

UTTARAKHAND JAL VIDUT NIGAM
LIMITED

2X60 MW HYDRO ELECTRIC PROJECT
VYASI, UTTARAKHAND

VOLUME – II – B

**TECHNICAL SPECIFICATION
FOR**

**HEATING, VENTILATION AND AIR
CONDITIONING SYSTEM**

SPECIFICATION NO.: PE-TS-407-571-11000-A001 Rev 0



BHARAT HEAVY ELECTRICALS LIMITED

POWER SECTOR

PROJECT ENGINEERING MANAGEMENT

NOIDA, INDIA

	TITLE 2x60 MW VYASI HEP INDEX	SPECIFICATION NO. PE-TS-407-571-11000-A001
		VOLUME : II B
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TITLE

2x60 MW VYASI HEP

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2X60 MW VYASI HEP

HEATING, VENTILATION AND AIR CONDITIONING SYSTEM

INTENT OF SPECIFICATION

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SECTION A

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SECTION-A

INTENT OF SPECIFICATION



TITLE

2X60 MW VYASI HEP

HEATING, VENTILATION AND AIR CONDITIONING SYSTEM

INTENT OF SPECIFICATION

SPECIFICATION NO. PE-TS-407-571-11000-A-A001

VOLUME II B

SECTION A

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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, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles (as applicable) fill of lubricants & consumables, spares along with spares for erection, start-up and commissioning as required, forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation to stores area & storage, transportation to site (from stores area) & in-site transportation, assembly, erection & commissioning, final painting at site, minor civil work, trial run at site and carrying out Performance guarantee / Functional / Demonstration tests at site (As applicable), training of customer/client O&M staff and handover in flawless condition of the package to the end customer complete with all accessories of **HEATING, VENTILATION AND AIR CONDITIONING SYSTEM** as per details in different sections / volumes of this specification for **2X60 MW VYASI HEP** at VYASI UTTARAKHAND.
- 1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the contractor of the responsibility of providing such facilities to complete the supply, erection and commissioning, performance and guarantee/demonstration testing of **HEATING, VENTILATION AND AIR CONDITIONING SYSTEM**.
- 1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to high 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/BOQ.
- 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

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covered by this specification is subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein. 1.6 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders’ responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under Vol-III of the specification within 10 days of receipt of tender documents. In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser / Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication. 1.7 The bidder’s offer shall not carry any sections like clarification, interpretations and /or assumptions. 1.8 Deviations, if any, should be very clearly brought out clause by clause along with cost of withdrawal in the enclosed schedule (in Vol – III); otherwise, it will be presumed that the vendor’s offer is strictly in line with NIT specification. If no cost of withdrawal is given against the deviation, it will be presumed that deviation can be withdrawn without any cost to BHEL/its customer. 1.9 In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, Section - C shall prevail over section – D, however more stringent requirement as per the interpretation of the owner shall apply. 1.10 In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection. 1.11 For definition of word like Contractor, bidder, supplier, vendor, Customer/ Purchaser / Employer, consultant, please refer relevant clause(s) of GCC.			

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TECHNICAL SPECIFICATION
HEATING, VENTILATION AND AIR-CONDITIONING
SYSTEM
PROJECT INFORMATION

SPECIFICATION No: PE-TS-407-571-11000-A-A001

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SECTION B

REV. 00

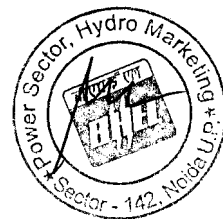
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SECTION: B
PROJECT INFORMATION

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INFORMATION FOR CONTRACTOR

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INFORMATION FOR BIDDERS (IFB)

1.0 Project Background

Lakhwar Vyasi Project comprising 300 MW Lakhwar Dam Scheme and 120 MW Vyasi Dam Scheme is a multipurpose scheme on the river Yamuna. The project has been under active construction since 1987 to 1992 and thereafter work on this project has been stopped. After formation of State of Uttarakhand, the project by virtue of its location was transferred to UJVNL Limited by Govt. of India in Nov, 2001. The Project was subsequently handed over to NHPC for further execution through a MOU between Govt. of Uttarakhand, UJVNL and NHPC in Nov, 2003. The DPR of the project was submitted by NHPC in July, 2006. However, since the issue of sharing of project cost between beneficiary states towards Irrigation & drinking water & power generation relating to Lakhwar HEP is still under resolution, it was decided to take up construction of Vyasi HE Project independently and Lakhwar Scheme can be taken up at a later date after resolution of cost sharing between beneficiary states. Vyasi Project has now been taken over from NHPC by Govt. of Uttarakhand and is being implemented by UJVNL on its own.

2.0 Project Layout

Vyasi HEP is a run-of the river scheme on river Yamuna. The project, envisages utilization of 111 m of net head by construction of 86 m high concrete gravity dam, known as Vyasi Dam located near Judo village (5 Km d/s of Lakhwar Dam). Water is led to powerhouse through 2.7 Km long, 7.00 m diameter Headrace tunnel. The surface powerhouse on left bank of the river located near Hathiri Village is proposed to house two units of 60 MW each. The total energy generation works out to be 438.73 MU for 90% dependable year, with 95% machine availability.

The salient features of the project are as given here under:

SALIENT FEATURES

LOCATION

Country

State

District

River

Location of Dam

India

Uttarakhand

Dehradun

Yamuna

Village Vyasi, 5.0 Km.d/s of Lakhwar




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Location of Power House	Village Hathiari 9.5 Km. d/s of Lakhwar
Nearest Airport & Railhead	Dehradun
Latitude	30° 31' 00" N
Longitude	77° 53' 00" E

HYDROLOGY

Catchment area (including snow catchment)	2100 Sq. Km.
Snow catchment	60 Sq. Km.
Normal rainfall in the catchment	1250-2000 mm
Design flood	8850 Cumecs
Maximum annual runoff (1988-89)	3763 M.m ³
Average annual runoff (1963-64)	2318 M.m ³
Minimum annual runoff (1965-66)	1222 M.m ³

DIVERSION CHANNEL

Location	On the left bank
Number & size.	One 8.6W mx6.0 to 8.0 m H.
Length	370 m

DIVERSION CONDUITS

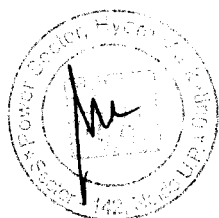
Location	On the left bank
Number and size.	2 Nos. 4.25 m x 5.20 m.
Length	46 m

UPSTREAM COFFER DAM

Top of Dam	EL. 594.50m
River bed level	EL 584.00 m
Top width.	7.00 m
Upstream slope	1.75(H) : 1 (V)
Downstream slope	1.5(H) : 1 (V)

DOWN STREAM COFFER DAM

Top Dam	EL. 591 m
Riverbed level	EL. 581 m
Top width.	7.00 m
Upstream slope	1.5(H): 1 (V)
Downstream slope	1.75(H): 1 (V)



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2 X 60 MW Vyasi HEP
Tender No.: 01/UJVNL/Vyasi/ 2009-10

Section – III
Information for Bidders (IFB)

DAM

Type	Concrete Gravity type
Maximum height above deepest foundation	86.0 m
Top of Dam	EL 634.0 m
River bed level at dam site	EL 584.0 m
Expected deepest foundation level	EL 548.0 m
Top road width	8.25 m
Top length	207.20 m
Upstream slope	0.3 (H): 1 (V)
Downstream slope	0.65 (H): 1 (V)

SPILLWAYS

Type of Spillway	Orifice Type Spillway
No. & size of openings	4 Nos. of 10 m x 15 m
Crest elevation	598.0 m.
Design flood	8850.00 Cumecs
Energy dissipation	Stilling basin with d/s sill.
Stilling Basin floor level	EL 567.00 m

RESERVOIR

Reservoir Level (FRL/MWL)	El. 631.50 m
Minimum Draw Down Level (MDDL)	El. 626.00 m
Gross Storage at FRL/MWL	13.69 M.m ³
Dead Storage at MDDL	9.98 M.m ³
Reservoir Area at FRL/MWL	72.9 Hectare
Live Storage	3.71 M.m ³

INTAKE

Location	27.5m from dam axis
Intake type	Bell mouth intake
Invert level	El. 611.00 m
Trash racks	Inclined.
Bulkhead gate size	4.5 x 7.0 m (2 nos.)
Service gate size	4.5 x 7.0 m (2 nos.)

HEADRACE TUNNEL

Size	7 m dia circular
Length	2.7 Km. Long
Design discharge	119.78 m ³ /sec



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SURGE SHAFT

Type	Restricted Orifice type.
Size	18 m dia
Height	63.50 metre
Area of orifice	12 m²

PRESSURE SHAFT

No. of pressure shaft	2
Diameter of pressure shaft	4.0 m Circular
Length of pressure shaft	209m

POWER HOUSE

Type	Surface Power House
Machine Location	Near village Hathiari
Nos. & size of units	2 units of 60 MW each
Dimensions of the power house	72m (L) X 24m (W) X 40.2m (H)
Deepest foundation level	El. 500.50 m
Machine centre line.	El. 510.30 m.
Machine & Erection bay floor level.	El. 520.30 m.

TURBINES

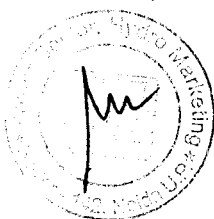
No. & type	2 Nos. Francis type
Maximum gross head.	117.7 m
Rated net head	111.00 m.
Design discharge	59.89 Cumecs
Generator	Vertical shaft Suspended.

TRANSFORMER HALL

Location	El.535.0 m, deck d/s.of Machine hall
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DRAFT TUBES

Nos. & Size	2 Nos. of size 7.2 m (W) x 5.0 m (h)
Gate openings	2 Nos. of size 3.1 m (W) x 5.0 m (h) (For each draft tube)
Gate Operation Floor level	El. 535.00 m.
TWL (1 unit running)	El. 513.80 m
TWL (2 unit running)	El. 514.00 m



SWITCHYARD

Location	D/s of Power House.
Size	140 m x 85 m
Level	El. 570.00 m

POWER GENERATION

Installed capacity	120 MW
Annual energy generation	443.19 MU.
Annual energy generation (90% dependable year)	438.73 MU.

3.0 Implementation of the Project and Contract Package

The project is planned to be implemented by splitting the project works into Civil, Hydro-Mechanical and Electro-Mechanical packages:

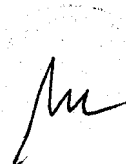
The Electro-Mechanical works of the project will be implemented on International Competitive Bidding (ICB) as per scope of work given here under:

The scope of Electro-Mechanical works covers the provision of labour, tools, plants materials and performance of work necessary for design, manufacture, quality assurance, quality control, shop Assembly, shop testing, delivery at site, site storage and preservation, installation, commissioning, performance testing, acceptance testing, training of Employers personnel, handing over to UJVNL and guarantee for two (2) years of two (2) sets of vertical Francis Turbines, Generators, Transformers, Bus Duct, 220 KV outdoor, switchyard Equipment and other Electrical & Mechanical Equipment as per technical specifications given in the Bid document hereunder, each complete with all auxiliaries accessories, spare parts and warranting a trouble free safe operation of the installation and confirming to latest internationally accepted technologies & practices.

4.0 Power Station Civil Works

A surface power house having over all size 66.5 m (L) x 21 m (W) x 35 m (H) has been proposed. Main inlet valve (MIV), Turbines, Generators, Associated auxiliary Electrical and Mechanical equipment is located inside Power house building. Transformer deck for generator step-up Transformers is proposed to be located outside on downstream side of P/H building. A cable Trench proposed to be laid between Power house and outdoor switchyard (located on left side of P/H) shall facilitate power evacuation from P/H to outdoor Switchyard through 220 KV XLPE cables. The tailrace water will be fed in the existing course of river Yamuna adjacent to power house.

Presently excavation of power house up to river bed level has been completed.



5.0 Location and Access

5.1 Vyasi HE Project, (2X60 MW) is located in Dehradun District of Uttarakhand.

The Project sites are easily accessible by road, as all the project components are located on double lane approach roads taking off from National Highway NH-123 at Barawala (3 km from Dakpathar).

The nearest railhead (Broad Gauge) is at Dehradun.

The approximate road/rail distances between relevant project related places/sites and important towns are as given here under:

S. No.	From	To	Distance in Km	
			(Roads way)	(Railway)
1	Delhi	Dehradun	240.0	313
2	Dehradun	Lakhwar	72.0	-
3	Dehradun	Kalsi	52.0	-
4	Kalsi	Barawala	4.0	-
5	Badhwala	Vyasi Dam	17.0	-
6	Badhwala	Hathiari PH	11.5	-

6.0 Maintenance of access roads during construction of the Project

The construction of the roads as indicated in the road map and their subsequent maintenance is not in the scope of E&M Contractor. However, all the roads within the E&M Contractor acquired area and the approach road thereto from the existing road shown in the map shall be maintained by the E&M contractor.

7.0 Transport Facilities available in the area

7.1 Goods Transport

The nearest broad gauge railhead is Dehradun. National Highway NH-123 from this rail head up to Barawala and thereafter approach roads taking off from NH-123 to various work sites of the project can meet project construction requirements relating to transportation of goods.

8.0 Transport Limitation

As per the location of the project and its approachability through NH-123 and thereafter through double lane approach roads taking off from National Highway and reaching to various works sites, there may not be any specific transport limitations. However, the E&M contractor is advised to visit the

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access routes to the project & carefully examine all aspects relating to transportation of E&M equipment up to worksite.

9.0 Communication Facilities at Work Site

9.1 BSNL / IDEA telephone facility is available at in and around the project sites.

In addition to the BSNL / IDEA telephone system, the contractor may have to install his own reliable communication system like VSAT, LDST etc, at their own cost.

10.0 Availability of local facilities:

10.1 Fuel station

The contractor has to make arrangement for his own fuel station near to his work area having sufficient storage capacity for meeting his petrol and HSD requirement. The nearest fuel station is available at Vikas Nagar, which is about 22 km from project site.

10.2 Post Office / Courier / Taxi

Above facilities are available at Dakpathar.

10.3 Medical facilities

District hospital and other private nursing homes with all facilities are available at Dehradun. LEYHMANN Hospital at Herbertpur and other private nursing homes at Vikas Nagar are also available. However, the contractor is to make his own arrangement at the work site or at camps for the requisite medical facilities required for their personnel fulfilling all legal formalities.

11.0 Ecological Balance

11.1 The Contractor shall be required to ensure that there shall be no indiscriminate felling of trees by him or his labourers or their family members and he will be solely responsible for their acts in this regard. The Contractor shall try to maintain ecological balance by preventing deforestation, water pollution and defacing of natural landscape in the vicinity of work areas. The Contractor shall so conduct his construction operations as to prevent an unnecessary destruction of, scarring or defacing the natural surroundings in the vicinity of the work area. In order to maintain the ecological balance, the Contractor shall specifically observe the following instructions:

- a) Where unnecessary destruction, scarring, damage or defacing may occur as a result of the Contractor's operation, the same shall be repaired, replanted or otherwise corrected at the Contractor's expense. The Contractor will prevent scattering of rocks and other debris outside the



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work areas. All work areas shall be smoothed and graded in a manner to conform to the natural appearance of the landscape as directed by the Engineer-in-Charge.

- b) All trees and shrubs which are not specifically required to be cleared or removed for construction purposes shall be preserved and shall be protected from any damage that may be caused by the Contractor's Construction Operation and equipment. The removal of trees or shrubs will be permitted only after prior approval by the Engineer-in-Charge. Special care shall be exercised where trees or shrubs are exposed to injuries by construction equipment, blasting, excavating, dumping, chemical damage or other operation and the Contractor shall adequately protect such trees by use of protective barriers or other methods approved by the Engineer-in-Charge. Trees shall not be used for anchorage.
- c) The Contractor's construction activities shall be performed by methods that will prevent entrance or accidental spillage of solid matter contaminants, debris and other objectionable pollutants and wastage into the river. Pollutants and wastes shall be disposed of in a manner and at sites approved by the Engineer-in-Charge. The Contractor shall fully comply with "The Water (Prevention and Control of Pollution) Act 1974."
- d) In the Conduct of construction activities and operation of equipment, the Contractor shall utilize such practicable methods and devices as are reasonably available to control, prevent and otherwise minimize air pollution. The Contractor shall fully comply with "The Air (Prevention and Control of Pollution) Act, 1981."
- e) Burning of materials resulting from clearing of tree, bush, combustible construction materials and rubbish may be permitted only when atmospheric conditions for burning are considered favourable.
- f) Contractor (including its sub-contractor) shall supply the cooking gas/kerosene oil/Electricity to all its canteen /mess, labourers and staff working in the Project to avoid felling of trees for use as firewood. Fuel depot shall be opened to provide the fuel to the labourers.
- g) No wood shall be used for scaffolding, shuttering or centering in the construction of dam, powerhouse, tunnels and similar works.
- h) Wood, if required, shall have to be purchased from the State Forest Department.
- i) The Contractor shall be required to prevent flowing of debris and muck in to the river. Necessary retaining structures like walls/crates etc shall be constructed for the purpose. The Contractor shall also stabilize the muck fully before handing it over to the Employer at the end of construction period.



j) Medical facilities as well the recreational facilities shall also be provided to the labourers.

k) All labourers to be engaged for the construction work shall be thoroughly examined by health personnel and adequately treated before they are deployed in the work

11.2 Separate payment will not be admissible to the Contractor for complying with the provisions of this clause and all costs shall be deemed to have been included in the items mentioned in the Bill of Quantities. If any provision(s) is not complied with, within a reasonable time even after issue of a notice in this respect, the necessary operations would be carried out by the Engineer-in-Charge at the cost of the Contractor.

12.0 Skilled and Unskilled Labour

Efforts must be made to employ maximum number of local people in not only un-skilled category but also in semi-skilled and skilled categories by making provisions of imparting skills through training to selected locals. Detailed plans regarding this should be submitted by the contractor within two months from the date of issue of Letter of Award.

13.0 Electric Power

13.1 The construction power is of vital importance for construction for any project and need to be planned in a proper manner so that it is available all the time uninterruptedly. Power shall be supplied to the contractor at 11 kV, 3-phase, 50 Hz at one suitably located point of substation from where contractor will have his own arrangement for stepping down the voltage and constructing and maintaining distribution system and shall be charged at the category and rates approved by state regulatory authority prevailing during the period of commissioning.

Normally, supply of the electricity shall be continuous but in case of emergency contractor shall make his own arrangement to cope the situation by using DG Sets. Permission from State authorities, if required, for installing DG Sets shall be arranged by the Contractor, for which Employer will issue necessary recommendation.

All work areas shall be suitably lighted by the contractor at his own expenses for proper execution and inspection to the satisfaction of the Engineer-in-charge in accordance with the provisions of the Indian Electricity Act/rules and any other laws in force. All electrical works of the contractor shall conform to the rules and regulations relating in such works in force from time to time as specified in the Indian Electricity Acts / Rules & any other laws and to the satisfaction of the Engineer-in-charge.

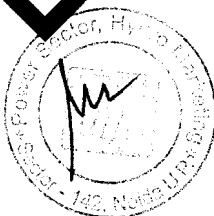
14.0 Control Points

As per post bid discussions sn (114) BHEL stated that EOT cranes in power house will be used by the contractor free of charge and will be made available during normal working hours and in extended shift operation to suit the erection & commissioning program. Day to day maintenance of the cranes shall be done by contractor. UJVNL stated that Electricity charges for using EOT crane shall be paid by the contractor. Crane operator shall also be arranged by the contractor.

14.1 The Contractor will provide a suitable base and elevation datum at the site of the work for horizontal and vertical control during the pendency of the contract. These control points will be clearly identified on the ground and shall be properly protected by the Contractor against damage. The Contractor shall be responsible for ensuring that these control points are not interfered with during the course of work. Any suspected damage to the control points shall be reported immediately by the Contractor to the Engineer-in- Charge who will check the accuracy of the control points and make necessary adjustments at the contractor's expense, if any.

16.0 Water Supply

The main source of water supply for construction purpose as well as domestic use is river Yamuna. However, water may be also available in various natural springs in the vicinity of the project area. Necessary pumping arrangement for supply of water and filtration/ treatment facilities if required are to be undertaken by the Contractor of his own. Permission from state authorities, if required for drawing / pumping water from any source, shall be arranged by the contractor for which employer will issue necessary recommendation.



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17.0 Climate & Isoceraunic Conditions

17.1 Physiography

River Yamuna, after flowing approximately 100 Km from its source at Yamunotri passes through a narrow gorge at village Judo. The catchment area is bounded between latitude 30° 25' N to 31° 05' N and longitude 77° 52' E to 78° 35' E. The catchment area of river Yamuna up to the proposed Vyasi dam site is 2100 sq km, out of which 2080 sq km is catchment of Lakhwar Dam, which is located 5 km upstream of Vyasi Dam and 20 sq km is intermediate catchment between Vyasi and Lakhwar Dam Site. About 60 sq km of the total catchment is snow bound. The region is mountainous, partly covered with vegetation and varying in elevation from about EL 620 m to EL 631.50 m.

The river channel is without any extensive flood plains so that the attenuation of flood peak due to channel storage is not considerable. Pronounced orographic features favour a quick run off. These factors are conducive to short duration and high peak floods.

17.2 Climate

The climate is well defined in spring, summer & rainy seasons. The foothill areas of the catchment in the vicinity of the project site are characterized by a temperature of 2.5 °C to 40 °C during winter & summer respectively. The relative humidity measures between 25% to 85 % with saturated atmosphere during rainy seasons.

The monthly maximum and minimum temperatures at Dehradun in degrees centigrade for different months of the year from 1967 to 2002 is available. The maximum observed temperature is 42.8 °C and minimum observed temperature is 0.3 °C. The relative humidity is generally high during monsoon and low during post monsoon and winter seasons. The maximum observed relative humidity is 100% & minimum observed relative humidity is 8%.

The rainfall data at rain gauge stations such as Kempt, Dhamta, Lohari, Bausan, Naugoan, Dehradun, Dakpathar, Dhanaulti, Chibro, Koti, Purola, Uttarkashi & Chakrata are available for different periods. Out of which Naugoan, Kempt & Dhamta are inside the catchment at Vyasi. While Lohari, Dhanaulti, and Chakrata station are on the periphery of the catchment boundary and Bausan, Chibro, Koti and Dehradun is outside the Vyasi catchment. The annual average rainfall varies from 1250 to 2000 mm.

17.3 Design Flood

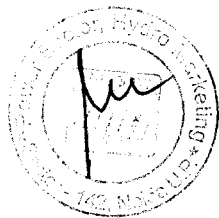
The design flood has been estimated as 8850 cumecs.

17.4 Diversion Flood

The Diversion flood has been estimated as 350 cumecs.

18.0 EPF Code & Sales Tax

The Contractor has to obtain EPF Code No. of Uttarakhand and Sales Tax clearance certificate from Excise and Taxation Department, which is mandatory.



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WATER ANALYSIS REPORT

1.7.26.1 Water

The characteristics of the water of Yamuna River at Dam site of Vyasi HE Project are as follows:

	PARAMETER	SAMPLING SITES								
		1	2	3	4	5	6	7	8	9
1	pH	8.05	8.10	8.05	8.10	8.09	8.10	8.17	8.32	7.10
2	Temperature °C	20.5	22.0	22.0	22.0	20.5	21.5	20.9	23.9	22.4
3	Turbidity (NTU)	0.620	510	484	382	0.652	0.274	165	0.058	321
4	EC (µs/ cm)	136	124	129	130	120	121	117	346	138
5	DO (mg/ l)	7.2	6.95	6.62	6.72	6.86	6.25	6.18	6.2	5.35
6	Sulphate SO ₄ (mg/ l)	90	79	66	62	65	67	69	127	57
7	Nitrate NO ₃ (mg/ l)	1.8	1.7	2.2	2.00	1.6	1.9	1.5	2.0	2.2
8	Calcium Ca (mg/ l)	35.50	34.25	32.5	21.42	27.34	32.31	40.47	36.92	38.7
9	Phosphate - P PO ₄ -P (mg/ l)	5.0	3.6	3.4	3.0	5.6	3.0	2.7	0.8	1.7

Site -1: Hathiyari Power house down stream water, Site - 2: Hathiyari Power House upstream water, Site- 3: Vyasi Dam downstream water, Site -4: Vyasi Dam upstream water, Site -5: Lakhwar dam downstream water, Site -5: Lakhwar dam upstream water, Site -7: below Yamuna bridge water, Site -8: Aglar water, Site- 9: Zero point river water.



TECHNICAL SPECIFICATION
HEATING, VENTILATION AND AIR-CONDITIONING
SYSTEM
SPECIFIC TECHNICAL REQUIREMENT

SPECIFICATION No: PE-TS-407-571-11000-A001

VOLUME II B

SECTION C1

REV. 00

DATE: MAY 2019

SECTION: C1
SPECIFIC TECHNICAL REQUIREMENT



TITLE

**2X60 MW VYASI
HVAC SYSTEM
SPECIFIC TECHNICAL REQUIREMENT**

SPECIFICATION No: PE-TS-407-571-11000-A001

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1. FUNCTION

The purpose of the system is to provide Air-Conditioning & Ventilation for different areas of Vyasi (2 x 60 MW) under the scope of tender.

2. SYSTEM DESCRIPTION**2.1 AC SYSTEM**

Air-cooled Package type air conditioning plant shall be provided to cater to the air conditioning requirements of the following areas of **unit 1&2**:

2.1.1 Control Room at 535.00Mtr.

The configuration of the equipment (Air Cooled Package AC) shall be 4 x 50%.

2.1.2 Multiple Split AC shall be provided for the offices & conference/ committee room within power house.**2.2 VENTILATION SYSTEM****2.2.1 ONCE THROUGH TYPE VENTILATION SYSTEM**

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

Supply air from once through AHU shall be fed to various areas as detailed below through insulated duct

- LT Room at 535.00Mtr.
- Service Bay / Machine Floor at El. 519.85Mtr.
- Generator Floor at El. 513.90Mtr.
- MIV / Turbine Floor at El. 506.28Mtr.

Return from various areas shall be taken back to the AHU room through ducting work, However air from toilet, battery and workshop etc. shall be thrown out of the building through exhaust fan.

2.2.2 DRY TYPE MECHANICAL VENTILATION SYSTEM

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

- Battery Room.
- Electrical & Mechanical Workshop Room.
- Toilets within the Power House Building.
- DG sets Room.
- Stores



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- 2.2.3 Exhaust duct shall be provided from Mechanical workshop/ electrical workshop & Store to Main exhaust air duct.

3 DESIGN CRITERIA

3.1 SYSTEM DESIGN CRITERIA - AIR CONDITIONING SYSTEM

- 3.1.1 The outside design conditions considered shall be under:-

	Summer	Monsoon	Winter
DBT (°C)	42.8	31.3	0.3
WBT (°C)	23.5	27.0	0.3

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

24°C ± 1°C & RH 55% ± 5% for control room etc.

- 3.1.3 Fresh air requirement shall be minimum 1.0 air change per hour for control room areas or 16 CFM per person whichever is higher. For other areas like office, Fresh air shall be considered as per ISHRAE.
- 3.1.4 A design margin of 10% on total sensible and latent heat shall be considered while designing the AC Plant capacity for each area.
- 3.1.5 Lighting load considered shall be 2 W/sqft.
- 3.1.6 The Occupancy considered shall be 1 person in 25SQM or (actual), whichever is higher.
- 3.1.7 Necessary Heater and Humidifier shall be provided.

3.2 SYSTEM DESIGN CRITERIA - VENTILATION SYSTEM

Ventilation provision for various locations is envisaged as follows:

S.No.	Area	Type of Ventilation	ACPH
1.	Power House	Once Through water System	3
2.	Battery Room	Wall mounted exhaust fans (spark proof with flame proof motor), Wall mounted exhaust fans with ducting(if required) Fresh air supply through of Louvers	6
3.	Workshop Room (Electrical & Mechanical)	Exhaust by means of wall mounted axial flow fans. Fresh air supply through of Louvers	6
4.	D.G set Room	Exhaust by means of wall mounted axial flow exhaust fans. Fresh air supply through of Louvers	20
5.	Toilets & pantries for Power House	Exhaust by means of propeller type exhaust fan. Supply through door undercuts / door louvers	8
6.	Unloading Bay	2 nos. of Exhaust by means of wall mounted axial flow fans.	6



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4 LAYOUT CONSIDERATIONS:**4.1 AIR CONDITIONING SYSTEM**

Air Cooled Package type AC for AC plant shall be housed in AC plant room near control room in Power House Building. The locations of the equipment given above may change during detail engineering.

4.2 VENTILATION SYSTEM

- a. AHU with 100% standby in AHU Room at 540.00 M level.

5 EQUIPMENTS TO BE PROVIDED FOR AC SYSTEM

- a. Two number (2) Air Cooled Package type (working) and Two Number (2) air cooled Package type AC (standby) with R-22/ R-134a / R-407c/ 410a refrigerants complete with all accessories as described hereinafter.
- b. 1 (one) Pan type humidifier in PAC room(If required).
- c. 1 lot strip type duct heaters.
- d. Lot – Pre-filters having efficiency of 90% down to 10 micron particle size (inside the pre-filter section of the PACs
- e. Lot - Fine filters having efficiency of 99% down to 5 micron particle size (shall be provided in Common discharge of PACs). Differential pressure sensor with alarm to be provided across filter sets.
- f. Fresh air arrangement complete with louvers, filters fan and motor shall be provided for each PAC room
- g. Lot- Refrigerant piping with insulation interconnecting PAC and fittings such as elbows, tees, reducers, flanges etc.
- h. Lot-Drain water piping out of MS pipes conforming to IS-1239, Part I, heavy grade and galvanized as per IS:4736, from various equipment's like Package AC etc. up to the nearest drain point.
- i. The supply air duct shall be provided with motor operated fire damper at locations where duct pass through walls & floors for ease of isolation, maintenance and as well as for emergency operation. The operation of these automatic dampers shall be interlocked with the fire alarm system. Fire dampers shall be of rating 90 minutes.
- j. Lot – GSS Ducting (as per IS-277) with 180 g/sqm of zinc coating sheet metal work, complete with volume control dampers, Extruded aluminum supply air (with VCD) and return air grills, hangers, supports, flexible connections, including thermal insulation on complete supply air duct & return air duct with 13mm thick Aluminum foil faced nitrile rubber (as applicable).

k. ACOUSTIC INSULATION

Lot- Acoustic insulation 25 mm thick of fibre glass with 48kg/m³ of first 5 M of ducting after PAC but limited to plenum.

6 AC EQUIPMENT**a) Air Cooled Package AC**

Each air cooled type package unit shall comprise of the following as per Manufacturer standard:

- i. Scroll/Reciprocating Compressors (Semi-Hermetic / Hermetic) with R-22/ R-134a/R-407c/R-410a refrigerant, motors complete with suction and discharge shut off valves, oil pumps, high pressure cut out, low pressure cut out, oil pressure cut out, built-in automatic capacity control etc.



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- ii. One (1) No. fan and fin type air cooled condenser Vapour inlet and liquid outlet connection for refrigerant, drain connection etc. One (1) No evaporator coil and fan having direct expansion type copper tubes and aluminium fins. The evaporator fan shall be DIDW forward curved centrifugal fan.
- iii. Lot- Copper refrigerant piping, valves and fittings, inter-connecting compressor, condenser and evaporator.
- iv. Lot-MS (Mild Steel) structural frame work with anti-vibration pads.
- v. Initial fill of refrigerant and compressor lube oil
- vi. Lot- insulation of suction line and chiller
- vii. Lot-Controls with microprocessor based control panel mounted on the PAC Panel in-built.
- viii. Fine filter in common plenum
- ix. Electric strip heater in common plenum
- x. Fresh air arrangement complete with louvers, filters fan and motor shall be provided for each Package AC Unit Rooms

b) SHEET METAL WORK

- 1. Lot – GSS (Galvanised Steel Sheet) supply and return air Ducting (as per IS-277) with 180 g/sq.m. of zinc coating complete with vanes, damper, hangers / supports etc.
- 2. Lot- Supply air diffusers / grilles (Frame and Louvres of Diffuser/Grilles shall be of extruded aluminium of 1.2 mm thick section, duly powder coated) with volume control dampers. Return air Diffusers will have no Volume control Damper.

7 VENTILATION EQUIPMENT:

a. CIRCULATION WATER PUMP SETS (2x100%)

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

- 1. One No. horizontal split casing / Back pull out type centrifugal pump of adequate capacity to match the system requirement.
- 2. One No. adequately sized TEFC sq. cage induction motor suitable for 415 V, 3 phase, 50 Hz AC supply.
- 3. One set of base plate, coupling guard, anti-vibration pads, foundation bolts etc.
- 4. Valves, Instruments other fittings etc along with chilled water pumps.
- 5. One No. Y-type strainer at inlet complete with brass screen, drain arrangement, etc.
- 6. 150 mm dia dial type pressure gauges one each at suction & discharge side of the pump set.
- 7. 150 mm dia dial type temperature gauges at suction side of each of the pump set.
- 8. Gate valves, one each at suction and discharge side of the pump set.
- 9. One No. non-return (check) valve at discharge side of pump set.
- 10. One No. Pressure Switch at discharge side of pump set.
- 11. Drain Piping from pump to nearest drain.



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12. Mechanical seals and all accessories as specified shall be provided.

b. AIR HANDLING UNIT (DOUBLE SKIN TYPE)

Each air handling unit shall comprise of the following:-

Double skin panels (inside and outside) shall be fabricated using minimum **1.0 mm (20 G)** galvanized steel, with 25 mm thick polyurethane insulation of minimum 40 kg/m³ density in between, GSS channels shall be used as reinforcing to give structural strength. 16G MS Structure of Sectionalized construction, insulated SS drain pan, and all accessories as specified are to be provided.

Filter section shall be separate.

Fan-motor set on a common base frame with all drive accessories shall be provided in the fan section and fan section shall be provided with access door

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

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

Coil section (integral with filter section) with suitably sized circulation water coil made of as per manufacturer standard and aluminium fins along with valves for isolation.

Flat filter sections complete with 50 mm thick dry panel type filter having efficiency 90% down to 10 micron.

Drain piping from the AHUs up to nearest drain point.

Lot – Controls comprising:

1. 150 mm dia dial type temperature gauges one each at suction & discharge side of the coil of AHU.
2. 150 mm dia dial type pressure gauges one each at suction & discharge side of the coil of AHU.

Lot – Serrated rubber pads for vibration isolation

C. SHEET METAL WORK

Same as clause no. 6(b).



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INSULATION

Insulation shall be provided as under:

S.No	Surface	Insulation Material	Insulation Form	Thickness (mm)	Finish
i)	AC Duct	Al foil faced Nitrile rubber / Eqvt	Roll / Slab	13	Al Foil Facing
ii)	Acoustic insulation of first 5M of ducting after AHUs but limited to plenum	Fibreglass (48 Kg density)	Roll / Slab	25	Perforated Al sheet
iii)	Refrigerant Piping	Al foil faced Nitrile rubber / Eqvt	Roll / Slab	39	Al cladding
iv)	AHU drain pipe*	-do-	Roll / Slab	26	Al cladding
v)	Circulation water piping, valves & specialties	-do-	Roll / Slab	39	Al cladding
v)	Circulation water piping, valves to (Exposed atmosphere)	EPS (TF Quality 16 Kg Density)	Pipe section	50	Sand cement plaster and Al cladding
vi)	Circulation Water Pumps	-do-	Roll / Slab	39	Al cladding
vii)	Expansion tank with pipe(if required)	Al foil faced Nitrile rubber / Eqvt	Roll / Slab	06	Al cladding

*** NOTE: FOR INSULATION DETAILS, PLEASE REFER CUSTOMER SPECIFICATION CLAUSE NO. 22.5.1.2.2**

9.

SPLIT AIR CONDITIONER

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

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

10.

CYCLONE SEPARATOR

Cyclone separators in water circuit to achieve the cleanliness of water to suit the HVAC system water requirement.

The materials of the cyclone separators casing shall be of stainless steel (316 or better). The separators shall be of continuous duty with flanged inlet and outlet for use with raw water



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pumped from draft tube/tail race. Cyclone separator should be capable of removing of all material as small as 74-40 microns in cooling water circuit with the efficiency of 98%. Bolting type lower and upper half of cyclone separator is preferable in view of maintenance aspects.

The separators shall be complete with pinch type purge valve having neoprene rubber liners and controls for automatic continuous operation.

11. CONTROL PHILOSOPHY

HVAC system control shall be PLC based. The PLC system shall be connected through soft connectivity with plant SCADA for monitoring purpose.

- i. PLC based control system shall be provided for HVAC system.
- ii. Operation and alarm annunciation for all the equipment's (AHU, pumps, PAC and safety interlocks) shall be provided in the local control panels.
- iii. PLC shall be interfaced with Plant SCADA System through soft link (TCP/IP Protocol over fibre optic). Critical signals shall be provided in the SCADA for monitoring purpose.

12. POWER SUPPLY ARRANGEMENT

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

13. ACCEPTANCE TEST

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

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

The Noise level of the AC system shall not be exceed 55dB (A) in rooms as in the Control Rooms, Offices & Reception Room.

14. SITE STORAGE

Land for storage near project site shall be provided to bidder by BHEL. However, bidder has to make his own arrangement to develop infrastructure for all their men and material during the construction period. The necessary residential and labour camps including other facilities like water supply, sanitation etc. are to be developed by the bidder at their own cost.



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15.0 GENERAL (SCOPE AND OTHER)

- 1) Basis of design, all calculations including heat load calculations for summer seasons, equipment selection criterion, layout drawings/ schemes/G.A. dwg and documents like data sheet/ technical particulars etc. are subject to Customer approval during detail engineering stage.
- 2) Vendor to furnish characteristic curves for all major equipment offered indicating duty point during detailed engineering.
- 3) Vendor to include one no. Pressure switch at discharge of each pump.
- 4) All drawings and documents shall be computer based.
- 5) All commissioning spares & consumables for trouble free operation till handing over shall be provided.
- 6) 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.
- 7) Indicative list of makes is enclosed as per Annexure-I however these makes shall be subject to Customer approval during detail engineering Stage.
- 8) Inserts or any support arrangement for fixing ducting, fans, piping etc. shall not be provided by BHEL. Necessary supports may be taken from nearest structure / walls / roofs / floors etc. by Vendor.
- 9) Fixing frame works for diffusers and grilles in the scope of Vendor.
- 10) Anchor fastener shall be used by vendor for fixing duct pipes etc. wherever applicable.
- 11) Necessary supports and structures / frames etc. as required for supporting the duct / piping / equipments etc. as lump-sum basis is in the scope of Vendor and no unit rates shall be applicable for these items.
- 12) Drain piping within room up to the drain point to be provided by the Vendor.
- 13) Vendor to furnish schedule of power and control cables. Vendor to furnish cable termination details interconnection drawings etc. during detail engineering stage. All cables shall be in bidder's scope.
- 14) The tools and machine required for erection of equipment shall be arranged by Vendor.
- 15) Tools & tackles as required for regular maintenance shall be supplied by Vendor.
- 16) Instruments required for performance testing of various equipment / system of the package shall be arranged by Vendor at site.
- 17) Instrument for testing shall be calibrated from NABL accredited lab by HVAC supplier before taking up testing.
- 18) Temperature gauges shall be provided with thermo wells and fixing arrangement.
- 19) Pressure gauges shall have provision for air venting.

