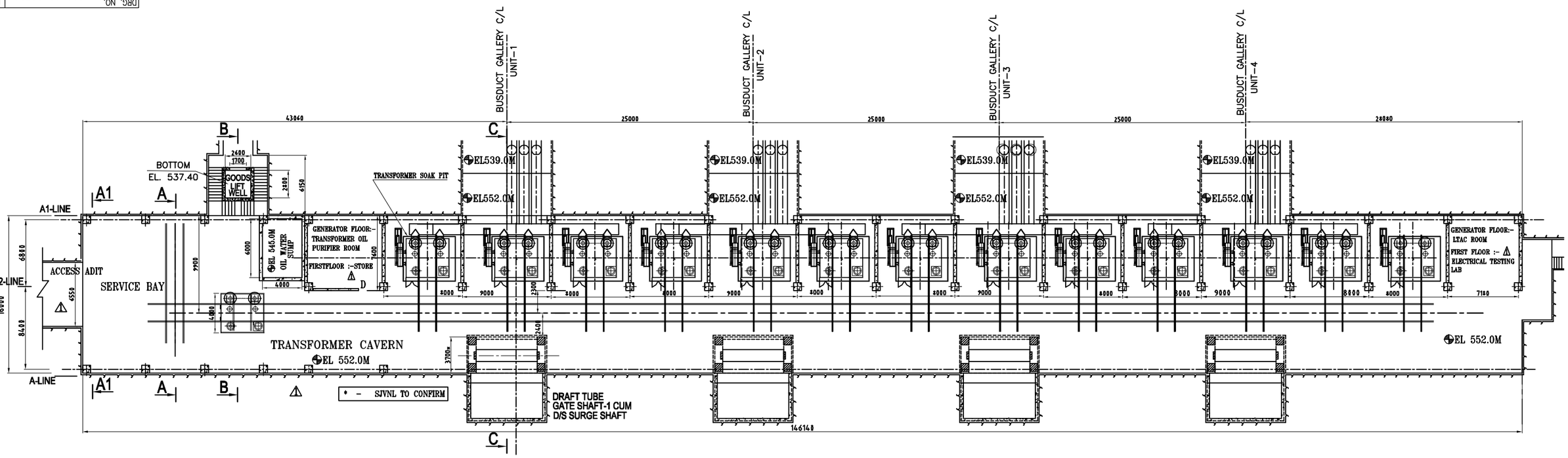
ADDITIONAL INFORMATION			PROJECT	ARUN-3 HYDRO ELECTRIC PROJECT, NEPAL (4x 225 MW)
STATUS OF DRAWING	U		CONSULTANT / CUSTOMER	SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF HP)
DISTRIBUTION OF PRINTS			CUSTOMER / CONSULTANT	SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF HP)
	NAME	SIGN / DATE / NO. OF VAR.	CONTRACTOR	भारत हेवी इलेक्ट्रिकल्स लिमिटेड, भोपाल Bharat Heavy Electricals Limited, Bhopal
DRWN	DK	16.10.18		
CHKD	DK	16.10.18		
APPD	RS	16.10.18		
SUB-SUPPLIER / VENDOR			DEPT HSE / CODE 415	UNTOL. DIMS. GR. / ANGLE / SCALE 1:200 / WEIGHT(kg) / REF.TO ASSY.DRG. / ITEM NO. / NO.OF ITEMS
			TITLE	LAYOUT & CIVIL GUIDLEINES OF SERVICE BAY
			DRAWING NO.	32000020551
			REV.	02
			SHEET NO. 01	NO. OF SHEETS. 01

REF. DRG. NO. / SIGN. & DATE / INVENTORY NO.

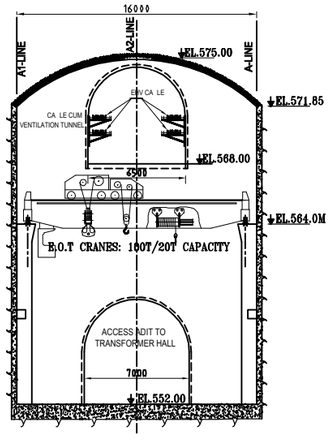
A1 SIZE

DRG. NO. 1 200 00 20570 REV. 02

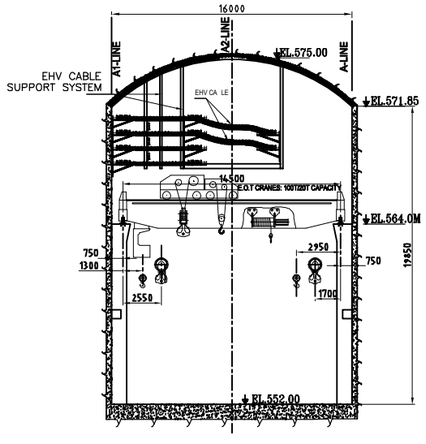
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IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY.



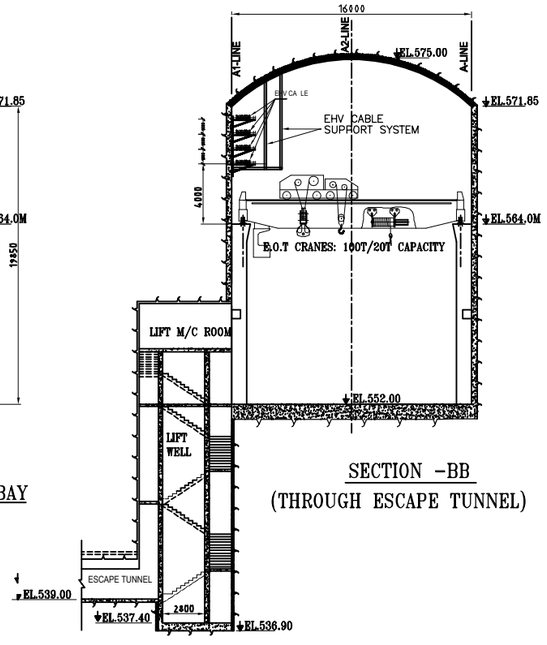
PLAN OF TRANSFORMER CAVERN AT EL 552.0M



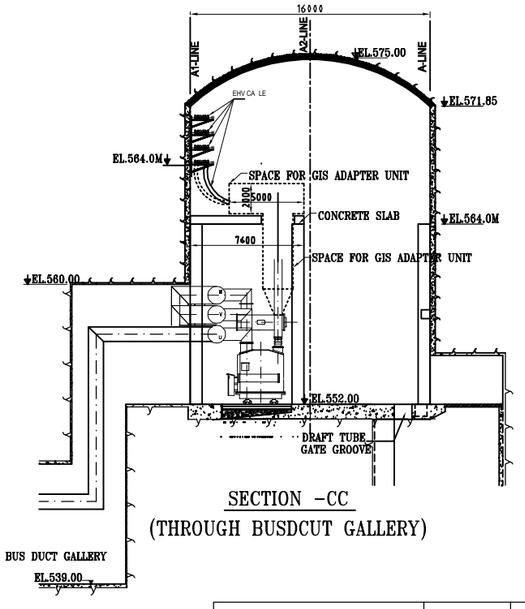
SECTION -A1A1
CROSS-SECTION THROUGH SERVICE BAY



SECTION -AA
CROSS-SECTION THROUGH SERVICE BAY



SECTION -BB
(THROUGH ESCAPE TUNNEL)



SECTION -CC
(THROUGH BUSDCUT GALLERY)

- LAYOUT PLAN AT EL 564.0 M SHALL BE INCORPORATED AFTER FINALIZATION OF HV SYSTEM DRAWINGS.
- INTERFACING DETAILS BETWEEN GSU TRANSFORMER , LV & HV BUSDUCT SHALL BE INCORPORATED LATER AFTER FINALIZATION OF SYSTEM DRAWINGS.
- DETAILS OF TRANSFORMER SOAK PIT SHALL BE INCORPORATED AFTER FINALIZATION OF TRANSFOREMER DRAWING.

NOTES:

01. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES.
02. SIZE/LOCATION OF COLUMNS AND BEAM ARE TENTATIVE AND MAY BE REVIEWED BY SJVNL.

REV.	DATE	ALTERED / CHECKED / APPROVED	
02	15.06.19	ALTERED / CHECKED / APPROVED	DK / DK / RS
ZONE		REVISED AS PER MOM DATED 19.04.19 ⚠2	
01	15.03.19	ALTERED / CHECKED / APPROVED	DK / DK / RS
ZONE		REVISED AS PER SJVNL'S COMMENTS DATED 05.02.19 AT PLACES MARKED ⚠1	

ADDITIONAL INFORMATION		PROJECT	ARUN-3 HYDRO ELECTRIC PROJECT, NEPAL (4x 225 MW)
STATUS OF DRAWING	U	CUSTOMER	SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)
DISTRIBUTION OF PRINTS		CONSULTANT	SJVN LIMITED (A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF HP)
		CONTRACTOR	भारत हेवी इलेक्ट्रिकल्स लिमिटेड, भोपाल Bharat Heavy Electricals Limited, Bhopal

	NAME	SIGN	DATE	NO. OF VAR.
DRWN	DK		10.9.18	
CHKD	DK		10.9.18	
APPD	RS		10.9.18	

SUB-SUPPLIER / VENDOR

DEPT	CODE	UNTOL. DIMS. GR.	ANGLE	SCALE	WEIGHT(kg)	REF.TO ASSY.DRG.	ITEM NO.	NO.OF ITEMS
HSE	415			1:200				

TITLE: CROSS SECTION AND PLAN OF TRANSFORMER CAVERN

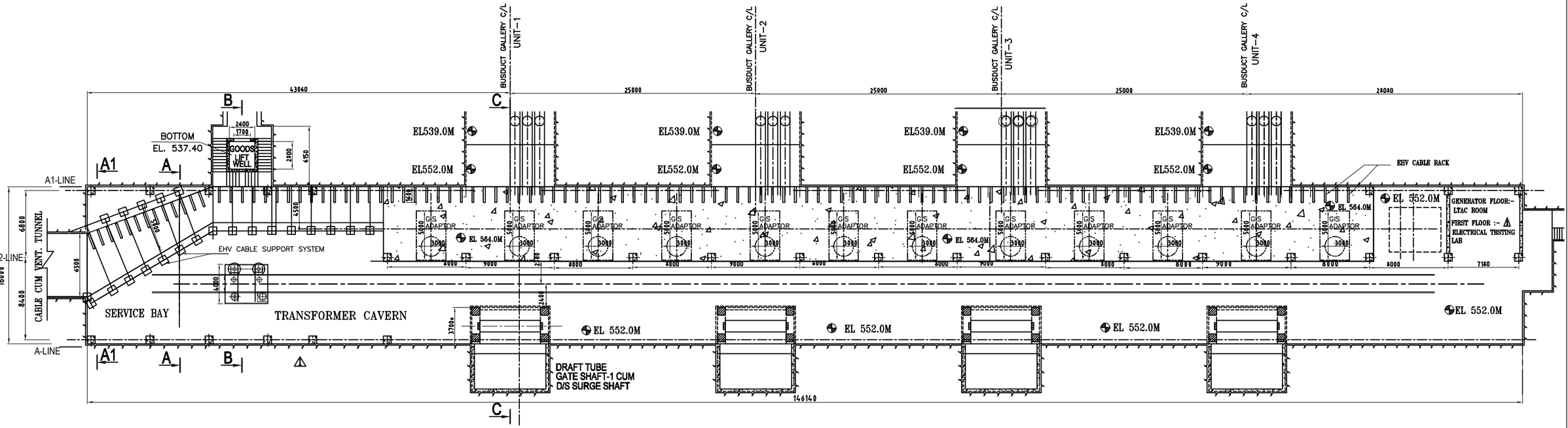
DRAWING NO. 1 200 00 20559 REV. 02

SHEET NO. 01 NO. OF SHEETS. 02

INVENTORY NO. | REF. DRG. NO. | SIGN. & DATE

FIRST ANGLE PROJECTION

DRG. NO. 1 200 00 20570 REV. 02



PLAN OF TRANSFORMER CAVERN AT EL 552.0M/ EL 564.0 M

NOTES:

01. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES.
02. SIZE/LOCATION OF COLUMNS AND BEAM ARE TENTATIVE AND MAY BE REVIEWED BY SJVNL.

REV.	DATE	ALTERED / CHECKED / APPROVED		ZONE
02	15.06.19	CHECKED: DK; APPROVED: RS	REVISED AS PER MOM DATED 19.04.19 ⚠	
01	15.03.19	CHECKED: DK; APPROVED: RS	REVISED AS PER SJVNL'S COMMENTS DATED 05.02.19 AT PLACES MARKED ⚠	

	NAME	SIGN	DATE	NO. OF VAR.
DRWN	DK		10.9.18	
CHKD	DK		10.9.18	
APPD	RS		10.9.18	

ADDITIONAL INFORMATION

STATUS OF DRAWING: U

DISTRIBUTION OF PRINTS

SUB-SUPPLIER / VENDOR

PROJECT: ARUN-3 HYDRO ELECTRIC PROJECT, NEPAL (4x 225 MW)

CUSTOMER: SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)

CONSULTANT: SJVN LIMITED (A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF HP)

CONTRACTOR: भारत हेवी इलेक्ट्रिकल्स लिमिटेड, भोपाल Bharat Heavy Electricals Limited, Bhopal

DEPT HSE | CODE 415 | UNTOL. DIMS. GR. | ANGLE | SCALE 1:200 | WEIGHT(kg) | REF.TO ASSY.DRG. | ITEM NO. | NO.OF ITEMS

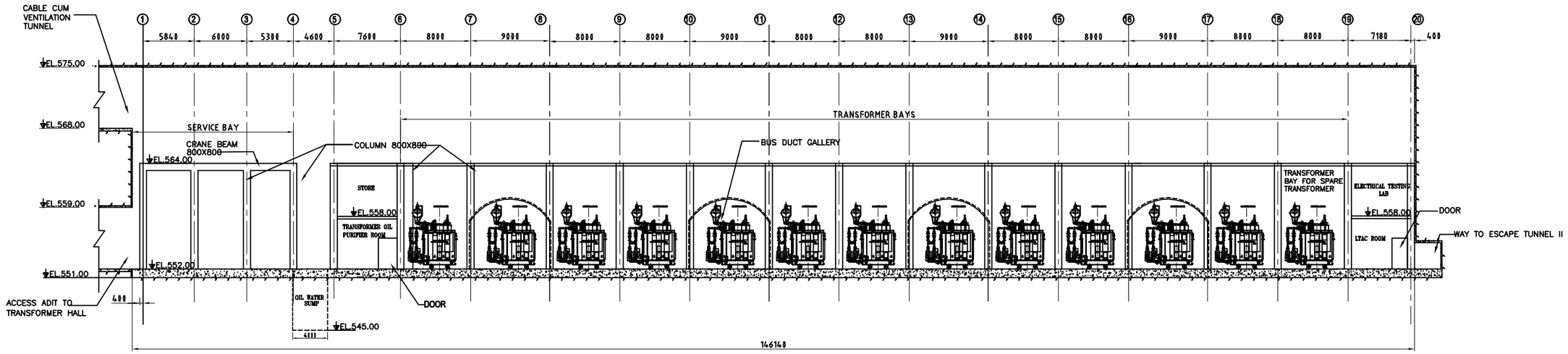
TITLE: CROSS SECTION AND PLAN OF TRANSFORMER CAVERN

DRAWING NO. 1 200 00 20559 | REV. 02

SHEET NO. 02 | NO. OF SHEETS. 02

A1 SIZE

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IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY.



LONGITUDINAL SECTION THROUGH CENTER LINE OF TRANSFORMER CAVERN

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES.

REF. DRG. NO.	SIGN. & DATE	INVENTORY NO.

REV.	DATE	ALTERED / CHECKED / APPROVED	ZONE

ADDITIONAL INFORMATION		PROJECT	ARUN-3 HYDRO ELECTRIC PROJECT, NEPAL (4x 225 MW)
STATUS OF DRAWING		CUSTOMER	SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)
DISTRIBUTION OF PRINTS		CONSULTANT	SJVN LIMITED (A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF HP)
		CONTRACTOR	भारत हेवी इलेक्ट्रिकल्स लिमिटेड, भोपाल Bharat Heavy Electricals Limited, Bhopal

	NAME	SIGN	DATE	NO. OF VAR.
DRWN	DK		27.03.19	
CHKD	DK		27.03.19	
APPD	RS		27.03.19	

SUB-SUPPLIER / VENDOR

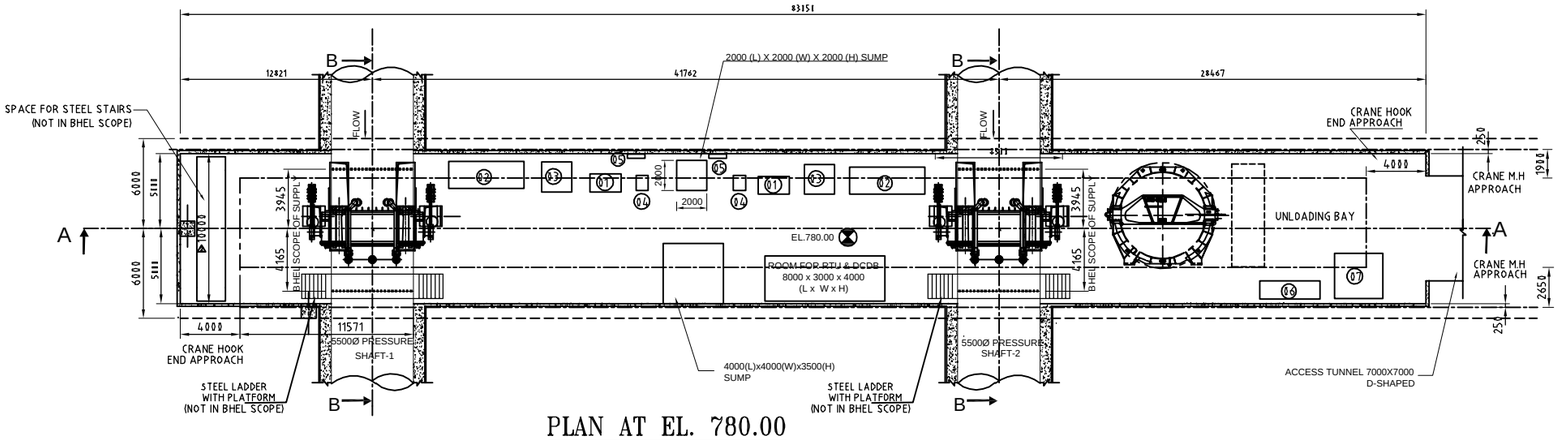
DEPT	UNTOL. DIMS. GR.	ANGLE	SCALE	WEIGHT(kg)	REF.TO ASSY.DRG.	ITEM NO.	NO.OF ITEMS
CODE			1:250				

TITLE: TRANSFORMER CAVERN- L SECTION

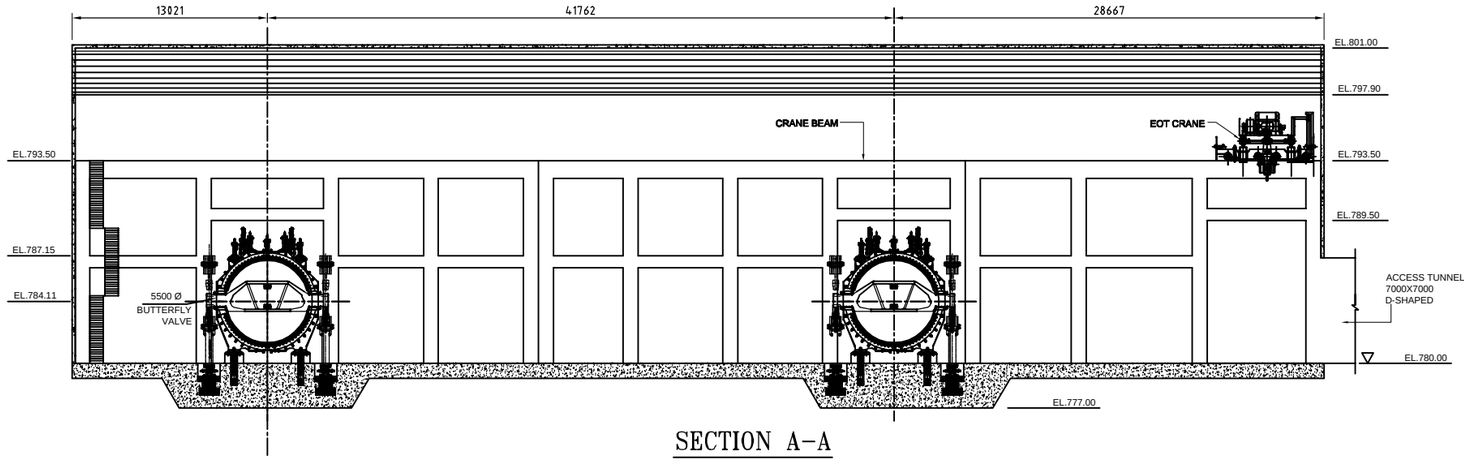
DRAWING NO. 1 200 00 20563 REV. 00

SHEET NO. NO. OF SHEETS.