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20)	Matching sockets / stubs (weld type) for flow switches and other instruments shall be supplied.		
21)	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%.		
22)	Besides the system performance as above, bidder shall guarantee major technical parameters of various equipments as per design basis / details furnished.		
23)	All calibrated instruments to be used for the tests at manufacturer's works/site shall be arranged by the bidder. Any Electrical/C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope. Only those items shall be provide free of cost by BHEL which are categorically listed in the Electrical scope sheet of technical specification.		
24)	Motorized fire damper will be installed at supply air duct and return air path/ duct at suitable locations where duct pass through wall & floors for ease of isolation, maintenance and as well as for emergency operation. Fire damper in the supply air duct and return air path/ duct will be closed on receiving fire signal from fire protection system and shall also be possible manually from remote control panel. Necessary arrangement shall be incorporated in the duct for providing duct mounted multi- sensor detectors in the return air path/ duct for all air conditioned and ventilation areas. Also respective PAC/ AHU/ fans shall trip on receiving fire signal from fire protection system.		
25)	For motorized fire damper / 3 Way valve actuators, power supply shall be derived by vendor from respective control panels. BHEL will not provide any feeder for fire damper / 3 Way/ Motorized valve. Suitable transformer shall be provided by bidder (if required) to derive the power input.		
26)	Feeder for a combination of fire damper/ valves etc. shall be derived from respective control panel by vendor. Distribution through junction box/ distribution board shall be in vendor scope and shall have provision for isolation of individual fire damper/ valves.		
27)	Tender drawings enclosed form the part of specification and the bidder shall adhere the space requirements.		
28)	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/BMS/PLC / panel / MCC shall be selected. Any Electrical / C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope.		
29)	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.		
30)	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.		
31)	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.		

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- 32) Sealing of duct opening, grouting of foundation, foundation bolts etc. including special type of grouting like GPX2 etc. are in the scope of HVAC vendor.
- 33) Flat, platform type RCC / PCC foundation shall be provided for installing PAC/ PUMP, AHU and FAN etc. Vendor shall fix the equipment using anchor fasteners to secure the equipment obtain parameters related to vibration and noise.
- 34) 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.
- 35) HVAC plant supplier to furnish drawings/ documents as per the dwg. / documents distribution as per project requirement.
- 36) Each motor terminal box shall be provided with cable gland and lugs for the size and type of power and control cable of respective motor.
- 37) All electrical equipment shall be suitable for the power supply fault levels and other climatic conditions indicated in project information / synopsis / specifications enclosed.
- 38) The bidder's proposal shall be in accordance with the tech. Specification.
- 39) The bidder shall furnish complete tech. Particulars in data sheet and schedules as specified elsewhere in the specification.
- 40) Consumables and lubricants shall be in bidder's scope.
- 41) Owner's personnel training shall be in is bidder's scope.
- 42) Supplies / Services mentioned under Electrical and C&I portion of Specification.
- 43) Any supplies /services mentioned in GCC & SCC as relevant to HVAC system package.

16 EXCLUSIONS

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

- a) Construction of HVAC plant room, air handling unit room, foundations for HVAC equipments.
- b) False ceiling, drop ceiling.
- c) Slab cut out for running ducts, pipes, cables, grilles/dampers. Underground masonry trenches and masonry risers. However minor civil work like making opening to suit / finishing of opening, sealing of duct opening, grouting of foundation bolts including special type of grouting like GPX2 etc. are in the scope of HVAC system vendor.
- d) Provision of drain traps / points.
- e) For Electrical scope, refer Electrical scope matrix sheet.
- f) Under-deck Insulation.



TECHNICAL SPECIFICATION
**2X60 MW VYASI
HVAC SYSTEM**

SPECIFICATION No: PE-TS-407-571-11000-A001

VOLUME II B

SECTION C2-A

REV. 00

DATE: MAY 2019

SECTION: C2-A
CUSTOMER SPECIFICATION

22. HEATING, VENTILATION AND AIR CONDITIONING SYSTEMS

22.1. Scope of Work

Scope of work under this section covers the provision of labour , tools , plants, material and performance of work necessary for the detailed design and engineering, manufacture, quality assurance, quality control, shop assembly, shop testing, transportation, delivery at site, site storage and preservation, erection, testing and commissioning, performance testing, field acceptance testing, training of the Employers personnel, handing over to the Employer and guarantee for two years, of the heating, ventilation and air conditioning systems complete with all accessories and necessary components for making the equipment and the system complete and for warranting a trouble-free and safe operation.

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

22.1.1. Detailed Scope of Supply

- Two (2), exhaust air fans for exhaust of air from battery and battery charger room each of 100% of required capacity.
- Required number of exhaust air fans for exhaust of air from each toilets, canteen, locker room, mechanical workshop, electrical workshop etc. at different floors each of 100% of required capacity.
- Minimum Two (2) exhaust air fans for exhaust of air from DG set room each of 100% of required capacity.
- Two (2), exhaust air fans for exhaust of air from unloading bay area each of 100% of required capacity.
- Air duct distribution system for supply and return air of entire air handling and ventilation systems, with necessary galvanized sheet metal ducts (for battery room exhaust air system, complete plastic ducts, grills etc.), elbows, tees, supports, fixations, including all necessary grills, louvers, outside air louvers, adjusting duct dampers, motorized air dampers, heating and cooling insulations, etc.
- Central control panel for HVAC system complete with all wiring instrumentation and associated accessories etc.
- Local control panels for air handling units, circulation/ cooling water pumps, strainer, exhaust fans etc.

- Necessary pressure, temperature, flow/ humidity, sensing devices/ instruments, meters etc.
- Provision of necessary contacts and/ or ports for integration with plant SCADA system through local control board of common services.
- Items not specified above, but are necessary for satisfactory operation of air conditioning and ventilation systems.
- All specified devices, tools maintenance equipment etc. required for installation, testing, commissioning and maintenance of the air conditioning and ventilation systems.
- Spares.

The quantities of equipment / units mentioned in clause 22.1.1 above are tentative only. The actual quantities may need to be examined and reviewed and shall have to be got approved from the Employer during detailed engineering.

22.2. Special Design and Layout Conditions

The total Power House building shall be divided into three areas for ventilation and air conditioning. The brief description of each area and the requirement of equipment are described below:

Mechanical Area:

This area shall consist of floors at EL506.60 m and EL 511.00 m. AHU1 and AHU2 each of 100% of required capacity for ventilation of this area shall be provided. These AHU's shall be located at a suitable elevation & location to be finalised during detailed engineering. Exhaust fans of suitable capacity and 100% standby shall be provided to exhaust the 100% air of the areas.

Electrical Area:

This area shall consist of Turbine floor at EL 515.30 m, and machine hall & service bay at EL 520.30 m. Cable spreading floor at EL524.00 m and unloading bay at EL 535.00 m AHU3 and AHU4 each of 100% of required capacity for ventilation of this area shall be provided. These AHU's shall be located at suitable elevation to be finalised during detailed engineering.



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2 X 60 MW Vyasi HEP

Tender Notice No.: 01/UJVNL/ Vyasi/2009-10

Section IX
Particular Technical Specifications (PTS)**22.3. Basic Dimensions and Ratings**

The system design shall be based on criteria, factors, and details recommended or indicated in the ASHRAE handbook.

22.3.1. Indoor Air Conditioners

Rooms as control room, computer room and relay room etc. shall be maintained at temperature of $24^{\circ}\text{C} \pm 1^{\circ}\text{C}$ at relative humidity of $50 \pm 5\%$. During the winter season when the ambient temperature is below 24°C , heating requirement in the control rooms and offices shall be met with the combination of duct heaters and base board heaters. The use of Class I ozone-depleting chemicals including all chlorofluorocarbons, halons, or their mixtures are prohibited.

The HVAC systems shall be designed and erected to guarantee the room conditions according to the design requirements. The internal heat production from electrical and mechanical equipments shall be calculated and submitted by the Contractor. Final calculation depends on the design data of individual manufacturer's equipment.

22.3.2. Air Changes per Hour

For all ventilated and air conditioned rooms, the air changes shall be as per relevant ASHRAE / IEC / IS to provide the desired heat relief and maintain a minimum level of fresh air in the powerhouse. All ventilated and air conditioned area shall be designed to maintain a positive pressure within the powerhouse.

22.3.3. Noise Levels

The noise levels caused by operation of the ventilation and air conditioning systems shall not exceed 55 dB (A) in rooms as in the control rooms, offices, & reception room.

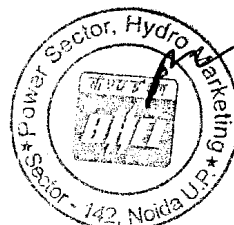
Silencer, as required, shall be provided to guarantee the above sound levels.

22.3.4. Maximum Air Velocities

In main ducts	Maximum 10m/sec
In branch ducts	Maximum 8m/sec
Ducts in the occupied room zones	Maximum 2m/sec

22.3.5. Standards and Codes

All works shall be performed in accordance with the most advanced practice in engineering for each class of equipment and completed in a workmanlike manner following the best modern practice in the manufacture of high-grade equipment. The standards under which the equipment is to be designed, constructed, erected and tested shall be the following:



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Indian Standards	IS
International Standard Organization (for machine work tolerances)	ISO
Deutsche Industries-Norm	DIN
American Society for Testing and Material for material	ASTM
International Electro technical Commission (for electric installation)	IEC
American Society of Heating, Refrigerating and Air Conditioning Engineers	ASHRAE
Air Moving and Conditioning Association	AMCA
American Society of Refrigerating Engineers	ASRE

22.4.

Performance Criteria and Guarantee

The ventilation and air conditioning systems along with all its accessories shall be capable of performing all intended duties and it is the responsibility of the Contractor to supply the equipment as per guaranteed technical particulars.

22.5.

Design and Construction

22.5.1.

Air Handling Units

22.5.1.1.

General Description

Unit shall be central station air handler. It shall consist of a fan with the following factory installed components as indicated on the equipment schedule:

- Heating coil section with Electric coil
- Access and Plenum Section.
- Filter Section
- Mixing box section
- Face and bypass damper sections for
- Exhaust section.
- Multi zone damper section
- Air mixer section
- Return fan section

Units shall be shipped in the number of sections necessary to meet project requirements. All sections shall be flanged and gasketed to allow easy assembly and disassembly.

22.5.1.2.

Casing

22.5.1.2.1.

Construction

All unit sections shall be supplied with 12-gage G90 galvanized steel structural support rails. Perimeter 10 gage lifting lugs for overhead



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rigging shall be provided on each section. Slings of units in lieu of lifting lugs is not acceptable.

Exterior panels (top, sides, and bottom) shall be constructed of G90 galvanized steel, with pre-painted, baked enamel finish. These panels shall be capable of withstanding a 500-hour salt spray test per ASTM Standard B-117.

Interior panels (double wall option) shall be 20-gage G90 galvanized steel.

Casing panels shall be removable for easy access to unit. All panels shall be gasketed to ensure a tight seal.

Fan supports, structural members, panels, or flooring shall not be welded, unless aluminium, stainless steel, or other corrosion-resistant material is used. Painted welds on unit exterior steel or galvanized steel are not acceptable.

Each component section shall have mating flanges for assembly. The flange shall extend around the complete perimeter of each section. Fasteners shall be located no further than 12 in. on centre. The manufacturer shall install closed cell gasket for full perimeter coverage.

The fan section shall have a G90 galvanized steel floor of sufficient size to enable field personnel to service or adjust the motor and drive without damaging the insulation. A double-wall hinged access door shall be provided on both sides of the fan section.

All coil sections shall be constructed of insulated, double-wall, galvanized steel panels. Coil sections shall have coil tracks to facilitate coil removal. Blow-thru coil sections shall have a diffuser plate as an integral part of the coil section if used immediately downstream of the fan section.

Filter sections shall be designed and constructed to house the specific type of filter approved during detail engineering. A double-walled hinged access door shall be provided on both sides of the section.

All mixing boxes and filter-mixing boxes shall have a double-wall hinged access door as specified. Filter-mixing boxes shall have doors on both sides of component. Mixing boxes shall have floors of G90 galvanized steel to protect insulation.

Access sections shall have a double-wall hinged access door on both sides of component. Sections shall have floors of G90 galvanized steel to protect insulation.

22.5.1.2.2. Insulation

Each section shall be factory insulated. Insulation shall have full coverage waterproof adhesive to firmly secure the material to the unit casing. Insulation shall meet the erosion requirements of UL 181. Insulation and insulation adhesive shall comply with NFPA 90A requirements for flame spread and smoke generation.

22.5.1.2.3. Access Doors:

Access doors shall be of double wall construction. Hinge pins shall be non-removable to avoid loss. Use of "drop-in" hinge pins is not acceptable. Sufficient handles shall be provided to assure positive closure. Doors shall be gasketed and shall open outward for negative pressure sections and inward for positive pressure sections. Doors shall be provided on both sides of all access, fan and filter sections. All fan and access sections must have handles on inside and outside of door in compliance with OSHA requirements for confined space access.

22.5.1.2.4. Drain Pans

Drain pans shall be constructed of insulated double wall stainless steel. The pan shall be sloped toward the drain fitting. Drain pan shall have a recessed bottom drain design with integral FPT elbow for side discharge and trapping. One drain outlet shall be supplied for each cooling coil section. Drain pan shall allow no standing water and comply with ASHRAE Standard 62-R. Where two or more coils are installed in a coil bank, intermediate drain pans shall be provided that extend a minimum of 6 in. from the downstream side of the upper coil face and the condensate shall be piped to the bottom drain pan. The bottom coil shall not serve as a drain path for the upper coil.

22.5.1.3. Fans

22.5.1.3.1. General

Forward-curved fans

Shall have one double width double inlet (DWDI) fan wheel and scroll. They shall be constructed of heavy gage galvanized steel. They shall be designed for continuous operation at the maximum rated fan speed and motor horsepower. Fans shall have a minimum AMCA Class II rating.

Airfoil fan sections

These sections shall have one DWDI airfoil fan wheel and scroll. Airfoil blades shall be double thickness design. They shall be painted with zinc chromate primer and enamel paint. Fans shall have a minimum AMCA Class II rating.

Plenum fan sections

These sections shall have one single width single inlet (SWSI) airfoil fan wheel. Airfoil blades shall be double thickness design. Wheels shall be painted with zinc chromate primer and enamel paint. They shall be designed for continuous operation at the maximum rated fan speed and motor horsepower. Fans shall have a minimum AMCA Class II rating.

Fan wheels

Fan wheels shall be keyed to the shaft and shall be designed for continuous operation at maximum rated fan speed and motor horsepower. Fan wheels and shafts shall be selected with a maximum operating speed 25% below the first critical, and shall be statically and dynamically balanced as an assembly.

Fan shafts

Fan shafts shall be solid steel, turned, ground, polished and coated with rust preventative oil.

Fan motor

Fan motor shall be mounted within the fan section casing on slide rails equipped with two adjusting screws. Motor shall be of high efficiency, open drip-proof or totally enclosed fan cooled NEMA Design B with size and electrical characteristics as shown on the equipment schedule. Premium efficiency motors shall be available. Motor shall be mounted on a horizontal flat surface and shall not be supported by the fan or its structural members. All motors shall have a $\pm 10\%$ voltage utilization range and a 1.15 minimum service factor. Motor shall be compliant with EPACT where applicable.

22.5.1.3.2. Performance Ratings

Fan performance shall be rated and certified in accordance with ARI Standard 430.

22.5.1.3.3. Sound Ratings

Manufacturer shall furnish first through eighth octave sound power for fan discharge and casing radiated sound.

22.5.1.3.4. Mounting

Fan scroll, wheel, shaft, bearings, drives, and motor shall be mounted on a common base assembly which shall be isolated from the outer casing with factory-installed 50 mm. deflection spring isolators and vibration absorbent fan discharge seal. The isolation system shall be designed to conform to seismic zone 5 requirements.

22.5.1.3.5. Fan Accessories

Forward curved fans — Inlet guide vanes (IGV) shall be available for variable volume control, as required.

Airfoil fans — Inlet guide vanes (IGV) shall be available for variable volume control, as required.

Plenum fans:

Inlet guide vanes (IGV) shall be available for variable volume control, as required.

Rotor/Fan guard package shall be available as required.



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22.5.1.3.6. Coils

General Fabrication:

All water and refrigerant coils shall have 15 mm OD seamless copper tubes mechanically expanded into fins to ensure high thermal performance with lower total flow and pumping requirements. Minimum tube wall thickness shall be 0.025 inches.

Copper plate fin type with belled collars. Copper-finned coils shall be supplied with stainless steel casing and tube sheets

Water Cooling Coils:

Headers shall be non-ferrous with steel MPT connections. Headers shall have threaded drain and vent connections accessible from outside the unit casing.

Coils shall be drainable, with non-trapping circuits. Working pressure shall be 300 psig at 200 F.

Refrigerant Coils:

Headers shall be seamless copper tubes with brazed joints.

Coils shall be provided with a minimum of two brass liquid distributors with solder type connections. Distributors shall have removable brass venturi (nozzles). Distributor to coil capillary feeder tubes shall be seamless copper.

Coils for full face-active or face-split operation shall have intertwined circuits for equal loading on each circuit. Suction and liquid connections shall be on the same end.

Electric Heating Section:

Electric heating sections shall be constructed of pre painted galvanized steel and shall provide mounting of the heater control box access door on the side of the unit.

Coils shall be open-wire type, 80% nickel, 20% chromium resistance coils, insulated by floating ceramic bushings and supported in a galvanized steel frame. Bushings shall be recessed into embossed openings and stacked into supporting brackets, spaced no more than 4-inch centres. Thermal cut-outs for over-temperature protection shall be provided to meet UL and NEC requirements. Maximum element heating density shall be 55-watts/sq inch.

The manufacturer shall furnish an integral control box. It shall contain thermal cut-outs, primary and secondary control, sub-circuit fusing, airflow switch, and fused control transformer.

Units with electric heat sections shall be listed under UL1995 Standard for Safety.

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22.5.1.3.7. Filter Sections

Flat filter sections shall accept 1-in, 2-in., or 4-in. width filters in any combination that totals 1,2,3, or 4 inches. Sections shall include side access slide rails. Rails shall be constructed of extruded aluminium for increased rigidity.

Angle filter sections shall accept 2-in. filters of standard sizes, arranged in a horizontal V formation. Filter tracks shall be constructed of extruded aluminium for increased rigidity.

Draw thru bag cartridge filter sections shall be capable of accepting standard size 12-in. deep rigid media or bag filters. For bag filters with lengths longer than 12 in., additional access section(s) shall be available.

Blow thru bag cartridge filter sections shall contain a face loading Farr type 8-filter frame.

22.5.1.3.8. Dampers

Mixing boxes, filter-mixing boxes, and exhaust boxes shall have parallel blades and interconnecting outside-air and return-air dampers. Exhaust ducts in the room containing a fire hazard shall have dampers with automatic and manual mode of operation during fire.

Damper blades shall be constructed of galvanized steel with a double-skin airfoil design. They shall have silicone blade seals and stainless steel jamb seals. Blades shall be mechanically fastened to hex axle rod rotating in stainless steel bearings. To eliminate blade warping, dampers shall be sectionalized to limit blade length to 48 inches maximum. Maximum leakage rate shall be 5 cfm/ft² at 1-inch wg (0.25 kPa) differential pressure.

Face and Bypass Dampers:

Shall be factory mounted in galvanized steel frame. Damper blades shall be constructed of galvanized steel, with silicone blade seals and stainless steel edge seals. Blades shall be mechanically fastened to hex axle rod rotating in self-lubricating synthetic bearings. To eliminate blade warping, dampers shall be sectionalized to limit blade length to 48 inches maximum. Dampers shall be opposed-acting and arranged to match coil face with top bypass, and external linkage.

Multi-Zone Dampers:

Shall be factory mounted in galvanized steel frame. Damper blades shall be constructed of galvanized steel, with blade seals and stainless steel edge seals. Axles shall have self-lubricating nylon bearings. Linkage shall have external connections. Number of zones shall vary by size of section.



22.5.1.3.9 Air Mixer

Air Mixer shall be constructed of welded aluminium framing and turbulence. The mixer shall have no moving parts. It shall contain a primary set of direction-changing vanes, a secondary set of turbulence vanes, and a cone design for mixing of air streams.

Unit shall mix two or more air streams of different temperatures (at nominal flow) to within a range of 6° F standard deviation of theoretical mixed-air temperature. It will provide a uniform velocity contour entering a downstream filter or oil bank.

22.5.1.4 Humidifier

AHU shall be provided with Humidifier, Pan type steam boiler to raise and maintain specified level of indoor Relative Humidity (RH). The Humidifier will consist of insulated Pan, electric heater, water connection and wiring.

The pan will be fabricated from 22 G stainless steel (SS) sheet with welded nozzle and openable top fastened with SS nuts/ bolts. Steam will be generated by heating water with electrical resistance immersion type tubular heating sheet with welded nozzle and openable top fastened with SS nuts/ bolts. Steam will be generated by heating water with electrical resistance immersion type tubular heating element. It will have 12 mm/ 15 mm GI pipes nipple for connection to water line header. Accessories will include float switch for low water level cut-out, float valve with SS Ball thermostat, sight glass and humidistat for sensing/ controlling Humidity.

It will be duly factory wired (control as well as power) with copper bus bar connection and terminal box. The pan will be thermally insulated with 25 mm thick fibreglass slab (150 crown) and properly cladded with 22G GI sheet. In addition to providing heating element of required rating, as specified in BOQ, the humidifier will be provided with 0.5 KW heater with thermostat to maintain water temperature.

22.5.1.5 ~~Air Cooled Chiller (ACC)~~

~~The packaged air cooled liquid chiller will consist of accessible hermetic/ semi - hermetic, direct driven screw compressor with independent circuits evaporator, condenser, microprocessor based control and a unit-mounted motor starter, refrigerant charged, factory run tested and rated in accordance with ARI 550-90 and ready for operation.~~



Remote clear language display will have the ability to control multiple units. In the multiple unit configuration, the Remote Clear language Display Panel will have the capability to communicate with up to four units. Each unit will require a separate communication link with the Remote Display Panel.

22.5.2.5 Interface to the Station DAC System

The system should have provisions and facility for interfacing the chiller with Station DAC System:

- Chiller inputs will include:
 - Chiller enable/ disable
 - Circuit enable/ disable
 - Chilled water set point
 - Current limit set point
- Chiller outputs will include:
 - Compressor running indication
 - Alarm indication (for each circuit)
 - Maximum capacity

22.5.3. Ducts

All ducts for the ventilating and air conditioning systems shall be of galvanized sheet metal in accordance with DIN 1946 and DIN 2415 or as per relevant IS. The supply and exhaust air ducts of the battery room shall be of acid resistant plastic (PVC). Flexible connections should be provided between fan and ductwork to prevent the noise of fan vibration being transmitted directly to the sheet-metal ducts. The size of the air ducts shall be worked out from the permissible air velocities recommended in the relevant standards/codes in practice.

The sheet thickness shall not be below the thickness indicated in the following table, the thickness depending on the length of the longer side of the duct:

From 150 mm to 500 mm	0.63 mm
From 501 mm to 750 mm	0.80 mm
From 751 mm to 1000 mm	0.80 mm
From 1001 mm to 1250 mm	1.00 mm



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2 X 60 MW Vyasi HEP

Tender Notice No.: 01/UJVNL/ Vyasi/2009-10

Section IX

Particular Technical Specifications (PTS)

Over 1251 mm

1.25 mm

The cylindrical spiral ducts shall have the following thickness:

Up to 300 mm

0.63 mm

From 301 mm to 600 mm

0.63mm

From 601 mm to 750 mm

0.63 mm

From 751mm to 1000 mm

0.80 mm

From 1001 mm to 1500

0.80 mm

From 1501 mm to 2250

1.0 mm

Over 2250

1.25 mm

All ducts shall be airtight with opening at suitable locations.

If necessary, the rectangular elbows shall be equipped with aerodynamically formed guiding vanes.

All take-off branches shall be equipped with an adjustable volume extractor, which assists in balancing by directing a regulated amount of air for supply outlets from the main duct.

The ducts shall be supported by straps attached directly to the sides of the duct if the duct size is not more than 400 mm, but larger ducts shall be carried by structural angles, hanging in rods with adjustable nuts, anchored to the ceiling of walls by concrete fastener bolts or anchors. Maximum allowable distance between duct supports is 1500 mm.

22.5.4. Insulations

The fresh air and cooled down supply air ducts shall be insulated to prevent condensation on the duct surfaces.

The insulation material (thickness to be as per detail design) shall be non-hygroscopic, rot-proof, preferably of mineral raw material such as rock wool. The insulation mats or plates shall be fastened on the duct and wrapped with aluminium foils. The insulation material shall be also sufficient to obtain the acoustical guarantee.

The chilled and cooling water piping shall be properly insulated. The mentioned insulations shall be included in the supply.

22.5.5. Grills

The supply air grills shall be used for correct air distribution by horizontal and vertical adjustable bars of sidewall installations.

The return air grills shall be suitable for adjustment from outside and shall be equipped with 45° horizontal fixed fins.

The design has to fit the architectural false ceiling and lighting schemes and the grills be made of aluminium powder coated with high surface finish and the sizes have to correspond to the fixed noise criteria.

Grills for the battery room shall be of acid resistant PVC.

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22.5.6. Outside Air Louvers

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

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

22.5.7. Louver Dampers

Double acting louvers shall be fabricated with a welded frame of rolled section.

Bearings shall be of the oil retaining porous bronze type and shall be fixed into the frame.

The louver dampers as well as the steel frames shall be hot-dip galvanized after fabrication.

Louvers and dampers shall be equipped with related limit switches to be used in control and interlocking system.

22.5.8. Air Filters

The filter banks shall be composed of panels not bigger than 500 x 500 mm, which can be easily removed by hand. They shall be designed taking care of the recommended velocity of the air passing through an area as per relevant standards/codes in practice. The filters shall be of the viscous impingement type, cleanable, aluminium wire mesh coated with viscous substance such as filter oil or grease. Separation degree may be similar to EU4 (rough air filter), according to EUROVENT or DIN 24185 standards.

The frame structure of the panel cells shall be made of aluminium sections.

A properly positioned pressure gauge of the inclined tube type shall give an indication of the degree of dust loading on the filters for establishing the periods between services.

22.5.9. Fans

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.

All bearings shall be pre-lubricated, self-aligning and selected for a minimum of 40000 hour's average life at the maximum design rating. If, however, frequent lubrication is required this should be possible from the outside of the fan casing without disturbing the fan duct assembly.

Bearing 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, which is below the first critical speed.

All motor bases shall be adjustable and V-belt drives selected for 120 percent of motor power.

The steel casing of the air fans shall be made of hot-dip galvanized steel or aluminium.

Where the impeller is accessible in operation, guards shall prevent injuries to maintenance personnel.

Anti-vibration mountings shall be provided for each fan.

22.5.10. Piping Systems

The necessary piping installation for condense water discharge from all above-mentioned air coolers shall be included in the supply. The supply shall also include the necessary fittings, valves (manually and motor operated valves, return valves etc.), flow control meters, pressure gauges, thermostats, insulations and fixations. All pipes shall be galvanized and insulated.

~~2.5.10.1 Chilled Water Pumps~~

~~For chilled water circuits, water pumps shall be provided. The speed of pumps shall be 1450/ 1500 rpm. Pump bearings shall be water lubricated.~~

22.5.11. Bolts, Nuts and Washers

All bolts, screws and nuts shall be of metric thread standards and have hexagonal heads. The material shall be of stainless steel.

22.5.12. Controls and Electrical Equipment

The HVAC system shall be equipped with operation on fully automatic mode and manual mode.

Automatic Control and Regulation

The HVAC system shall be equipped with a fully independent computerized and automatic control system for efficient operation, which shall be included in the supply. It should automatically shutdown all fans immediately in case of fire detection.

All sensors and instruments (temperature, pressure, humidity, etc.), limit switches, etc. required for automatic regulation and monitoring of proper service of the systems shall be included in the supply.

Manual mode

Individual starting and stopping of equipments by push buttons.

All the necessary cabling between the control panels and the field HVAC components (as fans, sensors, pumps, valves, air dampers, etc.) shall be included in the supply and shall be in accordance with relevant standards/codes in recent practice.

Each of the control systems shall be equipped with the necessary control, interlocking and security devices. Any failure or breakdown in the control system shall be indicated by a signal on the respective control panel, as well as remotely in the main control room. Potential free contacts and terminals for remote indication of the alarms shall be provided in the panels. All necessary protection viz single phasing, IDMT and Instantaneous over current relays, Under voltage relays etc. shall be provided.

Pumps shall be provided with electric motors, anchor bolts and other mounting materials. The pumps shall be with starting unit suitable for 415 V + 10%, 50 HZ + 5% with contacts for remote operation / indication.

22.6.

Quality Control and Assurance

The contractor shall follow the quality assurance and testing requirements specified separately in Section XII – Quality Assurance Plan.

22.7.

Drawings, Documents and Design Calculations

22.7.1.

Drawings and Documents

The Contractor shall submit all the drawings and documents as per clause no. 2 of Section VIII.

22.7.2.

Design Calculation

The Contractor is required to submit the design calculation for following to the Engineer for approval during detail engineering.

Sizing of ducts for air distribution

Calculation for selecting the AHU and other fans capacity

Cooling loads, air flow rate and temperature & humidity conditions at all locations/areas

22.8.

Shop Tests

The HVAC system shall be type and routine tested as per relevant IEC / IS / Standards. The contractor is required to carry out all type tests on air cooled chiller units and other equipment of one-unit and routine tests on all units and submit the reports to the Employer. At the discretion of the Employer, type test certificates can be accepted in place of type tests.

22.9. Installation and Commissioning

The contractor shall furnish all labour, supervision, tools, supplies, bracing, spiders, shims and supports and all other provisions or materials necessary to assemble, erect, install, test and commission of the equipment in a thorough workman like manner following the best modern practices.

The equipment and all its components shall be placed with great care and accuracy and shall be aligned correctly to provide an installation consistent with the close tolerances used in the erection of modern equipment. The proper elevations and centrelines to which equipment is to be set shall be established by the contractor.

All necessary materials and labour for performing all the above tests shall be provided by the contractor. All test equipment and instruments shall be furnished by the contractor and will remain the contractor's property after the fulfilment of all field tests.

All civil work required for foundation shall be carried by "other contractors". The contractor is required to submit all foundation drawings and supporting steels well in advance.

22.10. Field Tests

After installation, the HVAC system shall be field tested for operational tests, visual inspection of complete installations, main air flow rates, performance of heaters, electrical consumption of electrical components, room conditions in all rooms, control system, hydrostatical tests of whole piping systems, air tightness, vibration and noise due to turbulence in the duct assembly etc. The contractor shall prepare and hand over to Employer details of all test results in a report in a mutually agreed format.

22.11. Spare Parts**22.11.1. General Spare Parts**

The Contractor shall supply the general spare parts as per clause number 3.1.1 of Section VIII. The supply of this spares shall be as per the approved list of spares for each component / equipment / item during detail engineering.

22.11.2. Recommended Spare Parts

The Contractor shall furnish the list of recommended spare parts as per clause number 3.1.3 of Section VIII.

22.11.3. Specified Spare Parts

The following specified spare parts, as defined in clause number 3.1.2 of Section VIII, which shall comprise the total requirement for HVAC system under this Contract, shall be supplied.

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Section IX
Particular Technical Specifications (PTS)

S. No	Description	Qty
1	Filter bank of each type and size	4 sets
2	V- belts of each type and size	2 sets
3	Circulation chilled water pump motor set	1 no.

A set is defined as the total number required for one unit.

22.12. Special Tools

The Contractor shall provide one set of all necessary special tools and maintenance equipment for repair and maintenance of the Air conditioning and Ventilation system as recommended by the manufacturer.

A list of such tools shall be approved during detail engineering.

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TECHNICAL SPECIFICATION
2X60 MW VYASI
HVAC SYSTEM

SPECIFICATION No: PE-TS-407-571-11000-A001

VOLUME II B

SECTION C2-B

REV. 00

DATE: SEPTEMBER 2015

SECTION: C2-B

GENERAL TECHNICAL REQUIREMENT

1. GENERAL REQUIREMENTS**1.1 General**

The Contractor shall strictly observe this General Technical Specification in conjunction with the Particular Technical Specifications. He shall carry out all works in a skilled and workman like manner in conformity with modern methods of engineering. All design; calculations, materials, works, manufacturing and testing shall conform to the latest applicable standards.

In addition, the Contractor shall conform to all applicable regulations regarding the execution of construction and installation work, and shall follow all instructions issued by the competent Authorities, and the Engineer.

The particular technical specifications shall take precedence over the general technical specifications in case of any contradiction or conflict.

Clause number cross-references refer to the Section in which they occur unless stated otherwise.

1.2 Scope of Work

The scope of work covered by these Electro-Mechanical Works-General Technical Specifications is established in the Particular Technical Specifications-Section - IX. In addition to this, the Contractor shall prepare the detailed design, construction and installation drawings as well as calculations, material specifications, operating and maintenance instructions, etc., for the works as stipulated in the Particular Technical Specifications.

The Contractor shall design, manufacture, supply, erect, test & commission and hand-over to Owner and guarantee for two years after commissioning all works complete in every respect with all necessary accessories for reliable, efficient and trouble free continuous operation as per the detailed particular technical specifications.

These Specifications include the performance of all works and the provision of all labours, materials, permanent and temporary equipment, tools, accessories for transport to the site, including loading, unloading, if necessary reloading in the port of arrival, intermediate storage, protection of the Works from the effects of the weather, cleaning, drying, storage at site and preservation related works, complete installation, painting, testing and commissioning of all works and accessories of the works.

The Contractor shall make competent and experienced staff available for the training and assistance of the operating staff during commissioning and trial operation and, if required by the Employer, for a period after completion of the trial operation which shall be agreed separately.



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The period provided for testing and commissioning is established in the Special Conditions of Contract.

The Contractor shall supply the Operation and Maintenance Instruction Manuals in a number and at a time as stated in the General and Special Conditions of Contract.

1.3 Standards

Although European or IEC standards for design, stipulated testing, workmanship material and Works have been mostly stipulated in these specifications as a basis of reference, other standards and recommendations of standard international organizations will be acceptable provided they ensure equal or higher quality than those specified, and provided, furthermore, that the Contractor submits for approval detailed standards which he proposes to use.

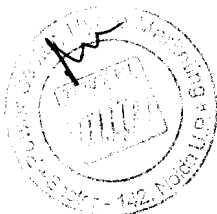
When IEC or ISO Recommendations or other Standards are referred to, the Edition shall be that current at the time of issue of Tender Documents, and any Amendments issued till then.

If requested by the Engineer, the Contractor shall supply at his own expense three copies in English and one in the original language of any national standards, if these are not English, which are applicable to the Contract.

Standard publications issued by the following organizations of standardization are considered as acceptable standards for the works subject to acceptance of the Employer:

1.3.1 Standards for General Application

AGMA	American Gear Manufacturers Association
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing of Materials
AWS	American Welding Society
BS	British Standards
CCITT	International Telephone & Telegraph Consulting Committee
CECT	European committee for Manufacturing of Boilers & Kindred Steel Structures
CMAA	Crane Manufacturers Association of America
DIN	Deutsche Institute for Normung



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IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronic Engineers
IIW	International Institute of Welding
IPCEA	Insulated Power Cable Engineer's Association
IS	Indian Standards
ISO	International Standards Organisation
JEC	Standards of the Japanese Electro-technical Committee
JIS	Japan Industrial Standards
KS	Korean Industrial Standards
NEMA	National Electrical Manufacturers Association
VDE	Verein Deutscher Elektroingenieure
VDI	Verein Deutscher Ingenieure
SIS	Swedish Standards Institute
USAS	United States of America Standards Institute

"Notwithstanding reference made to various standards all equipment and works as per provisions and requirements of relevant and latest Indian Standards shall be acceptable"

1.3.2

Basic Design Standards

ISO System for Limits and Fits,	ISO/R286-1963
Part I, General Tolerances and Deviations	ISO/R1829-1975
Permissible Machining Variations in	ISO/2786-1973
Dimensions without Tolerance Indication	
Screw Threads	ISO 68-1973
	ISO262-1973
	ISO/R724-1978

1.3.3

Manufacturing and Testing Standards

Methods and Definitions for

Mechanical Testing of Steel ASTM-A370
Products

Tension Testing of Metallic ISO/R82-1959
Materials

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Section VIII
General Technical Specifications (GTS)

Notched Bar Impact Testing of	ASTM- E23 and
Metallic Materials	ISO/R83-1976
Bend Test for Steel	ISO/R85-1959
Liquid Penetrant Inspection	ASTM-E165
Recommended Practice for	ASTM- E94
Radiographic Testing	
Ultrasonic Examination of	ASTM-A388
Heavy Steel Forgings	
Guided Bend Test for Ductility of Welds	ASTM-E190
Welders' Qualification Tests	AWS (American Welding Society) Group B,
	DIN EN 287
Preparation of Steel Surfaces for	
Painting by Sand blasting	SIS 05-5900
Designation of Degree of Rusting of Painted Surfaces	DIN53210
Certificates of Material Testing	DIN50049

"Notwithstanding reference made to various standards all equipment and works as per provisions and requirements of relevant and latest Indian Standards shall be acceptable".



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1.3.4 Material Standards

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

Material tests according to DIN 50 049-3.1 C shall be provided for all important parts of the equipment such as: steel plates for parts under hydraulic pressure, all major castings (runner, shut-off valve, etc.), Large forgings (turbine and generator shaft etc.), high stressed large bolts etc.