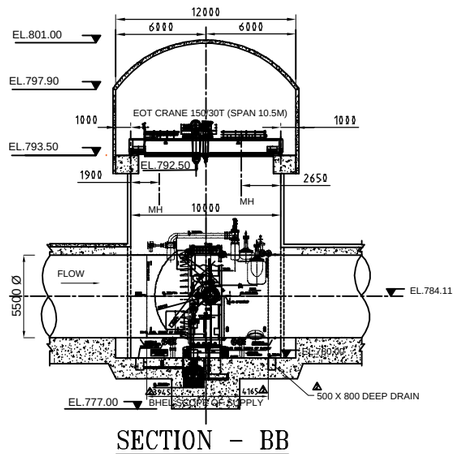
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IT MUST NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY.



PLAN AT EL. 780.00



SECTION A-A



SECTION - BB

TABLE FOR DIMENSIONS OF EQUIPMENTS (TENTATIVE):

ITEM. No	DESCRIPTION	APPROX. SIZE (mm) LENGTH	WIDTH	HEIGHT	WEIGHT (kg)	QUANTITY PER BFV	TOTAL QUANTITY	REMARKS
01	OIL SUMP TANK FOR BFV	2100	1200	1100	3500	1	2	HPE(GOV)
02	PISTON ACCUMULATOR FOR BFV	5000	1800	3500	4500	1	2	HPE(GOV)
03	NITROGEN BOTTLES BANK	2000	2000	3000	3500	1	2	HPE(GOV)
04	BFV HYDRAULIC CONTROL PANEL	700	1000	2350	400	1	2	HPE(GOV)
05	BFV ELECTRICAL CONTROL PANEL	800	1000	2500	300	1	2	HPE(GOV)
06	SERVICE BOARD	4000	1200	2400		-	1	HPE
07	250KVA TRANSFORMER	3250	3025	2950		-	1	JHANSI

01. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES.
02. SIZE OF EQUIPMENTS SHOWN ARE TENTATIVE AND SHALL BE REVIEWED AFTER DETAILED DESIGN.

REV.	DATE	ALTERED / CHECKED / APPROVED	ZONE	DESCRIPTION
02	03.02.20	CHECKED DK / APPROVED RS		DWG REVISEE AS PER LATEST CIVIL DWG RECEIVED FROM SJVNL
01	19.02.19	CHECKED DK / APPROVED RS		DWG REVISEE AS PER LATEST CIVIL DWG RECEIVED FROM SJVNL

ADDITIONAL INFORMATION

STATUS OF DRAWING: U

DISTRIBUTION OF PRINTS

	NAME	SIGN	DATE	NO. OF VAR.
DRWN	DK		12.12.18	
CHKD	DK		12.12.18	
APPD	RS		12.12.18	

SUB-SUPPLIER / VENDOR

PROJECT: ARUN-3 HYDRO ELECTRIC PROJECT, NEPAL (4x 225 MW)

CUSTOMER: SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)

CONSULTANT: SJVN LIMITED (A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF HP)

CONTRACTOR: भारत हेवी इलेक्ट्रिकल्स लिमिटेड, भोपाल Bharat Heavy Electricals Limited, Bhopal

DEPT HPE | CODE 415 | UNTOL. DIMS. GR. | ANGLE | SCALE | WEIGHT(kg) | REF.TO ASSY.DRG. | ITEM NO. | NO.OF ITEMS

TITLE: CROSS SECTION AND EQUIPMENT LAYOUT PLAN OF BF VALVE HOUSE

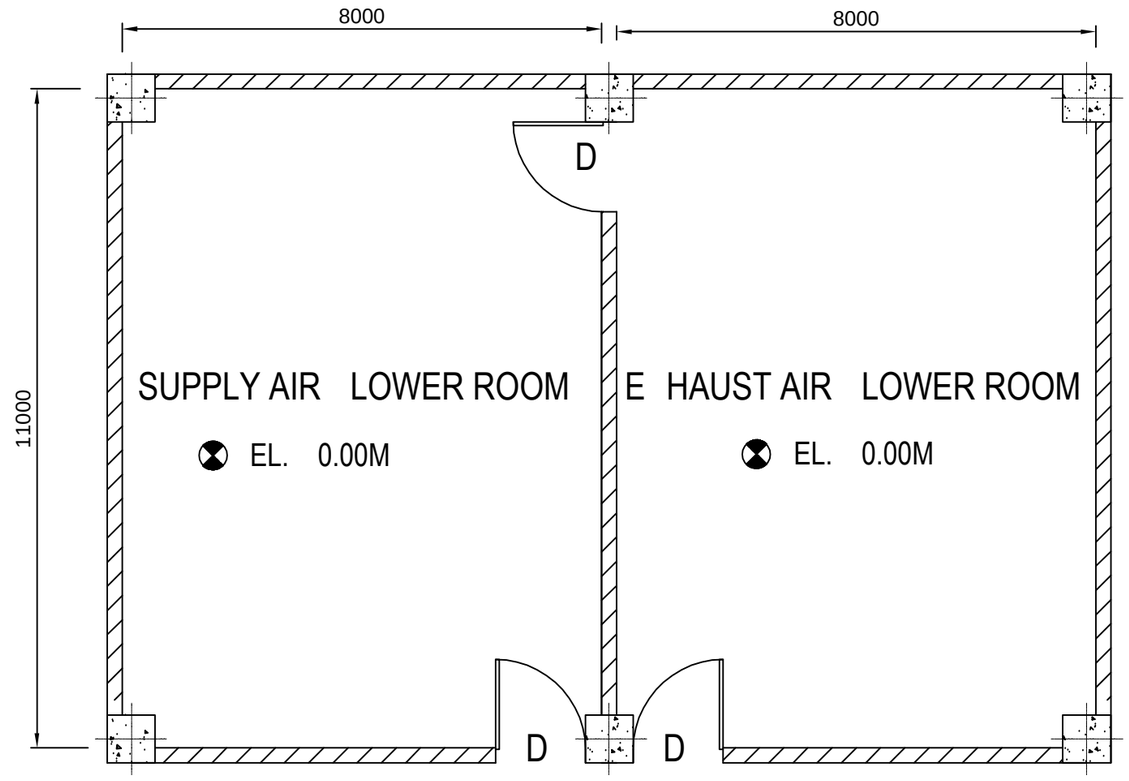
DRAWING NO. 1 200 00 20560 | REV. 02

SHEET NO. 01 | NO. OF SHEETS. 01

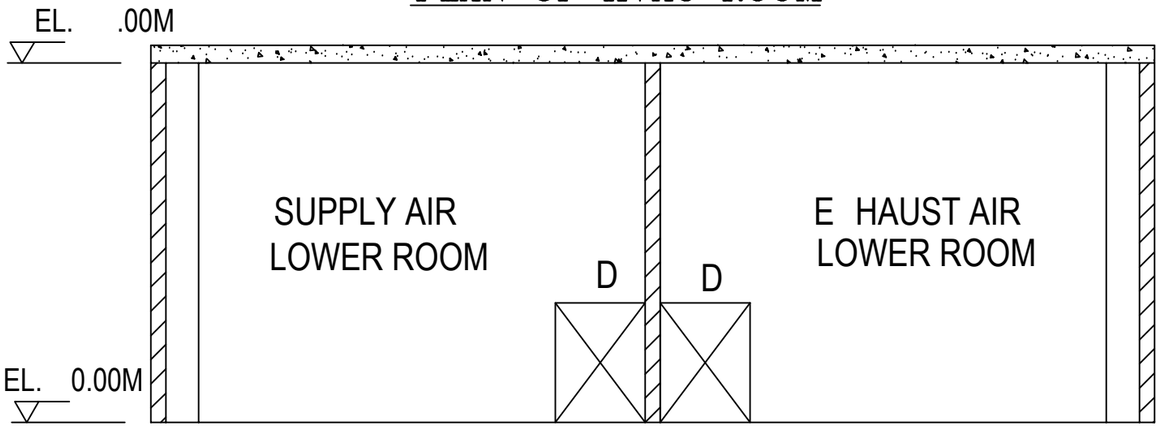
REF. DRG. NO. | SIGN. & DATE | INVENTORY NO.

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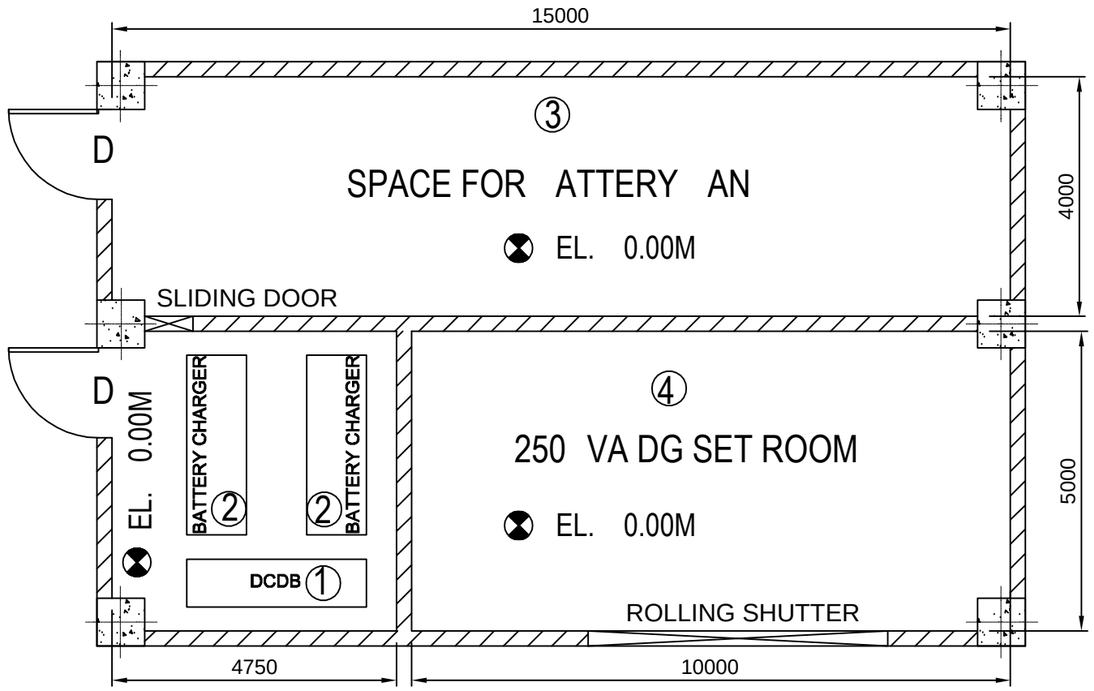
DRG. NO. 1 200 00 20571 REV. 00



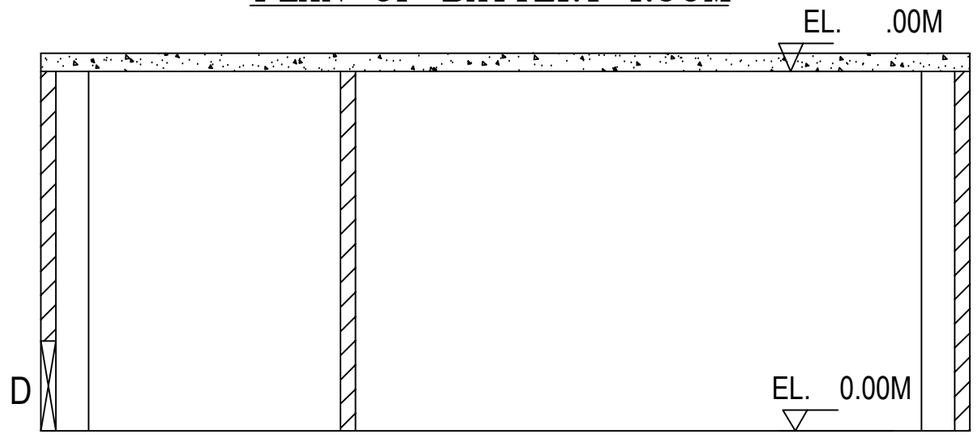
PLAN OF HVAC ROOM



ELEVATION OF HVAC ROOM



PLAN OF BATTERY ROOM



ELEVATION OF BATTERY ROOM

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES.
2. SIZE OF EQUIPMENT SHOWN ARE TENTATIVE AND SHALL BE FINALIZED AFTER DETAIL DESIGN.
3. ELEVATION MARKED ARE TENTATIVE AND SHALL BE FINALIZED BY SJVNL.
4. HVAC ROOM & BATTERY ROOM ARE TO BE PLACED AT THE PORTAL OF PPV AND EXACT LOCATION SHALL BE FINALIZED BY SJVNL.

EQUIPMENT'S PLACED AT BATTERY ROOM (TENTATIVE)

ITEM NO.	DESCRIPTION	DIMENSION W x D x H	QTY NO.	SCOPE OF SUPPLY
01	DCDB FOR VALVE HOUSE	3000x800x2400	01	BHEL-HPE
02	BATTERY CHARGER	3000x1000x2400	02	BHEL-HPE
03	SPACE FOR BATTERY BANK	15000x4000x500	01	BHEL-HPE
04	SPACE FOR DG ROOM	10000x5000x3000	01	BHEL-HPE

REV	DATE	ALTERED
		CHECKED
		APPROVED

ZONE

SUB-SUPPLIER / VENDOR

ADDITIONAL INFORMATION

STATUS OF DRAWING: U

DISTRIBUTION OF PRINTS

	NAME	SIGN	DATE	NO. OF VAR.
DRWN	TK		31.03.19	
CHKD	DK		31.03.19	
APPD	RS		31.03.19	

PROJECT: ARUN-3 HYDRO ELECTRIC PROJECT, NEPAL (4x 225 MW)

CUSTOMER: SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)

CONSULTANT: SJVN LIMITED (A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF HP)

CONTRACTOR: भारत हेवी इलेक्ट्रिकल्स लिमिटेड, भोपाल Bharat Heavy Electricals Limited, Bhopal

DEPT HSE	UNTOL. DIMS. GR.	ANGLE	SCALE 1:100	WEIGHT(kg)	REF.TO ASSY.DRG.	ITEM NO.	NO.OF ITEMS
CODE 415							

TITLE: LAYOUT OF HVAC & BATTERY ROOM AT PPV PORTAL

DRAWING NO. 1 200 00 20571 REV. 00

SHEET NO. 01 NO. OF SHEETS. 01

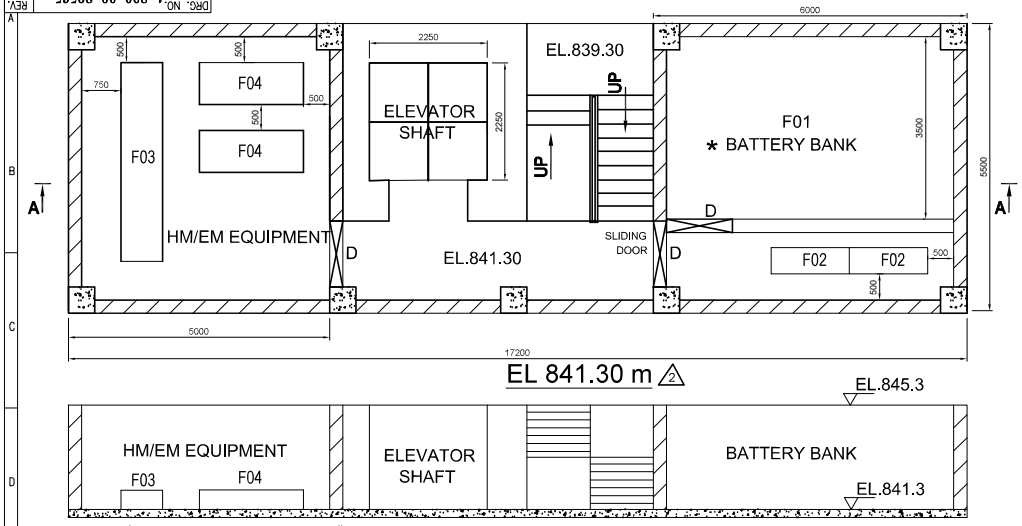
REF. DRG. NO. | SIGN. & DATE | INVENTORY NO.

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN "mm")

DRG. NO. 1 200 00 20565 REV. 04

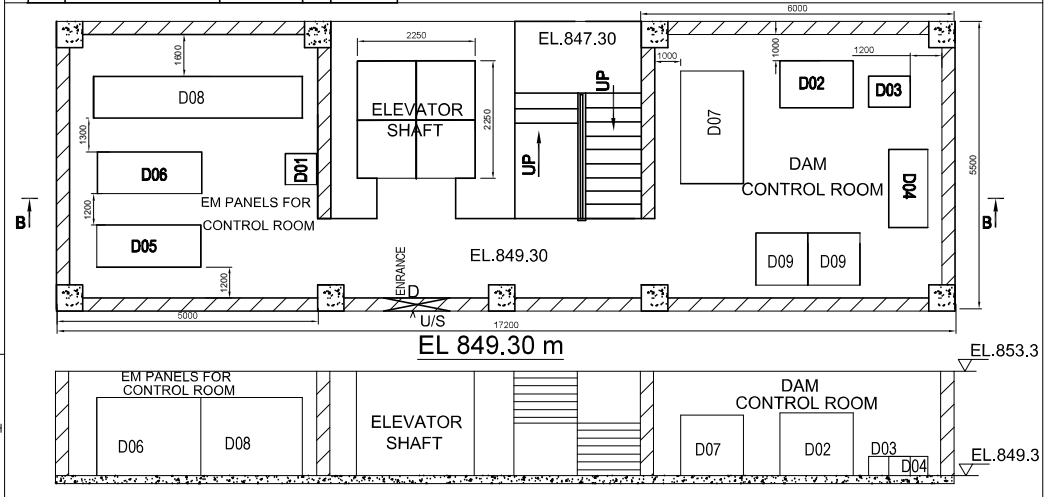
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SECTION-AA

EQUIPMENT'S PLACED AT EL.–841.3 M"

ITEM NO.	DESCRIPTION	DIMENSION W x D x H	QTY NO.	SCOPE OF SUPPLY
F01	ROOM FOR BATTERY BANK	3500x5500x4000	01	BHEL-HPE
F02	BATTERY CHARGER	4000x1000x2400	01 SET (02 NOS)	BHEL-HPE
F03	LCB	3804x800x2415	01	EDN
F04	ACDB INVERTER	2000x800x2400	02	BHEL-HPE



SECTION-BB

EQUIPMENT'S PLACED AT EL.–"849.30 M"

ITEM NO.	DESCRIPTION	DIMENSION W x D x H	QTY NO.	SCOPE OF SUPPLY
D01	OPGW TERMINATION (WALL MOUNTED)	600x600x450	01	EDN
D02	LVS	1400x900x2400	01	EDN
D03	PRINTER	800x600x740	01	EDN
D04	OPERATOR WORK STATION	1500x750x750	01	EDN
D05	EPABX PANEL	2000x800x2400	01	BHEL-HPE
D06	CCTV PANEL	2000x800x2400	01	BHEL-HPE
D07	ACDB ILLUMINATION	2160x1200x2315	01	BHEL-PEM
D08	DCDB	4000x800x2400	01	BHEL-HPE
D09	AC INVERTER	1000x1000x1000	02	BHEL-HPE

LIST & SIZES OF EQUIPMENTS ARE TENTATIVE AND MAY BE REVISED DURING DETAIL ENGINEERING OF RESPECTIVE SYSTEM

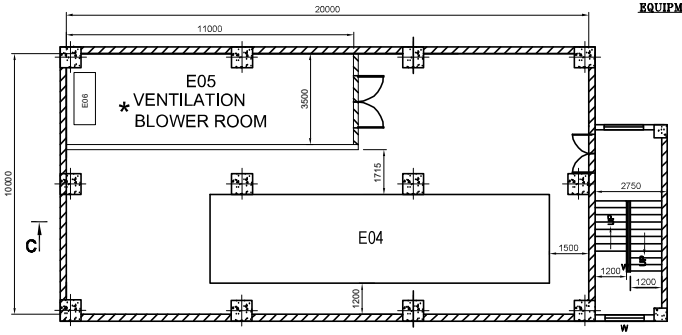
Dam Control building

NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES.
2. EL. X TO BE FINALIZED BY SJVNL.
3. THIS LAYOUT SHOWS EQUIPMENT/ SPACE REQUIRED IN BHEL SCOPE ONLY
4. FOUNDATION/ TRENCHES/ OTHER CIVIL DETAILS SHALL BE SHOWN LATER AFTER FINALIZATION OF SYSTEM DESIGN.
*5. DETAILS OF DG, TANK & PANEL SIZE, BATTERY ROOM, VENTILATION ROOM SHALL BE SHOWN AFTER FINALIZATION OF SYSTEM DESIGN.
6. SIZES AND LOCATIONS OF COLUMN/ BEAM ARE INDICATIVE ONLY.