For less important parts, certificates according to DIN 50 049-2.3 are acceptable.

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

For using stock material not specifically prepared for the works under this Contract, the Contractor shall submit evidence that the material complies with approved standards and that the material is suitable for the intended use.

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

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

"Notwithstanding reference made to various standards all equipment and works shall be as per provisions and requirements of relevant and latest Indian Standards and shall be acceptable".

1.3.5 Electrical Standards

The following basic standards for electrical works or any other equivalent approved standards shall be applied:

IS (Indian Standards)

Standards issued by IEC (International Electro technical Commission)

Standards issued by CCITT (International Telephone and Telegraph Consultative Committee)

For specific standards see the Particular Technical Specifications.



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1.4 Units of Measurements

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

1.5 Works Identification System

An approved, uniform Works identification system shall be applied for all Mechanical, Electrical and Instrumentation and Control (I&C) Works to be agreed upon during detailed design.

1.6 Time Schedule

According to the relevant articles in the General and Special Conditions of Contract, the progress of the work shall conform to the basic Programme of Work on which the Contract is based.

The "Programme" to be submitted shall include the following information

Design work

Shop work

Testing and inspection of works

Transport to the Site

Storage at site

Preparations at the Site

Interdependence with works of other Contractors

Erection and commissioning

Acceptance testing

Handing over

Trial operation for thirty (30) days

Removal of erection equipment and clearing of the Site

The Contractor shall pay particular attention to the dates established for the submission of installation and foundation drawings with loading data, anchoring details, recesses, block-outs etc.



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2. TECHNICAL DOCUMENTS

2.1 General

This clause specifies the general scope and gives a definition of the documents which, together with those listed in the Particular Specifications, shall be delivered by the Contractor to the Engineer within the periods, and in a number and quality as specified in the General and Special Conditions.

The Engineer reserves the right to request the Contractor for additional documents as may be required for proper understanding and definition of constructional, operational, co-ordination or other matters.

All documents to be supplied shall be submitted in accordance with the agreed programme so that any comment made and change requested by the Engineer can be taken into account before starting the manufacture in the workshop and/or erection or installation at the Site.

If the Contractor fails to submit such documents, then the later execution of changes requested by the Engineer and the resulting additional cost and/or delays shall be the Contractor's responsibility and liability. The Contractor shall not be relieved of his responsibility and guarantee after drawings and computations have been approved by the Engineer.

The preparation of drawings, computations or other technical documents shall not be sublet by the Contractor without the written authorization of the Engineer. In such a case the Contractor shall be fully responsible for such drawings, computations and other technical documents as if they were done by him.

On drawings, catalogue sheets or pamphlets of standard Works submitted to the Employer or Engineer in charge, the applicable types, paragraphs, data, etc. shall either be marked distinctively or the non-applicable parts shall be crossed out. Documents not marked in such a manner will not be accepted and approved by the Engineer-in-Charge.

For proper understanding of the documents, additional descriptions/explanations shall be given on these documents or on separate sheets if so requested by the Employer. All symbols, marks, abbreviations, etc., appearing on any document shall clearly be explained by a legend on the same document or on an attached sheet.

Each device appearing on any document (drawing, diagram, list, etc.) shall clearly be designated. The abbreviation mark used for an individual device shall be identical throughout the complete documentation so as to avoid confusion. All documents shall have a uniform title-block and agreed by the Engineer in charge. Beginning with the very first submittal to the Engineer in charge, the Contractor's drawings shall bear a serial number corresponding to a drawing classification plan to be agreed upon by the Contractor and the Engineer in charge.

Revised technical documents replacing previously submitted documents shall be marked accordingly. Also, the revised part in the Document itself shall be marked clearly with cloud mark. Annex No. 4 of this Section specifies the documents to be supplied and the purpose, namely "FOR APPROVAL" (A) or "FOR INFORMATION" (I), respectively.

Any comment given by the Engineer on a "I" type drawing shall have the same effect as if it were given on a "A" type drawing.

2.2 Drawings

2.2.1 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.

2.2.2 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.

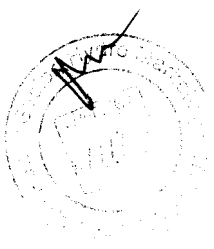
In addition, they shall include openings, sleeves, slopes and the arrangement of any supporting structure, i.e. base-frames or other steel constructions for permanent fixing or erection purposes.

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

2.2.3 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.).

The Arrangement or Layout Drawings of electrical and instrumentation and control equipment shall indicate the location of all apparatus wherever used, i.e. in or on machines, control boards, switchboards,



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cubicles, control desks and panels, etc. The apparatus shall be denominated with the same standardised abbreviations as used in all other documents.

2.2.4 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.

2.2.5 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 Tender Drawings and shall show:

- - 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.

2.2.6 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.

2.3 Diagrams

For electrical diagrams general reference is made to IEC 113-1.

"Notwithstanding reference made to various standards all equipment and works as per provisions and requirements of relevant and latest Indian Standards shall be acceptable".

2.3.1 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.

Single-line diagrams of individual main components and switchboards shall additionally show the control, indicating, measuring, metering, protection, automatic, and other auxiliary electric devices separated for each individual installation site and location as applicable:

Local:	Switchboard control compartment, switch compartment, cable termination compartment, etc.
Remote:	Control room (from workstation).
	Unit control Board (from MMI)
	Relay (in auxiliary relay cubicle, UCB, LCB, protection cubicle)
	Separate energy meter cubicle.

Furthermore, the applied recommended setting of adjustable devices (protection and control elements, time relays, etc.) shall be indicated.

2.3.2 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 information.

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Yamuna, Dehradun-248001

The control part shall be subdivided into separately drawn "current paths", each showing all its components regardless of their actual physical location. The individual circuits are to be drawn in a straight-line sequence, avoiding line crossings. The current paths (to be designated by numbers) shall be drawn starting from two horizontal lines, which represent the control voltage source. All devices belonging to the Works or forming part of the Works or control devices shall appear between these two lines.

Contact developments of the installed switches, contactors, relays and other apparatus which appear in the diagram shall be shown below the respective contactor coil, indicating by means of numbers and, if not on the same, also the page No., the current path in which the corresponding contact has been used.

Interconnections to other circuit diagrams shall be clearly marked by means of dotted line separations and the corresponding functional designation.

The power circuit portion of the installation shall be drawn at the left side of the drawing.

Circuit diagrams shall also contain all terminals and their correct designations. Terminals grouped together to terminal blocks of switchboards, distributors, etc. shall be shown on the circuit diagrams in one fictitious horizontal line surrounded by demarcation lines. If, for any reason, the current paths of circuit diagrams must be separated, the corresponding counter terminal has to be indicated by all means.

The representation of electrical Works and control circuits shall not be terminated at the limits of the scope of supply, but has to be extended beyond this limit by all switchgear, protective, measuring and monitoring equipment required for full comprehension of the whole circuit. All terminals and functions of Works to be supplied by others shall be taken over as well.

Standard Circuit Diagrams are patterns of circuit diagrams which have been standardised with regard to scope, arrangement, representation and allocation of Works with the aim of simplification and easy surveillance of electrical circuitry.

2.3.3 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.

Wherever possible, a Block Text Diagram may be prepared, consisting essentially of explanatory texts enclosed in outlines which are linked by


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lines showing the functional relationships that exist between the various parts of an installation, Works or circuit.

2.3.4 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.

2.3.5 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:

- - Terminal number of terminal board with targets (terminal number and current path) of incoming and outgoing cables and wires.
- - Cable designation
- - Type of cable
- - Number and cross-section of conductors
- - Assignment of conductors
- - Number of spare conductors
- - Approx. length of cable and its destination.

2.3.6 Protection Co-ordination Diagrams

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

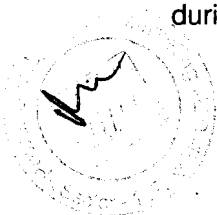
A simplified single-line diagram of the circuit with technical data of all instrument transformers and relays.

Co-coordinated tripping curves of related protection devices.

Setting of the protection devices.

2.3.7 Emergency Shutdown Diagram

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



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2.4 Specifications

2.4.1 Material Specifications

Such specifications shall be prepared for all principal Works and installations. They shall describe the performance (design, material, dimensions, corrosion protection, etc.) of the Works and include a list of components providing information on the manufacturer, type and technical data to obtain the following:

- Full information on the Works, completing the general requirements fixed in the Tender Specification by the data/information of the specific manufacture.
- Proof of compliance with Contract Specification.

For standard Facilities (for example valves, switchgear, control gear, relays, transmitters, indicators, lighting fittings, etc.) catalogues or pamphlets shall be submitted.

The technical data of electrical Works shall include as a minimum:

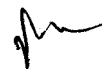
- - Max. Permissible ambient conditions (temperatures, humidity)
- - Rated current and rated output/capacity
- - Same data as above under specified severest site conditions
- - Rated voltage and ratio or regulation/setting range
- - Max. Service voltage (acc. to IEC)
- - Power frequency and impulse withstand voltages
- - Type and code No. of protection relays and of instantaneous or thermal releases directly attached to circuit breakers and contactors
- - Power requirements for each voltage level (A.C./D.C.).
- - Specific requirements are described in the following paragraphs.

2.4.1.1 Motor Specifications

The motor specifications shall include the thermal motor characteristic both for cold and hot condition, the start-up characteristic when running with the driven machine and all data required for selection of the appropriate motor protection relay (both for cold and hot condition) and for locked rotor protection. Construction type, class of protection and insulation shall also be given.

2.4.1.2 Cable Specifications

The General Cable Specification shall include the calculation of the de-rating factors for the individual modes of installation at applicable ambient temperatures and grouping of cables, and furthermore, for each cross section:



- - The rated current carrying capacity
- - The maximum Short-circuit capacity
- - The voltage drop
- - Type, insulation serving, armouring and sheathing of cable
- - Type, description and catalogue/pamphlet of cable termination.

Separate specification(s) shall be prepared for cable trays, conduits, supporting structures and other accessories.

2.4.1.3 Measurement and Control Apparatus Specifications

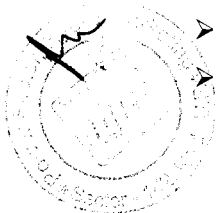
The accuracy of performance with respect to variable ambient conditions and the power supply requirements shall be included.

2.5 Lists and Schedules

2.5.1 Motor Lists

The motor lists shall be prepared according to the power distribution boards. The motors are connected to, and shall contain at least the following information/data:

- - Works identification number
- - Description
- - Manufacturer, type, rated data of driven machine
- - Manufacturer and type of electric motor/consumer
- - Rated capacity
- - Service factor (ratio between motor output and power requirement of the driven machine)
- - Rated speed
- - Rated voltage
- - Rated current
- - Ratio of starting current to rated current
- - Ratio of pull-out torque to rated torque
- - Power factor at rated capacity
- - Efficiency at rated capacity
- - Power consumption at machine design loading
- - Total weight
- - Design/enclosure/cooling (acc. to IEC)
- - Duty (continuous/intermittent/start-up)
- - Starting method/permissible starting frequency



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- - Denomination of feeder
- - Motor protection
- - Applicable Standard Circuit Diagram (Category)
- - Maximum number and overall diameter of power cable(s)
- - Manufacturer and type of bearing(s)
- - Manufacturer, type and quantity of lubricant, service interval
- - Manufacturer, type, number, size, spring pressure and service interval of brushes (if applicable).

2.5.2 Motor Starter Lists

The motor starter lists shall include all starters and contactors used for motors and contain the following technical information as a minimum:

- - Works identification number
- - Electrical design data as nominal and actual current rating, voltage rating, coil rating, making and breaking capacity, mode of operation
- - Maximum power cable size
- - Maximum control cable size
- - Current transformer ratio, class and capacity
- - Type of protection relaying and catalogue number
- - Setting of protection relays and maximum continuous rating of the protected circuit
- - Type and current rating of the back-up fuses/MCBs for the main and control circuits.

Note: Motor Starter Lists can be substituted by part lists, already forming part of switchgear manuals

2.5.3 Cable Lists/Interconnection Lists

The Cable Lists shall include for each individual cable the following as a minimum:

- Cable number, in accordance with Identification System.
- Cable type
- Rated voltage
- Number and size of conductors
- Overall diameter
- Cable termination at each end




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- Connection point at each end with cubicle/Works identification and terminal numbers

- Cable routing

In case interconnecting cubicles are used, the lists shall be prepared to show:

- - Cable termination for incoming and out coming cables
- - Interconnection wiring

2.5.4 List of Measurements

This list shall indicate all measurements, local as well as remote, and shall contain at least:

- - Item/code number, function code
- - Description and denomination of measuring loop
- - Data of tapping point
- - Data of local devices (as detectors, instrument transformers, transmitters)
- - Data of remote devices.

2.5.5 Alarm Lists

These lists shall indicate all alarms and shall contain at least:

- - Item/code number and function code
- - Description and denomination of alarm
- - Data of alarm detector (contact) referring to applicable circuit diagram
- - Data of alarm annunciator (location and clear text labeling)

2.5.6 List of Final Control Elements

This list shall indicate all control actuators and control valves and shall contain at least:

- - Item/code number
- - Data of pipe and valve connections
- - Data of valve layout
- - Rated power



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2.5.7 Workshop Test Schedules

Individual Workshop Test Schedules shall be prepared for Works/installations (such as pipes, cranes, machines, switchgears, control gear, cables) and shall contain at least:

- - Works identification number
- - Manufacturer
- - Place of manufacture
- - Place of test
- - Date of test
- - Objective of test (all individual tests)
- - Standards applied
- - Certification
- - Inspection (by Engineer / Independent Test Authority / Contractor/ Subcontractor)
- - Release for shipment
- - Remarks

On the above schedule or on separate sheets the Test Procedure shall be specified giving for each test item (kind of test) a description, test method / Standards, used instruments, sample/routine test, test judgment.

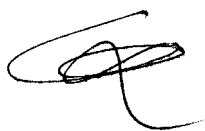
2.5.8 Site Test Schedules

Testing at site shall include tests specified in the Particular Technical Specifications (Section-IX) and any tests recommended by the manufacturers as per their standard practices.

2.5.9 List of Tools and Appliances

Lists of Tools and Appliances shall detail for all tools and appliances included in the scope of supply:

- - Item and code number
- - Description
- - Quantity
- - Weight
- - Gross storage requirements (separate for open-air, indoor, air-conditioned) for individual component sets.



2.5.10 Spare Part Lists

Spare part lists shall detail for all spare parts included in the scope of supply:

- - Detailed drawing (where possible)
- - Item and code number
- - Description
- - Quantity
- - Weight
- - Gross storage requirements (separate for open-air, indoor, air-conditioned) for individual component sets.

2.5.11 List of Works Identification Numbers

This list shall contain the identification numbers of Works in alphanumeric order and for each of them a description (the defined Works denomination, for example as written on the Works label) and the location (short definition of outdoor area and level elevation or building/room with elevation and room number).

2.6 Calculations

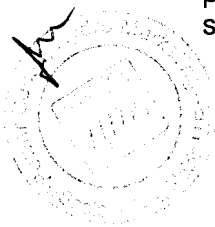
In addition to the drawings or whenever the contractual documents do so require, the Contractor shall submit to the Engineer for checking, the appropriate calculations for determining the main sizes, stress levels, dimensions and operational characteristics, safety factors, clearly indicating the principles on which the calculations were based. The calculations shall include the formulae, standards, test results, basic assumptions, etc. Submission of computer calculations without baseline information such as derivation of the calculation method, applied formulas, definition of variables and constants, explanation of abbreviations etc., will not be accepted.

2.6.1 Short-Circuit Calculations

The short-circuit calculations shall be performed in accordance with VDE Standard 0102, part 1.

2.7 Installation and Commissioning Procedures**2.7.1 Installation Procedures**

The installations procedures shall describe in sequential steps the erection of major equipment and shall contain sufficient details such as equipment preparation on erection bay, handling of large and heavy pieces, leveling, anchoring, site welding, site painting, erection checks, site pressure tests, site flushing and cleaning of hydraulic systems,



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alignment and run out checks to allow the engineer/employer to plan and supervise the Works at site, if required.

2.7.2 Pre-Commissioning Tests and Procedures

Pre-commissioning tests and procedures shall be described in sequential steps for the pre-commissioning of all electrical and mechanical equipments and shall also contain sufficient details viz. checking of installations, ratings, cable terminal checking and operation test of all auxiliary equipments etc.

2.7.3 Commissioning Procedures

The commissioning procedures shall sequentially and in sufficient detail describe activities and tests for all systems covered by the Contract Document.

2.7.4 Commissioning Test

Commissioning acceptance tests shall be carried out, on all generating units to verify the rating characteristics of generating units and other equipment's in accordance to relevant standards. The complete field acceptance test reports shall be prepared by the Contractor and submitted to the Employer for approval.

2.7.5 Test Run

The test run on generating units shall be carried out as per relevant provisions of IEC standards.

2.8 Operation and Maintenance Manuals

2.8.1 Contents

The Operation and Maintenance Manuals shall be provided in Ten (10) copies along with CD-ROM (three sets), and shall contain the following information in sufficient detail to enable the Employer to maintain, dismantle, reassemble, adjust and operate the Works with all its items of Works and installations:

- Table of Contents
- List of Illustrations
- Introduction

The Introduction shall contain:

- A brief general description of the Works items
- A brief description of the use of the Works items

- Definitions of technical terms used in subsequent graphs of the instruction book
- A complete list of all items used in accordance with the Works Components Identification System.
- Detailed Description

Detailed description shall contain a complete and accurate description of the Works, all components and ancillaries, their assembling and dismantling. An accurate list stating clearances, tolerances, temperatures, fits, etc. shall be included.

- Operating Principles and Characteristics

A brief summary of the technical operating principles of the Works, including diagrams, circuit diagrams, sequence diagrams, piping, etc.

- Operating Instructions

The instructions shall be accurate and easy to understand, and shall contain the sequence of individual manipulations required for operation. The information shall be presented in such a manner that the contents of this paragraph can be used for instructing personnel in the operation of the Works. Tables, lists and graphic presentations should be used whenever possible for making the description readily understandable. An appropriate trouble-shooting list shall be included in this chapter.

- Testing and Adjustment

The entire testing and adjustment procedure required for the Works after overhauls and during operation shall be described.

- Maintenance Instructions

This section is divided into six parts:

1) Preventive maintenance, indicating the inspections required at regular intervals, the inspection procedure, and the routine cleaning and lubricating operations, the regular safety checks and similar steps.

- The maintenance instructions shall include a tabular (or in other approved form) summary of the required activities sorted according to

- Daily
- Weekly
- Monthly
- Quarterly
- Yearly
- (Or other) cycles as applicable.

This document shall provide the maintenance engineer with brief and yet fully comprehensive information including all references to the applicable, detailed service and maintenance instructions.

Dr. General Manager (E&M) Section-I
UJVNL Limited, Ganga Bazar
Dehradun-248001

- 2) Repair and adjustment, describing the inspections, fitting and dismantling of parts, fault tracing as well as repair and adjustment procedures.
- 3) Spare part lists, containing all the necessary data for ordering spare parts. These lists shall include all spare parts, those to be supplied and those not to be supplied under the present Contract. Detailed drawing for each item of spare parts shall be supplied. The above list should include minimum and maximum quantities of spares to be maintained by the project.
- 4) Tool lists, containing all necessary data for identification of tools to be delivered under the present Contract.
- 5) List of suppliers and alternative suppliers and addresses.
- 6) As-built drawings

2.8.2 Performance

Each drawing aforementioned shall have a uniform size. The final size of drawings for the Operation and Maintenance Manual shall be decided by the Engineer-in-charge. Catalogue sheets, illustrations, printed specifications, etc., shall be checked and prepared by the Contractor in such a way that the figures, statements and data valid for the delivered sizes and types of the Works concerned are clearly marked. All figures, statements and data valid for sizes and types not delivered must be crossed out.

2.8.3 Revisions and Supplements

The completeness of the manuals shall be checked during installation, testing, commissioning and trial operation jointly by the Contractor and Engineer-in-charge.

If it becomes evident during the installation, commissioning trial operation and defects liability period of the Works that the Operation and Maintenance Manuals are inadequate or incorrect, the Contractor shall supply immediately the necessary supplements and corrections. This shall be handled in the following manner:

➤ Deletions:

One sheet of errata, printed on pink paper, shall be issued indicating the pages and date of issue of those pages, which are to be deleted, and are no longer valid.

➤ Corrections, Revisions, Replacements:

New sheet or sheets shall be issued to replace the wrong pages. Whenever a new sheet is added to the instruction manuals, this sheet shall be given the new date of issue and a revision symbol, and an indication "Substituted for ... " and a marking of the corrected/revised items.




➤ Insertions, Supplements:

Insertions or supplements shall be accompanied by a new respective "Table of Contents" page, where the latter shall be handled as described above under replacements.

The revisions and supplements requested by the Engineer-in-charge shall be made by the Contractor at the Site as far as possible and shall be submitted in each case to the Engineer for checking and approval as stated above.

Before issuing the "Taking-Over Certificate", the ten sets of revised copies of the Operation and Maintenance Manuals shall be submitted together with the specified number of complete sets of drawings of the Works as completed. The Works shall not be considered complete for purposes of taking over under the terms of the General Conditions of the Contract until the above documents have been supplied by the Contractor.

2.9

Progress Reports during Design and Manufacturing

During every quarter design and manufacturing the Contractor shall quarterly submit four (4) copies of the progress reports in a format acceptable to the Engineer, detailing the progress of the work during the preceding period. The report shall contain (but not be limited to) the following information:

- - A general description of the Works performed during the reporting period on each main activity, and include any notable problems, which were encountered.
- - The total overall percentages of design and manufacturing works completed, with reference to the CPM programme. Appropriate comments shall explain any differences.
- - The percentages of each main work activity completed during the reported quarter vis-à-vis the scheduled programme. Appropriate comments shall explain any differences.
- - A list of all activities of scheduled and actual progress during the reporting period including actual starting dates versus scheduled starting dates and actual completion dates versus scheduled completion dates for each activity. Appropriate remarks shall explain any differences, and also methods/actions prepared to be taken for making up the deficiencies in actual design and manufacturing process.
- - A list of activities scheduled to be started within the next two (2) months, with expected starting and completion dates. If the expected starting and/or completion dates are different from those shown on the CPM programme, an explanation shall be given.



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2.10 Progress Reports during Installation at Site

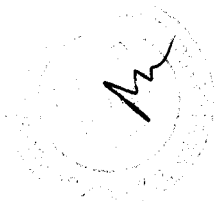
During erection the Contractor shall, before the tenth (10th) day of each calendar month, submit four (4) copies of the monthly progress reports in a format acceptable to the Engineer, detailing the progress of the work during the preceding month. The report shall contain (but not be limited to) the following information:

- - A general description of the Works performed during the reporting period on each main activity, and includes any notable problems, which were encountered.
- - The total overall percentages of erection works completed, with reference to the CPM programme. Appropriate comments shall explain any differences.
- - The percentages of each main work activity completed during the reported month with reference to the scheduled programme. Appropriate comments shall explain any differences.
- - A list of all activities of scheduled and actual progress during the reporting period including actual starting dates and scheduled starting dates and actual completion dates, scheduled completion dates for each activity. Appropriate remarks shall explain any differences.
- - A list of activities scheduled to be started within the next period of two (2) months, with expected starting and completion dates. If the expected starting and/or completion dates are different from those shown on the CPM programme, an explanation shall be given.
- - A list of local manpower (by trade classification) employed during the reporting period.
- - A list of expatriate personnel (by position) employed during the reporting period.
- - A list of the Contractor's Equipment and materials available at the Site at the beginning of the report period. Also a list of equipment and materials, which arrived at Port of entry and status of custom clearance.
- - Photographs of progress of significant events. The Engineer-in-charge may demand specific photographs if deemed necessary.
- - Main items of temporary facilities constructed during the reporting period.
- - A statement detailing the status of progress on the overall programme and how to regain any lost time or setbacks, which may have occurred.
- - A list of inoperable temporary equipment, and the estimated date when the repair will be completed.




- - A statement about labour relations & an explanation of actual and potential problems.
- - A listing of each accident at the site involving the hospitalization and/or death of any person
- - A listing of the amount & date of any payments received during the reporting period & the amount of any monthly invoice, which has been submitted but not yet paid.
- - A list of claims (if any) submitted during the reporting period including the claimed cost & extension of time.
- - A statement concerning potential problems and recommendations on how they could be resolved.

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Dy. General manager (E&M Design-I)
UJVNL Limited, Ganga Bhawan
Yamuna Colony, Dehradun-248001

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TECHNICAL SPECIFICATION
2X60 MW VYASI
HVAC SYSTEM

SPECIFICATION No: PE-TS-410-571-11000-A001

VOLUME II B

SECTION C2-C

REV. 00

DATE: OCTOBER 2015

SECTION: C2-C
PERFORMANCE GUARANTEE

25. Commissioning and Operational Acceptance

25.1 Commissioning

- 25.1.1 Completion of the Facilities or any part thereof shall be completed by the Contractor as per procedures detailed in Technical Specifications.

The Employer shall unless otherwise specified in the Technical Specifications supply the operating and maintenance personnel. All raw materials, utilities, lubricants, chemicals, catalysts, facilities, services and other matters required for Commissioning shall be provided by the Contractor, unless otherwise specified in the Technical Specifications.

25.2 Guarantee Test

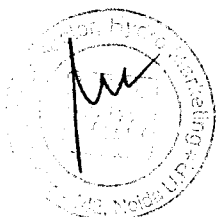
- 25.2.1 The Guarantee Test (and repeats thereof) shall be conducted by the Contractor after Completion of the Facilities or the relevant part thereof to ascertain whether the Facilities or the relevant part can attain the Functional Guarantees specified in the Contract documents. The Contractor's and Engineer In-Charge's advisory personnel shall attend the Guarantee Test. The Employer shall promptly provide the Contractor with such information as the Contractor may reasonably require in relation to the conduct and results of the Guarantee Test (and any repeats thereof).

- 25.2.2 If for reasons not attributable to the Contractor, the Guarantee Test of the Facilities or the relevant part thereof cannot be successfully completed within the period agreed upon by the Employer and the Contractor, the Contractor shall be deemed to have fulfilled its obligations with respect to the Functional Guarantees, and GCC Sub-Clauses 28.2 and 28.3 shall not apply.

25.3 Operational Acceptance

- 25.3.1 Subject to GCC Sub-Clause 25.4 (Partial Acceptance) below, Operational Acceptance shall occur in respect of the Facilities or any part thereof when

- (a) The Guarantee Test has been successfully completed and the Functional Guarantees are met; or
- (b) The Guarantee Test has not been successfully completed or has not been carried out for reasons not attributable to the Contractor within the period agreed upon as specified in GCC Sub-Clause 25.2.2 above, but successful completion of the Facilities has been achieved; or



- (c) The Contractor has paid the liquidated damages specified in GCC Sub-Clause 28.3 hereof; and
 - (d) Any minor items mentioned in GCC Sub-Clause 24.7 hereof relevant to the Facilities or that part thereof have been completed.
- 25.3.2 At any time after any of the events set out in GCC Sub-Clause 25.3.1 have occurred, the Contractor may give a notice to the Engineer In-Charge requesting the issue of an Operational Acceptance Certificate in the form provided in the Bidding Documents or in another form acceptable to the Employer in respect of the Facilities or the part thereof specified in such notice as at the date of such notice.
- 25.3.3 The Engineer In-Charge shall, after consultation with the Employer, and within twenty-one (21) days after receipt of the Contractor's notice, issue an Operational Acceptance Certificate.
- 25.3.4 If within twenty-one (21) days after receipt of the Contractor's notice, the Engineer In-Charge fails to issue the Operational Acceptance Certificate or fails to inform the Contractor in writing of the justifiable reasons why the Engineer In-Charge has not issued the Operational Acceptance Certificate, the Facilities or the relevant part thereof shall be deemed to have been accepted as on the date of the Contractor's said notice.
- 25.4 Partial Acceptance**
- 25.4.1 If the Contract specifies that **Completion** and Commissioning shall be carried out in respect of parts of the Facilities, the provisions relating to **Completion** and Commissioning including the Guarantee Test shall apply to each such part of the Facilities individually, and the Operational Acceptance Certificate shall be issued accordingly for each such part of the Facilities.
- 25.4.2 If a part of the Facilities comprises facilities such as buildings, for which no Commissioning or Guarantee Test is required, then the Engineer In-Charge shall issue the Operational Acceptance Certificate for such facility when it attains **Completion**, provided that the Contractor shall thereafter complete any outstanding minor items that are listed in the Operational Acceptance Certificate.

F. Guarantees and Liabilities**26. Completion Time Guarantee**

- 26.1 The Contractor guarantees that it shall attain **Completion** of the Facilities within the Time for **Completion** specified in the Contract




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pursuant to GCC Sub-Clause 8.2, or within such extended time to which the Contractor shall be entitled under GCC Clause 40 (Extension of Time for **Completion**) hereof.

26.2

If the Contractor fails to attain **Completion of any milestones within the Time specified for Completion (as per Annexure-1 of GCC) or any extension thereof under GCC Clause 40 (Extension of Time for completion), the Contractor shall pay to the Employer liquidated damages in the amount computed @ one half percent (0.5 %) of the amount specified for respective Ex-works / CIF or CIP price of BoQ per week or part thereof of delay subject to maximum of 10%. If whole project is delayed the Contractor shall pay to the Employer liquidated damages in the amount computed @ one half percent (0.5 %) of the Contract price excluding applicable taxes / duties and "Local Transportation including Port Clearance & Port Charges and Inland Insurance" per week or part thereof, of delay subject to maximum of 10%. If whole project is completed in time, intermittent deductions, on account of delay, shall be reimbursed to the contractor without interest.** The aggregate amount of such liquidated damages shall in no event exceed ten percent (10 %) of the Contract price excluding applicable taxes / duties and 'Local Transportation including Port Clearance & Port Charges and Inland Insurance'. Once the "Maximum" is reached, the Employer may consider termination of the Contract, pursuant to GCC Sub-Clause 42.2.2.

Such payment shall completely satisfy the Contractor's obligation to attain Completion of the Facilities or the relevant part thereof within the Time for completion or any extension thereof under GCC Clause 40 (Extension of Time for completion). The Contractor shall have no further liability whatsoever to the Employer in respect thereof.

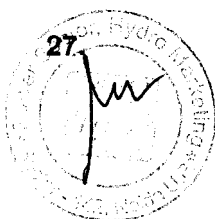
However, the payment of liquidated damages shall not in any way relieve the Contractor from any of its obligations to complete the Facilities or from any other obligations and liabilities of the Contractor under the Contract.

Save for liquidated damages payable under this GCC Sub-Clause 26.2, the failure by the Contractor to attain any milestone or other act, matter or thing by any date specified in the program of work prepared pursuant to GCC Clause 18.2 (Program of Performance) shall not render the Contractor liable for any loss or damage thereby suffered by the Employer.

26.3

No bonus will be given for earlier Completion of the Facilities or part thereof.

Defect Liability



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27.1 The Contractor warrants that the Facilities or any part thereof shall be free from defects in the design, engineering, materials and workmanship of the Plant and Equipment supplied and of the work executed.

27.2 The Defect Liability Period shall be twenty-four (24) months from the date of Operational Acceptance of the Facilities (or any part thereof), unless specified otherwise in the Contract.

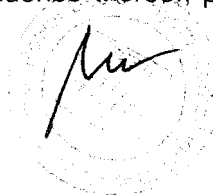
If during the Defect Liability Period any defect should be found in the design, engineering, materials and workmanship of the Plant and Equipment supplied or of the work executed by the Contractor, the Contractor shall promptly, in consultation and agreement with the Employer regarding appropriate remedying of the defects, and at its cost, repair, replace or otherwise make good (as the Contractor shall, at its discretion, determine) such defect as well as any damage to the Facilities caused by such defect. The Contractor shall not be responsible for the repair, replacement or making good of any defect or of any damage to the Facilities arising out of or resulting from any of the following causes:

- (a) Improper operation or maintenance of the Facilities by the Employer
- (b) Operation of the Facilities outside specifications provided in the Contract
- (c) Normal wear and tear.

27.3 The Contractor's obligations under this GCC Clause 27 shall not apply to

- (a) Any materials that are supplied by the Employer under GCC Sub-Clause 21.2 (Employer-Supplied Plant, Equipment and Materials), are normally consumed in operation, or have a normal life shorter than the Defect Liability Period stated herein
- (b) Any designs, specifications or other data provided, supplied or specified by or on behalf of the Employer or any matters for which the Contractor has disclaimed responsibility herein
- (c) Any other materials supplied or any other work executed by or on behalf of the Employer, except for the work executed by the Employer under GCC Sub-Clause 27.7.

27.4 The Employer shall give the Contractor a notice stating the nature of any such defect together with all available evidence thereof, promptly



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following the discovery thereof. The Employer shall afford all reasonable opportunity for the Contractor to inspect any such defect.

- 27.5 The Employer shall afford the Contractor all necessary access to the Facilities and the Site to enable the Contractor to perform its obligations under this GCC Clause 27.

The Contractor may, with the consent of the Employer, remove from the Site any Plant and Equipment or any part of the Facilities that are defective if the nature of the defect, and/or any damage to the Facilities caused by the defect, is such that repairs cannot be expeditiously carried out at the Site.

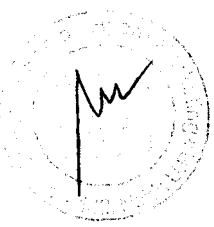
- 27.6 If the repair, replacement or making good is of such a character that it may affect the efficiency of the Facilities or any part thereof, the Employer may give to the Contractor a notice requiring that tests of the defective part of the Facilities shall be made by the Contractor immediately upon commissioning of such remedial work, whereupon the Contractor shall carry out such tests.

If such part fails the tests, the Contractor shall carry out further repair, replacement or making good (as the case may be) until that part of the Facilities passes such tests. The tests in Character shall in any case be not less than what has already been agreed by the Employer and the Contractor for the original equipment / part of the Facilities..

- 27.7 If the Contractor fails to commence the work necessary to remedy such defect or any damage to the Facilities caused by such defect within a reasonable time (which shall in no event be considered to be less than fifteen (15) days), the Employer may, following notice to the Contractor, proceed to do such work, and the reasonable costs incurred by the Employer in connection therewith shall be paid to the Employer by the Contractor or may be deducted by the Employer from any moneys due the Contractor or claimed under the Performance Security.

- 27.8 If the Facilities or any part thereof cannot be used by reason of such defect and/or making good of such defect, the Defect Liability Period of the Facilities or such part, as the case may be, shall be extended by a period equal to the period during which the Facilities or such part cannot be used by the Employer because of any of the aforesaid reasons.

Upon correction of the defects in the Facilities or any part thereof by repair/replacement, such repair/replacement shall have the Defect Liability Period extended by a period of twenty-four (24) months from the time such replacement/repair of the Facilities or any part thereof. **however aggregate defect liability shall be limited to thirty six (36)**



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months from the date of operational acceptance except for latent defect.

- 27.8.1 At the end of the Defect Liability Period, the Contractor's liability ceases except for latent defects. The Contractor's liability for latent defects warranty shall be limited to a period of five (5) years from the end of Defect Liability Period. For the purpose of this clause, the latent defects shall be the defects inherently lying within the material or arising out of design deficiency which do not manifest themselves during the Defect Liability Period defined in this GCC Clause 27, but later.
- 27.9 Except as provided in GCC Clauses 27 and 33 (Loss of or Damage to Property/Accident or Injury to Workers/ Indemnification), the Contractor shall be under no liability whatsoever and howsoever arising, and whether under the Contract or at law, in respect of defects in the Facilities or any part thereof, the Plant and Equipment, design or engineering or work executed that appear after Completion of the Facilities or any part thereof, except where such defects are the result of the gross negligence, fraud, criminal or willful action of the Contractor.
- 27.10 In addition, the Contractor shall also provide a warranty for a period of 2 years for all painting (Ref. Clause 4.13.7 of the General Technical Specifications) of any such component of the Facilities and during the period of time as may be specified in the Technical Specifications.
- 27.11 The contractor shall not be liable to pay compensation for the loss of generation and revenue thereof to the Employer due to shut down of one or both the generating units on account of manifestation of defects or rectification thereof during the defect liability period or extension thereof as per clause 27.8.
- 28. Functional Guarantees**
- 28.1 The Contractor guarantees that during the Guarantee Test, the Facilities and all parts thereof shall attain the Functional Guarantees specified in Appendix 8 (Functional Guarantees) to the Contract Agreement, subject to and upon the conditions therein specified.
- 28.2 If, for reasons attributable to the Contractor, the Functional Guarantees specified in Appendix 8 (Functional Guarantees) to the Contract Agreement are not met either in whole or in part, the Contractor shall at its cost and expense make such changes, modifications and/or additions to the Plant or any part thereof as may be necessary to meet such Guarantees. The Contractor shall notify the Employer upon completion of the necessary changes, modifications and/or additions, and shall request the Employer to repeat the Guarantee Test until the

minimum level of the Guarantees has been met. If the Contractor eventually fails to meet the minimum level of Functional Guarantees, the Employer may consider termination of the contract pursuant to GCC Sub-Clause 42.2.2 and recover the payments already made to the Contractor.

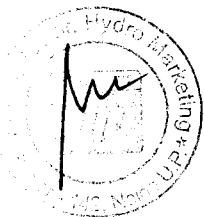
28.3 If, for reasons attributable to the Contractor, the Guarantees specified in Appendix 8 (Functional Guarantees) to the Contract Agreement are not attained either in whole or in part, the Contractor shall, at the Employer's option, either

- (a) Make such changes, modifications and/or additions to the Facilities or any part thereof that are necessary to attain the Functional Guarantees at its cost and expense within a mutually agreed time, and shall request the Employer to repeat the Guarantee Test or
- (b) Pay liquidated damages to the Employer in respect of the failure to meet the Functional Guarantees in accordance with the provisions in Appendix 8 (Functional Guarantees) to the Contract Agreement.

28.4 In case the Employer exercises its option to accept the equipment after levy of liquidated damages, the payment of liquidated damages under GCC Sub-Clause 28.3, up to the limitation of liability specified in the Appendix 8 (Functional Guarantees) to the Contract agreement, shall completely satisfy the Contractor's guarantees under GCC Sub-Clause 28.3, and the Contractor shall have no further liability whatsoever to the Employer in respect thereof. Upon the payment of such liquidated damages by the Contractor, the Engineer In-Charge shall issue the Operational Acceptance Certificate for the Facilities or any part thereof in respect of which the liquidated damages have been so paid.

29. Patent Indemnity

29.1 The Contractor shall, subject to the Employer's compliance with GCC Sub-Clause 29.2, indemnify and hold harmless the Employer and its employees and officers from and against any and all suits, actions or administrative proceedings, claims, demands, losses, damages, costs, and expenses of whatsoever nature, including attorney's fees and expenses, which the Employer may suffer as a result of any infringement or alleged infringement of any patent, utility model, registered design, trademark, copyright or other intellectual property right registered or otherwise existing at the date of the Contract by reason of: (a) the installation of the Facilities by the Contractor or the use of the Facilities in the country where the Site is located; and (b) the sale of the products produced by the Facilities in any country.



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Such indemnity shall not cover any use of the Facilities or any part thereof other than for the purpose indicated by or to be reasonably inferred from the Contract, any infringement resulting from the use of the Facilities or any part thereof, or any products produced thereby in association or combination with any other equipment, plant or materials not supplied by the Contractor, pursuant to the Contract Agreement.

- 29.2 If any proceedings are brought or any claim is made against the Employer arising out of the matters referred to in GCC Sub-Clause 29.1, the Employer shall promptly give the Contractor a notice thereof, and the Contractor may at its own expense and in the Employer's name conduct such proceedings or claim and any negotiations for the settlement of any such proceedings or claim.

If the Contractor fails to notify the Employer within twenty-eight (28) days after receipt of such notice that it intends to conduct any such proceedings or claim, then the Employer shall be free to conduct the same on its own behalf. Unless the Contractor has so failed to notify the Employer within the twenty-eight (28) day period, the Employer shall make no admission that may be prejudicial to the defence of any such proceedings or claim.

The Employer shall, at the Contractor's request, afford all available assistance to the Contractor in conducting such proceedings or claim, and shall be reimbursed by the Contractor for all reasonable expenses incurred in so doing.

- 29.3 The Employer shall indemnify and hold harmless the Contractor and its employees, officers and Subcontractors from and against any and all suits, actions or administrative proceedings, claims, demands, losses, damages, costs, and expenses of whatsoever nature, including attorney's fees and expenses, which the Contractor may suffer as a result of any infringement or alleged infringement of any patent, utility model, registered design, trademark, copyright or other intellectual property right registered or otherwise existing at the date of the Contract arising out of or in connection with any design, data, drawing, specification, or other documents or materials provided or designed by or on behalf of the Employer.

30. Limitation of Liability

- 30.1 Except in cases of criminal negligence or wilful misconduct,

- (a) The Contractor shall not be liable to the Employer, whether in contract, tort, or otherwise, for any indirect or consequential loss or damage, loss of use, loss of production, or loss of profits or interest costs, provided that this exclusion shall not apply to any

obligation of the Contractor to pay liquidated damages to the Employer and

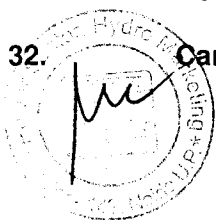
- (b) The aggregate liability of the Contractor to the Employer, whether under the Contract, in tort or otherwise, shall not exceed the total Contract Price, provided that this limitation shall not apply to the cost of repairing or replacing defective equipment, or to any obligation of the Contractor to indemnify the Employer with respect to patent infringement.

G. Risk Distribution

31. Transfer of Ownership

- 31.1 Ownership of the Plant and Equipment (including spare parts) to be imported into the country where the Site is located shall be transferred to the Employer upon loading on to the mode of transport to be used to convey the Plant and Equipment from the country of origin to that country and upon endorsement of the dispatch documents in favour of the Employer.
- 31.2 Ownership of the Plant and Equipment (including spare parts) procured in the country where the Site is located shall be transferred to the Employer when the Plant and Equipment are loaded on to the mode of transport to be used to convey the plant and equipment from the works to the site and upon endorsement of dispatch documents in favour of the Employer.
- 31.3 Ownership of the Contractor's Equipment used by the Contractor and its Subcontractors in connection with the Contract shall remain with the Contractor or its Subcontractors.
- 31.4 Ownership of any Plant and Equipment in excess of the requirements for the Facilities shall revert to the Contractor upon Completion of the Facilities or at such earlier time when the Employer and the Contractor agree that the Plant and Equipment in question are no longer required for the Facilities provided quantity of any plant or equipment specifically stipulated in the Contract shall be the property of the Employer whether or not incorporated in the Facilities.
- 31.5 Notwithstanding the transfer of ownership of the Plant and Equipment, the responsibility for care and custody thereof together with the risk of loss or damage thereto shall remain with the Contractor pursuant to GCC Clause 32 (Care of Facilities) hereof until Completion of the Facilities or the part thereof in which such Plant and Equipment are incorporated.

32. Care of Facilities



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TECHNICAL SPECIFICATION
2X60 MW VYASI
HVAC SYSTEM

SPECIFICATION No: PE-TS-571-11000-A001

VOLUME II B

SECTION C2-D

REV. 00

DATE: SEPTEMBER 2015

SECTION: C2-D
QUALITY ASSURANCE

13 PROTECTION SYSTEM

13.1 Type Test

The contractor is required to carry out all type tests as per relevant IEC / International Standards on one apparatus of each type of similar rating and shall submit the reports to the Employer. The type test may not be mandatory if similar equipment has been type tested and test certificate(s) for relevant tests are accepted by the Employer.

13.2 Shop Test

All Relays shall be routine tested as per IEC: 60255 and British Standards 142 & 5992 and submit reports to Employer. Following shop tests shall be carried out by the manufacturers at their works:-

- Visual inspection
- Check for BOM
- Wiring test
- Insulation test
- High voltage test on outgoing circuits
- Functional tests of all relays
- Functional tests of protection scheme

The details of tests are given in Model Quality Assurance Plan of Protection System.

13.3 Field Test

All field tests including tests during installation, pre-commissioning, commissioning, field acceptance tests shall be conducted by the Contractor, in presence of representative of the Employer.

Procedure to be adopted for conducting the operational, pre-commissioning, commissioning, performance and field acceptance test shall submitted well in advance, at least six(6) month before start of relevant testing, for approval by the Employer.

13.3.1 Tests during installation and pre commissioning

Following tests shall be performed by the Contractor

- Ratio and polarity of CTs, CVTs and PTs,
- Correctness of interconnections between CTs, CVTs and PTs as well as CT groups and associated relays,
- Testing, calibration and adjustment of protection relays,
- Check of functional characteristics of each of the electrical protections,

By General Manager (QA) (Sec 37-1)
UJVNL Limited, Colaba, Mumbai - 400 006
Phone: 22222222, 22222222

- Check of tripping sequence,
- Check of orders issued by each of the protections with respect to the corresponding tripping sequence,
- The systematic testing of the operation of each chain forming the protection, the associated tripping sub-assembly, the links to the connected systems and all fault simulations by test kit for which the system is to react,
- The co-ordination of protection and relay setting,
- The testing of the protection system behaviour during failure of one of its components,
- The testing of the protection system behaviour in the event of failure of one of the connected system to which it is connected,
- Analysis of information consistency and of alarms supplied by protection system.

13.3.2 Commissioning tests

Following tests shall be performed by the Contractor:

- The systematic testing of the operation of each chain forming the protection, the associated tripping sub-assembly, the links to the connected systems and all fault simulations by creating real fault for which the system is to react,
- The final co-ordination of protection and final relay setting,
- The testing of the protection system behaviour in the event of failure of one of the connected system to which it is connected,
- Analysis of information consistency and of alarms supplied by protection system.

Checks shall be made after the protection systems have been commissioned to ensure that all connections and test links have been replaced and test leads removed and relay setting has been done, as well as to confirm the integrity of the current transformer circuits. Where necessary, voltage readings shall be taken at the terminals on each relay to ensure that loop connections between the relays are complete.

14 POWER AND CONTROL CABLES (INCLUDING CABLE TRAYS)

14.1 Type Test

The contractor is required to carry out all type tests as per relevant IEC / International Standards on one apparatus of each type of similar rating and shall submit the reports to the employer. The type test may not be mandatory if similar equipment has been type tested and test certificates for relevant tests are accepted by the employer.

Type test reports of the following items shall be submitted for acceptance with adequate details/drawings to establish equivalence with the offered type.

- ◆ All type of cables, termination kits and accessories,
- ◆ Conduits, ducts, channels etc.,
- ◆ Cable trays and supports.

14.2 Shop Test

The Power & Control Cable and Cable Tray shall be acceptance & routine tested as per relevant IEC with latest amendments. Following shop tests shall be carried out on Power & Control Cable by the manufacturer at their works as per IEC: 502, IS: 7098, IS: 1554:-

- Annealing Test (For Cu)
- Tensile Test (For Al)
- Wrapping Test (For Al)
- Conductor Resistance Test
- Tests for thickness of Insulation & Sheath
- T.S. & E.B. of Insulation & Sheath
- Hot Set Test for Insulation (XLPE Cable only)
- Insulation Resistance Test
- High Voltage Test (At Room Temp.)
- Partial Discharge Test (for Screened XLPE Cable only)

The following FRLS tests are to be conducted as per the referred standards:

- HCL gas evolution test (IEC - 754.1),
- Oxygen Index (ASTM-D-2863),
- Temperature Index (ASTM-D-2863),
- Smoke density test (ASTM-D-2863),
- Flammability test (IEC-332.1),
- Swedish Chimney test (SS-424 14 75),
- Ladder Test (IEEE-383),
- Heat Shock Test (IS:1554) &
- Anti Rodent & Termite Test.

MCD. General Manager
Dy. General Manager (E&T) (S&H)
UJVNL Limited, G-36, Ph. 201
Yamuna Colony, Dehra Dun-244001

Following test on Cable Trays as per relevant IS

- Galvanization Test
- Load Capacity Test (Deflection Test)

The details of tests are given in Model Quality Assurance Plan of Power and Control Cables including Cable Trays.

14.3 Field Test

All field tests including tests during installation, pre-commissioning, commissioning 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 six (6) months before start of relevant testing, for approval of the Employer.

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:

- Cabling checking,
- Continuity checking,
- Meggar testing in accordance with the applicable codes and standards,
- Resistance checking.
- Insulation resistance measurement,
- Verification of phase order,
- HV test

15. 415 V SWITCHGEAR, AUXILIARY AND STATION TRANSFORMERS

15.1 Type Test

The contractor is required to carry out all type tests as per relevant IEC / International Standards on one apparatus of each type of similar rating and shall submit the reports to the Employer. The type test may not be mandatory if similar equipment has been type tested and test certificates for relevant tests are accepted by the Employer.

15.2 Shop Test

The UAT, SST and 415 V Switchgear shall be routine tested as per relevant IEC with latest amendments. Following shop tests shall be carried out by the manufacturer at their works:-

Test on Power Transformer, Oil Filled Transformer, Dry Type Transformer as per IEC: 60726 & IEC 60076 are as follows:-

- Measurement of Winding Resistance.
- Measurement of Voltage Ratio/ Check of Polarity/Vector Relationship.
- Measurement of No Load Losses.
- Measurement of Magnetizing Current (before and after Dielectric Test).
- Measurement of Insulation Resistance and Polarization Index.
- Separate Source Voltage Withstand Test.
- Induced Over Voltage Withstand Test.
- Partial Discharge Test.
- Determination of sound level.
- Determination of transient voltage transfer characteristics.

Following Tests on 415 V Cubicle assembly as per relevant IEC:

- Visual & BOM Check,
- Scheme Checking,
- Insulation Resistance Test
- High Voltage Test.

The details of tests are given in Model Quality Assurance Plan of 415 V Switchgear, Auxiliary & Station Service Transformer.

15.3 Field Test

All field tests including tests during installation, pre-commissioning, commissioning 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



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General Manager (E&M Design-I)
By: UJVNL/Gen. Secy. 01/2009-10
Yamuna Corporation

in advance, at least six (6) months before start of relevant testing, for approval of the Employer.

15.3.1 Tests during installation and pre commissioning

At least following inspections/ tests shall be performed:-

15.3.1.1 Transformers

- Correct functioning of the various protection systems.
- Inspection of the insulation to earth of the various parts of the transformers.
 - Phase order checking.
 - Measurement of the winding resistance.
 - Measurement of capacitance and $\tan\delta$.
 - Ratio test.
 - Measurement of the no load current at 415 V.
 - Measurement of impedance at low voltage.
 - Calibration and setting of WTI.
 - Transformer operation at no load for 24 hours (voltage, no load current, temperature measurement and noise),
 - Final IR values between windings and winding and earth,
 - Measurement of the magnetising current at U_r ,
 - Checking of Neutral Earthing & Shorting of unused CTs.

15.3.1.2 415 V switchgear

- 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,
- Verification of component temperatures,
- 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,

Other test as suggested by the Contractor and/or the Employer at site.

16. 500 KVA SILENT DG SET (CUSTOMER SCOPE)

16.1. Type Tests

The contractor is required to carry out all type test as per relevant IEC/ International Standards on one apparatus of each type and similar rating and shall submitted the reports to the employer. The type test may not be mandatory if similar equipment has been type tested and test certificate (S) for relevant tests are accepted by employer.

16.2. Shop Tests

The DG Set Engine, Alternator & Panels shall be routine tested as per relevant IEC with latest amendments. Following shop tests shall be carried out by the manufacturer at their works:-

Test on DG Set Engine shall be performed

- Performance Test
- 12 hrs Full load Test including 10 % Overload Test for 1 hr in any 12 hrs operation
- Governing Test (Checking of Droop Characteristic)
- Fuel Consumption Test
- Power Determination Test
- Lube Oil Consumption Test
- Pressure Test on Oil Coolers
- Visual & Dimensional Check

Test on DG Set Alternator shall be performed

- Visual & Dimensional Check
- Winding Resistance of Main Stator & Rotor and Exciter Rotor & Stator
- Insulation Resistance before after HV Test of Main Stator & Rotor and Exciter Rotor & Stator
- High Voltage Test on Main Stator & Rotor and Exciter Rotor & Stator
- Short Circuit Test
- Open Circuit Test
- Phase Sequence w.r.t Direction of Rotation

HV & IR test on Panels shall be performed

Leakage Tests on Fuel Tank shall be performed



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Dy. General manager (E&M Design-I)
UJVNL Limited, G-10, Yamuna Colony,
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- **Protection Equipment:**
 - System integration & Testing for functions.
 - Supply voltage variation test.
 - Frequency measurements.
 - Guard frequency tests.
 - Trip command frequency Test.
 - Transmitter output level.
 - Receiver level.
 - Trip input & output test.
 - Transmission time.
 - Operation loop testing.
 - Unblocking.
 - Provision for integration with plant SCADA system.

The details of tests are given in Model Quality Assurance Plan of PLCC.

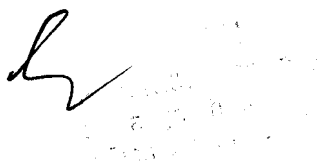
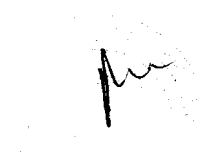
17.3 Field Test

All field tests including tests during installation, pre-commissioning, commissioning, field acceptance tests shall be conducted by the Contractor, in presence of representative of the Employer.

Procedure to be adopted for conducting the operational, pre-commissioning, commissioning, performance and field acceptance test shall submitted well in advance, at least six(6) month before start of relevant testing, for approval by the Employer.

Following test shall be performed:

- Self checking of links,
- Local loop mode,
- Change of state of relays (Issue of commands, blocking etc.),
- Transmission of command frequencies,
- DB level measurement by level oscillator cum meter.
- Comprehensive protection e.g. inter tripping / blocking tests with line protection

22 HVAC System

22.1 Type Test

The contractor is required to carry out all type tests as per relevant National / International Standards on one apparatus of each type of similar rating and shall submit the reports to the Employer. The type test may not be mandatory if similar equipment has been type tested and test certificate(s) for relevant tests are accepted by the Employer.

Type Test reports of the following items shall be submitted for acceptance with adequate details/drawings to establish equivalence with the offered type:

- Air Handling Unit including Fan / Blower & Motor,
- Air Conditioning Unit & Water Cooled Chilling Unit including Compressor, Motor, Condenser, Evaporator
- Pumps, Heat Exchanger
- Other items felt necessary during detailed engineering.

22.2 Shop Test

The equipments / components of HVAC System like Air Handling Unit including Fan / Blower & Motor, Air Conditioning Unit & Water Cooled Chilling Unit including Compressor, Motor, Condenser & Evaporator, Pumps, Damper, Copper Coil, Heat Exchanger, Instrumentation, Valves, Piping, Control Panel etc. shall be routine tested as per relevant National / International Standards with latest amendments.

Following shop Test shall be carried out by the Manufacturer at their works.

- **Test on Air Handling Unit**
 - Dynamic Balancing of Blower/Fan
 - IR & HV, Speed of Blower/Fan
 - Air Delivery on complete assembly
 - Noise Level
- **Test on Chiller Unit**
 - Pressure Test with N₂ gas on Evaporator & Condenser
 - Vacuum Test
 - RunTest / Performance Test
 - Vibration & Noise Level
- **Test on Motor**
 - IR & HV
 - No-Load Running

- Locked Rotor
- Reduced Voltage Running
- **Test on Pump**
 - Hydrostatic Test on Pump Casing
 - Dynamic Balancing on Impeller
- **Performance Test on Pump - Motor Assembly** - Measurement of Rate of Flow, Head, Power Input, Speed & Efficiency
 - NPSH
- **Test on Control Panel**
 - IR & HV
 - Functional Test
- **Test on Heat Exchanger**
 - Hydrostatic Pressure Test

The details of tests mentioned above are given in Model Quality Assurance Plan of HVAC System.

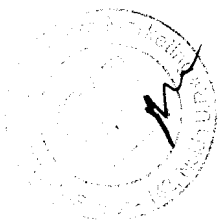
22.3 Field Test

All field tests including tests during installation, pre-commissioning, commissioning 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 six (6) months before start of relevant testing, for approval of the Employer.

The Following tests shall be conducted during commissioning:

- Dimensional check of Duct, Duct Sheet
- Functional test of louver, Damper, Thermostat/Temperature Sensor
- Pressure test or leakage test,
- Main Air Flow rate
- Performance test of AHU, Package type Air Conditioner, Chiller Unit, Pump etc
- IR & HV Test on Control Panel
- Vibration & Noise Level of AHU & Chiller Unit



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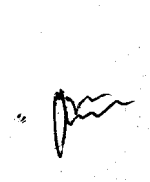
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23 **Grounding System**

Inspection & Testing Clause are not applicable for this package.

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The undersigned
has read and
understands the
contents of the
above mentioned
document and
declares that
it is true and
correct.



27. 220 kV XLPE Cable

27.1 Type Test

The contractor is required to carry out all type tests as per relevant IEC / International Standards on 220 kV XLPE Cable & its Accessories of each type of similar rating and shall submit the reports to the Employer. The type test may not be mandatory if similar equipment has been type tested and test certificates for relevant tests are accepted by the Employer.

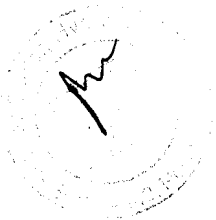
Following Type Tests shall be done:

- Bending Test
- Tan δ measurement
- Heating Cycle Voltage Test
- Partial Discharge Tests
 - o At Ambient Temperature &
 - o At High Temperature.
- Switching Impulse Voltage Test
- Lightning Impulse Voltage Test
- Test of Outer Protection for Buried Joints
- Examination of Cable System with Cable & Accessories

27.2 Shop Test

The 220 KV XLPE Cable shall be tested as per relevant IEC with latest amendments. Following Shop Tests shall be carried out by the manufacturer at their works as per IEC: 62067 as follows:-

- Partial Discharge Test
- Voltage Test
- Electrical Tests on Oversheath
- Conductor Examination (no. of strands, lay direction, lay length)
- Electrical Resistance of Conductor
- Measurement of Thickness of Insulation and Oversheath
- Measurement of Thickness of Metallic Sheath
- Measurement of Diameter of core and overall diameter of cable
- Hot Set Test for XLPE Insulation
- Measurement of Capacitance
- Water Content on XLPE insulation
- Measurement of External Diameter
- Lightning Impulse Test followed by a Power Frequency Voltage Test



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Following Shop Tests shall be carried out on Terminations by the manufacturer at their works as per IEEE Std 48:-

- Power Frequency Voltage 1 min Dry Withstand Test
- Power Frequency Voltage 6 hrs Dry Withstand Test
- Power Frequency Partial Discharge (Corona) Extinction Voltage Test
- Lightning Impulse Voltage Withstand Test
- Direct Voltage 15 min Dry Withstand Test
- Cycle aging test
- Dielectric Tests
- Partial Discharge Tests
- Pressure Leak Tests

The following FRLS Tests are to be conducted as per the referred standards:

- HCL Gas Evolution Test (IEC - 754.1),
- Oxygen Index (ASTM-D-2863),
- Temperature Index (ASTM-D-2863),
- Smoke Density Test (ASTM-D-2863),
- Flammability Test (IEC-332.1),
- Swedish Chimney Test (SS-424 14 75),
- Ladder Test (IEEE-383),
- Heat Shock Test (IS:1554) &
- Anti Rodent & Termite Test.

The Contractor shall submit the routine test report for Accessories of Cable System.

The details of tests are given in Model Quality Assurance Plan of 220 kV XLPE Cable.

27.3 Field Test

All field tests including tests during installation, pre-commissioning, commissioning 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 six (6) months before start of relevant testing, for approval of the Employer.

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:

- Cabling checking,
- Continuity checking,
- Meggar Testing in accordance with the applicable codes and standards,
- Ac Voltage Test of insulation with voltage of U_0 for 24 hours,
- DC Voltage Test of over-sheath
- Resistance checking.
- Insulation Resistance measurement,
- Verification of phase order,
- HV Test.

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QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT : Battery Charger

CLIENT: UJVNL Limited
VENDOR :
NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE ACCEPTANCE DOCUMENTS NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
						Perform	Witness	Verify	
1.	Cabinet								
a)	Metal sheet	Chem./ Phy.	100%	Tech.Spec./ Appd.drg.	TC	3/2	-	1	TC
a)	Dimensions	Measurement	-do-	-do-	TC	3/2	-	1	TC
b)	Paint shade & Finish	Visual	-do-	-do-	TC	3/2	-	1	TC
2.	Cables								
a)	Surface defects	Visual	-do-	Tech.Spec./ Appd.drg./ IS:1554	TC	3/2	-	1	TC
b)	Routine Electrical test	Electrical	-do-	-do-	TC	3/2	-	1	TC
3.	Dry Type Transformer								
	Routine Test	Electrical	-do-	Tech.Spec./ Appd.drg./ IS:11171	TC	3/2	-	1	TC
4.	Components								
	(Circuit Breakers, MCCB- AC & DC, Voltmeters, Ammeters, Contactors, Switches, Relays Alarm)								
a)	Make, Type, Rating	Visual	-do-	Tech.Spec./ Appd.drg.	TC	3/2	-	1	TC
b)	Operation/ Functional Check	Electrical	-do-	-do-	TC	3/2	-	1	TC
c)	IR & HV	-do-	-do-	-do-	TC	3/2	-	1	TC
d)	Calibration.	-do-	-do-	-do-	TC	3/2	-	1	TC

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, TC - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT : Battery Charger

CLIENT: UJVN Limited
VENDOR :
NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE ACCEPTANCE DOCUMENTS NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
						Perform	Witness	Verify	
5.	Type Test								
a)	Rated Current test	Electrical	Sample plan	Tech Spec./IEC:146 & 119	TC	3/2	-	1	TC
b)	Power loss determination for assemblies and equipments.	-do-	-do-	-do-	TC	3/2	-	1	TC
c)	Temperature rise test.	-do-	-do-	-do-	TC	3/2	-	1	TC
6.	Final Inspection								
a)	Inspection bill of material, components, marking and layout fixing, accessibility.	Visual	1/type	-do-	JIR	3/2	1	-	CHP
b)	Inspection of terminals, dimensions, location and connection of electrical circuits.	Visual	-do-	Tech.Spec./Appd.drg./IEC:439	JIR	3/2	1	-	
c)	Inspection of continuity of earth circuits and dangerous voltage protective measures.	Electrical	-do-	Tech.Spec./Appd.drg./IEC:439 & IEC:146	JIR	3/2	1	-	
d)	Check for provision of ground resistance alarm device on both poles.	Visual	-do-	-do-	JIR	3/2	1	-	

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

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Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT : Battery Charger

CLIENT: UJVNL Limited
VENDOR :
NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE ACCEPTANCE DOCUMENTS NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
						Perform	Witness	Verify	
e)	Insulation Test	-do-	1/type	-do-	JIR	3/2	1	-	CHP
f)	Light load and Functional test	-do-	-do-	-do-	JIR	3/2	1	-	
g)	Checking of Auxiliary devices.	-do-	-do-	-do-	JIR	3/2	1	-	
h)	Checking the properties of the control equipment.	Electrical	-do-	Tech.Spec./Appd.drg./ IEC:60146 & 60119	JIR	3/2	1	-	
i)	Checking the protective devices (Over voltage, under-voltage, ground fault, over current, etc.)	-do-	-do-	-do-	JIR	3/2	1	-	
j)	Protection against drooping characteristics.	-do-	-do-	-do-	JIR	3/2	1	-	
k)	Measurement of inherent voltage regulation.	-do-	-do-	-do-	JIR	3/2	1	-	
l)	Overcurrent Capability test	-do-	-do-	Tech.Spec./Appd.drg./IEC:146	JIR	3/2	1	-	
m)	Measurement of ripple voltage and current.	-do-	-do-	-do-	JIR	3/2	1	-	

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

1454

1454

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT : CONTROL & MONITORING SYSTEM

CLIENT: UJVN Limited
VENDOR :
NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
	Control & Monitoring System									
A	Bought Out Items Operator Workstation, Fixed Engineering Station, Portable Engineering Station Plant Computers, Server LAN Switches, etc.									
a)	Performance Test Certificate form Manufacturer.	Test	100%	Tech.Spec./Appd.Drg./IEC:Code		TC	3/2	-	1	TC
b)	Check of BOM.	Visual	-do-		-do-	JIR	3/2	1	-	} CHP
c)	Checking of Make, Type, & Rating.	-do-	-do-		-do-	JIR	3/2	1	-	
d)	Inspection of Power supply	Electrical	-do-		-do-	JIR	3/2	1	-	
e)	Functional Test.	Test	-do-		-do-	JIR	3/2	1	-	
2	Video Display Units									
a)	Performance Test Certificate form Manufacturer.	Test	-do-		-do-	TC	3/2	-	1	TC
b)	Checking of Make, Type, & Rating.	Visual	-do-		-do-	JIR	3/2	1	-	} CHP
c)	General Visual Inspection.	-do-	-do-		-do-	JIR	3/2	1	-	
d)	Functional Test.	Test	-do-		-do-	JIR	3/2	1	-	

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL' 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

1458

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT :CONTROL & MONITORING SYSTEM

CLIENT: UJVNL Limited
VENDOR :
NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
3	Printers									
a)	Performance Test Certificate form Manufacturer.	Test	100%	Tech.Spec./Appd.Drg./IEC:Code		TC	3/2	-	1	TC
b)	Checking of Make, Type, & Rating.	Visual	-do-	-do-		JIR	3/2	1	-	} CHP
c)	General Visual Inspection.	-do-	-do-	-do-		JIR	3/2	1	-	
d)	Functional Test	Test	-do-	-do-		JIR	3/2	1	-	
4	Key Boards									
a)	Performance Test Certificate form Manufacturer.	Test	-do-	-do-		TC	3/2	-	1	TC
b)	Checking of Make, Type, & Rating.	Visual	-do-	-do-		JIR	3/2	1	-	} CHP
c)	General Visual Inspection.	-do-	-do-	-do-		JIR	3/2	1	-	
d)	Functional Test	Test	-do-	-do-		JIR	3/2	1	-	
5	Large Screen Display									
a)	Performance Test Certificate form Manufacturer.	Test	-do-	-do-		TC	3/2	-	1	TC
b)	Checking of Make, Type, & Rating.	Visual	-do-	-do-		JIR	3/2	1	-	} CHP
c)	General Visual Inspection.	-do-	-do-	-do-		JIR	3/2	1	-	
d)	Functional Test	Test	-do-	-do-		JIR	3/2	1	-	
6	Optical Fiber Cable									
	Routine Tests	Test	100%	Tech.Spec./ Appd. Drg./ IEC:60793		TC	3-2	-	1	TC

Note: a. 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT :CONTROL & MONITORING SYSTEM

CLIENT: UJVN Limited
VENDOR :
NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
B 1	Final Inspection SCADA System Local Control Boards consisting of Unit Control Board for Generating Units, Controller for Plant Auxiliaries & Station Services System, 220 kV Switchyard Control Board, Communication / Data Transfer Control Board, Remote Operation Control Board, etc.									
a)	Check for B.O.M and Layout.	Visual	100%	Tech.Spec./ Approved Drg.	TC	3-2	-	1	TC	TC
b)	System Testing	Electrical	-do-	Tech.Spec./ Appd.Drg./ IEC Code	TC	3-2	-	1	TC	TC
i)	Verification of Power supplies to be within tolerance.									
ii)	I/O verification tests.									
iii)	Ethernet and serial communications testing.									
c)	Regulatory Tests	-do-	-do-	-do-	JIR	3/2	1	-	CHP	CHP
i)	Dielectric Strength									
ii)	Ground Leakage.									

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

1460

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT :CONTROL & MONITORING SYSTEM

CLIENT: UJVN Limited
VENDOR :
NIT/P.O. REFERENCE :

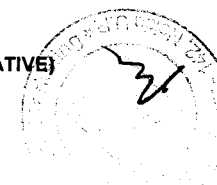
SR. NO.	ITEM /COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
d)	Hardware Acceptance Testing. (Programmable Controller, Interfacing Equipments, RTU Equipments, Data Storage System, Routers,etc.)	Testing	100%	Tech.Spec./ Appd.Org./ IEC Code		TC	3/2	-	1	TC
e)	Software Acceptance Testing.	-do-	-do-	-do-		TC	3/2	-	1	TC
f)	Factory Acceptance Test (Integrated Acceptance Testing / System checking.) (as per acceptance test plan.)	Visual / Electrical	-do-	-do-		JIR	3/2	1	-	CHP
2	Time Synchronization System consisting of Clocks, Antenna, etc.	-do-	-do-	-do-		JIR	3/2	1	-	

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

1461

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)



QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT :CONTROL & MONITORING SYSTEM

CLIENT: UJVNL Limited
VENDOR :
NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
5	VSAT Equipment									
a)	Router									
i)	Make,Type & Rating	Visual	-do-	Tech.Spec./ Appd.Org./ IEC Code		TC	3/2	-	1	TC
ii)	Functional check	Test	-do-			TC	3/2	-	1	TC
iii)	Manufacturer's Test Certificate	-do-	-do-			TC	3/2	-	1	TC
b)	RFT									
i)	Make,Type & Rating	Visual	-do-		-do-	TC	3/2	-	1	TC
ii)	Functional check	Test	-do-		-do-	TC	3/2	-	1	TC
iii)	Manufacturer's Test Certificate	-do-	-do-		-do-	TC	3/2	-	1	TC
c)	Data Card , Voice Card									
i)	Make,Type & Rating	Visual	-do-		-do-	TC	3/2	-	1	TC
ii)	Functional check	Test	-do-		-do-	TC	3/2	-	1	TC
iii)	Manufacturer's Test Certificate	-do-	-do-		-do-	TC	3/2	-	1	TC
d)	Modem									
i)	Make,Type & Rating	Visual	-do-		-do-	TC	3/2	-	1	TC
ii)	Functional check	Test	-do-		-do-	TC	3/2	-	1	TC
iii)	Manufacturer's Test Certificate	-do-	-do-		-do-	TC	3/2	-	1	TC
e)	Antenna									
i)	Make & Type	Visual	-do-		-do-	TC	3/2	-	1	TC
ii)	Functional check	Test	-do-		-do-	TC	3/2	-	1	TC
iii)	Manufacturer's Test Certificate	-do-	-do-		-do-	TC	3/2	-	1	TC

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

1462

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QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT :CONTROL & MONITORING SYSTEM

CLIENT: UJVN Limited
VENDOR :
NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
f)	Switches									
i)	Make,Type & Rating	Visual	100%	Tech.Spec./ Appd.Org./ IEC Code		TC	3/2	-	1	TC
ii)	Functional check	Test	-do-	-do-		TC	3/2	-	1	TC
iii)	Manufacturer's Test Certificate	-do-	-do-	-do-		TC	3/2	-	1	TC
l)	UPS									
i)	Make & Rating	Visual	-do-	-do-		TC	3/2	-	1	TC
ii)	Capacity Test	Electrical	-do-	-do-		TC	3/2	-	1	TC
iii)	Functional Check (Protection)	-do-	-do-	-do-		TC	3/2	-	1	TC
iv)	Battery (Make & Rating)	Visual	-do-	-do-		TC	3/2	-	1	TC
v)	Voltage Check up of UPS									
	Line to Neutral	Electrical	-do-	-do-		TC	3/2	-	1	TC
	Line to Ground	-do-	-do-	-do-		TC	3/2	-	1	TC
	Neutral to Ground	-do-	-do-	-do-		TC	3/2	-	1	TC
	Load Back-up Test	-do-	-do-	-do-		TC	3/2	-	1	TC

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.

b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report

c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT : PROTECTION SYSTEM

CLIENT: UJVN Limited
VENDOR :
NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
A	Test on Protection Panels :- (Turbine-Generator units, Generator-Transformer units, 220 kV Outdoor Switchyard, 220 kV XLPE Cables, UAT, Excitation Transformer, 220 kV Transmission Line, Synchronizing panel, etc.)									
1	Panel									
a)	Dimension & Sheet thickness	Measurement	100%	Tech.Spec./ Appd.drg/ IS & IEC		JIR	3/2	1	-	} CHP
b)	Painting (Shade, Thickness & Uniformity), Door lock, etc.	Visual	-do-	-do-		JIR	3/2	1	-	
2	Check of BOM & Component Identification. (Marking / Name plate)	-do-	-do-	-do-		JIR	3/2	1	-	
3	Layout checking & accessibility.	-do-	-do-	-do-		JIR	3/2	1	-	
4	Inspection of terminals, Electrical wiring of the Panel, Mounting, Termination ends and Continuity check.	-do-	-do-	-do-		JIR	3/2	1	-	

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'sub-supplier', 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT : PROTECTION SYSTEM

CLIENT: UJVNL Limited
VENDOR :
NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
5	Inspection of continuity of earth circuits and dangerous voltage protective measures.	Electrical	100%	Tech.Spec./Appd.drg/IS & IEC		JIR	3/2	1	-	CHP
6	Relays			Tech.Spec./Appd.drg/IEC:60255						
a)	Routine Test	-do-	-do-	BS:142 & 5992, IS:Code		TC	3/2	-	1	TC
b)	Functional Test	-do-	-do-			TC	3/2	-	1	TC
7	IR Test	-do-	-do-	Tech.Spec./Appd.drg/IS & IEC		JIR	3/2	1	-	CHP
8	HV Test (2.0 KV for 1 min.)	-do-	-do-	-do-		JIR	3/2	1	-	
9	Scheme Checking	-do-	-do-	-do-		JIR	3/2	1	-	
a)	Checking of control circuit									
b)	Checking of alarm & trip circuit.									
11	Checking of Protection Class	Visual	-do-	-do-		JIR	3/2	1	-	CHP
12	Provision for communication with SCADA via an optical fibre link.	-do-	-do-	-do-		JIR	3/2	1	-	

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT : 11 kV XLPE Cable

CLIENT: UJVNL Limited
VENDOR :
NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS/ CHRACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
A	Raw Material and Bought Out Items									
1	Aluminium Rods									
a)	Diameter	Measurement	100% Coils	Tech. Spec./ IS:5484 & 1753		TC	2/3	-	1	TC
b)	Resistivity	Electrical	Sample plan	Tech. Spec./ IS:5484		TC	2/3	-	1	TC
c)	T.S. and E.B.	Mechanical	-do-	-do-		TC	2/3	-	1	TC
d)	Chemical Composition	Chemical	-do-	Tech. Spec./ IS:1753		TC	2/3	-	1	TC
e)	Surface Finish	Visual	-do-	Tech. Spec./ IS:5484		TC	2/3	-	1	TC
2	Copper Conductor									
a)	Diameter	Measurement	100% Drum	Tech.Spec./ IS:8130,613 & 2982		TC	3/2	-	1	TC
b)	No. of Strands	Count.	-do-	-do-		TC	3/2	-	1	TC
c)	DC Resistance	Electrical	-do-	-do-		TC	3/2	-	1	TC
d)	Lay Direction	Visual	-do-	-do-		TC	3/2	-	1	TC
e)	Resistivity	Electrical	-do-	-do-		TC	3/2	-	1	TC
f)	T.S. & E.B.	Mechanical	-do-	-do-		TC	3/2	-	1	TC
g)	Chemical Composition.	Chemical	-do-	Tech.Spec./ IS:191		TC	3/2	-	1	TC
3	PVC Compound									
a)	Specific Gravity	Measurement	1Bag/Consign	Tech. Spec. & IEC:540		TC	2/3	-	1	TC
b)	T.S. & E.B. before and after Ageing	Mechanical	-do-	Tech. Spec./ IS:5831		TC	2/3	-	1	TC
c)	Loss of mass	Thermal.	-do-	-do-		TC	2/3	-	1	TC
d)	Thermal Stability	-do-	-do-	-do-		TC	2/3	-	1	TC
e)	Oxygen Index	Envi.	-do-	Tech. Spec./ IS:7098 part-1		TC	2/3	-	1	TC
f)	Temperature Index	Envi.	-do-	-do-		TC	2/3	-	1	TC

Note: a. In 'Inspection Agency' column figure 1,2, or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