Approximate distance between Dam control building and auxiliary building is 250 M

EQUIPMENT'S PLACED AT EL.–"X"(GROUND FLOOR) (TENTATIVE)

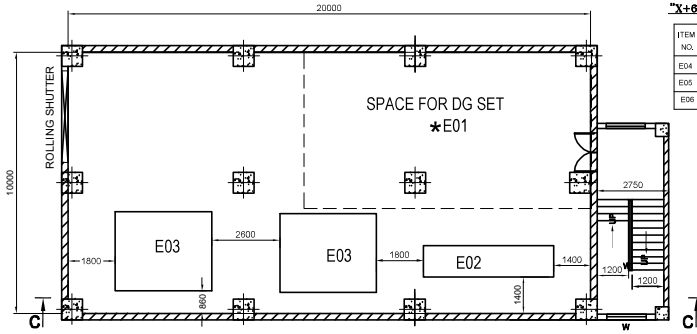
ITEM NO.	DESCRIPTION	DIMENSION W x D x H	QTY NO.	SCOPE OF SUPPLY
E01	SPACE FOR DG SET	11000x6000x4000	01	BHEL-HPE
E02	LT DISTRIBUTION BOARD	5000x1200x2400	01	BHEL-HPE
E03	630KVA TRANSFORMER	3700x3025x2950	02	BHEL-JHANSI



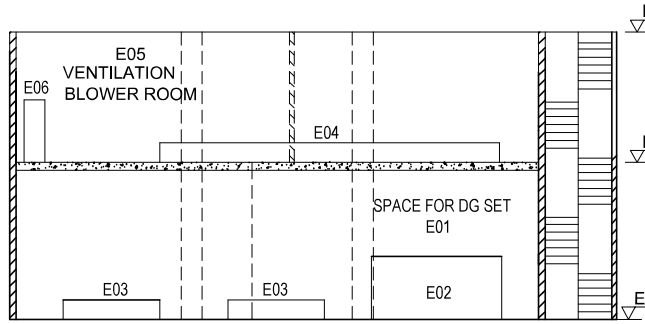
⚠ FIRST FLOOR PLAN AT EL.–"X+6M"

EQUIPMENT'S PLACED AT EL.–"X+6M"(GROUND FLOOR) (TENTATIVE)

ITEM NO.	DESCRIPTION	DIMENSION W x D x H	QTY NO.	SCOPE OF SUPPLY
E04	33 KV PANEL	13000x3800x2600	01	SWE
E05	VENTILATION BLOWER ROOM	8000x4000x4500	01	BHEL-PEM
E06	MCC FOR VENTILATION/AC	2000x800x2100	01	BHEL-PEM



⚠ GROUND FLOOR PLAN AT EL.–"X M"



SECTION-CC

Auxiliary building

REV	DATE	ALTERED / CHECKED / APPROVED	DK / DK / RS	ZONE
03	14.09.19			REVISED AS PER CUSTOMER COMMENTS DATED 01.07.19
02	03.06.19			REVISED AS PER MOM DATED 19.04.19
01	02.03.19			REVISED AS PER SJVN COMMENTS DATED 10.01.19
04	28.04.20			REVISED AS PER SJVN COMMENTS ON THE PEDM

465

	NAME	SIGN	DATE	NO. OF VAR.
DRWN	DK		10.12.18	
CHKD	DK		10.12.18	
APPD	RS		10.12.18	

SUB–SUPPLIER / VENDOR

ADDITIONAL INFORMATION	
STATUS OF DRAWING	U
DISTRIBUTION OF PRINTS	
PROJECT	ARUN-3 HYDRO ELECTRIC PROJECT, NEPAL (4x 225 MW)
CUSTOMER	SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)
CONSULTANT	SJVN LIMITED (A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF HP)
CONTRACTOR	भारत हेवी इलेक्ट्रिकल्स लिमिटेड, भोपाल Bharat Heavy Electricals Limited, Bhopal

DEPT	HPE	UNTOL. DIMS. GR.	ANGLE	SCALE	WEIGHT(kg)	REF.TO ASSY.DRG.	ITEM NO.	NO.OF ITEMS
CODE	415			1:100				

TITLE: DAM SITE– EQUIPMENT LAYOUT PLAN

DRAWING NO. 1 200 00 20565 REV. 04

SHEET NO. 01 NO. OF SHEETS. 01

A1 SIZE

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN "mm")

DRG. NO. 32000020552 REV. 00

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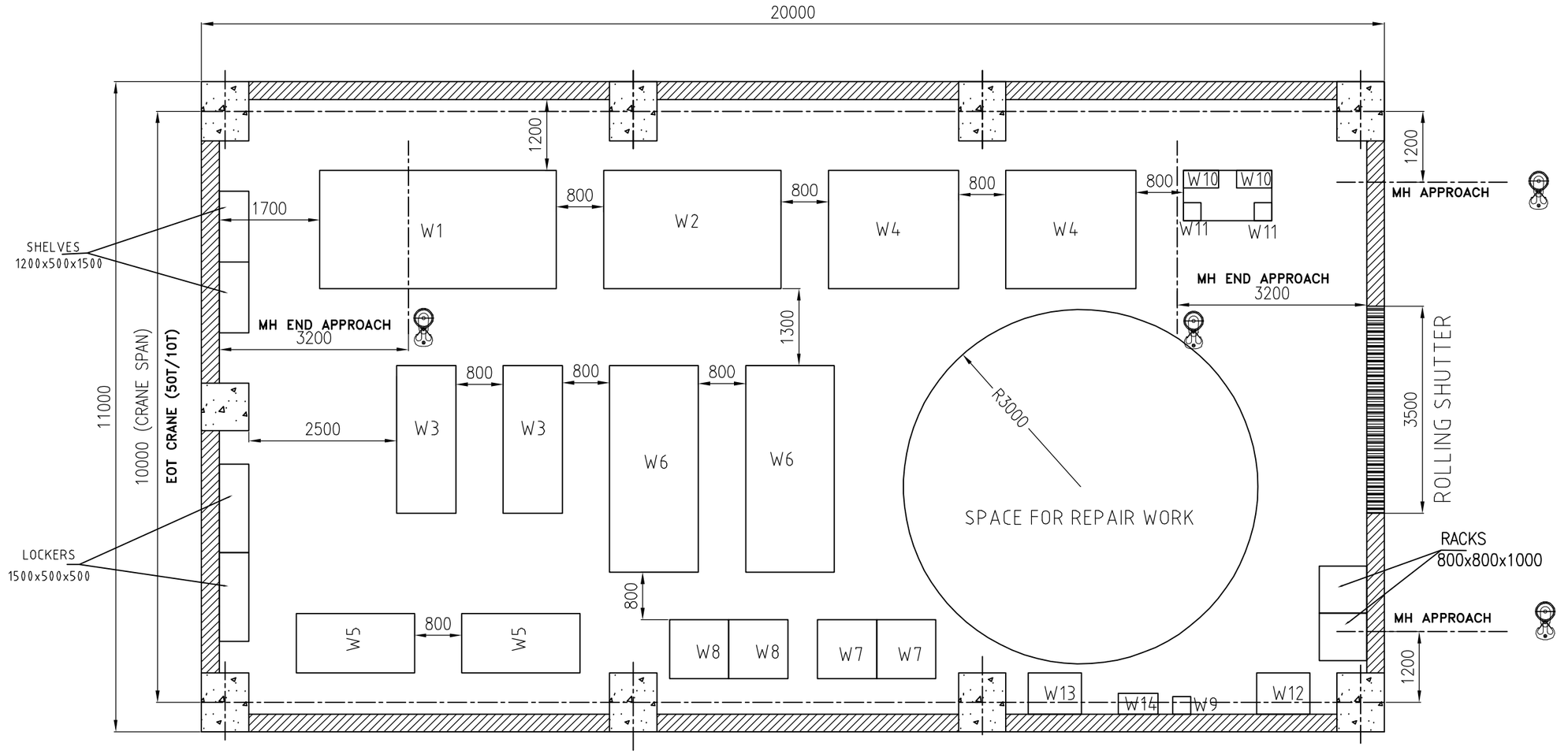


TABLE FOR DIMENSIONS OF EQUIPMENTS IN MECHANICAL WORKSHOP

ITEM. No	DESCRIPTION	APPROX. SIZE (mm) LENGTH	WIDTH	HEIGHT	WEIGHT (kg)	QUANTITY PER UNIT	TOTAL QUANTITY	DIVISION
W1	LONG LATHE	4000	2000	2000	5000	-	1	HPE
W2	MEDIUM LATHE	3000	2000	2000	4000	-	1	HPE
W3	TOOL MAKER'S LATHE	2500	1000	700	3000	-	2	HPE
W4	SHAPER MACHINE	2200	2000	2000	4500	-	2	HPE
W5	POWER HACKSAW	2000	1000	2200	1500	-	2	HPE
W6	RADIAL DRILLING MACHINE	3500	1500	2000	4500	-	2	HPE
W7	PIPE CUTTING MACHINE	1000	1000	1000	200	-	2	HPE
W8	PIPE BENDING MACHINE	1000	1000	1000	200	-	2	HPE
W9	FLOOR MOUNTED ELECTRIC OVEN	300	300	480	200	-	1	HPE
W10	ANVIL	600	300	480	200	-	2	HPE
W11	BEARING PULLAR	300	300	480	200	-	2	HPE
W12	MIG WELDING MACHINE	900	700	600	200	-	1	HPE
W13	TIG WELDING MACHINE	900	700	600	200	-	1	HPE
W14	RECTIFIER TYPE WELDING MACHINE	675	350	600	200	-	1	HPE

MECHANICAL WORKSHOP

NOTES:-

1) LOCATION AND SIZES OF COLUMNS/WALLS/ROLLING SHUTTER IS TENTATIVE AND TO BE FINALIZED BY SJVNL.
2) LOCATION OF WORKSHOP ROOM IN SWITCHYARD IS TO FINALIZED BY SJVNL.
3) CRANE APPROACHES SHOWN ARE INDICATIVE ONLY.