1466

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT : 11 kV XLPE Cable

CLIENT: UJVN Limited
VENDOR :
NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS/ CHRACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
g)	Acid Gas Generation Test	Chemical	-do-	Tech. Spec./ IS:7098 part-1/ IEC 754-1		TC	2/3	-	1	TC
h)	Smoke Density Test	Envi.	-do-	Tech. Spec./ ASTM D2843-93		TC	2/3	-	1	TC
i)	Anti Termite & Anti Rodent Test	Chemical	-do-	Tech. Spec./ IS		TC	2/3	-	1	TC
4	Copper Tape									
a)	Dimension	Measurement	Sampling Plan	Tech. Spec./ IS		TC	2/3	-	1	TC
b)	Tensile & Elongation	Mechanical	-do-	-do-		TC	2/3	-	1	TC
c)	Resistivity	Electrical	-do-	-do-		TC	2/3	-	1	TC
d)	Surface Finish	Visual	-do-	-do-		TC	2/3	-	1	TC
e)	ID/OD of coil	Measurement	-do-	-do-		TC	2/3	-	1	TC
5	Armour Wire /Strip									
a)	T.S. & E.B.	Mechanical	-do-	Tech. Spec./ IS:3975		TC	2/3	-	1	TC
b)	Torsion	-do-	-do-	-do-		TC	2/3	-	1	TC
c)	Dip Test	-do-	-do-	-do-		TC	2/3	-	1	TC
d)	Mass of Zinc Coating	-do-	-do-	-do-		TC	2/3	-	1	TC
e)	Resistivity	Mechanical	-do-	-do-		TC	2/3	-	1	TC
f)	Dimension	Measurement	-do-	-do-		TC	2/3	-	1	TC
g)	Winding Test	Physical	Sampling Plan	-do-		TC	2/3	-	1	TC
h)	Weight of Coil	Measurement	-do-	-do-		TC	2/3	-	1	TC

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

1467

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT : 11 kV XLPE Cable

CLIENT: UJVNL Limited
VENDOR :
NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS/ CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
6	XLPE Compound									
a)	Sp. Gravity	Measurement	1 Box	Tech. Spec & IEC :540		TC	2/3	-	1	TC
b)	Tensile & Elongation before & after Ageing.	Measurement	-do-	-do-		TC	2/3	-	1	TC
c)	Volume Resistivity	Measurement	-do-	-do-		TC	2/3	-	1	TC
d)	Moisture Content Test	Thermal	-do-	-do-		TC	2/3	-	1	TC
7	Semi Conducting Compound									
	Sp. Gravity	Measurement	1 box/Consign	-do-		TC	2/3	-	1	TC
C	FINAL TEST									
1	Acceptance Test									
a)	Annealing Test (For Cu)	Mechanical	One lot/size	Tech.Spec./IS:1554, 8130,10810		JIR	2/3	1	-	CHP
b)	Tensile Test (For Al)	-do-	-do-	-do-		JIR	2/3	1	-	CHP
c)	Wrapping Test (For Al)	-do-	-do-	-do-		JIR	2/3	1	-	CHP
d)	Conductor Resistance Test	Electrical	-do-	Tech.Spec./IS:2982,10810		JIR	2/3	1	-	CHP
e)	Tests for thickness of Insulation & Sheath	Measurement	-do-	Tech.Spec./IS:1554 Part-1,10810		JIR	2/3	1	-	CHP
f)	T.S. & E.B. of Insulation & Sheath	Mechanical	-do-	-do-		JIR	2/3	1	-	CHP
g)	Hot Set Test for Insulation	-do-	-do-	Tech.Spec./IS: 7098 Part-1,10810		JIR	2/3	1	-	CHP
h)	Insulation Resistance Test	Electrical	-do-	Tech.Spec./IS:5831,10810		JIR	2/3	1	-	CHP
i)	High Voltage Test (At Room Temp.)	-do-	-do-	Tech.Spec./IS:7098 part-2,10810		JIR	2/3	1	-	CHP
j)	Partial Discharge Test (for Screened only)	-do-	-do-	Tech.Spec./IS:7098 part-2 & IEC:840,10810		JIR	2/3	1	-	CHP

Note: a. In 'Inspection Agency' column figure 1,2, or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

1468

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT : 11 kV XLPE Cable

CLIENT: UJVN Limited
VENDOR :
NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS/ CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
2	Routine Tests									
a)	Conductor Resistance Test	-do-	100%	Tech.Spec./IS:2982,10810		TC	2/3	-	1	TC
b)	High Voltage Test (At Room Temp.)	-do-	-do-	Tech.Spec./IS:7098 part-2,10810		TC	2/3	-	1	TC
c)	Partial discharge test(for Screened only)	-do-	-do-	Tech.Spec./IS:7098 part-2 & IEC-840,10810		TC	2/3	-	1	TC
3	FRLS Tests									
a)	HCL Gas Generation Test	Chem.	One lot/size	Tech.Spec./IS:7098 part-1		JIR	2/3	1	-	CHP
b)	Oxygen Index Test	Thermal	-do-	-do-		JIR	2/3	1	-	CHP
c)	Temperature Index Test	-do-	-do-	-do-		JIR	2/3	1	-	CHP
d)	Smoke Density Test	-do-	-do-	Tech.Spec./ASTM D 2843		JIR	2/3	1	-	CHP
e)	Flammability Test	Flam.	-do-	Tech.Spec./IS:1554		JIR	2/3	1	-	CHP
f)	Swedish chimney Test	-do-	-do-	Tech.Spec./SS-424 14 75		JIR	2/3	1	-	CHP
g)	Ladder Test	-do-	-do-	Tech.Spec./IEEE-383		JIR	2/3	1	-	CHP
h)	Heat Shock Test	Ther.	-do-	Tech.Spec./IS:1554 & 10810		JIR	2/3	1	-	CHP
i)	Anti Rodent & Termite Test	Chem.	-do-	Tech spec		JIR	2/3	1	-	CHP
4	Check for Embossing and Colour Coding, etc.	Visual	-do-	Tech.Spec./Appd.drg./ IS 7098 part-2		JIR	2/3	1	-	CHP
5	Packing, Marking & End Sealing									
a)	Marking on Cable Drum	Visual	Each Drum	-do-		TC	2/3	-	1	TC
b)	End Sealing	-do-	One lot/size	-do-		JIR	2/3	1	-	CHP

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

1469

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT : Cable Tray

CLIENT: UJVNL Limited
VENDOR :
NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
A	Raw Material & Bought Out Items.									
1	(MS Sheet/Channel/Angle)									
a)	Chemical composition	Chem.	Sampling Plan	Tech.Spec./ Appd.drg./IS:1079	-do-	TC	3/2	-	1	TC
b)	Physical Properties	Test	-do-	-do-	-do-	TC	3/2	-	1	TC
c)	Surface Finish	Visual	-do-	-do-	-do-	TC	3/2	-	1	TC
d)	Dimensions	Measurement	-do-	Tech.Spec./ Appd.drg./IS:1852	-do-	TC	3/2	-	1	TC
2	Fasteners and Hardware									
a)	Visual and Dimensional	Visual & Measurement	-do-	Tech.Spec./ Appd.drg./IS:1367	-do-	TC	3/2	-	1	TC
b)	Quantity of Zinc Deposit Over Threaded Portion	Measurement	-do-	-do-	-do-	TC	3/2	-	1	TC
B	In Process Inspection									
1	Galvanising									
	Galvanisation, Chemical Composition of Zinc, Surface Defects, Bath Temperature.	Chem./Visual	Sampling plan	Tech.Spec./ Appd.drg./IS:2629	-do-	TC	3/2	-	1	TC
2	Galvanised Trays									
a)	Surface Defects	Visual	Sampling Plan	-do-	-do-	TC	3/2	-	1	TC
b)	Uniformity of Zinc Coating	Test	-do-	Tech.Spec./ Appd.drg./IS:2633	-do-	TC	3/2	-	1	TC
c)	Thickness of Zinc Coating	Measurement	-do-	Tech.Spec./ Appd.drg.	-do-	TC	3/2	-	1	TC
d)	Adhesion Test	Physical	-do-	Tech.Spec./ Appd.drg./IS:2629	-do-	TC	3/2	-	1	TC
e)	Weight of Zinc Coating	Measurement	-do-	Tech.Spec./ Appd.drg./IS:6745	-do-	TC	3/2	-	1	TC
3	Dicromating	Visual	-do-	Tech.Spec./ Appd.drg.	-do-	TC	3/2	-	1	TC

Note: a. In 'Inspection Agency' column figure 1,2, or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDOR'S Q.C. DEPT. OR REPRESENTATIVE)

QUALITY ASSURANCE PLAN(MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT : Cable Tray

CLIENT: UJVNL Limited
VENDOR :
NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
C	Final Inspection									
1	Dimension/ Finish of Trays & Covers	Measurement & Visual	Sampling Plan	-do-	-do-	TC	3/2	-	1	TC
2	Load Capacity	Deflection Test	-do-	-do-	-do-	TC	3/2	-	1	TC
3	Surface defects / Black Spot	Visual	-do-	-do-	-do-	TC	3/2	-	1	TC
4	Uniformity of Zinc Coating	Test	-do-	Tech.Spec./ Appd drg./IS:2633	-do-	TC	3/2	-	1	TC
5	Weight of Zinc Coating	Measurement	-do-	Tech.Spec./ Appd drg./IS:6745	-do-	TC	3/2	-	1	TC
6	Check for Dicromating	Visual	-do-	Tech.Spec./ Appd drg./IS:2629	-do-	TC	3/2	-	1	TC
7	Thickness of Zinc Coating	Measurement	-do-	Tech.Spec./ Appd drg.	-do-	TC	3/2	-	1	TC
8	Adhesion Test	Hammer Test	-do-	Tech.Spec./ Appd drg./IS:2629	-do-	TC	3/2	-	1	TC

Note: a. In 'Inspection Agency' column figure 1,2, or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.

b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report

c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

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QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT : Power, Control & Instr. Cable

CLIENT: UJVNL Limited
VENDOR :
NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
A	Raw Material and Bought Out items									
1	Aluminium Rods									
a)	Diameter	Measurement	100% Coils	Tech. Spec./ IS:5484		TC	3/2	-	1	TC
b)	Resistivity	Electrical	Sample plan	-do-		TC	3/2	-	1	TC
c)	T.S. and E.B.	Mechanical	-do-	-do-		TC	3/2	-	1	TC
d)	Chemical Composition	Chemical	-do-	Tech. Spec./ IS:1753		TC	3/2	-	1	TC
d)	Surface Finish	Visual	-do-	Tech. Spec./ IS:5484		TC	3/2	-	1	TC
2	PVC Compound									
a)	Sp. Gravity	Measurement	1 Bag/Consgn.	Tech. Spec./ IEC:540		TC	3/2	-	1	TC
b)	T.S. & E.B. Before and After Ageing	Mechanical	-do-	Tech. Spec./ IS:5831		TC	3/2	-	1	TC
c)	Loss of Mass	Therm.	-do-	-do-		TC	3/2	-	1	TC
d)	Thermal Stability	Therm.	-do-	-do-		TC	3/2	-	1	TC
e)	Oxygen Index	Envi.	-do-	Tech. Spec./ IS:7098 part-1		TC	3/2	-	1	TC
f)	Temperature Index	Envi.	-do-	-do-		TC	3/2	-	1	TC
g)	Acid Gas Generation Test	Chem.	-do-	Tech. Spec./ IEC:754-1/ IS:7098 part-1		TC	3/2	-	1	TC
h)	Smoke density Test	Envi.	-do-	Tech. Spec./ ASTM D2843-93		TC	3/2	-	1	TC
i)	Anti Termite & Anti Rodent Test	Chem.	-do-	Tech. Spec./ IS		TC	3/2	-	1	TC

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT : Power, Control & Instr. Cable

CLIENT: UJVNL Limited
VENDOR :
NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
3	Galvanized Steel Wires & Strips.									
a)	Dimension	Measurement	Sample plan	Tech.Spec./ IS:3975 & 3979		TC	3/2	-	1	TC
b)	Resistivity	Electrical	-do-	-do-		TC	3/2	-	1	TC
c)	T.S. and E.B.	Mechanical	-do-	-do-		TC	3/2	-	1	TC
d)	Uniformity Test	-do-	-do-	-do-		TC	3/2	-	1	TC
e)	Wt.of Zinc Coating	-do-	-do-	-do-		TC	3/2	-	1	TC
f)	Torsion Test.	-do-	-do-	-do-		TC	3/2	-	1	TC
4	Copper Conductor									
a)	Diameter	Measurement	100% Drum	Tech.Spec./ IS:8130,613 & 2982		TC	3/2	-	1	TC
b)	No. of Strands	Count.	-do-	-do-		TC	3/2	-	1	TC
c)	DC Resistance	Electrical	-do-	-do-		TC	3/2	-	1	TC
d)	Lay Direction	Visual	-do-	-do-		TC	3/2	-	1	TC
e)	Resistivity	Electrical	-do-	-do-		TC	3/2	-	1	TC
f)	T.S. & E.B.	Mechanical	-do-	-do-		TC	3/2	-	1	TC
g)	Chemical Composition.	Chemical	-do-	Tech.Spec./ IS:191		TC	3/2	-	1	TC

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

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Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT : Power, Control & Instr. Cable

CLIENT: UJVNL Limited
VENDOR :
NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCERTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
B	FINAL TEST									
1	ACCEPTANCE TESTS									
a)	Annealing Test (For Cu)	Mechanical	One lot/size	Tech. Spec./ IS:8130 & 10810	JIR	2/3	1	-	-	CHP
b)	Tensile Test (For Al)	-do-	-do-	-do-	JIR	2/3	1	-	-	CHP
c)	Wrapping Test (For Al)	-do-	-do-	-do-	JIR	2/3	1	-	-	CHP
d)	T.S. & E.B. of Insulation & Sheath	-do-	-do-	Tech. Spec./ IS:5831,10810	JIR	2/3	1	-	-	CHP
e)	Test for thickness of Insulation and Sheath	-do-	-do-	Tech. Spec./ IS:1554 part-1,10810	JIR	2/3	1	-	-	CHP
f)	Conductor Resistance Test	Electrical	-do-	Tech. Spec./ IS:8130,10810	JIR	2/3	1	-	-	CHP
g)	Insulation Resistance Test	-do-	-do-	Tech. Spec./ IS:7098 part-1, IS:1554 part-1,10810	JIR	2/3	1	-	-	CHP
h)	High Voltage Test (At Room Temp.)	-do-	-do-	-do-	JIR	2/3	1	-	-	CHP
2	ROUTINE TESTS									
a)	Conductor Resistance Test	-do-	100%	Tech. Spec./ IS:8130,10810	TC	3/2	-	-	1	TC
b)	High Voltage Test (At Room (Temp.)	-do-	-do-	Tech. Spec./ IS:7098 part-1, IS:1554 part-1,10810	TC	3/2	-	-	1	TC

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

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QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT : Power, Control & Instr. Cable

CLIENT: UJVN Limited
VENDOR :
NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
3	FRLS Tests									
a)	HCL Gas Generation Test	Chem.	One lot/size	Tech.Spec./IS:7098 part-1	JIR	2/3	1	-	-	CHP
b)	Oxygen Index Test	Therm.	-do-	Tech.Spec./ASTM-D-2843/IS 7098 part-1	JIR	2/3	1	-	-	CHP
c)	Temperature Index Test	-do-	-do-	Tech.Spec./IS:7098 part-1	JIR	2/3	1	-	-	CHP
d)	Smoke Density Test	-do-	-do-	Tech.Spec./ASTM-D-2843/IS 7098 part-1	JIR	2/3	1	-	-	CHP
e)	Flammability Test	Flam.	-do-	Tech.Spec./IEC:332-1/IS 1554	JIR	2/3	1	-	-	CHP
f)	Swedish Chimney Test	-do-	-do-	Tech.Spec./SS-424 14 75	JIR	2/3	1	-	-	CHP
g)	Ladder Test	-do-	-do-	Tech.Spec./IEEE-383	JIR	2/3	1	-	-	CHP
h)	Heat Shock Test	Ther.	-do-	Tech.Spec./IS:1554 & 10810	JIR	2/3	1	-	-	CHP
i)	Anti Rodent & Termite Test	Chem.	-do-	Tech. Spec.	JIR	2/3	1	-	-	CHP
4	Check for Embossing and Colour Coding, etc.	Visual	-do-	Tech.Spec./IS:7098 part-1	JIR	2/3	1	-	-	CHP
5	Packing, Marking & End Sealing									
a)	Marking on Cable Drum	Visual	100%	Tech.Spec./IS:7098 part-1	TC	3/2	-	-	1	TC
b)	End Sealing	Visual	One lot/size	-do-	JIR	2/3	1	-	-	CHP

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT : 415 V, AC Switchgear

CLIENT: Uttarakhand Jal Vidyut Nigam Limited
VENDOR :
NIT/P.O. REFERENCE :

Sr.No.	ITEM /COMPONENTS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE ACCEPTANCE DOCUMENTS NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
						Perform	Witness	Verify	
A	Raw Material & Brought Out Items.								
1	Steel Sheets								
a)	Dimension Size of Sheet, Uniformity of Thickness, Surface Finish.)	Measurement	As per sampling plan	Tech. Spec./ Appd.drg./ IS:513	TC	2/3	-	1	TC
b)	Hardness	Mechanical	-do-	-do-	TC	2/3	-	1	TC
c)	Bend Test	-do-	-do-	-do-	TC	2/3	-	1	TC
2	Copper/ Copper Alloy flats for Bus-bars & Links.								
a)	Dimension	Measurement	-do-	Tech. Spec./ Appd.drg./ IS:613	TC	2/3	-	1	TC
b)	Bend Test	Mechanical	-do-	Tech. Spec./ Appd.drg./ IS:191	TC	2/3	-	1	TC
c)	Hardness	-do-	-do-	-do-	TC	2/3	-	1	TC
d)	Tensile Strength	-do-	-do-	Tech. Spec./ Appd.drg./ IS:1897	TC	2/3	-	1	TC
e)	Chemical Composition.	Chemical	-do-	Tech. Spec./ Appd.drg./ IS:6160	TC	2/3	-	1	TC
f)	Conductivity	Electrical	-do-	Tech. Spec./ Appd.drg.	TC	2/3	-	1	TC
3	PVC Wire								
a)	Dimension	Measurement	-do-	Tech. Spec./ Appd.drg./ IS:694	TC	2/3	-	1	TC
b)	Insulation Resistance	Electrical	-do-	-do-	TC	2/3	-	1	TC
c)	Conductor Resistance	Electrical	-do-	-do-	TC	2/3	-	1	TC
d)	Material Properties: (Annealing, TS, Thickness of Insulation & Sheath, etc.)	Mechanical	-do-	-do-	TC	2/3	-	1	TC

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT : 415 V, AC Switchgear

CLIENT: Uttarakhand Jal Vidyut Nigam Limited
VENDOR :
NIT/P.O. REFERENCE :

Sr.No.	ITEM /COMPONENTS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE ACCEPTANCE DOCUMENTS NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
						Perform	Witness	Verify	
4	Electrical Meters (Ammeter, Voltmeter, Freq. meter etc.)								
a)	Physical condition	Visual	100%	Tech. Spec./ Appd.drg./IS:1248	TC	2/3	-	1	TC
b)	Verification of Scale & Range.	Electrical	-do-	-do-	TC	2/3	-	1	TC
c)	Insulation Resistance	-do-	-do-	-do-	TC	2/3	-	1	TC
d)	High Voltage Test	-do-	-do-	-do-	TC	2/3	-	1	TC
e)	Calibration Test	Verification	-do-	-do-	TC	2/3	-	1	TC
5	Current Transformer								
a)	Make, Type & Rating	Visual	100%	Tech.Spec./Appd.drg./IEC:44	TC	3-2	-	1	TC
b)	Routine Test	Test	100%	-do-	TC	3-2	-	1	TC
6	Voltage Transformer								
a)	Make, Type & Rating	Visual	100%	Tech. Spec./Appd.drg./IEC:186	TC	3-2	-	1	TC
b)	Routine Test	Test	100%	-do-	TC	3-2	-	1	TC
7	MCCB / MCB								
a)	Make, Type & Rating	Visual	100%	Tech. Spec./Appd.drg./IS:8828	TC	3-2	-	1	TC
b)	Operational Test	Electrical	-do-	-do-	TC	3-2	-	1	TC
c)	High Voltage test	-do-	-do-	-do-	TC	3-2	-	1	TC
8	Overload Relay								
a)	Make, Type & Rating	Visual	100%	Tech. Spec./ Appd.drg./IS:8544	TC	2/3	-	1	TC
b)	Operational Test	Electrical	-do-	-do-	TC	2/3	-	1	TC
c)	High Voltage test	-do-	-do-	-do-	TC	2/3	-	1	TC

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

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QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT : 415 V, AC Switchgear

CLIENT: Uttarakhand Jal Vidyut Nigam Limited
VENDOR :
NIT/P.O. REFERENCE :

Sr.No.	ITEM /COMPONENTS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE ACCEPTANCE DOCUMENTS NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
						Perform	Witness	Verify	
9	Power & Auxillary Contactor								
a)	Make, Type & Rating	Visual	100%	Tech. Spec./ Appd.drg./IS:2959	TC	2/3	-	1	TC
b)	Operational Test	Electrical	-do-	-do-	TC	2/3	-	1	TC
c)	High Voltage test	-do-	-do-	-do-	TC	2/3	-	1	TC
10	Bimetallic Overload Relays								
a)	Make, Type & Rating	Visual	100%	Tech. Spec./ Appd.drg./IS:8544	TC	2/3	-	1	TC
b)	Operational Test	Electrical	-do-	-do-	TC	2/3	-	1	TC
c)	High Voltage test	-do-	-do-	-do-	TC	2/3	-	1	TC
11	Timers (Electronics & Electro-pneumatic & Annunciators)								
a)	Time limits	Electrical	100%	Tech. Spec./ Appd.drg./ IS Code	TC	2/3	-	1	TC
b)	Operation	-do-	-do-	-do-	TC	2/3	-	1	TC
c)	High Voltage test	-do-	-do-	-do-	TC	2/3	-	1	TC
12	Switches & Control Switches								
a)	Breakage	Visual	100%	Tech. Spec./ Appd.drg./ IS:4064 & IS:6875	TC	2/3	-	1	TC
b)	Rating	Visual	-do-	-do-	TC	2/3	-	1	TC
c)	Operation	Electrical	-do-	-do-	TC	2/3	-	1	TC
d)	HV Test	-do-	-do-	-do-	TC	2/3	-	1	TC

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.

b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report

c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P
NAME OF
EQUIPMENT : 415 V, AC Switchgear

CLIENT: Uttarakhand Jal Vidyut Nigam Limited
VENDOR :
NIT/P.O. REFERENCE :

Sr.No.	ITEM /COMPONENTS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE ACCEPTANCE DOCUMENTS NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
						Perform	Witness	Verify	
13	ACB Routine test	Electrical	100%	Tech.Spec./Appd.drg./IS:13947	TC	2/3	-	1	TC
B	Final Inspection								
1	Mechanical Checks								
a)	BOM verification	Visual	100%	Tech.Spec./Appd.drg./IEC:Code	JIR	2/3	1	-	CHP
b)	Layout checking and Accessibility	Visual	-do	-do	JIR	2/3	1	-	
c)	Dimensional checks (Sheet thickness, Paint thickness, Paint shade & overall dimension)	Measurement	-do	-do	JIR	2/3	1	-	
d)	Name plate details	Visual	-do	-do	JIR	2/3	1	-	
e)	Mechanical operation of equipments.	Mechanical	-do	-do	JIR	2/3	1	-	
2	Electrical Checks								
a)	Electrical operation of equipments.	Electrical	-do	-do	JIR	2/3	1	-	
b)	Scheme checking	-do	-do	-do	JIR	2/3	1	-	
c)	IR Test before & after HV Test	-do	-do	-do	JIR	2/3	1	-	
d)	HV Test	-do	-do	-do	JIR	2/3	1	-	

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P

CLIENT: UJVN Limited

VENDOR :

NIT/P.O. REFERENCE :

NAME OF

EQUIPMENT : Air Conditioning and Ventilation System

SR. NO.	ITEM /COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
A	Air Handling Unit									
1	Filter									
a	Dimensional Check	Test	100%	Approv. Drg. / Tech. Spec. / Relevant Std.	-do-	IR	3/2	-	1	RR
b	Eurovent Test	Test	100%		-do-	TC	3/2	-	1	TC
c	Fire Test	Test	100%		-do-	TC	3/2	-	1	TC
2	Mixing Box									
a	Material Properties	Chemical & Mechanical	Sample		-do-	TC	3/2	-	1	TC
b	Dimensional Check	Measurement	100%		-do-	IR	3/2	-	1	RR
3	Louver Damper & Motorised Damper									
a	Material Properties	Chemical & Mechanical	Sample		-do-	TC	3/2	-	1	TC
b	Galvanizing Test	Test	Sample		-do-	TC	3/2	-	1	TC
c	Dimensional Check	Measurement	100%		-do-	IR	3/2	-	1	RR
d	Functional Test	Test	100%		-do-	TC	3/2	-	1	TC
e	Routine Tests of Motor for Motorized Damper	Test	100%		-do-	TC	3/2	-	1	TC
4	Blower & Fan									
a	Type, Make & Rating	Visual	100%		-do-	TC	3/2	-	1	TC
b	Chemical Properties for Blade & Shaft	Chemical	Sample		-do-	TC	3/2	-	1	TC
c	Mech. Properties including Bend Test	Mechanical	-do-		-do-	TC	3/2	-	1	TC

Note: a. In 'Inspection Agency' column figure 1, 2, or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.

b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report

c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P

CLIENT: UJVN Limited

NAME OF

VENDOR :

EQUIPMENT : Air Conditioning and Ventilation System

NIT/P.O. REFERENCE :

SR. NO.	ITEM /COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
d	Dimensional Check	Measurement	100%	Approv. Drg. / Tech. Spec. / Relevant Std.	-do-	IR	3/2	-	1	RR
e	Dynamic Balancing of Blower impeller	Measurement	100%	-do-	-do-	TC	3/2	-	1	TC
f	Routine Tests	Test	100%	-do-	-do-	TC	3/2	-	1	TC
g	Acceptance Test with Motor	Test	100%	-do-	-do-	JIR	3/2	1	-	CHP
5	Motor for Fan & Blower									
a	Type, Make & Rating	Visual	100%	-do-	-do-	TC	3/2	-	1	TC
b	Routine Test	Test	100%	-do-	-do-	TC	3/2	-	1	TC
6	Sheet for Duct									
a	Chemical Properties	Chemical	Sample	-do-	-do-	TC	3/2	-	1	TC
b	Mechanical Properties	Mechanical	-do-	-do-	-do-	TC	3/2	-	1	TC
c	Galvanizing Test	Test	-do-	-do-	-do-	TC	3/2	-	1	TC
d	Dimensional Check	Measurement	100%	-do-	-do-	IR	3/2	-	1	RR
7	Copper Coil									
a	Thickness & Diameter	Measurement	100%	-do-	-do-	IR	3/2	-	1	RR
b	Hydrostatic Pressure Test	Test	-do-	-do-	-do-	TC	3/2	-	1	TC

Note: a. In 'Inspection Agency' column figure 1-2, or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.

b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report

c. Test certificates shall be submitted at the time of final inspection.

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Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P

CLIENT: UJVNL Limited

VENDOR :

NIT/P.O. REFERENCE :

NAME OF

EQUIPMENT : Air Conditioning and Ventilation System

SR. NO.	ITEM / COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
8	Pipes, Flanges & Valves									
a	Make, Type & Size	Visual	100%	Approv. Drg. / Tech. Spec./ Relevant Std.		TC	3/2	-	1	TC
b	Hydrostatic Test	Test	100%	-do-		TC	3/2	-	1	TC
9	Control Panel									
a	Verification of Bill of Material	Visual	100%	-do-		TC	3/2	-	1	TC
b	Functional Check	Functional	100%	-do-		TC	3/2	-	1	TC
c	IR and HV Test on Control Panel	Elect.	100%	-do-		TC	3/2	-	1	TC
10	Complete Assembly of AHU									
a	Dimensional Check	Measurement	100%	-do-		TC	3/2	-	1	TC
b	Functional Test	Test	100%	-do-		TC	3/2	-	1	TC
c	Noise Level	Test	100%	-do-		TC	3/2	-	1	TC
d	Routine Tests	Test	100%	-do-		TC	3/2	-	1	TC

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.

b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report

c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P

CLIENT: UJVNL Limited

**NAME OF
EQUIPMENT : Air Conditioning and Ventilation System**

VENDOR :

NIT/P.O. REFERENCE :

SR. NO.	ITEM / COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
B	Air Conditioning Unit(Package Type)									
1	Compressor									
a	Make, Model & Capacity	Visual	100%	Approv. Drg. / Tech. Spec./ Relevant Std.	-do-	TC	3/2	-	1	TC
b	Routine Tests	Test	100%	-do-	-do-	TC	3/2	-	1	TC
c	Performance Test of Compressor with Motor	Test	100%	-do-	-do-	TC	3/2	-	1	TC
2	Motor for Compressor									
a	Type, Make & Rating	Visual	100%	-do-	-do-	TC	3/2	-	1	TC
b	Routine Tests	Test	100%	-do-	-do-	TC	3/2	1	1	TC
3	Condensor & Evaporator									
a	Make, Model & Capacity	Visual	100%	-do-	-do-	TC	3/2	-	1	TC
b	Dimensional Check	Measurement	100%	-do-	-do-	IR	3/2	-	1	RR
c	Pressure Test	Test	100%	-do-	-do-	TC	3/2	-	1	TC
4	Instrumentation									
a	Type, Make & Rating	Visual	100%	-do-	-do-	TC	3/2	-	1	TC
b	Calibration	Test	100%	-do-	-do-	TC	3/2	-	1	TC
5	Refrigerant									
a	Type & Make	Visual	100%	-do-	-do-	TC	3/2	-	1	TC

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.

b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report

c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)



QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P

CLIENT: UJVN Limited

VENDOR :

NIT/P.O. REFERENCE :

NAME OF

EQUIPMENT : Air Conditioning and Ventilation System

SR. NO.	ITEM / COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
6	Control Panel									
a	Verification of Bill of Material	Visual	100%	Approv. Drg. / Tech. Spec./ Relevant Std.		TC	3/2	-	1	TC
b	Functional Check	Functional	100%	-do-		TC	3/2	-	1	TC
c	IR and HV Test on Control Panel	Elect.	100%	-do-		TC	3/2	-	1	TC
7	Assembly Test of Air Conditioning Unit									
a	Dimensional Check	Measurement	100%	-do-		TC	3/2	-	1	TC
b	Functional Test	Test	100%	-do-		TC	3/2	-	1	TC
c.	Routine Test	Test	100%	-do-		TC	3/2	-	1	TC
C	Water Cooled Chiller Unit									
1	Compressor									
a	Make, Model & Capacity	Visual	100%	-do-		TC	3/2	-	1	TC
b	Routine Tests	Test	100%	-do-		TC	3/2	-	1	TC
c	Performance Test of Compressor with Motor	Test	100%	-do-		TC	3/2	-	1	TC
2	Motor for Compressor									
a	Type, Make & Rating	Visual	100%	-do-		TC	3/2	-	1	TC
b	Routine Tests	Test	100%	-do-		TC	3/2	-	1	TC

Note: a. In 'Inspection Agency' column figure 1, 2, or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

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QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P

CLIENT: UJVN Limited

NAME OF

VENDOR :

EQUIPMENT : Air Conditioning and Ventilation System

NIT/P.O. REFERENCE :

SR. NO.	ITEM / COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
3	Condensor & Evaporator									
a	Make, Model & Rating	Visual	100%	Approv. Drg. / Tech. Spec. / Relevant Std.	-do-	TC	3/2	-	1	TC
b	Dimensional Check	Measurement	100%	-do-	-do-	IR	3/2	-	1	RR
c	Pressure Test	Test	100%	-do-	-do-	TC	3/2	-	1	TC
4	Water Box & Shell									
a	Dimensional Check	Measurement	100%	-do-	-do-	IR	3/2	-	1	RR
b	Hydrostatic Test	Test	100%	-do-	-do-	TC	3/2	-	1	TC
5	Pump									
a)	Mech. Strength	Mechanical	Sample	-do-	-do-	TC	3/2	-	1	TC
b)	Chemical Composition	Chemical	-do-	-do-	-do-	TC	3/2	-	1	TC
c)	Water Tightness Test - Pump Body / Casing	Test	100%	Tech. Spec / App. Drg. / IS: 8034	-do-	TC	3/2	-	1	TC
d)	Dynamic Balancing of Impeller	Test	100%	Tech. Spec / App. Drg. / IS: 11723/ ISO:1940	-do-	TC	3/2	-	1	TC
e)	Make, Model & Capacity	Visual	100%	-do-	-do-	TC	3/2	-	1	TC
f)	Routine Tests	Test	100%	-do-	-do-	TC	3/2	-	1	TC
g)	Performance Test of Pump with Motor - Measurement of Rate of Flow, Head, Power Input, Speed & Efficiency and NPSH	Test	100%	-do-	-do-	TC	3/2	-	1	TC
6	Motor for Pump									
a	Type, Make & Rating	Visual	100%	-do-	-do-	TC	3/2	-	1	TC
b	Routine Tests	Test	100%	-do-	-do-	TC	3/2	-	1	TC
7	Sheet for Duct									
a	Chemical Properties	Chemical	Sample	-do-	-do-	TC	3/2	-	1	TC
b	Mechanical Properties	Mechanical	-do-	-do-	-do-	TC	3/2	-	1	TC
c	Galvanizing Test	Test	-do-	-do-	-do-	TC	3/2	-	1	TC
d	Dimensional Check - Thickness	Measurement	100%	-do-	-do-	IR	3/2	-	1	RR

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P

CLIENT: UJVNL Limited

VENDOR :

NIT/P.O. REFERENCE :

NAME OF
EQUIPMENT : Air Conditioning and Ventilation System

SR. NO.	ITEM / COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
8	Instrumentation									
a	Type, Make & Rating	Visual	100%	Approv. Drg. & Tech. Spec./ Relevant Std.	-do-	TC	3/2	-	1	TC
b	Calibration Tests	Test	100%		-do-	TC	3/2	-	1	TC
9	Refrigerant									
a	Type & Make	Visual	100%		-do-	TC	3/2	-	1	TC
10	Pipes, Flanges & Valves									
a	Make, Type & Size	Visual	100%		-do-	TC	3/2	-	1	TC
b	Hydrostatic Test	Test	100%		-do-	TC	3/2	-	1	TC
11	Control Panel									
a	Verification of Bill of Material	Visual	100%		-do-	TC	3/2	-	1	TC
b	Functional Check	Functional	100%		-do-	TC	3/2	-	1	TC
c	IR and HV Test on Control Panel	Elect.	100%		-do-	TC	3/2	-	1	TC
12	Assembly Test of Water Cooled Chiller Unit									
a	Dimensional Check	Measurement	100%		-do-	TC	3/2	-	1	TC
b	Performance Test	Test	100%		-do-	JIR	3/2	1	-	CHP
c	Routine Test	Test	100%		-do-	TC	3/2	-	1	TC

Note: a. In 'Inspection Agency' column figure 1,2 or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.
b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report
c. Test certificates shall be submitted at the time of final inspection.

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)

QUALITY ASSURANCE PLAN (MODEL)

PROJECT : Vyasi H.E.P

CLIENT: UJVN Limited

NAME OF

VENDOR :

EQUIPMENT : Air Conditioning and Ventilation System

NIT/P.O. REFERENCE :

SR. NO.	ITEM / COMPONENTS & CHARACTERISTICS	NATURE OF CHECKS	QUANTUM OF CHECKS	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD FORMAT	INSP. AGENCY			REMARKS
							Perform	Witness	Verify	
C 1	Heat Exchanger Make, Model & Rating	Visual	100%	Approv. Drg. / Tech. Spec./ Relevant Std.		TC	3/2	-	1	TC
2	Heat Transfer Plate									
a	Chemical composition	Chemical	Sample	-do-		TC	3/2	-	1	TC
b	Mech. Properties	Mechanical	Sample	-do-		TC	3/2	-	1	TC
3	Main Body (Compression & End Plate and Tie Rod & Nut)									
a	Chemical composition	Chemical	Sample	-do-		TC	3/2	-	1	TC
b	Mech. Properties	Mechanical	Sample	-do-		TC	3/2	-	1	TC
4	Gasket									
a	Material Properties	Chemical & Mechanical	Sample	-do-		TC	3/2	-	1	TC
b	Hardness	Test	Sample	-do-		TC	3/2	-	1	TC
c	Thickness	Test	100%	-do-		TC	3/2	-	1	TC
5	Assembly of Heat Exchanger									
a	Hydrostatic Test	Test	100%	-do-		TC	3/2	-	1	TC
b	Dimensional Check	Measurement	100%	-do-		TC	3/2	-	1	TC
D	Painting & Preservation	Visual & Measurement	100%	-do-		TC	3/2	-	1	TC

Note: a. In 'Inspection Agency' column figure 1,2,or 3 to be filled. 1- will indicate 'UJVNL', 2- will indicate 'supplier' & 3- will indicate 'sub-supplier'.

b. In 'Remarks' column following abbreviations shall be used - RR-Review of Records, T.C. - Test Certificate Submission, CHP - Customer Hold Point & JIR - Joint Inspection Report

c. Test certificates shall be submitted at the time of final inspection.

1525

Signature
UJVNL

Signature & Seal
(VENDORS Q.C. DEPT. OR REPRESENTATIVE)



TECHNICAL SPECIFICATION
2X60 MW VYASI
HVAC SYSTEM

SPECIFICATION No: PE-TS-571-11000-A001

VOLUME II B

SECTION C2-E

REV. 00

DATE: SEPTEMBER 2015

SECTION: C2-E
PAINTING SPECIFICATION

0477

2 X 60 MW Vyasi HEP
Tender Notice No.: UJVNL/Vyasi/ E&M

Section VIII
General Technical Specifications (GTS)

Annexure - I

PAINTING SYSTEM					
Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in μm	Remarks
A	Internal surfaces of steel linings, penstock, turbine spiral casing, valves and other wetted internal ferrous surfaces		<u>Intermediate Coat:</u> 2 x micaceous iron oxide paint, 2-component Base: epoxy resin	2 x 100	This paint system is for temperatures up to 120°C
			<u>Finish Coat :</u> 1 x topcoat, 2-component Base : epoxy resin	1 x 100	The colours of intermediate and finish coats shall be black - brown - black
			Total	300	

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870478

2 X 60 MW Vyasi HEP
Tender Notice No.: UJVNL/Vyasi/ E&M

Section VIII
General Technical Specifications (GTS)

PAINTING SYSTEM					
Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in μm	Remarks
B	External surfaces of penstocks, Gantries, Cranes, Lifting Beams, Fixed Hoist supports and other Drive Supports	Sa 2 1/2 - 3	Prime Coat: 1 x zinc dust primer, 2-component Base: epoxy resin	1 x 50	The pure metallic zinc shall be at least 92% of the polymerized film
			Intermediate Coat: 2 x micaceous iron oxide paint, 2-component Base: epoxy resin	2 x 80	This paint system is for temperatures up to 60°C
			Finish Coat : 1 x micaceous iron oxide paint, coloured, 2-component Base : epoxy resin	1 x 80	
			Total	290	

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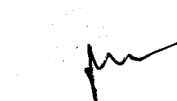
8479

2 X 60 MW Vyasi HEP
Tender Notice No.: UJVNL/Vyasi/ E&M

Section VIII
General Technical Specifications (GTS)

PAINTING SYSTEM					
Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in μm	Remarks
C	External surfaces of indoor ferrous parts such as valves, connection pipes, oil carrying tanks and pipes, supporting structures, gantries, etc.	Sa 2 1/2 - 3	Prime coat : 1 x zinc dust primer, 2-component Base: epoxy resin	1 x 50	The pure metallic zinc shall be at least 92% of the polymerized film
			Intermediate Coat: 2 x micaceous iron oxide paint, 2-component Base : epoxy resin	2 x 80	This paint system is for temperatures up to 120°C
			Finish Coat : 1 x topcoat, 2-component Base : epoxy resin	1 x 50	
			Total	260	


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VIII - 105

PAINTING SYSTEM					
Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in μm	Remarks
D	Control cabinets, panels, cubicles, electric motors.	Sa 3 and de-grease before painting	Prime Coat: 2 x zinc chromate primer, 2-component Base: epoxy resin	2 x 40	
			Finish Coat: 2 x topcoat, 2-component Base : epoxy resin	2 x 50	
			Total	180	

PAINTING SYSTEM					
Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in m	Remarks
E	Interior surfaces of oil tanks	Sa 2 1/2 - 3	2 x thixo trop consistent paint Base : epoxy resin	2 x 220	
			Total	440	

PAINTING SYSTEM					
Type	Description	Surface Preparation	Paint System	Main Dry Film Thickness in μm	Remarks
F	Frames, cover plates, pipes and tubes, and miscellaneous steel parts not especially mentioned	Hot-dip-galvanised as specified in Section 4.12.8.3 and de-grease before painting	<u>Intermediate Coat</u> : 1 x micaceous iron oxide paint, 2- components Base : epoxy resin	1 x 80	All the parts inaccessible for painting shall be only hot-dip galvanised
			<u>Finish Coat</u> 1 x topcoat, 2- component Base: epoxy resin	1 x 50	
			Total, incl. zinc	200	



TECHNICAL SPECIFICATION
2X60 MW VYASI
HVAC SYSTEM

SPECIFICATION No: PE-TS-407-571-1100-A001

VOLUME II B

SECTION C3

REV. 00

DATE: SEPTEMBER 2015

SECTION: C3

ELECTRICAL SPECIFICATION

**ELECTRICAL EQUIPMENT SPECIFICATION
FOR
HVAC**

2 x 60 MW VYASI HEP

SPECIFICATION NO.

VOLUME NO. : **II-B**

SECTION : **C**

REV NO. : **00** DATE : 29.05.15

SHEET : 1 OF 3

**TECHNICAL SPECIFICATION
FOR
HVAC
(ELECTRICAL PORTION)**

	ELECTRICAL EQUIPMENT SPECIFICATION FOR HVAC 2 x 60 MW VYASI HEP	SPECIFICATION NO.
		VOLUME NO. : II-B
		SECTION : C
		REV NO. : 00 DATE : 29.05.15
		SHEET : 2 OF 3

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**

2 x 60 MW VYASI HEP

SPECIFICATION NO.

VOLUME NO. : **II-B**

SECTION : **C**

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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.~~

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

PROJECT: HEATING, VENTILATION & AIR CONDITIONING SYSTEM

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	Vendor	Vendor	1. 415 V AC/240 V AC supply shall be provided by Vendor
2	Local Push Button Station (for motors)	Vendor	Vendor	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in vendor's scope b) one end equipment in vendor's scope	Vendor Vendor	Vendor Vendor	1. Finalisation of cable sizes shall be done by Vendor meeting specification requirements. Vendor shall provide lugs & glands accordingly. 2. Laying of cables by Vendor. 3. Termination at equipment terminals by Vendor.
4	Any special type of cable like compensating, co-axial, prefab, MICC, fibre optical etc.	Vendor	Vendor	
5	Cable trays, accessories & cable trays supporting system	Vendor	Vendor	
6	Cable glands and lugs for equipments supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power cables 3. Solder less crimping type heavy duty copper lugs for control cables.
7	Conduit and conduit accessories for cabling between equipments supplied by vendor	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537. Makes of conduits shall be subject to customer approval at contract stage.
8	Lighting	BHEL	BHEL	
9	Equipment grounding & lightning protection	Vendor	Vendor	
10	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer approval at contract stage.
11	Mandatory spares	Vendor	-	Vendor to quote as per specification.
12	Recommended O & M spares, E & C spares, erection & maintenance tools & tackle.	Vendor	-	As per specification
13	Any other equipment/material/service required for completeness of system but not specified above (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
15	a) Input cable schedules (C & I) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing & cable routing for C & I systems for vendor supplied equipment shall be furnished during detail engineering by vendor in soft copies.

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

6.3 Colour Code

In general, the colour code for electrical Works shall be as described in the Particular Technical Specifications.

The manufacturer's painting systems shall be used to the maximum possible extent, but shall by all means be subject to the approval of the Engineer. Final coats of paint shall be matching adjacent installations, where required.

6.4 Electric Motors

6.4.1 General

All motors shall be of approved manufacture and shall comply with the requirements of this Chapter. Motors of the same type and size shall be fully interchangeable and shall comply - as far as applicable - to IEC standard motor dimensions.

The general construction shall be stiff and rigid; no light metal alloy casings will be accepted. All precautions shall be taken to avoid any type of corrosion.

All motors shall be fitted with approved types of lifting hooks or eyebolts as suitable.

AC motors shall have squirrel cage type rotors.

Motor Voltages and Power Ratings

The service voltages and corresponding power ratings for electric motors to be used in the Project shall be as follows:

- Motors up to 100 kW
- Service voltage : 3-phase a.c. 415/240 V, 50 HZ
- Mode of starting : direct-on-line up to 50 kW

Above 50 kW with suitable starters

- Motors up to 0.75 kW
- Service voltage : single-phase a.c. 240 V, 50 HZ
- Mode of starting : condenser
- Motors intended to work on the d.c. System
- Service voltage : 220 V D.C.
- Mode of starting : resistor

6.4.2 Rating

The rating of the motors shall be adequate to meet the requirements of its associated equipment. The service factor, being the ratio of the installed motor output to the required power at the shaft of the driven

machine at its expected maximum power demand, shall be applied as follows:

Power Demand of Driven Machine	Service Factor
Up to 5 kW	1.2
More than 5 kW	1.1

A.C. motors shall be capable of operating continuously under rated output conditions at any frequency between 95% and 105% of the rated frequency and/or with any voltage variation between 90% and 110% of the nominal voltage. A transient over voltage of 130% of the nominal voltage shall as well be sustained.

Further, the motors shall be capable of maintaining stable operation when running at 70% nominal voltage for a period of 10 seconds. The pullout torque for continuously loaded motors shall be at least 160% of the rated torque and for intermittently loaded motors 200% of the rated torque.

D.C. motors shall be capable of operating continuously under rated output conditions at any voltage between 90% and 110% of the nominal voltage with a fixed brush setting for all loads. Unless otherwise approved, the speed drop between no-load and full-load shall not exceed 10% of no-load speed.

6.4.3 Starting

A.C. motors shall be designed for direct on-line starting. They shall be capable of being switched on without damage to an infinite bus bar at 110% of the nominal voltage with an inherent residual voltage of 100% even in phase opposition. For starting the motors from the individual main and auxiliary bus bars, a momentary voltage drop of 20% referred to nominal voltage should be taken into consideration. With 85% of the nominal voltage applied to the motor terminals, each motor shall be capable of accelerating its associated load to full speed with a minimum accelerating torque of 5% of full load torque.

The maximum starting currents (without any tolerance) shall not exceed the following values: -

- - 5 times of rated current for low voltage motors rated 100 kW or above
- - 2 times of rated current for D.C. motors (by means of starting resistors)

Generally, all motors shall be able to withstand three cold starts per hour, equally spaced. In addition, each medium voltage motor shall be capable of enduring two successive starts with the motor initially at operating temperature. Each low voltage motor shall be capable of withstanding three successive starts under the same conditions or once every twenty minutes without detrimental heating.

Motors for frequent automatic starting shall have an adequate rating. In the motor list the Contractor shall state the frequency of starts permitted in compliance with the motor design.

6.4.4 Windings and Insulation Class

The insulation of all motors shall be of class F but will not exceed the temperature limits of class B materials in operation. It shall be suitable for operation in damp locations, for occasional contact with corrosive gases and vapours and for considerable fluctuations in temperature.

The stator winding shall be suitably braced to withstand the forces due to direct-on-line starting and transfer conditions as mentioned before. The winding envelopment and tails shall be non-hygroscopic. The stator winding shall withstand the maximum fault current for the period determined by the associated protective devices.

The rotor winding (if applicable) shall be designed to give trouble-free continuous service including repeated direct-on-line starting. The rotor shall be subjected to a 120% over speed test for 2 minutes without showing any winding dislocation.

6.4.5 Ventilation and Type of Enclosure

All motors shall be of the totally enclosed fan-cooled type, protection class IP 54 according to IEC Recommendation 144. Cable termination points shall be of class IP55.

They shall have a closed internal cooling air circuit re-cooled by an external cooling air circuit drawn from the opposite side of the driving end.

Where motors are installed outdoors, a weatherproof design shall be chosen. L.V. motors of IEC size 132 and above shall be equipped with automatically controlled heating elements for protection against internal condensation of moisture during standstill periods. Such A.C. heater shall be suitably fixed inside the motor casing; the leads shall be led to a separate L.V. terminal box.

Motors installed outdoors and directly subjected to solar radiation shall be rated such as not to exceed a maximum metal temperature of 85°C. Where necessary, such motors shall be provided with sun shields.

Vertical motors shall be provided with a top cover to prevent the ingress of dirt, etc.

6.4.6 Bearings

As far as possible, the motors shall have sealed ball or roller bearings. All motors with ratings of about 1 kW and above shall be equipped with lubricators permitting greasing while the motor is running and for

preventing over-lubrication. Additionally, the bearings shall be fitted with grease nipples permitting the use of a universal grease gun.

Vertical motors shall have approved thrust bearings.

Where sleeve bearings are being used, they shall be of the self or forced lubricating type. If forced lubrication is required, it shall be arranged common to both the motor and the driven machine and provisions shall be made to ensure lubrication during start-up and shutdown operations without the necessity to start an auxiliary lube oil pump. Self-lubricated bearings shall be equipped with an easily accessible oil reservoir with overflow pipe and oil collecting vessel.

All bearings shall be easily controllable during operation or standstill without dismantling the bearings. The bearings shall further be protected and sealed against dust penetration and oil leakage.

In case of independent bearings, motor and bearing pedestals shall be fitted on a common base plate.

For the transport of motors equipped with ball or roller bearings, special bearing inserts shall be provided to prevent transport damage.

6.4.7 Shafts and Couplings

The motors shall be provided with a free shaft extension of cylindrical shape with key and keyway according to IEC Recommendation 72-1 and with the motor side coupling, which shall be pressed on the motor shaft and be balanced together with it. A coupling guard shall be provided.

6.4.8 Brush gear and Commutators

Brush gear for D.C. motors shall be designed to ensure constant brush pressure. Carbon brushes shall be provided which stand at least 6 months of operation without replacement. Each brush shall be independently adjustable but should not require adjustment throughout its life. A design of brush gear which permits the brush holder to touch the commutator as the brushes wear or which passes current through the pressure fingers will not be accepted.

A sufficient number of brushes, not less than two per pole, shall be fitted to ensure that vibrations do not affect the commutation.

The minimum safe wearing margin of commutators shall not be less than 20 (twenty) per cent of the total thickness of the commutator bars and the minimum safe diameter shall be clearly marked on it.

6.4.9 Terminal Boxes and Earthing

The terminal leads, terminals, terminal boxes and associated equipment shall be suitable for terminating the respective type of cables as specified in these General Technical Specifications and in the Particular Technical Specifications.

The terminal boxes shall be of ample size to enable connections to be made in a satisfactory manner. Supports shall be provided at terminal boxes as required for proper guidance and fixing of the incoming cable.

The terminal boxes with the cables installed shall be suitable for connection to supply systems with the short-circuit current and the fault clearance time determined by the motor protective devices.

A permanently attached connection diagram shall be mounted inside the terminal box cover. If motors are provided for only one direction of rotation, this shall be clearly indicated.

Terminal boxes shall be totally enclosed and designed to prevent the ingress of moisture and dust. All joints shall be flanged with gaskets of neoprene or similar material. For motors above 1 kW, the terminal box shall be sealed from the internal air circuit of the motor.

Depending on the size, the terminal box of L.V. motors shall be fitted either with an approved cable sealing-end or with a gland plate drilled as required and provided with suitable fittings for cable fixing and sealing. Such openings shall be temporarily plugged or sealed during transportation.

For earthing purposes, each motor shall have adequately sized bolts with washers at the lower part of the frame. In addition, each terminal box shall contain one earthing screw. Each equipment/panel shall be earthed by at least two separate earthing strips.

The cable termination philosophy to be adopted shall be such that extensive grouping of signals by a large scale use of field-mounted group. Junction boxes at strategic locations (where large concentration of signals are available, e.g. switchgear) is done. Termination / Junction boxes shall have either maxi- terminal or cage clamp type terminals

6.4.10 Noise-Level and Vibrations

Under all operating conditions, the noise level of motors shall not exceed 85 dB (A).

In order to prevent undue and harmful vibrations, all motors shall be statically and dynamically balanced.

Vibration displacements or velocity shall be measured in accordance with DIN 45 665 for IEC motor sizes 80 to 315. The results for all motors shall be within the "R" (reduced) limits.

6.4.11 Tests

Each motor shall be factory tested and shall undergo a test at site. The following tests shall be performed under full responsibility of the Contractor.

- Workshop Tests:
 - Measurement of winding resistances
 - No-load and short-circuit measurements
 - Measurement of starting current and torque
 - Efficiency measurement (type test)
 - Heat test run
 - Dielectric test
 - Measurement of insulating resistance
 - Over speed test
- Site Tests:
 - Measurement of insulation resistance
 - Measurement of motor vibrations
 - Measurement of starting time.

6.5 M.V. and L.V. Switchgear, Cubicles and Panels

6.5.1 Starters and contactors

Motor starters and contactors shall be equipped with short circuit protection and local disconnecting devices. Preferably, all starters shall be from one manufacturer. The control circuit voltage shall be obtained from a 415/240 V isolating transformer with primary circuit breaker and secondary fuse. The secondary winding of this transformer shall be grounded. The operating coils of the contactor shall be connected between the grounded side of the transformer and the control contacts.

Starters and contactors shall comply with IEC 292.1 or NEMA IC 1 and be suitable for direct on-line starting, uninterrupted electrical duty, and capable of 30 operations per hour. They shall be installed in ventilated enclosures for indoor installation and weatherproof enclosures for outdoor installation, unless otherwise approved by the Engineer. The enclosures shall be complete with locks, cable sealing boxes, conduit entries, cable gland plates, bus bars, internal wiring, terminal boards, etc. as required by the duty of the starter or contactor.

Starters and contactors shall be of minimum size compatible with motor size and capable of satisfactory operation, without damage, for a period of 5 minutes at a voltage 25 percent below nominal, at nominal frequency.

15. ~~11 KV AND 415 V SWITCHGEAR, AUXILIARY AND STATION TRANSFORMERS~~

15.1. Scope of Work

Scope of work under this section covers the provision of labour , tools , plants, material and performance of work necessary for the detailed design and engineering, manufacture, quality assurance, quality control, shop assembly, shop testing, transportation, delivery at site, site storage and preservation, erection, testing and commissioning, performance testing, field acceptance testing, training of the Employers personnel, handing over to the Employer and guarantee for two years,

the 415 V switchgear complete with all accessories including supporting structures and cubicles for making the equipment complete and for warranting a trouble free safe operation.

15.1.1. Detailed Scope of Supply

draw out type MCCBs, instrument transformers, instruments, cabling, wiring, and other accessories.

- All cabling and interconnections for making the system functional.
- Other items not specified above but all necessary for satisfactory operation of the system and as decided during detailed engineering.
- All special devices, tools, maintenance equipment etc., required for installation, testing commissioning and maintenance of the transformers and the distribution systems.
- Spares.

15.2. Special Design and Layout Conditions

15.2.1. General

Each unit auxiliary board will normally be supplied by one 500 KVA unit auxiliary transformer. Each station service board will be supplied by one 1000 KVA station service transformer. Valve house board will be supplied by one 250 KVA 11kV/415V valve house transformer. 11 kV supply to valve house transformer shall be supplied from 11 kV bus-bar of power house. In the case of a total outage of the grid supply, the diesel engine will be started automatically and power automatically switched to the power house through 415V station service switchgear. However, it is the responsibility of the Contractor to complete the work in all respect and to make the scheme functional.

The interconnection between transformers and the switchgear assembly shall be made by cables.

The switchgear system is solidly grounded, four wires (3 phases + neutral), according to IEC Publication 60364-3.

15.2.2. Standards

Unless otherwise stated hereafter, ratings, characteristics, tests and test procedures, etc. concerning to equipment under this section shall comply with the provisions and requirements of the latest approved recommendations of the International Electro-technical Commission (IEC), each as they apply.

15.3. Basic Dimensions and Ratings

Unless otherwise agreed upon the rating, insulation levels and test voltages of equipment and devices in the system shall be as follows:

15.3.2. Switch Gear

Nominal voltage	415 V
Rated frequency	50 Hz
Rated power frequency withstand voltage 60 s for main circuits	2500V
Rated power frequency withstand voltage 60 s for control circuits	2000V

15.3.2.1. UAB/SSB/Valve House Board

Rated current of bus bars of UAB	1000 A
Rated current of bus bars of SSB	1600 A
Rated current of bus bars of Valve House Board	400 A
Rated short time withstand current bus bar and boards, 1 s (UAB, SSB)	40 kA
Rated circuit breaker short circuit breaking capacity (UAB, SSB)	40 kA
Rated short time withstand current bus bar and boards, 1 s (Valve house Board)	25 kA
Rated circuit breaker short circuit breaking capacity	25 kA

15.3.3. Current Ratings and Short Circuit Capabilities

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 unfavourable service conditions.

15.4. Performance Criteria and Guarantee

The equipment covered under this section shall be suitable for conditions mentioned in general technical conditions and Contractor shall be required to fill complete data in guaranteed technical particulars and shall guarantee to supply the equipments as per guaranteed technical particulars. The fixed losses and load losses of the transformers shall be as low as possible and shall be consistent with the modern design practices and techniques, reliability and economical use of material. Limit on losses shall be as per IEC/IS. Penalty if any due to high iron losses and copper losses in excess to guaranteed losses shall be imposed as follows:

Iron losses

UAT Rs. 3,00,000 / kW
SST Rs. 3,00,000 / kW

Copper losses

UAT Rs. 1,00,000 / kW
SST Rs. 1,00,000 / kW

15.5. Design and Construction

15.5.1. UABs, SSBs and Valve House Board

15.5.1.1. General

The 415 V UABs, SSBs and valve house board switchgear shall be metal enclosed indoor cubicles free floor standing type.

The cubicle assemblies shall be designed in accordance with the recommendations of IEC Publication 60439-1 with protection class IP 40 according to IEC Publication 60529. The assemblies must be built to suit the equipment shown on the single line diagram. 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. Provision for future expansion of cubicles shall be made in end cubicles.

Continuous lifting angle or lifting hooks shall be provided to facilitate the installation of the cubicles.

15.5.1.2. Compartments

Each cubicle shall be divided into sections, or compartments, housing the incoming, interconnecting or out going feeder air circuit breaker units and moulded case circuit breaker units respectively.

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.

15.5.1.3. Cable Compartments

All feeders to and from the cubicle assemblies will be cables. 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.

15.5.1.3. 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 nameplate placed near the top edge.

15.5.1.5. Wiring

All secondary and control wiring shall be done with stranded copper wires, of size 1.5mm², with voltage rating 1.1 kV, except that current transformer secondary leads shall not be less than 2.5 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. The terminal blocks shall be according to IEC Publication 60947-7-1.

All spare compartments shall be completely wired. All terminals and terminal blocks shall be marked according to an approved system. Terminal blocks shall have approximately 10% extra terminals as spare and for future circuits.

15.5.1.6. Bus Bars

The bus bars of UABs and SSBs and valve house board shall have a continuous current carrying capacity of minimum 800A, 1600 A, 400 A respectively. Bus bar conductors shall be made of copper. All connections shall be in accordance with the best modern practice.

A continuous PEN bus of the same cross section as the main bus shall be furnished and connection of ample size shall be brought to each feeder compartment, for bolted connection of the feeder PEN wire.

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 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.

15.5.1.7. Instruments

Control switches and instruments shall be mounted on the circuit breaker compartment doors / front side of the panel.

15.5.2. Air Circuit Breakers

15.5.2.1. General

The Contractor shall provide air circuit breakers in accordance with Schedule of equipment of this specification, and the single line diagrams. The air circuit breakers shall be designed in accordance with the recommendations of IEC Publications 60947.1 and 60947.2. All circuit breakers shall be of the draw out type, housed in individual metal-enclosed compartments. Each air circuit breaker shall be mounted on a carriage assembly with wheels running on tracks secured to the inside of the compartment. The carriage shall have self-engaging definite position stops for disconnected, test and connected position. Means shall be provided for easy removal and handling of the breakers.

The air circuit breakers shall be three pole electrically operated with motor driven stored-energy operating mechanism. The motor for operating the spring loading device shall be for 220 V D.C. supply. The closing and tripping coils shall be for 220 V DC. The closing mechanism shall be trip-free and wired so that "pumping" is not possible. Manual charging and operation of the breakers shall be possible. The provision for remote indication and operation shall be made.

The operating handle shall be located so that the air circuit breakers can be operated without opening the compartment door.

A mechanical interlock shall prevent moving of the air circuit breaker from the connected position, while the breaker is closed, and prevent

the access door being opened unless the circuit breaker is in test or withdrawn position.

The frame of the air circuit breakers shall be solidly grounded in both test and connected positions. In the test position, it shall be possible to operate the breaker and perform complete functional tests.

The air circuit breaker shall be equipped with shutters, which automatically cover live parts when the breaker is withdrawn. Provision shall be made for padlocking the circuit breaker in the disconnected and test position.

15.5.2.2. Contacts

The main circuit breaker contacts shall be of the self-cleaning type, made from an arc resisting material and provided with auxiliary arcing contacts as a protection against burning during the operation of the breaker. All contacts shall be self-aligning, and shall be readily replaceable.

Main and secondary disconnecting contacts shall be silver plated with springs, which will ensure high-pressure contacts. Secondary contacts shall be engaged both in connected and test position.

Auxiliary contacts for position indication, control, interlocks, etc., showing whether the breaker is in open, closed or tripped position and whether the operating spring is locked, shall be provided and wired to terminals. Mechanical position indicators, visible from the outside without opening the circuit breaker compartment door, shall also be provided. At least 2 NO and 2 NC auxiliary contacts shall be provided for each breaker as spares.

15.5.2.3. Protection

The air circuit breakers shall be equipped with adjustable magnetic short circuit over current and instantaneous trip mechanism/ relay, with auxiliary magnetic short circuit contacts for indication of tripped condition. The protection equipment shall be interchangeable.

15.5.3. Moulded Case Circuit Breakers

15.5.3.1. General

The Contractor shall provide MCCBs in accordance with Schedule of equipment of this specification. The MCCBs shall be designed in accordance with the IEC Publications 60947.1 and 60947.2. All MCCBs shall be manually operated and shunt trip type.

All MCCB shall be of the draw out type, housed in individual metal-enclosed compartments. Each MCCB shall be mounted on a carriage assembly with wheels running on tracks secured to the inside of the compartment. The carriage shall have self-engaging definite position stops for disconnected and connected position. Means shall be

provided for easy removal and handling of the units. ON, OFF TRIP position of MCCBs should be indicated.

A mechanical interlock shall prevent moving of the MCCB from the connected position, while the breaker is closed, and prevent the access door being opened unless the breaker is in withdrawn position.

15.5.3.2. Contacts

The MCCB contacts shall be of the self-cleaning type, made from an approved arc resisting material. All contacts shall be self-aligning, and shall be readily replaceable.

Main and secondary disconnecting contacts shall be silver plated, with spring, which will ensure high-pressure contact. Secondary contacts shall be engaged both in connected and test position.

15.5.4. Instrument Transformers

15.5.4.1. Current Transformers

The Contractor shall provide single-phase current transformers manufactured in accordance with IEC Publication 60044-1

The ratings for CTs of UAB's, SSB's, VHB of air circuit breakers shall be in accordance with following technical requirements:

UAB:

Primary current	800 A
Secondary current	5 A
Protection cores: Accuracy class	0.5
Over current and E/F	5P20
UAT REF	PS
Measuring core: Accuracy class	0.2

SSB:

Primary current	1600 A
Secondary current	5 A
Protection cores: Accuracy class	0.5
Over current and E/F	5 P20
SST REF	PS

Measuring core: Accuracy class 0.2

Valve House Board:

Primary current 400 A

Secondary current 5 A

Protection cores: Accuracy class 0.5

-Over current and E/F 5 P20

Measuring core: Accuracy class 0.2

Other air circuit breakers connected to UAB and SSB shall have single core CTs of suitable rating (based on capacity of breaker) for protection of 5P20 class.

15.5.5. Control Description

15.5.5.1. General

Each air circuit breaker shall be equipped with facilities for remote operation. Each air circuit breaker unit shall be equipped with a manual/auto selection switch, local start-stop push button and an indicator showing the position of the breaker in the control room. The air circuit breaker shall be operable with the breaker in test position. Auxiliary contactors with an alarm contact for remote indication of tripped condition shall be provided for protection of the control circuits.

Auxiliary contacts for the following remote indications of the circuit breakers shall be wired to terminal blocks:

- Main contact position
- Test and connected /service position.
- Trip condition
- Fault condition
- Spring charging condition

MCCBs shall be operable by means of push button switches/ handle.

The LT switchgear shall be compatible with station SCADA, regarding input and output needed for operation, control and monitoring of LT switchgear and SCADA. The LT switchgear Contractor shall comply with provisions of 'Control and Monitoring scheme of the power house.

15.5.5.2. Metering

All instruments, relays and control switches mounted in the switchgear shall be in accordance with chapter "Control and Monitoring" and "Protection system". Instruments shall be furnished with all necessary resistors, shunts etc.

Each incoming feeder containing current transformers and voltage transformer shall have energy meter, ampere meters and ammeter selector switches, voltmeters and voltmeter switches located in the respective feeder compartment doors.

All metering circuits shall be terminated in terminal blocks for remote metering purposes.

15.5.5.3. Interlocks

The breakers connecting the UAB's to the unit auxiliary transformers shall be interlocked mutually in order to prevent paralleling of the supply during normal operation. Interlocking scheme to prevent parallel operation of UAT supply to SST supply and DG set supply shall also provided by Contractor In case of sustained voltage drop at the UABs, an automatic changeover to the other Station service boards shall be provided.

15.5.6. Schedule of Equipment

The UAT, SST, Valve house transformer, 11 KV and 415 V switchgear system shall contain the following major equipment including the necessary bus bars and wiring.

- One (1), 11/0.415 kV, 50 Hz, three phase, valve house transformer (oil type), 250 kVA.
- One (1) 11 KV switch gear with seven feeder trucks.
- Two (2) Unit Auxiliary Boards.
- Two (2) Station Service Boards.
- One (1) Valve house board.

The details of some of the equipments to be provided in the above-mentioned boards are indicated below. However, the quantities are to be worked out by the Contractor based on the single line scheme enclosed in Tender Drawing and shall be approved by Employer during detail engineering.

- Draw out type, motor operated air circuit breakers with magnetic short circuit over current and instantaneous trip according to single line diagram.
- MCCB as per single line diagram.
- Required no. of single phase, single core current transformers 800/5A as per single line diagram for incoming feeder of UAB.
- Required no. of single-phase current transformer of 1600/5A as per single line diagram for incoming feeder of SSB.
- Required no. of single-phase current transformer of 400/5A as per single line diagram for incoming feeder of valve house board
- Required no. of single phase CTs as per single line diagram for tie feeders in UAB, SSB.
- Required no. of ampere meters, rated 800 A with selector switches for UAB
- Required no. of ampere meters, rated 1600 A with selector switches for SSB
- Required no. of ampere meters, rated 400 A with selector switches for Valve house board
- Required no. of voltmeters with selector switches, rated 500 V and required no. of under voltage relay.
- Local control switches.
- Indicators as specified.
- Oil & Winding temperature alarm and trip along with Buchholtz alarm and trip protection relays for the auxiliary transformers.

(Other transformer protections like UAT, SST, over current and REF etc will be supplied under chapter "Protection system").

- Valve house board protection for over current & earth fault and under voltage
- All necessary auxiliaries for control and supervisory circuits.
- Other feeder units necessary to fulfil the requirements of the specification and sockets etc.
- All secondary wiring, terminal blocks, labelling and nameplates, sockets etc.
- All necessary AC bus bars. (including N- bus bar)
- Cubicle lighting including lighting fixtures and power and communication sockets
- Cubicle heating including heating elements
- Energy meters in incoming panels of UAB, SSB and valve house board.

15.6. Quality Control and Assurance

The contractor shall follow the quality assurance and testing requirements specified separately in Section XII – Quality Assurance Plan.

15.7. Drawings, Documents and Design Calculations

15.7.1. Drawings and Documents

The Contractor shall submit all the drawings and documents as per clause no. 2 of Section VIII.

15.7.2. Design Calculation

The Contractor is required to submit the design calculation for following to the Engineer for approval during detail engineering.

- Fault level at each board taken in consideration for their design
- Load on various transformers and burden on CTs

15.8. Shop Test

15.8.1. General

All transformers and their associated equipment shall be fully assembled, wired and tested in the manufacturer's factory.

The factory test equipment and the test methods used shall conform to the IEC Publications and shall be subject to approval.

The following tests shall be performed on different equipments as described below.

15.8.2. Power Transformers

All power transformers shall be tested in accordance with IEC Publication 60076.

Type tests on one transformer of each type

Routine tests on all transformers of each type

All tests shall be recorded and a test report shall be issued by the Contractor for approval of the Employer. The cost of performing these tests shall be included in the Contract Price.

15.8.3. Cubicle Assemblies

The cubicle assemblies shall be tested in accordance with the IEC Publication 60439:

Type test on one assembly of each type

Routine tests on all assemblies.

15.8.4. Circuit Breakers

The circuit breakers shall be tested in accordance with IEC Publications 60947-1 and 60947-2:

Type test on one circuit breaker of each type

Routine tests on all circuit breakers

15.8.5. Contactors

The contactors shall be tested in accordance with IEC Publications 60947-4-1 and IEC 61095.

Type test on one contactor of each type

Routine tests on all contactors

15.8.6. Current Transformers

The current transformers shall be tested in accordance with IEC Publication 60044-1:

Type test on one current transformer of each type

Routine tests on all current transformers

15.8.7. Operational Test:

All electrical equipment and installations shall be subject to a complete operational test to check the correct operation thereof in terms of the operational requirements specified in these Specifications.

15.8.8. Certificates

Instead of carrying out the above mentioned type tests, the Contractor may submit suitable certificates for tests made on equipment of the same type and same capacity. However, the Employer reserves the right to accept these certificates or to reject them partially or totally.

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

15.9. Installation and Commissioning

The Contractor shall furnish all labour, tools, supplies, shims, and supports, and all other items or materials necessary to assemble, erect, and install the equipment in a thorough workmanlike manner following the best modern practices. The equipment and all its components shall be placed with great care and accuracy and shall be aligned correctly to provide an installation consistent with the close tolerances used in the manufacture of modern equipment. The proper elevations and centrelines to which equipment is to be set shall be established by the Contractor.

All civil works required for foundation shall be carried by "other contractors". The contractor is required to submit all foundation drawings and supporting steels well in advance.

15.10. Field Tests

All the equipment being supplied by the contractor shall comply with the requirements of type tests prescribed in the relevant IEC/IS standard. It shall be certified by the contractor that type test in accordance with the relevant standards have been successfully carried out for all the equipments.

The contractor shall furnish a complete outline of the proposed methods and procedures to be followed for auxiliary and station transformer, valve house transformer including 415 V switchgear testing. The list of equipment and instruments to be used, shall be included in the above and the list be submitted to Employer for review at least 60 days before schedule testing.

After installation and prior to putting the switchgear into operation, at least the following tests shall be made:

- Power frequency withstand-voltage test
- 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 relays.
- Resistance measuring of all major circuits.
- Other test as suggested by the Contractor and / or Employer at site.

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

All necessary materials and labour for performing these tests shall be provided by the Contractor. All test equipment and instruments shall be furnished by the Contractor and will remain Contractor's property after fulfilment of all tests.

15.11. Spare Parts

15.11.1. General Spare Parts

The Contractor shall supply the general spare parts as per clause no. 3.1.1 of Section VIII. The supply of this spares shall be as per the approved list of spares for each component / equipment / item during detail engineering.

15.11.2. Recommended Spare Parts

The Contractor shall furnish the list of recommended spare parts as per clause no. 3.1.3 of Section VIII.

15.11.3. Specified Spare Parts Refer 415 V switchgear spare parts only

The following specified spare parts, as defined in clause no. 3.1.2 of Section VIII, which shall comprise the total requirement for 415 V Switchgear system under this Contract, shall be supplied.

S. No.	Description	Qty
1	Air circuit breakers of each type used	1 no.
2	MCCB each type used	2 nos.
3	Current transformer of each type used.	3 nos.
4	Supporting insulator of each type used.	6 nos.
5	Bushing of each type used.	1 no.
6	Arcing chamber assemblies for each type of circuit breaker.	2 sets
7	Main contacts for three poles, with spring, bolts, nuts etc. for each type of circuit breaker.	10 sets
8	Primary isolating contacts used.	10 sets

9	Coils for tripping and closing of each type used.	12 nos.
10	Complete motor drives, of each type.	4 nos.
11	Complete spring closing mechanism for the breakers. (If applicable)	13 nos.
12	Oil & Winding temperature protection relay for the auxiliary transformers of each type used.	1 no.
13	Overload and instantaneous trip mechanism for circuit breakers of each type used.	3 nos.
14	Indication lamps used including assemblies	10 nos. of each type
15	Fuses of all type used	10 nos. of each type
16	Control and instrumentation switches	3 nos. of each type
17	Contactors of each type used	4 nos. of each type
18	Indicating instruments	2 nos. of each type
19	11 kV(SST) & 11kV(UAT), 11kV valve house transformer terminal bushing	3 nos. each
20	415 V, terminal bushing	1 set
21	Under voltage relays	2 nos.
22	Over current and E/F relays	2 nos.

A set is defined as the total number required for one breaker.

15.12. Special Tools

The Contractor shall provide one set of all necessary special tools and maintenance equipment for repairs and maintenance of the LT switch gear equipment, as recommended by the manufacturer.

A list of such tools shall be approved during detail engineering.

However, it shall include at least following maintenance equipment for repairs and maintenance of the LT switchgear,

- One portable hand operated hoist for lifting and moving the draw out type circuit breakers. The hoist shall be mounted on a trailer with rubber tires and ball bearings.
- One relay test plug of each type.
- One breaker test cable, with plugs for testing the breaker in disconnected position.
- One hand lever or crank for manual closing of the electrically operated breakers. (or other means as applicable)
- One complete set of all special wrenches, tools, etc. required for the installation, maintenance and repair of the equipment furnished under this section.

6.4.11 Tests

Each motor shall be factory tested and shall undergo a test at site. The following tests shall be performed under full responsibility of the Contractor.

- Workshop Tests:
 - Measurement of winding resistances
 - No-load and short-circuit measurements
 - Measurement of starting current and torque
 - Efficiency measurement (type test)
 - Heat test run
 - Dielectric test
 - Measurement of insulating resistance
 - Over speed test
- Site Tests:
 - Measurement of insulation resistance
 - Measurement of motor vibrations
 - Measurement of starting time.

6.5 M.V. and L.V. Switchgear, Cubicles and Panels

6.5.1 Starters and contactors

Motor starters and contactors shall be equipped with short circuit protection and local disconnecting devices. Preferably, all starters shall be from one manufacturer. The control circuit voltage shall be obtained from a 415/240 V isolating transformer with primary circuit breaker and secondary fuse. The secondary winding of this transformer shall be grounded. The operating coils of the contactor shall be connected between the grounded side of the transformer and the control contacts.

Starters and contactors shall comply with IEC 292.1 or NEMA IC 1 and be suitable for direct on-line starting, uninterrupted electrical duty, and capable of 30 operations per hour. They shall be installed in ventilated enclosures for indoor installation and weatherproof enclosures for outdoor installation, unless otherwise approved by the Engineer. The enclosures shall be complete with locks, cable sealing boxes, conduit entries, cable gland plates, bus bars, internal wiring, terminal boards, etc. as required by the duty of the starter or contactor.

Starters and contactors shall be of minimum size compatible with motor size and capable of satisfactory operation, without damage, for a period of 5 minutes at a voltage 25 percent below nominal, at nominal frequency.

Thermal type overload and phase failure relays shall be supplied with starters for motors of 7.5 kW or greater. For motors of less than 7.5 kW, suitable rated 3-phase thermal overloads will be acceptable. Ammeters to read current in one phase shall be provided for motors above 7.5 kW.

Each starter shall have sufficient number of auxiliary contacts required for interlocking and indication purposes plus two spare convertible contacts for Owner's use.

6.5.2 Moulded case circuit breakers

All moulded case circuit breakers shall be of 2 or 3-pole type as required, having thermal time delay and instantaneous trips with "On-Trip-Off", indicating/operating mechanism. Circuit breakers used in combination type motor starters or contactors shall have the operating mechanisms interlocked with the starter or contactor cover so that the cover cannot be opened unless the circuit breaker is open. The breakers shall comply with applicable section of IEC 157/1 or equivalent standards.