	NAME	SIGN	DATE	NO. OF VAR.
DRWN	TK		06.05.19	
CHKD	SS		06.05.19	
APPD	RS		06.05.19	

ADDITIONAL INFORMATION

STATUS OF DRAWING: U

DISTRIBUTION OF PRINTS

SUB-SUPPLIER / VENDOR

PROJECT: ARUN-3 HYDRO ELECTRIC PROJECT, NEPAL (4x 225 MW)

CUSTOMER: SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)

CONSULTANT: SJVN LIMITED (A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF HP)

CONTRACTOR: भारत हेवी इलेक्ट्रिकल्स लिमिटेड, भोपाल Bharat Heavy Electricals Limited, Bhopal

REV.	DATE	ALTERED / CHECKED / APPROVED	ZONE

DEPT HPE | CODE 415 | UNTOL. DIMS. GR. | ANGLE | SCALE 1:40 | WEIGHT(kg) | REF.TO ASSY.DRG. | ITEM NO. | NO.OF ITEMS

TITLE: LAYOUT OF MECHANICAL WORKSHOP IN SWITCHYARD

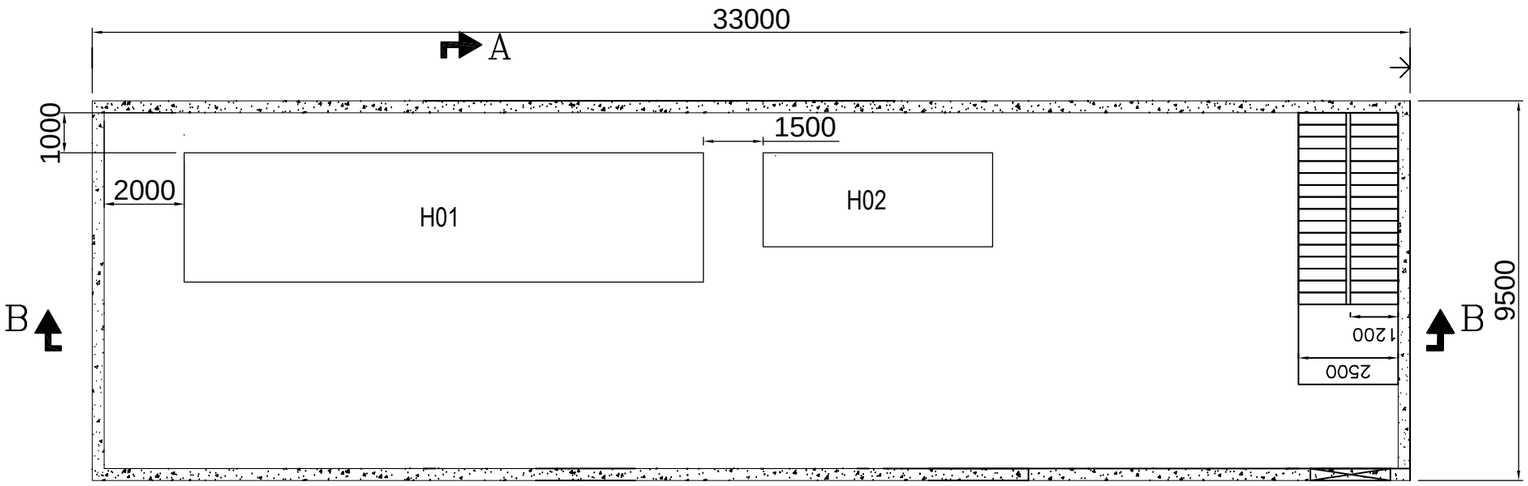
DRAWING NO. 32000020552 | REV. 00

SHEET NO. 01 | NO. OF SHEETS. 01

REF. DRG. NO. | SIGN. & DATE | INVENTORY NO.

A1 SIZE

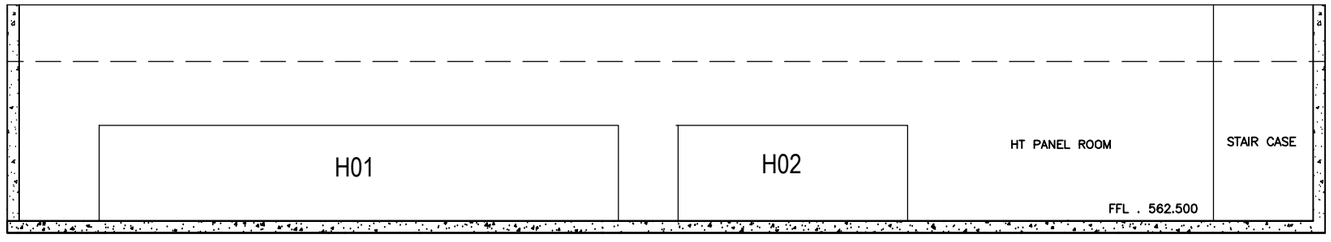
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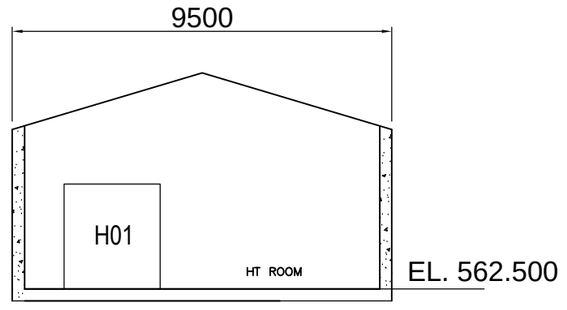
PLAN AT EL 562.50

NOTES

1. ALL DIMENSION ARE IN MM UNLESS OTHERWISE NOTED.
2. HEIGHT OF ROOMS SHOWN IN SECTION IS CLEAR HEIGHT FROM BEAMS TO FFL.
3. ELEVATION SHOWN ABOVE IS FOR INDICATION OF HEIGHTS ONLY.
4. CABLE ENTRY FOR ALL PANELS SHALL BE THROUGH BOTTOM.
5. SIZE AND NUMBER OF PANELS INDICATED HERE ARE TENTATIVE AND SUBJECT CHANGES.
6. SIZE OF DG ROOM SHALL BE 16M(L)X20M(W)X7M(H) LOCATED NEAR POTHEAD YARD..



SECTION B-B



SECTION A-A

EQUIPMENT'S PLACED AT EL.–562.50 M (TENTATIVE)

ITEM NO.	DESCRIPTION	DIMENSION W x D x H	QTY NO.	SCOPE OF SUPPLY
H01	33KV SWITCH GEAR	13000X3240X2400	01	BHEL-SWE
H02	11 KV SWITCH GEAR	5740X2355X2400	01	BHEL-SWE

REV	DATE	ALTERED	DK	REV	DATE	ALTERED	DK
		CHECKED	DK			CHECKED	DK
		APPROVED	RS			APPROVED	RS
ZONE				ZONE			

ADDITIONAL INFORMATION

STATUS OF DRAWING: U

DISTRIBUTION OF PRINTS

	NAME	SIGN	DATE	NO. OF VAR.
DRWN	DK		10.12.18	
CHKD	DK		10.12.18	
APPD	RS		10.12.18	

SUB–SUPPLIER / VENDOR

PROJECT: ARUN-3 HYDRO ELECTRIC PROJECT, NEPAL (4x 225 MW)

CUSTOMER: SJVN ARUN-3 POWER DEVELOPMENT COMPANY PVT. LTD. (SAPDC LTD.)

CONSULTANT: SJVN LIMITED (A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF HP)

CONTRACTOR: भारत हेवी इलेक्ट्रिकल्स लिमिटेड, भोपाल Bharat Heavy Electricals Limited, Bhopal

DEPT HSE | CODE 415 | UNTOL. DIMS. GR. | ANGLE | SCALE 1:100 | WEIGHT(kg) | REF.TO ASSY.DRG. | ITEM NO. | NO.OF ITEMS

TITLE: HT ROOM LAYOUT AT SWITCHYARD

DRAWING NO. | REV.

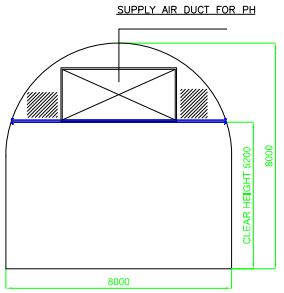
SHEET NO. 01 | NO. OF SHEETS. 01

REF. DRG. NO. | SIGN. & DATE | INVENTORY NO.