6.5.3 Control relays

Relays used as auxiliary control devices in conjunction with motor starters and magnetic contactors shall be of the type designed for machine tool application featuring contact convertibility. All contacts shall have a minimum thermal current rating of 10A over a range of 6 to 600 V AC.

6.5.4 Pilot devices

Pilot devices such as selector switches, push-button starters and thermostats shall be of heavy duty type and, where mounted outdoors, shall be housed in weather proof enclosures specially designed for the environment.

All electrical contacts for control, alarm and shutdown shall have a thermal current rating of not less than 10 A at 220 V DC.

6.5.5 Terminal blocks

All terminal blocks shall be mounted in an accessible position with the spacing between adjacent blocks not less than 100 mm and space between the bottom blocks and the cable gland plate being a minimum of 200 mm. Sufficient terminals shall be provided to allow for the connection of all incoming and outgoing cables, including spare conductors and drain wires. In addition, 20 percent spare terminals shall be provided. In enclosed cubicles, the terminal blocks shall be inclined toward the door for facilitating terminations.

Terminals shall be of the channel mounting type and shall comprise a system of individual terminals so that terminal blocks can be formed for easy and convenient cabling consistent with the high reliability required of the circuits.

Terminal blocks shall be provided with shorting links and paralleling links where applicable and mounting identification numbers and/or letters.

Terminal blocks shall conform to the applicable standards. The smallest size to be used shall be designated for 2.5-sq. mm wire and not more than two conductors shall be connected under one terminal clamp.

Terminal identification shall be provided corresponding to wire number of connected leads.

Circuit terminals for 415 V AC shall be segregated from other terminals and shall be equipped with nonflammable, transparent covers to prevent contact with live parts. Warning labels with red lettering shall be mounted thereon in a conspicuous position.

6.5.6 Equipment wiring

All wiring connections shall be readily accessible and removable for test or other purposes. Wiring between terminals of the various devices shall be point to point.

Splices or tee connections between terminal points are not acceptable. Wire runs shall be neatly dressed inside the panels or in wiring troughs. Whenever possible, unused areas of the panels shall be kept free of wiring to facilitate the installation of future equipments.

Multi conductor cables shall be connected to the terminal blocks in such a manner as to minimise crossovers. Approved claw washers of crimp type connector shall be used to terminate all small wiring. Each conductor shall be individually identified at both ends through a system providing ready and permanent identification, utilising slip-on ferrules approved by the Engineer.

Markers may be typed individually or made up from sets of numbers and letters firmly held in place. Open markers will not be accepted.

Markers must withstand a tropical environment and high humidity and only fungus proof materials will be accepted. Ferrules of adhesive type are not acceptable.

All trip circuits shall employ markers having a red background.

Sensitive control circuits shall be effectively shielded against extraneous signals and interference. A separate terminal shall be provided for termination of individual cable shields, which will be grounded at source end only.

6.5.7 Cubicles and control panels

Cubicles and control panel enclosures shall be of sheet steel with minimum thickness of 2.5mm, of rigid, self-supporting construction and supplied with channel bases.

Cubicles shall be fitted with close fitting, gaskets, hinges, lift-off doors capable of being opened through 180 deg. The doors shall be provided with integral lock and master key.

Cubicles and panels shall be vermin proof. Removable gland plates shall be supplied and located to provide adequate working clearance for the termination of cables. Under no circumstances shall the floor/roof plate be used as a gland plate. The cables and wiring shall enter from bottom or top as approved or directed by the Engineer.

The cubicles and panels shall be adequately ventilated, if required, by vents or louvers, and shall be so placed as not to detract from the appearance. All ventilating openings shall be provided with corrosion-resistant metal screens or a suitable filter to prevent entrance of insects or vermin. Space heating elements with thermostatic control shall be included in each panel.

Where cubicles are split between panels for shipping, terminal blocks shall be provided on each side of the split with all necessary cable extensions across the splits. These cable extensions shall be confined within the panels with suitable internal cable ducts.

Unless stated otherwise, all cubicles and panels shall be provided with a ground bus with 40mm copper bar extending through out the length. Each end of this bus shall be drilled and provided with lugs for connecting ground cables ranging from 70 to 120mm².

The standard phase arrangement when facing the front of the motor control centres and switchboard shall be RYB from left to right, from top to bottom and front to back. All instruments, devices, buses and other equipments involving 3 phase circuits shall be arranged and connected in accordance with the standard phase arrangement, where possible. Electrical clearances shall conform to applicable standards and shall not require cutting away of adjacent framework.

All instruments, control knobs and indicating lamps shall be flush mounted on the panels. Relays and other devices sensitive to vibration shall not be installed on doors or hinged panels, and no equipment shall be installed on rear access doors.

The instrument and control wiring, including all electrical interlocks and all interconnecting wiring between sections, shall be completely installed and connected to terminal blocks by the manufacturer.

The arrangement of control and protection devices on the panels and the exterior finish of the panels shall be subject to the approval of the Engineer. The interior of all cubicles and panels shall have a mat white finish unless specified otherwise.

Switched interior light and socket outlets shall be provided for all cubicles and control panels.

All cubicles and control panels shall be provided with lamacoid nameplates, identifying the purpose of the panel and all of its components.

6.5.8 Alarm contacts

Where applicable, all alarm contacts shall be of galvanically isolated type and provide inputs to the following devices.

- -Local annunciator
- -Station annunciator
- -Supervisory control and sequence of events / fault recorder system.

All alarm contacts shall be changeover type. Where required, relays shall be provided as contact multiplier.

6.6 Cables

Refer to particular technical specifications Section-IX.

6.7 Earthing System

The contractor of Electro-Mechanical Equipment will make the design calculation and supply the necessary material and install the earthing system during powerhouse construction in co-ordination with civil contractor

6.8 Explosion Proof Works

6.8.1 General

According to the kind of oils and fuels used, explosion in hazardous locations may be caused by standard type electrical works. Therefore, the installation in such locations shall generally be kept to a minimum with said works designed or installed in compliance with the latest issue of IEC recommendation 79 and the appropriate articles of the American National Electric Code (NEC) or the German VDE Standards 0165, 0170 and 0171.

6.8.2 Definition of Hazardous Locations

Hazardous locations shall be defined as follows:

- Class 1, Div. 1 locations are those:
- Where hazardous concentrations of inflammable vapours or gases exist continuously, intermittently, periodically under normal

14. POWER & CONTROL CABLES

14.1. Scope of Work

Scope of work under this section covers the provision of labour , tools , plants, material and performance of work necessary for the detailed design and engineering, manufacture, quality assurance, quality control, shop assembly, shop testing, transportation, delivery at site, site storage and preservation, erection, testing and commissioning, performance testing, field acceptance testing, training of the Employers personnel, handing over to the Employer and guarantee for two years of the power, control, coaxial, communication and instrumentation cables, cable trays, support structures, complete with cable terminals and all accessories for making the systems complete and for warranting a trouble free and safe operation.

14.1.1. Detail Scope of Supply

The intent of scope is to provide all cabling, cable routing & termination in power house and all adjoining functional areas.

The scope of work shall be a comprehensive functional system complete in every respect including but not limited to following:

Power control cable shall comprise of:

- 1 lot - 11Kv XLPE power cable (High voltage cable)
- 1 lot - 600/1000 volt grade power cable (Low voltage cable)
- 1 lot - Control, instrumentation, coaxial and communication cables
- 1 lot - Cable trays, supporting steel structures, cable terminals, termination kit, cable lugs, cable glands, PVC conduits, button tape (strap & stud), and cable junction boxes, hydraulic operated crimping tools and control cable crimping tools and all other accessories.
- All special devices, tools, maintenance equipment etc required for installation, testing, commissioning and maintenance of power and control cable.
- Set of spares

14.2. Special Design and Layout Conditions

14.2.1. Power Cables

14.2.1.1. 11KV XLPE Cable:

The 11 kV power cables shall be required to interconnect:

- 2 nos. 11KV Generator Bus duct Tap off to UAT

14.2.1.2. LT Power Cables:

The 415 V / 240 V AC and 220 V/48 V DC cables shall be required to interconnect the different auxiliary service boards and connect various equipment to various distribution boards as required in Power House complex, Valve House, Surge shaft gallery and other area in vicinity of Power House such as fire pump house, fire tank etc.

14.2.2. Control, Instrumentation, Coaxial and Communication Cables

These shall include all cables required for the installation of the complete instrumentation, control, protection and communication systems in the powerhouse, switchyard area, valve house area and other areas in vicinity of power house.

The scope of remote instrumentation, protection, control and alarm systems is specified in the relevant chapters. Special reference is made to

External CT & PT cabling shall not be less than 4 mm² Copper Cable. 4x4 Copper conductor cable shall be used for a group of 3 phase wiring of CT & PT.

All Control cabling for operation & interlocking of circuit breakers , Isolators & operation of unit etc. shall be not less than 2.5 mm² Copper conductor cable .

Alarm /annunciation / signalling cables shall be of minimum 1 mm² size copper Conductor cable .

The central control and monitoring system with their local control panels, operator station, metering, protection and automatic control cubicles.

The Unit Control Boards incorporating the digital turbine governors, the digital voltage regulators, the local control panels and the logic control functions.

The spherical valves, Valve house, surge shaft gallery, switchyard and other area in the vicinity of powerhouse such as fire pump house, fire tank etc.

Automatic and manual control of unit and station services such as cooling water, drainage system etc. for linking LMU with PLCC cabinet

14.2.3. Cable Trays, Supporting Structures, Cables Terminals Etc.

The cable trays for all cables along with supporting structures, cable terminating lugs and other accessories shall be required to

interconnect various service boards and equipment to complete the system.

14.3. Basic Dimensions and Ratings

14.3.1. Design Features

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 $\pm 10\%$ 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 power station installation.

14.3.2. Power Cables - 11 kV System Single & Multi core Cables

11 kV power cable shall be of heavy duty, stranded circular Copper conductor, cross linked polyethylene (XLPE) insulated provided with conductor screening and insulation screening, laid up, extruded PVC inter sheathed, armoured conforming to IS 7098 (Part-II) / Relevant IEC and as specified in this specification. 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 shall meet IEC 60332-1, IEEE 383

14.3.3. Power Cables - 600/1000 Volt Grade

14.3.3.1. Single Core Cables

These cables shall be at least 600/1000 volt grade, heavy duty, single core, stranded Aluminium / Copper conductor, HR-PVC insulated and

PVC sheathed, armoured and shall conform to the same design and properties as cables conforming to IS: 1554 (Part-I) / IEC. The outer sheath shall be of specially formulated PVC compound to give the following properties:

Oxygen index	Min. 29(Test performed on, 27±20c)
Smoke density	Min. 40% light transmittance
Acid gas	Max. 20% by weight
Flame propagation shall meet	IEC 60332-1, IEEE 383

14.3.3.2. Multi core Cables:

The cable shall be at least 600/1000 volt grade, heavy duty multi core, stranded Aluminium conductor, PVC insulated, colour coded, laid up, armoured, inner sheathed with extruded PVC, 2/3.5 cores, conforming to IS 1554 (Part I) / relevant IEC. The outer sheath shall be of specially formulated PVC compound to give the following properties.

Oxygen Index	Min. 29, (Test performed on, 27±2 0C)
Smoke density	Min. 40% light transmittance
Acid gas	Max. 20% by weight
Flame propagation shall meet	IEC 60332-I, IEEE 383

14.3.3.3. Control & Instrumentation Cables

The control & instrumentation cables shall be multi core, colour coded, armoured, annealed stranded high conductivity Copper, single conductor, insulated with HR-PVC insulation, PVC sheathed and armoured, conforming to IS 1554 (Part- I & II) / relevant IEC. The outer sheath shall be of specially formulated PVC compound to give the following properties.

Oxygen index	Min. 29, (Test performed on, 27±2 0c)
Smoke density	Min. 40% light transmittance
Acid gas	Max. 20% by weight
Flame propagation	shall meet IEC 60332-1, IEEE 383

14.3.3.4. Coaxial Cable

Coaxial cable shall be offered to connect coupling unit installed in the switchyard to the PLCC terminals, installed in control room of powerhouse. The cable offered by the contractor shall be steel armoured. 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
60	1.4
300	3.3
500	4.7

14.4. Performance Criteria and Guarantee

The power, control, coaxial communication and instrumentation and other cables systems shall be capable of performing all intended duties and it is the responsibility of the contractor to supply the equipment as per guaranteed technical particulars.

14.5. Design and Construction

14.5.1. 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). All cables shall be armoured.

14.5.2. 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.

14.5.3. 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

14.5.4. 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.

14.5.5. Armour

Hard drawn Aluminium wire armouring /single galvanized steel tape/wire armouring shall be used for single core and multi core cables respectively. The diameter of the Aluminium wire shall be as per the table for the dimensions of the galvanized steel wire armour given in the relevant standard. This should be in accordance with relevant IS and IEC standards.

14.5.6. Service and Outer Sheath

Extruded PVC serving as specified shall be applied over armouring with suitable additives to prevent attack by rodents and termites. All servings must be given anti-termite treatment. 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.

14.5.7. Size & Length of Cables

The number of cores and sizes of the cables required for various circuits shall be worked out during detailed engineering.

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

14.5.8. Colour Scheme and Identification

To facilitate easy identification of phases a colour scheme of Red, yellow and Blue for phases and black for neutral shall be adopted for power cables. Multi-core control cables shall be colour coded for

identification of cores or numbered at equal interval as per relevant IS/IEC standards.

All the cables shall carry manufacturer data and UJVNL embossing in a permanent, legible manner at an interval of at least 3 meter run. The manufacturer's data shall include the name, cable size, and voltage rating together with any other information.

14.5.9. Termination Kit

The termination kits required for 11 kV 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 leave at least 5% of these items for future use by the Employer.

14.5.10. 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 IEC / IS make only.

14.5.11. Cable Accessories

The contractor shall supply all the required accessories that may be found necessary during actual execution of the job, within the quoted prices. No intermediate joint will be allowed in the run of any cable.

14.5.12. 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 IS 1653 / 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

14.5.13. 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.

14.5.14. Button Tape (Strap & 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'.

14.5.15. 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.

14.5.16. 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 & commissioning shall be supplied of good quality as per relevant Indian Standards.

14.5.17. Cable Trays & Support Structure

Perforated cable trays made out of 14-gauge mild steel sheet shall be fabricated. The trays shall be provided with long shape slots of 20mm x 8mm size. The trays shall be of perforated plates for proper ventilation of the cables.

The cable trays shall be fully galvanized or painted with at least one coat of red oxide or stove enamel grey paint as per the relevant IS / IEC and the Employer reserves the right to test galvanizing as specified in the relevant IS / IEC in presence of its representative. The tack-welded portion of trays and the contact surfaces shall be given a layer of epoxy paint or shall be treated with galvanized compound. The cable support shall be painted.

Detailed design of the cable trays & 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. The fixing arrangement shall be approved by the engineer. Embedment for the fixing of the supports shall be provided, installed and supervised during concreting for correctness of positioning and alignment by the contractor.

In addition to this, ladder type tray with double bends should be used wherever required. Also, various cable tray accessories such as vertical elbow, horizontal elbow, reducer, horizontal tee, and horizontal cross should be used.

14.5.18. 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.

14.5.19. Cable Junction Boxes

Junction box shall be constructed of sheet steel of thickness not less than 2mm. 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. Disconnecting (sliding) type terminal blocks shall be provided, to facilitate testing & maintenance without disconnecting the cables.

Multi block terminal board of 15 A, 500 V rating shall be provided to form in assembly of number of terminal block. Assembly may be secured with only two screws on the surface. There shall be provision on the strips to add more terminal in case of further requirement

14.5.20. Packing

All the cable 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.

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.

14.6. Quality control and assurance

The contractor shall follow the quality assurance and testing requirements specified separately in Section XII – Quality Assurance Plan.

14.7. Drawings, Documents and Design Calculations

14.7.1. Drawings and Documents

The Contractor shall submit all the drawings and documents as per clause no. 2 of Section VIII.

14.7.2. Design Calculation

The Contractor is required to submit the design calculation for following to the Engineer for approval during detail engineering.

Calculation for fault level and short circuit calculation for selecting the cable size, Cable schedule

14.8. Shop Tests

The cables shall be routine tested as per relevant IEC/IS at the works of Contractor in presence of Engineer. The Contractor is required to submit type test certificate and routine test reports of equipments.

Requirement of tests for power and control cables (IS 1554 & IS 7098 / IEC)

14.8.1. Type Tests:

Tests on conductor:

- Annealing test (for Cu.)
- Tensile test (for Al.)
- Wrapping test (for Al.)
- Conductor resistance test.

Test for armouring wires/strips: -

- Nominal thickness (for steel strip)
- Nominal diameter (for round wire)
- Test for thickness of insulation and sheath.
- Physical test for insulation and outer sheath.
- Tensile strength and elongation at break of insulation and sheath.
- Ageing in air oven.
- Shrinkage test
- Hot deformation
- Loss of mass in air oven.
- Heat shock test.

- Thermal stability.
- Insulation resistance test.
- High voltage test (water immersion test)
- High voltage test at room temperature.
- Test for bleeding and blooming of pigments.
- Fire Resistance Test

14.8.2. Acceptance Tests:

- Annealing test (for Cu.)
- Tensile test (for Al.)
- Wrapping test (for Al.)
- Conductor resistance test.
- Test for thickness of insulation and sheath.
- Tensile strength and elongation at break of insulation and sheath.
- Insulation resistance test.
- High voltage test at room temperature

14.8.3. Routine Tests:

- Conductor resistance test.
- High voltage test at room temperature

14.8.4. Optional Tests:

- Cold bend test
- Cold impact test
- Armour resistance test (for other than mining cables)
- The following FRLS tests are to be conducted as per the referred standard

14.8.5. FRLS Tests:

- HCL gas evolution test (IEC - 754.1)
- Oxygen Index (ASTM-D-2863)
- Temperature Index (ASTM-D-2863)
- Smoke density test (ASTM-D-2863)
- Flammability test (IEC-332.1)
- Swedish Chimney test (SS-424 14 75)
- Ladder Test (IEEE-383)
- XLPE cables shall be tested as per IS 7098 / IEC.
- The instrumentation cables shall be routine tested as per relevant IEC/IS

14.9. Installation and Commissioning

All installation and laying of cables and cable trays shall be done by skilled workers in a workmanlike manner. Sufficient cores in control cables shall be kept as spare cores in cable scheduling for future use. Before charging of cables all wiring/cable shall be checked as per cable schedule programme.

14.9.1. CABLE ROUTING

For the main cableways, a system of cable racks and trays as well as cable ducts and trenches shall be provided.

The cables for emergency lighting, fire alarm systems, etc., shall be run on separate trays.

The 11 kV XLPE cables and power and control cables shall be run separately on racks/trays, in cable trenches/cable tunnels and on columns, walls, ceiling and pulled through pipes. The contractor shall be responsible for carrying out proper dressing of the cables and supply non-magnetic/moulded fiber-glass cable fixing cleats, fasteners and clamps wherever necessary to hold the cables firmly to the trays.

Contractor shall take proper care in the handling of cables against external damage of any kind. Necessary rollers etc. shall be used while pulling and laying of the cables. Engineer- in- charge of the work shall have the right to stop the work in case of improper handling of the cables.

Cables shall be properly clamped at regular intervals with the help of non-magnetic/moulded fiberglass strip clamps/PVC sleeved clamps, of suitable size. Contractor shall submit typical drawings along with tender giving proposed clamping arrangement and give distance of clamping at bends and in regular run of cables.

14.9.2. 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.

Wire identification ferrules shall be provided in each core of the cables. Spare cores shall also be numbered indicating cable number & spare core number .

14.9.3. 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.

14.10. 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:

- Cabling checking
- Continuity checking
- Megger testing in accordance with the applicable codes and standards.
- Resistance checking

Contractor shall be responsible for conducting tests as per IS / IEC before termination of the cables i.e. measuring insulation resistance of each core to earth and core to core, identification of cores, all tests before and after termination etc.

14.11. Spare Parts

14.11.1. General Spare Parts

The Contractor shall supply the general spare parts as per clause no. 3.1.1 of Section VIII. The supply of this spares shall be as per the approved list of spares for each component / equipment / item during detail engineering.

14.11.2. Recommended Spare Parts

The Contractor shall furnish the list of recommended spare parts as per clause no. 3.1.3 of Section VIII.

14.11.3. Specified Spare Parts

The following specified spare parts, as defined in clause no. 3.1.2 of Section VIII, which shall comprise the total requirement for Power & Control Cables Including Cable Trays under this Contract, shall be supplied.

Description	Qty.
Cable 11kV	10% of Installed quantity
LV power cable each type	10% of Installed quantity

Control cable each type	10% of Installed quantity
Communication cable each type	10% of Installed quantity
Terminals-11 kV Outdoor type Indoor type	10% of Installed quantity
Lugs of each size	10% of Installed quantity
Coaxial cables	10% of Installed quantity
Cable glands of each size	20% of Installed quantity
Junction boxes of each size	20% of Installed quantity
Cable tray of each size	10% of Installed quantity
Cable supports, hardware etc	20% of Installed quantity

14.12. Special Tools

The Contractor shall provide one set of all necessary special tools and maintenance equipment for repairs and maintenance of the systems under this section as recommended by the manufacturer.

A list of such tools shall be approved during detail engineering.

23. GROUNDING SYSTEM

23.1. Scope of Work

Scope of work under this section covers the provision of labour , tools , plants, material and performance of work necessary for the detailed design and engineering, manufacture, quality assurance, quality control, shop assembly, shop testing, transportation, delivery at site, site storage and preservation, erection, testing and commissioning, performance testing, field acceptance testing, training of the Employers personnel, handing over to the Employer and guarantee for two years, of the complete grounding system for power house complex including switchyard area complete with all accessories & spares for making the system complete and for warranting a trouble free operation.

23.1.1. Detailed scope of Supply

The contractor shall make the design and the calculation of the whole grounding system of the powerhouse complex, including transformer deck area, discharge area of tailrace, switchyard area and other adjoining functional areas. The contractor shall supply, install and supervise all grounding conductors, grounding rods, connection material for the complete embedded grounding system. The concreting of the embedded grounding system shall be done by the civil contractor under the supervision of the contractor of this electromechanical lot.

The contractor shall supply and install all grounding conductors, connection materials etc. for the internal connection of all equipment, steel structures and metal parts and all connection to the embedded grounding system. The erection of grounding system shall have to be done with respect to the actual progress of work by civil contractors and slippage on this account shall not be acceptable.

The earthing system shall mainly consist of:

- An embedded earthing system in the powerhouse area.
- An embedded earthing system in the transformer bay and switchyard area connected with the power house earthing system
- An embedded earthing system in the discharge area of the tailrace, connected with the powerhouse earthing system.
- An interconnected above ground / above floor main earthing network at the powerhouse, transformer area, switchyard and to the other places wherever needed shall be laid. From this earthing network, the equipment conductor shall run to all machinery, equipment and other parts, which are to be earthed.
- The earth electrode system as well as other earthing networks shall be designed and constructed for the operating voltages, the short circuit capacities and the corresponding short circuit and earth fault currents.
- Independent earthing system for electronic panels as per requirement of manufacturer.

23.2. Special Design and Layout Conditions

The contractor shall design and construct the grounding system for protection of persons and material to allow a safe service and maintenance work on the installations.

The earthing system shall be constructed to comply with the requirements of the applicable standards and connected equipments. The grounding system shall be designed to avoid dangerous touch or step voltage.

More specifically and independent of the regulation and standards, the earthing system shall provide:

- Adequate protection of personnel against dangerous voltages, currents and arcs.
- Low earthing impedance for the transformer neutrals and the generator neutrals and sufficiently low neutral conductor impedance.
- The fault currents shall flow through the earthing system.
- Limiting the induced capacitive transformed voltages on electronic cables, circuits, panels and other equipments to low voltage, weak current.

23.3. Basic Dimensions and Ratings

The earthing conductors shall be dimensioned for carrying earth fault current in any section of the plant for at least one second without any harm to the conductors. The equivalent resistance of the whole earth electrode and main earth collector shall be less than 0.5Ω . Earth conductor in ground shall be thermo welded to each other. Fault current level for power house, transformer, and switchyard areas may be taken as 40 kA for 1 second. This fault current is indicative only. The contractor shall submit full detail calculation for fault level and ground mat design for approval.

The values of resistivity of the Powerhouse, transformer bay and switch yard areas shall be determined after excavation of respective terraces.

23.4. Performance Criteria and Guarantee

The complete grounding system covered under this contract shall be capable of performing all intended duties and the equipment shall be as per guaranteed technical particulars and final grounding mat resistance.

23.5. Design and Construction

23.5.1. Embedded Earthing System

The embedded earthing system for the power house, the transformer floor, the switchyard and the discharge area of the tailrace shall consist

of an interconnected earthing grid formed by MS electrode, rods / flats and copper conductors of suitable size.

The embedded earthing system of the powerhouse shall be connected to the penstock and to the earthing systems of the switchyard, transformer floor and the discharge area of the tailrace.

Prior and during the concreting stage, the contractor shall provide / erect all material and shall co-ordinate all appropriate information in sufficient details to enable the Civil Contractor to ensure concreting only after connection of reinforcement bars and to form the adequate grid.

The number and location of these interconnecting points shall be determined by the contractor and put up for approval of the employer.

All connections of the embedded earthing conductors shall be thermo welded.

The conductors buried in the soil or laid in cable trenches or similar, shall be MS flats/rods.

23.5.2. Above Ground / Above Floor Main Earthing System

The earthing system shall consist of individual loops with connections to the different equipment to be earthed and with connections to the embedded earthing grid. At certain locations earthing measuring points shall be installed.

Within the powerhouse and transformer floor, and other rooms or buildings containing electrical installations, at least one main protective earthing bus shall be provided, approximately 0.3 m above floor at the circumference of the building room. This bus consisting of bare MS flat of adequate dimension shall be connected with the embedded earthing system. This protective earthing system shall be carried along with the cable trays to reach every electrical consumer in a convenient manner.

The connection straps from the embedded net to the main protective earthing buses shall be provided with disconnect terminal lugs for measuring, always visible for inspection.

23.5.3. Conductors and Connections

All main conductors from the generator grounding system shall have individual connections as per the required standards. The contractor shall supply the all embedded conductor system and the connection rods/flats, and design suitable connection facilities for connection of individual conductors to the system.

All the system material i.e. generators, generator transformers, UAT's, excitation transformers, L.A' s, outdoor switchyard equipment and structures are to be connected with the embedded system at atleast two points. One of these should be to a main riser from embedded system.

23.5.3.1. Schedule of Connections

The connections shall include but not be limited to the following:

- Connection to all cubicle ground buses.
- All transformer neutrals.
- All surge arresters.
- Generator neutrals.
- Generator frame.
- All switchyard equipments and structures.
- All secondary circuits of instrument transformers.
- All metal equipment housings, and all other accessible metallic equipment and all steel structure parts.
- All cable screens.
- Other equipment and electrical installations as per requirement and relevant standard.

23.6. Quality Control and Assurance

The contractor shall follow the quality assurance and testing requirements specified separately in Section XII – Quality Assurance Plan.

23.7. Drawings, Documents and Design Calculations

23.7.1. Drawings and Documents

The Contractor shall submit all the drawings and documents as per clause no. 2 of Section VIII.

23.7.2. Design Calculation

The Contractor is required to submit the design calculation for following to the Engineer for approval during detail engineering.

- Design calculations of the whole grounding system including the embedded grounding system.

The design shall be as per applicable rules and standards, "Guide for Safety in AC Substation Grounding" ANSI / IEEE Std 80-1986

23.8. Shop Tests

The material used in grounding system shall be routine tested for dimension checking, corrosion protection and material strength as per relevant IS / IEC standards at the works of Contractor. The Contractor is required to submit routine test reports of materials.

23.9. Installation and Commissioning

The laying, erection and commissioning of all grounding system shall be carried out by contractor. The concreting shall be done by other contractors. The contractor is required to remain present at the time of concreting for supervision of work. The contractor is required to submit detail drawing for grounding system. All erection and commissioning of the grounding system shall be done by skilled workers in a workmanlike manner.

23.10. Field Tests

The grounding system shall be site tested to demonstrate operation capability as per the intended requirements.

The following tests shall be performed:

- Visual inspection of exposed system
- Electrical continuity test
- Measurement of earthing resistance, as far as reasonable of individual loops

23.11. Spare Parts

23.11.1. General Spare Parts

The Contractor shall supply the general spare parts as per clause no. 3.1.1 of Section VIII. The supply of this spares shall be as per the approved list of spares for each component / equipment / item during detailed engineering.

23.11.2. Recommended Spare Parts

The Contractor shall furnish the list of recommended spare parts as per clause no. 3.1.3 of Section VIII.

23.11.3. Specified Spare Parts

The following specified spare parts, as defined in clause no. 3.1.2 of Section VIII, which shall comprise the total requirement for grounding system under this Contract, shall be supplied.

Description	Quantity
Connecting cable/conductor including lugs and hard wares for connection between equipment and earthing.	24 nos. of suitable length and size

23.12. Special Tools

The Contractor shall provide one set of all necessary special tools for system if required.

A list of such tools shall be approved during detailed engineering.

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 Engineer 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.

1.7.13 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 Engineer, the functional tests shall be repeated until it is established that the functioning of the assemblies will comply with the requirements of the Contract Documents.

1.7.14 Embedded Parts and Anchor Bolts

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

The threaded end of the rod shall be provided with two steel nuts and two steel washers to permit levelling and anchoring the equipment prior to grouting.

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

1.7.15. Electrical Equipment

1.7.15.1. General

The electrical equipment delivered under this contract shall be new and of high quality, suitable for the purpose it is intended for, free from defects and imperfections, and it shall be of the classifications listed herein, or their equivalents, subject to acceptance by the Engineer.

The equipment shall meet the applicable IEC Recommendations, international standards such as ANSI - IEEE – DIN - SEN or others that can be shown to be comparable to these. The IEC and IEEE recommendations for approval of equipment and tools are applicable.

The equipment design shall be suitable to render satisfactory operation under the conditions prevailing at the site, and the equipment shall operate satisfactorily under normal load and voltage variations. The design shall further include all necessary provisions ensuring the safety of the operating and maintenance personnel.

Each equipment assembly, or unit containing electrical devices and wiring, shall be completely wired in the shop. Wiring shall be neatly arranged and protected against mechanical damage, terminating in terminal blocks located in a connection box or cubicle, on or near the unit.

1.7.15.2 Auxiliary supply voltage

1.7.15.2.1 AC Power

Three-phase system with grounded neutral for feeding three-phase and single-phase consumers (connected between phase and neutral), type TN-C 415/240 V $\pm 10\%$, 50 Hz $\pm 5\%$. All motors and other electrical apparatus should be designed to work continuously under $\pm 5\%$ frequency variation and $\pm 10\%$ voltage variation.

1.7.15.2.2 DC Power

D.C. Systems, ungrounded, with earth fault detection

-220 V $\pm 20\%$ for the supply of main control circuits for high and medium voltage switchgear, protection circuits and to other larger essential loads.

$\pm 48\text{V} \pm 20\%$ for the supply of PLCC and EPBAX etc.

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

1.7.15.3. Permissible Temperature Rise

The permissible temperature rise for the major electrical components is cited in the respective chapters of these Contract Documents. Wherever, temperature rise is not specifically mentioned, it shall be understood that the temperature rise is in accordance with the IEC recommendations.

1.7.15.4 System Parameters

	Nominal	Variation under worst condition
Voltage	220 kV	198 – 242 kV
Frequency	50 Hz	47.5 – 52.5 Hz

1.7.16 Electrical Motors

Refer to the General Technical Specifications, Section-VIII, clause 6.4.

1.7.17 Electrical Equipment Enclosures

1.7.17.1. General

All electrical equipment, apparatus and devices shall be of suitable design for satisfactory operation under the conditions prevailing at the Site. The equipment shall operate satisfactorily under normal load and voltage variations in accordance with IEC Publications.

The design shall also include all necessary provisions ensuring the safety of the operating and maintenance personnel.

All electrical connections and contacts shall be of ample cross section and capacity for carrying continuously the specified currents without undue heating and shall be secured by bolts or setscrews of ample size, fitted with locknuts or lock-washers of approved types.

Unless otherwise expressly stated conductors and all other current carrying parts shall be made from electrolytic grade copper in accordance with approved applicable standards.

Cubicles and other enclosures containing electrical equipment shall be especially treated to prevent corrosion. All cubicles shall be provided with a door switched lighting fixture and a single-phase socket for power outlet.

All interior surfaces of electrical apparatus, enclosures etc. including contactors, relays, and coils, etc., shall be treated in an approved manner to prevent mold growth. Such treatment shall in no way interfere with the proper operation of the equipment either electrically or mechanically.

Bigger assemblies such as switchboards, etc., shall be designed to present suitable transportation devices adapted to the local conditions within the plant.

Unless otherwise specifically called for or described in these Contract Documents all electrical appliances shall conform to the applicable IEC Publications.

1.7.17.2 Construction Requirements

All cubicles and enclosures shall be of good quality standard production subject to approval by the Engineer. Cubicles shall be free floor standing type, of rigid frame covered with removable steel sheets. The frame shall be bolted to the floor. Cubicles mounted in rooms with computer floors shall have their own supporting structures made of steel profiles, being fixed to the concrete floor. There shall be provision and enough space for entrance of cables from above or below as necessary. The cubicles shall be ventilated if needed; in this case, removable filter inserts shall be fitted to the air entrance openings. Provision for cable fastening shall be inside the cubicles and enclosures, and sufficient space from cable fastenings to nearest terminal.

All control and indicating devices such as contactors, circuit breakers, auxiliary relays, indicating instruments, switches etc., shall be

functionally displayed in appropriate location. All indicating devices shall be visible with the door closed. The layout is subject to the approval of the Engineer.

If required, flush mounted hinged steel doors with latches shall be available: doors shall be with approved locks. The locks shall be of the same type throughout the plant. All panels and cubicles shall have a uniform appearance.

The cubicles and enclosures shall be of protection class IP 40 or higher according to their location. For outside installation, the protection class of cubicles shall be IP 54. If necessary the cubicles shall be equipped with automatically controlled heating elements for protection against internal condensation and moisture.

All panels/cubicles shall have approximately 20% space for mounting of future devices.

Door operated interior illuminating lamps, power socket for 240V 5 / 15A and communication socket shall be provided in all panels.

1.7.17.3 Wiring

Wiring within cubicles and equipment enclosures shall conform to requirements of this section unless otherwise specified. Control wiring shall be stranded copper and shall be not smaller than 1.5 mm^2 , except as otherwise agreed by the Engineer.

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

Cables shall have at least 1000 V grade PVC insulation except for 110V DC and telemetering or communication system equipment for which 650V and 300 V ratings respectively may be acceptable.

For current and potential transformer secondary circuits the minimum cross section of the conductors shall not be less than 2.5 mm^2 .

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 plastic conduits accessible from the front door. The conduits shall not be filled more than 70 %.

Each cubicle shall be provided with an earthing bar (PE) of sufficient cross section carrying any possible fault current without undue heating. All metallic parts of the cubicle not forming part of the live circuits, all instrument transformer terminals to be earthed and other earthing terminals as well as all cable screens and PE-wires shall be connected to the earthing bar.

1.7.17.4 Terminal Blocks

The terminal blocks shall be located to allow a neat and easy connection work and shall be safely accessible while the equipment is

in service. Control circuits and power circuits shall be completely separated by use of divided or separate terminal blocks. Power terminal blocks shall be rated in accordance with applicable standards, and shall be provided with covers.

Control wiring terminal shall be equipped with facilities for opening the circuit. It shall be possible to interchange a single terminal block for a new one without dismantling a whole row. Current transformer terminal blocks shall have provisions for short-circuiting and disconnecting. Not more than two wires shall be connected to any one terminal. Terminal blocks using screws acting directly on the wire will not be accepted. At least 10% spare terminals shall be provided. Terminals shall be marked with printed labels.

1.7.17.5 Grounding

The Contractor shall connect all equipment included in the scope of delivery to the grounding system as described in chapter on Grounding System.

In addition to the grounding through cable screens, all equipment such as cubicles, motors, etc. shall be connected directly to the grounding system using copper wire of area not less than 50 mm² at two different points. In general, all iron parts such as supports, covers, railing, etc. shall be connected to the grounding system. Each conductor shall have its own separate connection point. Pressed on closed shoes shall be used for connections to bars.

1.7.17.6 Protection Devices

For short circuit and overload protection of power and control circuits, moulded case circuit breakers or MCBs shall be used.

Outlets from AC (and DC) distribution panels are protected in their respective panels.

Power supply system shall be provided with three stage of surge protection (First stage with class A type, Second stage with class B type and third stage with class D type of lightning arrestors) to protect electrical & electronic devices.

1.7.17.7 Marking of Equipment and Wiring

All internal equipment and wiring shall be neatly and clearly marked as indicated on the schematic and wiring diagrams. Internal wiring and cables shall be marked with sleeve type engraved marking. Marking system and marking material shall be subject to approval by Engineer. Identification of the respective conductors shall be in accordance with the requirements of IEC publication 60204. In cable, having five conductors or more the individual conductors shall be numbered throughout the entire length. In cables having less than five conductors colour coding in accordance with IEC Recommendations 60204 shall be used.

1.7.17.7.1 Colour Coding For Electrical Connections

Live parts of electrical connections shall be colour coded as follows:

Conductor Designation	Coding Alphanumeric	Symbol	Colour
A.C. network 3 phase	Phase 1	R	Red
	Phase 2	Y	Yellow
	Phase 3	B	Blue
	Neutral	N	Black
A.C. single phase	Phase	P	Red
	Neutral	N	Black
	Earth	E	Green-Yellow
D.C. Network	Positive	a	Red
	Negative	b	Black

1.7.17.7.2. Colour Coding for Mimic Diagrams

Mimic diagrams to be arranged on switchgear cubicles, control panels/desks, etc., shall be colour coded as follows:

Voltage	Colour
220 kV	Gold
11 kV	Signal red
415 V	Black
220 V D.C.	Violet
48 V D.C.	White

Note: Colours given under 1.7.17.7.1 and 1.7.17.7.2 shall be finally agreed upon during detailed design.