DRAWING NO. PE-DG-437-571-11000-A002

FIRST ANGLE PROJECTION

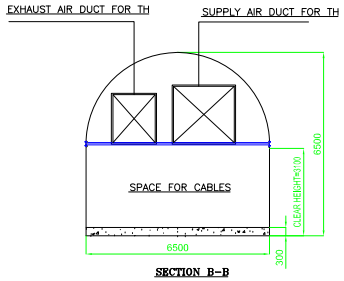
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SECTION A–A

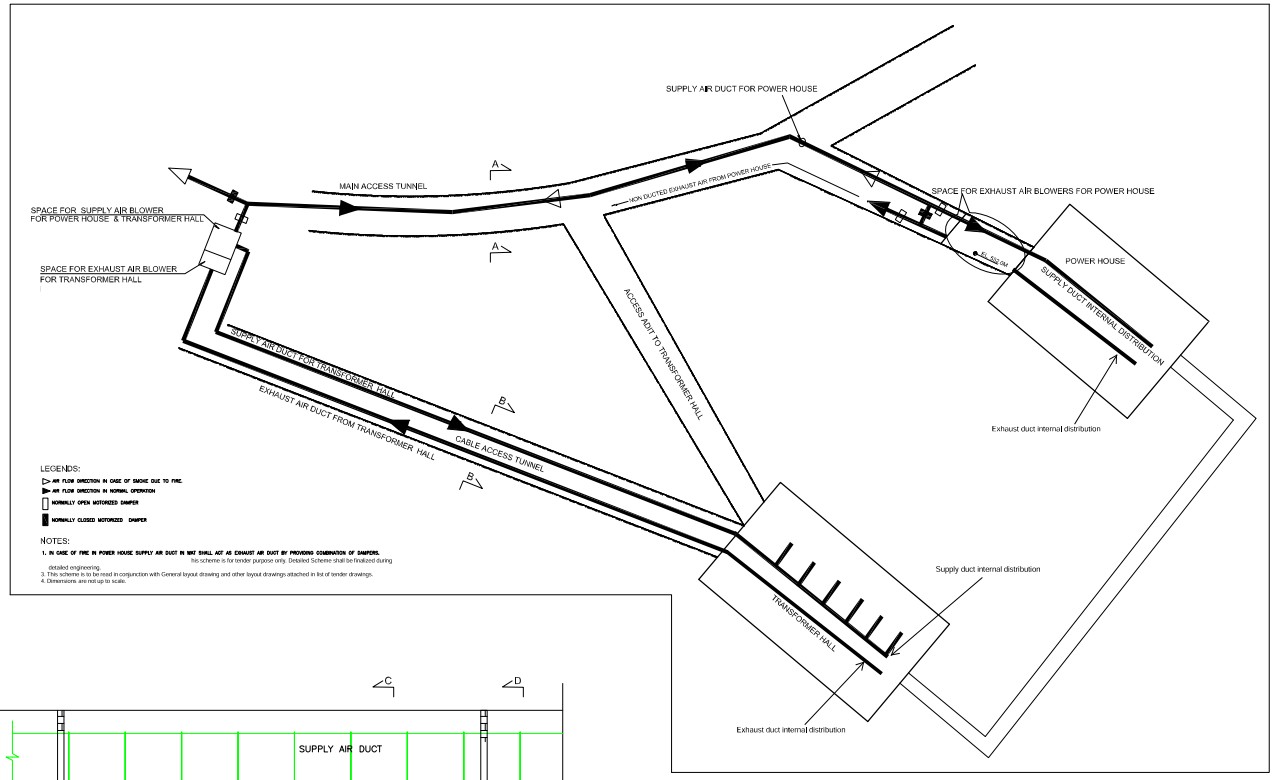
(Cross- section of MAT with supply Air duct for PH)

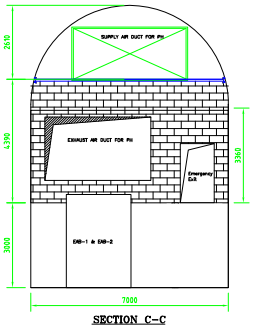
HATCHED AREA SHALL BE USED FOR ROUTING DUCTS FOR BATTERY ROOM, TOILETS, PANTRY ETC.



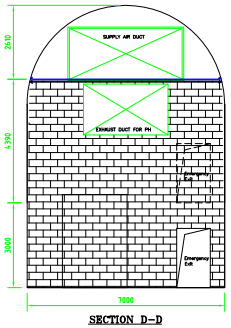
SECTION B–B

(Cross- section of CAT with Exhaust and Supply Air duct for TH)

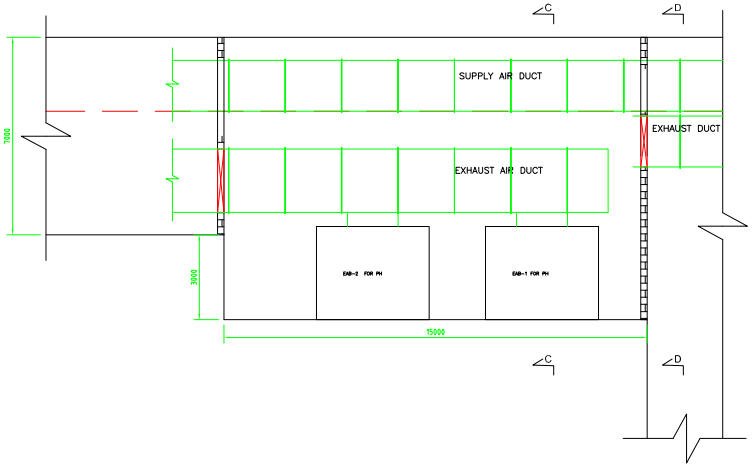




SECTION C–C



SECTION D–D



CUSTOMER		SAPDC (P.) LIMITED
CONSULTANT		SJVN LIMITED

ARUN-3 H. E. PROJECT NEPAL (900 MW)

EPC CONTRACTOR
BHARAT HEAVY ELECTRICALS LTD.
POWER SECTOR – PEM
NOIDA

	NAME	SIGN	DATE
DSN	MS		09.05.2019
DRW	MS		09.05.2019
CHD	LATA		09.05.2019
APPD	MM		09.05.2019

JOB NO. 437
STATUS CONTRACT

REV.	DATE	ALTD	CHD	APPD

PURPOSE: HVAC SYSTEM

DOCUMENT TITLE: VENTILATION SCHEME FOR POWER HOUSE & TRANSFORMER HALL

DRAWING No. PE-DG-437-571-11000-A002

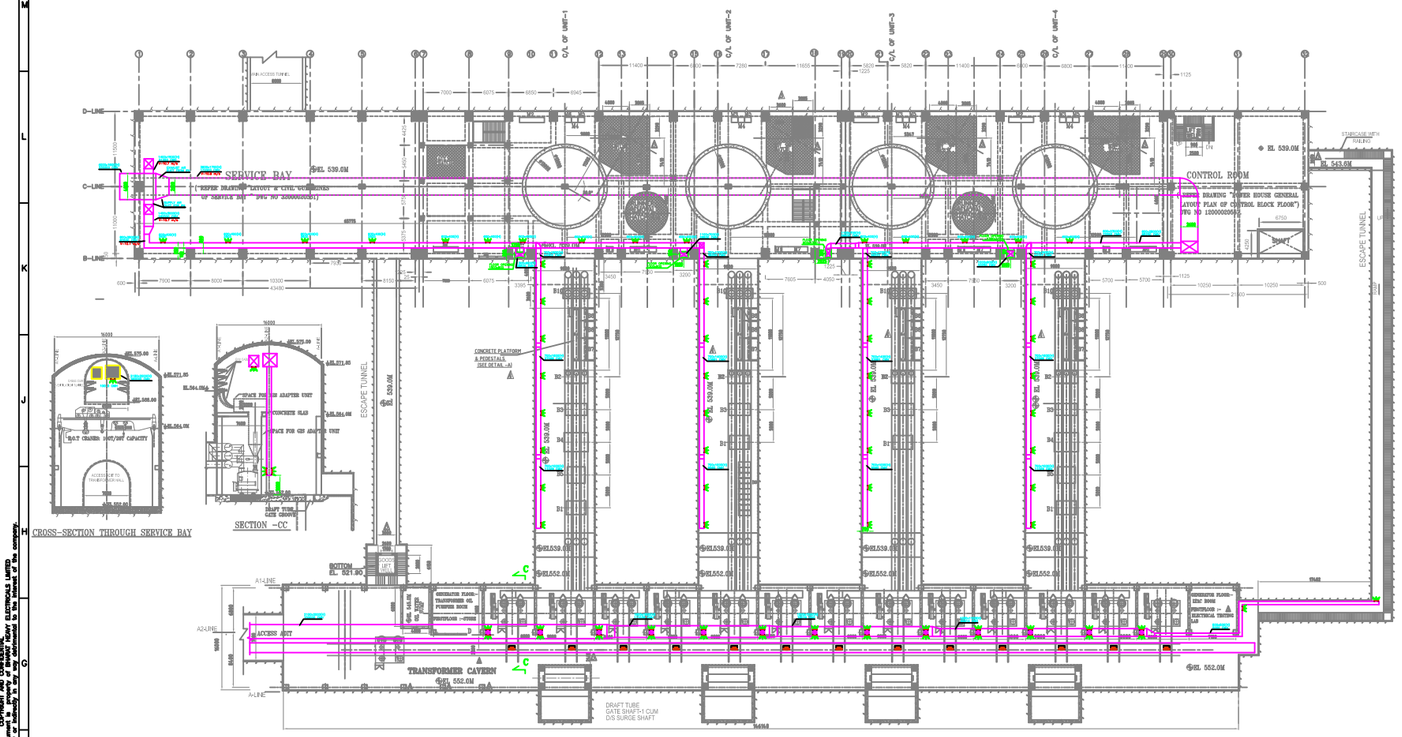
SHEET 1 OF 1 REV 0

FORMAT SIZE A1

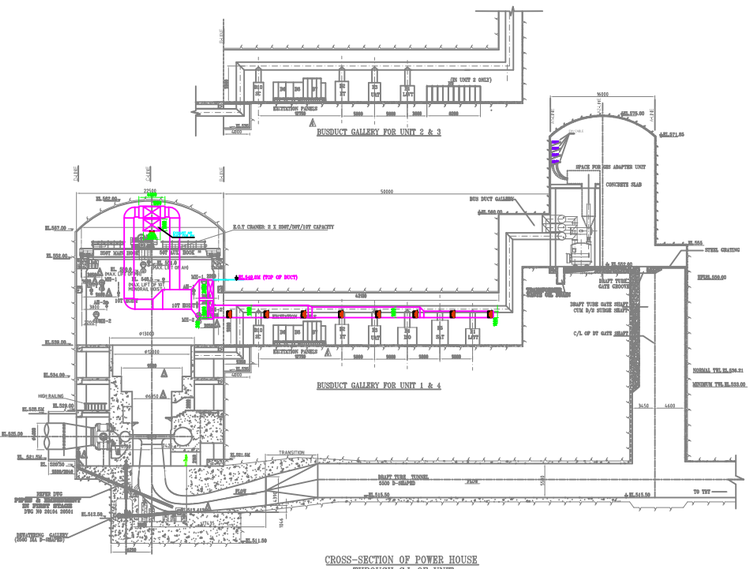
DRAWING NO. PE-DG-437-571-11000-A003

FIRST ANGLE PROJECTION

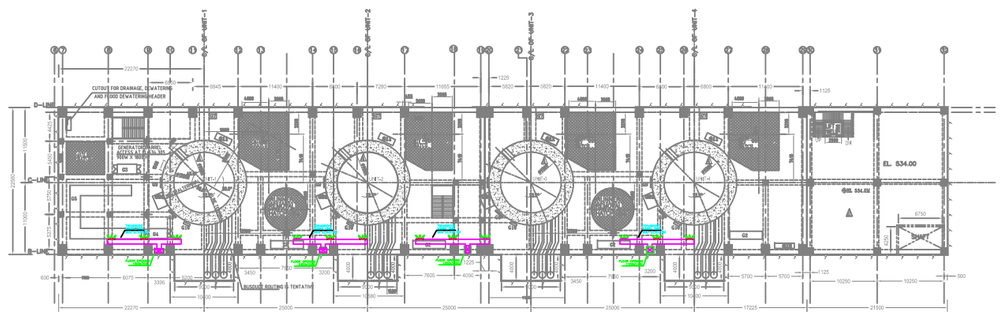
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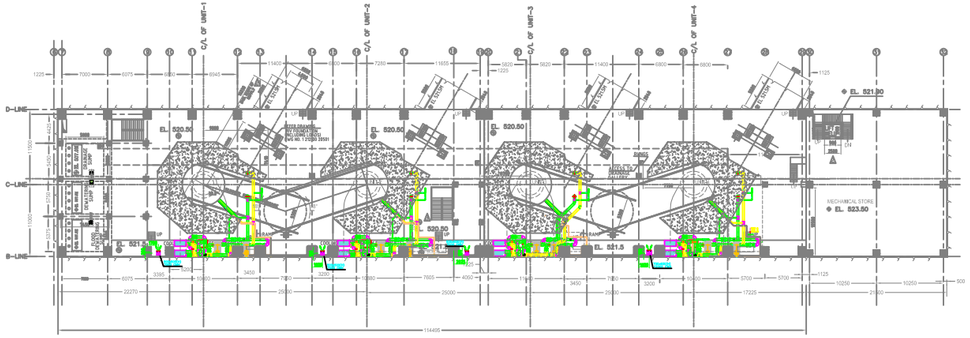
PLAN AT EL.539.0M & 552.0M



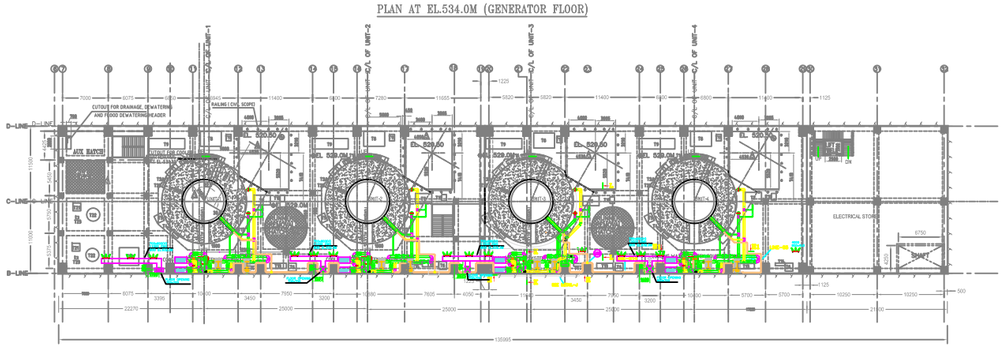
CROSS-SECTION OF POWER HOUSE THROUGH C.L OF UNIT



PLAN AT EL.534.0M (GENERATOR FLOOR)



PLAN AT EL.520.5 (MIV FLOOR)



PLAN AT EL.529.00 (TURBINE FLOOR)

THIS DUCTING LAYOUT IS INDICATIVE AND FOR TENDER PURPOSE ONLY.

CUSTOMER		SAPDC (P.) LIMITED
CONSULTANT		SJVN LIMITED

ARUN-3 H. E. PROJECT NEPAL (900 MW)

EPC CONTRACTOR
BHARAT HEAVY ELECTRICALS LTD.
POWER SECTOR - PEM
NOIDA

DSGN	BS	-/-/-	31.05.2020
CHKD	RS	-/-/-	31.05.2020
CHKD	AATH	-/-/-	31.05.2020
APPD	BSB	-/-/-	31.05.2020

JOB NO. 437
STATUS CONTRACT

HVAC SYSTEM

DOCUMENT TITLE
VENTILATION DUCTING FOR POWER HOUSE & TRANSFORMER HALL

DRAWING No. PE-DG-437-571-11000-A003

REV.	DATE	ALTD	CHD	APPD

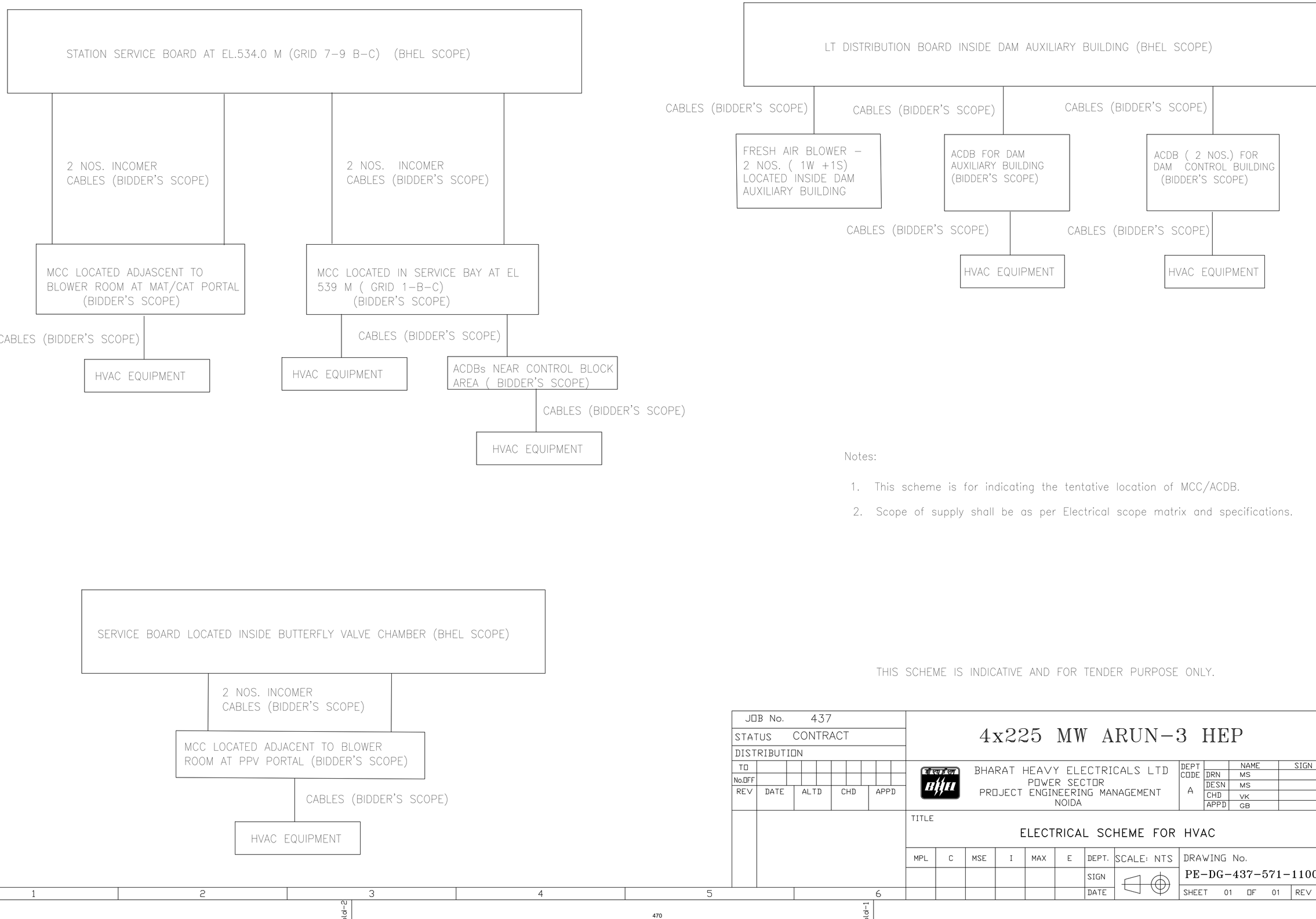
FORMAT SIZE A1

Fold-2 | ALL DIMENSIONS ARE IN MM | FIRST ANGLE PROJECTION | Fold-1

DRAWING No. | CUSTOMER'S DRAWING No.

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COMPUTER FILE NAME :



Notes:

1. This scheme is for indicating the tentative location of MCC/ACDB.
2. Scope of supply shall be as per Electrical scope matrix and specifications.

THIS SCHEME IS INDICATIVE AND FOR TENDER PURPOSE ONLY.

JOB No. 437				
STATUS CONTRACT				
DISTRIBUTION				
TO				
No.OFF				
REV	DATE	ALTD	CHD	APPD

4x225 MW ARUN-3 HEP

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

DEPT CODE		NAME	SIGN	DATE
A	DRN	MS		24.09.2020
	DESN	MS		24.09.2020
	CHD	VK		24.09.2020
	APPD	GB		24.09.2020

TITLE

ELECTRICAL SCHEME FOR HVAC

MPL	C	MSE	I	MAX	E	DEPT.	SCALE: NTS
						SIGN	
						DATE	

DRAWING No.
PE-DG-437-571-11000-A004

SHEET 01 OF 01 REV 00

SIZE-A2