1.7.17.8 Compatibility

Equipment serving similar or same purpose shall as far as possible be of same make and type. All indicating lights shall use same type of light bulbs.

1.7.18 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.

1.7.19. Control Concept

1.7.19.1. General

The operations, control procedures, monitoring and protective devices for the plant are described in chapter "Control and Monitoring system" and "Protection system". The Contractor shall provide all equipments required for effecting the intended method of operation and control, within the plant.

Primarily, control of equipment shall be automatic, but manual control and/or local control of the various components shall also be possible from control boards during operation, testing and maintenance of the respective components.

Interlocking devices shall be incorporated in the control circuits in the quantity needed to guarantee correct sequence of operation of the equipment. Protective devices shall be supplied and the particular needs of equipment furnished with the aim of ensuring a safe and reliable operation of the plant in the event of electrical and mechanical disturbances or in case of mal-operation by the plant personnel.

In the design of the control system for different parts of the plant the Contractor shall take care of standardizing the components used.

Where programmable logic controllers are used these shall to the extent possible be compatible. Where control systems are based on relays, sufficient information on the operating status shall be provided through potential free changeover contacts connected to outgoing terminals for comfortable connection.

1.7.20 Handling & Tensioning Devices

Lifting lugs, brackets, eyes, and other items required for attaching lifting devices shall be provided on all of the major components of the equipment weighing more than 24 Kg. All slings and lifting devices required for attachment to the components and assemblies and to a crane hook for handling during erection and later disassembly shall be furnished. Nylon slings shall be provided for lifting of various components up to 100 Tons. Wire rope slings may be provided for lifting loads more than 100 Tonnes.

Hydraulic tensioners shall be provided for tightening of bolts.

1.7.21. Control Switches, Indicating Lamps and Instruments

1.7.21.1. General

Control switches, indicating lamps and instruments shall be arranged so that all parts are readily accessible for servicing without the

run period of 30 days or that to be agreed with the Owner and the Contractor, has been completed in respect of last unit to be commissioned.

NOTE

A part or section of the permanent works shall, for the purpose of this contract, mean one generating unit with all its units and station auxiliaries required to operate the unit at its rated load.

9.4 Quality Assurance Plan & Inspection Schedules:

9.4.1 Quality Assurance Plan

The Contractor shall submit the detailed Quality Assurance Plan for the complete equipment/materials along with the bid for approval and acceptance by the Employer. This shall form integral part of the contract. The QAP shall include inspection and tests proposed to be conducted on raw material/bought out items at the time of induction in the process of manufacturing and at final stage of assembly.

9.4.2 ISO CERTIFICATION

The Contractor should have ISO-9000 Series certification. In case the Contractor does not possess ISO-9000 series certification, he shall submit following details along with the bid, for assessment of his capacity to supply quality equipment/materials/services under the contract.

- Contractor's quality system details:
- Details of system for dealing with items not conforming to prescribed specification.
- Details of sub vendor analysis procedure
- Details of stage and final inspection and auditing
- Contractor's system for calibration of testing and measuring equipment.
- Details of testing and measuring equipment available with contractor
- Details of important facilities/equipment available with the Contractor to produce reliable products having requisite standard.
- Qualification and experience of contractor's key QA personnel.

9.4.3 Inspection Schedules

To facilitate the Employer in planning its inspection activities, the Contractor shall submit along with the bid, the details of the lots along with the time schedule in which the ordered materials shall be offered for inspection as also the places of inspection. These details shall be finalized and approved and form an integral part of the Contract.

2.4 Specifications

2.4.1 Material Specifications

Such specifications shall be prepared for all principal Works and installations. They shall describe the performance (design, material, dimensions, corrosion protection, etc.) of the Works and include a list of components providing information on the manufacturer, type and technical data to obtain the following:

- Full information on the Works, completing the general requirements fixed in the Tender Specification by the data/information of the specific manufacture.
- Proof of compliance with Contract Specification.

For standard Facilities (for example valves, switchgear, control gear, relays, transmitters, indicators, lighting fittings, etc.) catalogues or pamphlets shall be submitted.

The technical data of electrical Works shall include as a minimum:

- - Max. Permissible ambient conditions (temperatures, humidity)
- - Rated current and rated output/capacity
- - Same data as above under specified severest site conditions
- - Rated voltage and ratio or regulation/setting range
- - Max. Service voltage (acc. to IEC)
- - Power frequency and impulse withstand voltages
- - Type and code No. of protection relays and of instantaneous or thermal releases directly attached to circuit breakers and contactors
- - Power requirements for each voltage level (A.C./D.C.).
- - Specific requirements are described in the following paragraphs.

2.4.1.1 Motor Specifications

The motor specifications shall include the thermal motor characteristic both for cold and hot condition, the start-up characteristic when running with the driven machine and all data required for selection of the appropriate motor protection relay (both for cold and hot condition) and for locked rotor protection. Construction type, class of protection and insulation shall also be given.

2.4.1.2 Cable Specifications

The General Cable Specification shall include the calculation of the de-rating factors for the individual modes of installation at applicable ambient temperatures and grouping of cables, and furthermore, for each cross section:

- - The rated current carrying capacity
- - The maximum Short-circuit capacity
- - The voltage drop
- - Type, insulation serving, armouring and sheathing of cable
- - Type, description and catalogue/pamphlet of cable termination.

Separate specification(s) shall be prepared for cable trays, conduits, supporting structures and other accessories.

2.4.1.3 Measurement and Control Apparatus Specifications

The accuracy of performance with respect to variable ambient conditions and the power supply requirements shall be included.

2.5 Lists and Schedules

2.5.1 Motor Lists

The motor lists shall be prepared according to the power distribution boards. The motors are connected to, and shall contain at least the following information/data:

- - Works identification number
- - Description
- - Manufacturer, type, rated data of driven machine
- - Manufacturer and type of electric motor/consumer
- - Rated capacity
- - Service factor (ratio between motor output and power requirement of the driven machine)
- - Rated speed
- - Rated voltage
- - Rated current
- - Ratio of starting current to rated current
- - Ratio of pull-out torque to rated torque
- - Power factor at rated capacity
- - Efficiency at rated capacity
- - Power consumption at machine design loading
- - Total weight
- - Design/enclosure/cooling (acc. to IEC)
- - Duty (continuous/intermittent/start-up)
- - Starting method/permissible starting frequency

- - Denomination of feeder
- - Motor protection
- - Applicable Standard Circuit Diagram (Category)
- - Maximum number and overall diameter of power cable(s)
- - Manufacturer and type of bearing(s)
- - Manufacturer, type and quantity of lubricant, service interval
- - Manufacturer, type, number, size, spring pressure and service interval of brushes (if applicable).

2.5.2 Motor Starter Lists

The motor starter lists shall include all starters and contactors used for motors and contain the following technical information as a minimum:

- - Works identification number
- - Electrical design data as nominal and actual current rating, voltage rating, coil rating, making and breaking capacity, mode of operation
- - Maximum power cable size
- - Maximum control cable size
- - Current transformer ratio, class and capacity
- - Type of protection relaying and catalogue number
- - Setting of protection relays and maximum continuous rating of the protected circuit
- - Type and current rating of the back-up fuses/MCBs for the main and control circuits.

Note: Motor Starter Lists can be substituted by part lists, already forming part of switchgear manuals

2.5.3 Cable Lists/Interconnection Lists

The Cable Lists shall include for each individual cable the following as a minimum:

- Cable number, in accordance with Identification System.
- Cable type
- Rated voltage
- Number and size of conductors
- Overall diameter
- Cable termination at each end

- Connection point at each end with cubicle/Works identification and terminal numbers
- Cable routing

In case interconnecting cubicles are used, the lists shall be prepared to show:

- - Cable termination for incoming and out coming cables
- - Interconnection wiring

2.5.4 List of Measurements

This list shall indicate all measurements, local as well as remote, and shall contain at least:

- - Item/code number, function code
- - Description and denomination of measuring loop
- - Data of tapping point
- - Data of local devices (as detectors, instrument transformers, transmitters)
- - Data of remote devices.

2.5.5 Alarm Lists

These lists shall indicate all alarms and shall contain at least:

- - Item/code number and function code
- - Description and denomination of alarm
- - Data of alarm detector (contact) referring to applicable circuit diagram
- - Data of alarm annunciator (location and clear text labeling)

2.5.6 List of Final Control Elements

This list shall indicate all control actuators and control valves and shall contain at least:

- - Item/code number
- - Data of pipe and valve connections
- - Data of valve layout
- - Rated power

2.5.7 Workshop Test Schedules

Individual Workshop Test Schedules shall be prepared for Works/installations (such as pipes, cranes, machines, switchgears, control gear, cables) and shall contain at least:

- - Works identification number
- - Manufacturer
- - Place of manufacture
- - Place of test
- - Date of test
- - Objective of test (all individual tests)
- - Standards applied
- - Certification
- - Inspection (by Engineer / Independent Test Authority / Contractor/ Subcontractor)
- - Release for shipment
- - Remarks

On the above schedule or on separate sheets the Test Procedure shall be specified giving for each test item (kind of test) a description, test method / Standards, used instruments, sample/routine test, test judgment.

2.5.8 Site Test Schedules

Testing at site shall include tests specified in the Particular Technical Specifications (Section-IX) and any tests recommended by the manufacturers as per their standard practices.

2.5.9 List of Tools and Appliances

Lists of Tools and Appliances shall detail for all tools and appliances included in the scope of supply:

- - Item and code number
- - Description
- - Quantity
- - Weight
- - Gross storage requirements (separate for open-air, indoor, air-conditioned) for individual component sets.

2.5.10 Spare Part Lists

Spare part lists shall detail for all spare parts included in the scope of supply:

- - Detailed drawing (where possible)
- - Item and code number
- - Description
- - Quantity
- - Weight
- - Gross storage requirements (separate for open-air, indoor, air-conditioned) for individual component sets.

2.5.11 List of Works Identification Numbers

This list shall contain the identification numbers of Works in alphanumeric order and for each of them a description (the defined Works denomination, for example as written on the Works label) and the location (short definition of outdoor area and level elevation or building/room with elevation and room number).

2.6 Calculations

In addition to the drawings or whenever the contractual documents do so require, the Contractor shall submit to the Engineer for checking, the appropriate calculations for determining the main sizes, stress levels, dimensions and operational characteristics, safety factors, clearly indicating the principles on which the calculations were based. The calculations shall include the formulae, standards, test results, basic assumptions, etc. Submission of computer calculations without baseline information such as derivation of the calculation method, applied formulas, definition of variables and constants, explanation of abbreviations etc., will not be accepted.

2.6.1 Short-Circuit Calculations

The short-circuit calculations shall be performed in accordance with VDE Standard 0102, part 1.

2.7 Installation and Commissioning Procedures

2.7.1 Installation Procedures

The installations procedures shall describe in sequential steps the erection of major equipment and shall contain sufficient details such as equipment preparation on erection bay, handling of large and heavy pieces, leveling, anchoring, site welding, site painting, erection checks, site pressure tests, site flushing and cleaning of hydraulic systems,

alignment and run out checks to allow the engineer/employer to plan and supervise the Works at site, if required.

2.7.2 Pre-Commissioning Tests and Procedures

Pre-commissioning tests and procedures shall be described in sequential steps for the pre-commissioning of all electrical and mechanical equipments and shall also contain sufficient details viz. checking of installations, ratings, cable terminal checking and operation test of all auxiliary equipments etc.

2.7.3 Commissioning Procedures

The commissioning procedures shall sequentially and in sufficient detail describe activities and tests for all systems covered by the Contract Document.

2.7.4 Commissioning Test

Commissioning acceptance tests shall be carried out, on all generating units to verify the rating characteristics of generating units and other equipment's in accordance to relevant standards. The complete field acceptance test reports shall be prepared by the Contractor and submitted to the Employer for approval.

2.7.5 Test Run

The test run on generating units shall be carried out as per relevant provisions of IEC standards.

2.8 Operation and Maintenance Manuals

2.8.1 Contents

The Operation and Maintenance Manuals shall be provided in Ten (10) copies along with CD-ROM (three sets), and shall contain the following information in sufficient detail to enable the Employer to maintain, dismantle, reassemble, adjust and operate the Works with all its items of Works and installations:

- Table of Contents
- List of Illustrations
- Introduction

The Introduction shall contain:

- A brief general description of the Works items
- A brief description of the use of the Works items

- Definitions of technical terms used in subsequent graphs of the instruction book
- A complete list of all items used in accordance with the Works Components Identification System.
- Detailed Description

Detailed description shall contain a complete and accurate description of the Works, all components and ancillaries, their assembling and dismantling. An accurate list stating clearances, tolerances, temperatures, fits, etc. shall be included.

- Operating Principles and Characteristics

A brief summary of the technical operating principles of the Works, including diagrams, circuit diagrams, sequence diagrams, piping, etc.

- Operating Instructions

The instructions shall be accurate and easy to understand, and shall contain the sequence of individual manipulations required for operation. The information shall be presented in such a manner that the contents of this paragraph can be used for instructing personnel in the operation of the Works. Tables, lists and graphic presentations should be used whenever possible for making the description readily understandable. An appropriate trouble-shooting list shall be included in this chapter.

- Testing and Adjustment

The entire testing and adjustment procedure required for the Works after overhauls and during operation shall be described.

- Maintenance Instructions

This section is divided into six parts:

1) Preventive maintenance, indicating the inspections required at regular intervals, the inspection procedure, and the routine cleaning and lubricating operations, the regular safety checks and similar steps.

- The maintenance instructions shall include a tabular (or in other approved form) summary of the required activities sorted according to
 - Daily
 - Weekly
 - Monthly
 - Quarterly
 - Yearly
 - (Or other) cycles as applicable.

This document shall provide the maintenance engineer with brief and yet fully comprehensive information including all references to the applicable, detailed service and maintenance instructions.

- 2) Repair and adjustment, describing the inspections, fitting and dismantling of parts, fault tracing as well as repair and adjustment procedures.
- 3) Spare part lists, containing all the necessary data for ordering spare parts. These lists shall include all spare parts, those to be supplied and those not to be supplied under the present Contract. Detailed drawing for each item of spare parts shall be supplied. The above list should include minimum and maximum quantities of spares to be maintained by the project.
- 4) Tool lists, containing all necessary data for identification of tools to be delivered under the present Contract.
- 5) List of suppliers and alternative suppliers and addresses.
- 6) As-built drawings

2.8.2 Performance

Each drawing aforementioned shall have a uniform size. The final size of drawings for the Operation and Maintenance Manual shall be decided by the Engineer-in-charge. Catalogue sheets, illustrations, printed specifications, etc., shall be checked and prepared by the Contractor in such a way that the figures, statements and data valid for the delivered sizes and types of the Works concerned are clearly marked. All figures, statements and data valid for sizes and types not delivered must be crossed out.

2.8.3 Revisions and Supplements

The completeness of the manuals shall be checked during installation, testing, commissioning and trial operation jointly by the Contractor and Engineer-in-charge.

If it becomes evident during the installation, commissioning trial operation and defects liability period of the Works that the Operation and Maintenance Manuals are inadequate or incorrect, the Contractor shall supply immediately the necessary supplements and corrections. This shall be handled in the following manner:

➤ Deletions:

One sheet of errata, printed on pink paper, shall be issued indicating the pages and date of issue of those pages, which are to be deleted, and are no longer valid.

➤ Corrections, Revisions, Replacements:

New sheet or sheets shall be issued to replace the wrong pages. Whenever a new sheet is added to the instruction manuals, this sheet shall be given the new date of issue and a revision symbol, and an indication "Substituted for ... " and a marking of the corrected/revised items.

➤ Insertions, Supplements:

Insertions or supplements shall be accompanied by a new respective "Table of Contents" page, where the latter shall be handled as described above under replacements.

The revisions and supplements requested by the Engineer-in-charge shall be made by the Contractor at the Site as far as possible and shall be submitted in each case to the Engineer for checking and approval as stated above.

Before issuing the "Taking-Over Certificate", the ten sets of revised copies of the Operation and Maintenance Manuals shall be submitted together with the specified number of complete sets of drawings of the Works as completed. The Works shall not be considered complete for purposes of taking over under the terms of the General Conditions of the Contract until the above documents have been supplied by the Contractor.

2.9 Progress Reports during Design and Manufacturing

During every quarter design and manufacturing the Contractor shall quarterly submit four (4) copies of the progress reports in a format acceptable to the Engineer, detailing the progress of the work during the preceding period. The report shall contain (but not be limited to) the following information:

- - A general description of the Works performed during the reporting period on each main activity, and include any notable problems, which were encountered.
- - The total overall percentages of design and manufacturing works completed, with reference to the CPM programme. Appropriate comments shall explain any differences.
- - The percentages of each main work activity completed during the reported quarter vis-à-vis the scheduled programme. Appropriate comments shall explain any differences.
- - A list of all activities of scheduled and actual progress during the reporting period including actual starting dates versus scheduled starting dates and actual completion dates versus scheduled completion dates for each activity. Appropriate remarks shall explain any differences, and also methods/actions prepared to be taken for making up the deficiencies in actual design and manufacturing process.
- - A list of activities scheduled to be started within the next two (2) months, with expected starting and completion dates. If the expected starting and/or completion dates are different from those shown on the CPM programme, an explanation shall be given.

2.10 Progress Reports during Installation at Site

During erection the Contractor shall, before the tenth (10th) day of each calendar month, submit four (4) copies of the monthly progress reports in a format acceptable to the Engineer, detailing the progress of the work during the preceding month. The report shall contain (but not be limited to) the following information:

- - A general description of the Works performed during the reporting period on each main activity, and includes any notable problems, which were encountered.
- - The total overall percentages of erection works completed, with reference to the CPM programme. Appropriate comments shall explain any differences.
- - The percentages of each main work activity completed during the reported month with reference to the scheduled programme. Appropriate comments shall explain any differences.
- - A list of all activities of scheduled and actual progress during the reporting period including actual starting dates and scheduled starting dates and actual completion dates, scheduled completion dates for each activity. Appropriate remarks shall explain any differences.
- - A list of activities scheduled to be started within the next period of two (2) months, with expected starting and completion dates. If the expected starting and/or completion dates are different from those shown on the CPM programme, an explanation shall be given.
- - A list of local manpower (by trade classification) employed during the reporting period.
- - A list of expatriate personnel (by position) employed during the reporting period.
- - A list of the Contractor's Equipment and materials available at the Site at the beginning of the report period. Also a list of equipment and materials, which arrived at Port of entry and status of custom clearance.
- - Photographs of progress of significant events. The Engineer-in-charge may demand specific photographs if deemed necessary.
- - Main items of temporary facilities constructed during the reporting period.
- - A statement detailing the status of progress on the overall programme and how to regain any lost time or setbacks, which may have occurred.
- - A list of inoperable temporary equipment, and the estimated date when the repair will be completed.

- - A statement about labour relations & an explanation of actual and potential problems.
- - A listing of each accident at the site involving the hospitalization and/or death of any person
- - A listing of the amount & date of any payments received during the reporting period & the amount of any monthly invoice, which has been submitted but not yet paid.
- - A list of claims (if any) submitted during the reporting period including the claimed cost & extension of time.
- - A statement concerning potential problems and recommendations on how they could be resolved.

DOWNLOADED



TITLE

LV MOTORS

DATA SHEET-A

SPECIFICATION NO.

VOLUME II B

SECTION D

REV NO. 00 DATE 01/10/2012

SHEET 1 OF 1

- | | | | |
|------|--|---|---|
| 1.0 | Design ambient temperature | : | 50 °C |
| 2.0 | Maximum acceptable kW rating of LV motor | : | ≤200KW |
| 3.0 | Installation (Indoors/ Outdoors) | : | As required |
| 4.0 | Degree Of Protection (Indoor/Outdoor) | : | IP54/IP55 |
| 5.0 | Type of Cooling | : | TEFC/CACA/TETV |
| 6.0 | Details of supply system | | |
| | a) Rated voltage (with variation) | : | 415V ± 10% |
| | b) Rated frequency (with variation) | : | 50 Hz (Variation: +3% TO –5%) |
| | c) Combined voltage & freq. variation | : | 10% |
| | d) System fault level at rated voltage | : | 45 kA for 1 sec |
| | e) Short time rating for terminal boxes | | |
| | o 110kW & Above (Breaker controlled) | : | 45 kA for 1 sec |
| | o Below 110kW (SFU+ Contactor controlled) | : | 45 KA for 0.20 sec. |
| | f) LV System grounding | : | Solidly |
| 7.0 | Class of insulation | : | Class 'F', with temp rise limited to class B.
(Refer clause 5.00.00 of Motors) |
| 8.0 | Minimum voltage for starting
(As percentage of rated voltage) | : | 85% 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 | : | 240 V, 1Φ , 50 Hz |
| 12.0 | Rating up to which Single phase motor | : | Acceptable below 0.20 kW |
| 13.0 | Tests | : | As per Customer motor spec. (enclosed) |
| 14.0 | Energy efficient/ Flame proof motor | : | As per Customer spec. requirement |

- Also detail Customer spec. for Motors to be referred as enclosed with spec.



DOCUMENT TITLE:

**DATA SHEET-A
LV SWITCHGEAR**

SPECIFICATION NO.

VOLUME NO.

SECTION :

REV NO. : **00** DATE:

SHEET : 1 OF 27

(I) LOW VOLTAGE SWITCHGEAR

(A) SWITCHGEAR

1.0 SYSTEM DESIGN DATA

1.1 Design Ambient : 50°C

1.2 Relative Humidity

a) Average : %

b) Maximum : %

1.3 Max. system voltage for continuous operations : 457 Volt

1.4 One minute power frequency withstand voltage:

a) Main circuit : 2.5 KV rms.

b) Aux. circuit : 2.0 KV rms.

1.5 *DC System fault level (220 V)* : **20 KA**

1.6 Formula for calculating Full Load Current (FLC) : kW x 1000

--

of motors $\sqrt{3} \times V(\text{line}) \times \text{PF} \times \text{Efficiency}$

2.0 **APPLICABLE STANDARDS** : Latest revision of Applicable Standard

3.0 CONSTRUCTIONAL FEATURES

3.1 GENERAL

3.1.1 Operational Fronts : [] Double Front

[] Single Front

[√] Both as per BOM

3.1.2 a. Type of sheet steel : [] Hot rolled

[√] Cold rolled

b. Sheet metal thickness (Minimum)

a) Non-load bearing covers : 1.6 mm

b) Non-load bearing partitions : 1.6 mm

c) Load bearing members : 2.0 mm

	DOCUMENT TITLE:		SPECIFICATION NO.
	DATA SHEET-A LV SWITCHGEAR		VOLUME NO.
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			SHEET : 2 OF 27
d) Frames : 2.0 mm e) Door : 1.6 mm f) Withdrawable unit : 1.6 mm 3.1.3 Rating above which louvers are permitted : 1600 Amp. 3.1.4 Degree of Protection of switchboards with modules in service and all doors closed. a) Without louvers : IP-54 b) With louvers : IP-42 3.1.5 Spare Modules : [√] As per BOM (Load list) [] % 3.2 DRAWOUT MODULES 3.2.1 Type of execution of modules (functional unit) : a) Circuit breaker unit (Incoming & outgoing) : [√] Withdrawable [] Fixed b) MCCB unit (Incoming) : [√] Withdrawable [] Fixed c) Switch-Fuse & Contactor (Incoming) : [√] Withdrawable [] Fixed d) Switch or Switch-Fuse (Incoming) : [√] Withdrawable [] Fixed e) MCCB unit (Outgoing) : [√] Withdrawable [] Fixed f) Contactor starter unit (Outgoing) : [√] Withdrawable [] Fixed g) Switch-Fuse unit (Outgoing) : [√] Withdrawable [] Fixed h) Incoming Voltage Transformer (VT) : [√] Withdrawable [] Fixed i) BUS VT : [√] Withdrawable [] Fixed j) Control Transformer (upto 2.5kVA) : [] Withdrawable [√] Fixed k) Space Heater : [] Withdrawable [√] Fixed l) Alarm : [] Withdrawable [√] Fixed m) DC Supply : [] Withdrawable [√] Fixed 3.2.2 Rating upto which withdrawable units : 630 Amp.			

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applicable, if specified in 3.2.1 b), d), e) and g) above. 3.2.3 Facility for functional testing of withdrawable modules required for : a) Incomer units (PCC) : ☒ YES ☐ NO b) Incomer units (MCC) : ☒ YES ☐ NO c) Outgoing contactor starters : ☒ YES ☐ NO d) Bus - Couplers : ☒ YES ☐ NO 3.3 BUSBARS & CONNECTIONS 3.3.1 Busbar material a) Phase & Neutral : ☐ Copper ☒ Aluminium b) Earth : ☐ Copper ☐ Aluminium ☒ Galvanised MS 3.3.2 Fault Level : 50 kA 3.3.3 Short time current a) for switchboards fed by ACB / MCCB : 50 KA ,1 sec. b) For switchboards fed thru HRC Fuses : 50 KA ,0.2 sec. 3.3.4 Temperature Rise (for Horizontal Busbar) a) Design ambient : ☐ 45 ☒ 50 °C b) Temp. rise for i. Silver plated joints : ☐ 60 ☒ 55 °C ii. Non-silver plated joints : ☐ 45 ☒ 40 °C 3.3.5 Whether HRPVC sleeving to be provided for horizontal busbar : ☒ YES ☐ NO 3.3.6 Whether Shrouds on busbar tap offs to be provided : ☒ YES ☐ NO 3.3.7 Applicable method of colour coding for black PVC sleeving : Bands as per Table 1 of IS:11353				



DOCUMENT TITLE:

**DATA SHEET-A
LV SWITCHGEAR**

SPECIFICATION NO.

VOLUME NO.

SECTION :

REV NO. : 00 DATE:

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3.3.8 Busbar clearances in air (minimum)

- | | | | |
|----|-------------|---|-------|
| a) | Phase-Phase | : | 25 mm |
| b) | Phase-Earth | : | 25 mm |

3.4 SECONDARY WIRING

- | | | | |
|-------|----------------------|---|-------------------------------|
| 3.4.1 | Colour code of wires | : | As per clause 3.4.3 of Sec D. |
|-------|----------------------|---|-------------------------------|

3.4.2 Sizes of wires (minimum)

- | | | | |
|----|-------------|---|---------------------|
| a) | CT leads | : | 2.5 mm ² |
| b) | Other wires | : | 1.5 mm ² |

3.5 AUXILIARY BUSES

Provision of following :

- | | | | | |
|----|--------------------------------|---|---|---|
| a) | AC Control Bus | : | ☐ 240 V | ☒ 110 V |
| b) | DC Control Bus | : | ☒ 220 V | ☐ 110 V |
| c) | 24V AC Wdg. htg. Bus | : | ☐ YES | ☒ NO |
| d) | 240V AC Space htg. Bus/buswire | : | ☒ YES | ☐ NO |
| e) | Alarm Bus/buswire | : | ☐ YES | ☒ NO |

3.6 CONTROLS, INDICATIONS & ALARMS

- | | | | | |
|-------|--|---|--|--|
| 3.6.1 | Means for simulation testing to be provided | : | ☐ YES | ☒ NO |
| 3.6.2 | Scope of interposing relays for remote command | : | ☐ Mounting & wiring only
☒ Supply, mounting & wiring interface | |

3.7 CABLING AND TERMINATIONS

- | | | | | | |
|----|---|---|--|--------------------------------|-------------------------------|
| a) | Cable Entry | : | ☒ BOTTOM | ☐ TOP | ☐ REAR |
| b) | Cable Sizes (tentative) | : | As per enclosed Annexure II | | |
| c) | Type of Incoming connections from transformer to PCC (Note : Also refer BOM for respective boards.) | : | ☐ Bus Trunking | ☐ Cable | |
| | | | ☒ Bus Duct | | |

3.8 EARTHING

- | | | | |
|--|-------------------|---|--|
| | Size of earth bus | : | ☐ 300 mm ² Copper(50 mm x 6mm) |
|--|-------------------|---|--|

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☒ 500 mm² Galvanised MS (90 mm x 9.5 mm) : ☐ 500 mm² Aluminium Alloy as per grade 19000 H2(50 mm x 9.5 mm)				
4.0 SWITCHGEAR MAIN ASSEMBLIES				
4.1 AIR CIRCUIT BREAKERS				
4.1.1	Rated voltage	:	415 Volts	
4.1.2	Rated frequency	:	50 Hz	
4.1.3	Number of Poles	:	☒ Three ☐ Four	
4.1.4	Symmetrical (RMS) Interrupting capacity at rated voltage.	:	50 KA.	
4.1.5	Momentary making current	:	105 KA (peak)	
4.1.6	Short circuit performance category	:	P-2	
4.1.7	Short time rating			
	a) Current	:	50 KA	
	b) Duration	:	1 sec.	
4.1.8	Normal (continuous) current rating at specified design ambient (Amperes)	:	As specified in board-wise BOM / SLD	
4.1.9	One minute power frequency withstand voltage (RMS)	:	2.5 KV.	
4.1.10	Operating mechanism			
	a) Closing	:	☒ Motor wound spring ☐ Manual	
	b) Tripping	:	☐ Direct acting on incoming to MCC & outgoing circuit on PCCs to MCCs ☐ Shunt trip ☒ Both of above	
4.1.11	Operation counter required	:	☒ YES ☐ NO	
4.1.12	Auxiliary voltage			
	a) Spring charging motor	:	☒ 220 V DC ☐ 240 V AC	

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b) Closing release coil : ☒ 220 V DC [] 240 V AC c) Shunt trip coil : ☒ 220 V DC [] 240 V AC 4.1.13 No. of Auxiliary Contacts required (min.) for indicating breaker 'ON/OFF' status and for purchaser's use : 6 NO + 6 NC 4.1.14 Type of release (where applicable) : ☒ Static [] Electromagnetic 4.1.15 Whether Programmable Secondary isolating contact required : ☒ YES [] NO 4.2 CONTACTOR STARTER UNITS (DIRECT-ON-LINE) 4.2.1 Max. motor rating upto which contactor starter can be applied. : BELOW 160 KW 4.2.2 Type of short circuit device : ☒ HRC Fuse [] MCCB 4.2.3 Locked rotor protection required : [] YES ☒ NO 4.2.4 Type of co-ordination between SCPD & other starter components as per IS:8544. : TYPE II 4.3 SWITCH-FUSE UNITS 4.3.1 Breaking capacity : 3 times rated current with conditions : a) Voltage : 110 % rated voltage b) Power Factor : 0.3 4.4 MOULDED CASE CIRCUIT BREAKERS (MCCB) 4.4.1 Application a) Contactor Starter : [] YES ☒ NO b) Other circuits : [] YES ☒ NO c) If Yes for b) Required for rating upto : Amp.			

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4.4.2 Rated voltage : 415 V				
4.4.3 Number of poles : Three				
4.4.4 Rated short circuit duty : P-2				
4.4.5 Rated breaking capacity (rms) at 415 V : kA				
4.4.6 Rated making current (peak) : kA				
4.4.7 On/Off operation				
a) Manual : ☐ YES ☐ NO				
b) Remote power operated : ☐ YES ☐ NO				
4.4.8 Releases required.				
a) Overload : ☐ YES ☐ NO				
b) Under voltage : ☐ YES ☐ NO				
c) Short circuit : ☐ YES ☐ NO				
d) Shunt trip : ☐ YES ☐ NO				
4.4.9 Auxiliary contacts				
a) Numbers : 1 NO + 1 NC				
b) Rating : Amp				
5.0 SWITCHGEAR COMPONENTS				
5.1 ISOLATING SWITCH				
5.1.1 No. of poles : 3				
5.1.2 Utilization category for main contacts : AC 23(For Motor Feeder) AC 22(For Other Feeders) DC22(For DC)				
5.1.3 Auxiliary contacts				
a) Number : 1 NO + 1 NC				
b) Rating : As per Requirements				
5.1.4 Minimum thermal rating : 16 Amp.				
5.2 POWER CONTACTORS				
5.2.1 Coil voltage (nominal) : [√] 110 V AC 50 Hz				

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☐ 240 V AC 50 Hz ☐ 110 V DC ☐ 220 V DC				
5.2.2	No. of poles for main contactor	:	Three	
5.2.3	Permissible supply voltage variation w.r.t. nominal coil voltage	:	85 – 110 %	
5.2.4	Minimum thermal rating when used in power circuit	:	16 Amp.	
5.2.5	Utilization category			
	I) AC			
	a) Reversible motor	:	AC 4(class-III)	
	b) Non-reversible motor	:	AC 3(class-III)	
	II) DC	:	DC2(class-I)	
5.2.6	Type of hold-in mechanism	:	☒ Electrically held ☐ Mechanical latch-in	
5.3	HIGH RUPTURING CAPACITY (HRC) FUSES			
5.3.1	Max. prospective fault current to be interrupted			
	a) For main circuit	:	50 KA	
	b) For Secondary circuit:			
	i. AC	:	50 KA	
	ii. DC	:	20 KA	
5.4	THERMAL OVERLOAD RELAY			
5.4.1	Range	:	80-120%	
5.4.2	Number of Contacts	:	1 NO + 1 NC	
5.4.3	Resetting	:	☒ Hand ☐ Self	
5.4.4	Single phasing prevention feature provided	:	☒ YES ☐ NO	
5.5	SINGLE PHASING PREVENTER (SPP)			
5.5.1	Separate SPP required	:	☐ YES ☒ NO	
	If yes, applicable above motor	:	kW	

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	DATA SHEET-A LV SWITCHGEAR		VOLUME NO.																																																						
			SECTION :																																																						
			REV NO. : 00 DATE:																																																						
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rating 5.5.2 Delay time : Variable upto 10 sec. 5.5.3 Number of Contacts : 1 NO + 1 NC 5.5.4 Resetting : [] Hand [] Self 5.6 INSTRUMENTS AND METERS 5.6.1 Indicating Instruments <table border="0"> <tr> <td>a) Function</td> <td>:</td> <td>VOLTMETER</td> <td>AMMETER</td> </tr> <tr> <td>b) Type</td> <td>:</td> <td colspan="2">Moving Iron Spring Controlled/Tau's Band</td> </tr> <tr> <td>c) Shape</td> <td>:</td> <td>Square</td> <td>Square</td> </tr> <tr> <td>d) size</td> <td>:</td> <td>96x96 mm</td> <td>96x96 mm</td> </tr> <tr> <td>e) Accuracy class</td> <td>:</td> <td>2.0</td> <td>2.0</td> </tr> <tr> <td>f) Current coil rating</td> <td>:</td> <td></td> <td>1 Amps.</td> </tr> <tr> <td>g) Voltage coil rating</td> <td>:</td> <td>110 Volts</td> <td></td> </tr> <tr> <td>h) Angle of deflection</td> <td>:</td> <td>90</td> <td>90 deg.</td> </tr> </table> 5.6.2 Energy Meters <table border="0"> <tr> <td>a) Type</td> <td>:</td> <td></td> </tr> <tr> <td>b) Accuracy class</td> <td>:</td> <td>0.5</td> </tr> <tr> <td>c) Hours of operation</td> <td>:</td> <td></td> </tr> <tr> <td>d) Current coil rating</td> <td>:</td> <td>Amps.</td> </tr> <tr> <td>e) Voltage coil rating</td> <td>:</td> <td>Volts</td> </tr> </table> 5.6.3 Provision of ammeter for motor rating : 30 KW and above 5.7 RELAYS 5.7.1 Type : ☒ Static ☐ Electromagnetic [] Numerical 5.7.2 Coil Rating : <table border="0"> <tr> <td>a) Current coil</td> <td>:</td> <td>☒ 1 Amp. [] 5 Amp.</td> </tr> <tr> <td>b) Voltage</td> <td>:</td> <td>110 V AC/220 V DC</td> </tr> </table> 5.7.3 Means for in-built : ☒ YES [] NO					a) Function	:	VOLTMETER	AMMETER	b) Type	:	Moving Iron Spring Controlled/Tau's Band		c) Shape	:	Square	Square	d) size	:	96x96 mm	96x96 mm	e) Accuracy class	:	2.0	2.0	f) Current coil rating	:		1 Amps.	g) Voltage coil rating	:	110 Volts		h) Angle of deflection	:	90	90 deg.	a) Type	:		b) Accuracy class	:	0.5	c) Hours of operation	:		d) Current coil rating	:	Amps.	e) Voltage coil rating	:	Volts	a) Current coil	:	☒ 1 Amp. [] 5 Amp.	b) Voltage	:	110 V AC/220 V DC
a) Function	:	VOLTMETER	AMMETER																																																						
b) Type	:	Moving Iron Spring Controlled/Tau's Band																																																							
c) Shape	:	Square	Square																																																						
d) size	:	96x96 mm	96x96 mm																																																						
e) Accuracy class	:	2.0	2.0																																																						
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c) Hours of operation	:																																																								
d) Current coil rating	:	Amps.																																																							
e) Voltage coil rating	:	Volts																																																							
a) Current coil	:	☒ 1 Amp. [] 5 Amp.																																																							
b) Voltage	:	110 V AC/220 V DC																																																							



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testing required

5.7.4 Relaying Requirement

- | | | | | |
|----|----------------------------|---|---|--|
| a) | Inverse time over current | : | ☐ YES | ☒ NO |
| b) | Definite time over current | : | ☒ YES | ☐ NO |
| c) | Motor protection | : | ☒ YES | ☐ NO |
| d) | Inverse time earth fault | : | ☐ YES | ☒ NO |
| e) | Definite time earth fault | : | ☒ YES | ☐ NO |

NOTE : Refer BOM for application of relays in various types of incomers and feeders.

5.8 CURRENT TRANSFORMERS (AS PER IS: 2705)

- | | | | |
|--------|--|---|--|
| 5.8.1 | Type | : | CAST RESIN |
| 5.8.2 | Secondary Rating | : | ☒ 1 Amp. ☐ 5 Amp. |
| 5.8.3 | Output | : | VA (As per Requirements) |
| 5.8.4 | Accuracy class (metering) | : | cl 2.0 |
| 5.8.5 | Accuracy class (protection) | : | 5P20 |
| 5.8.6 | Accuracy limit factor (ALF) | : | 20 |
| 5.8.7 | Primary current rating | : | (As per BOM) Amps. |
| 5.8.8 | Instrument security factor | : | Not More Than 5 |
| 5.8.9 | Specific data for CTs required for differential Protection | : | |
| a) | Lead resistance | : | |
| b) | VA burden (of remote device) | : | |
| 5.8.10 | Short time rating | : | 50 KA, 1sec. |
| 5.8.11 | Dynamic Current | : | 105 KA |

5.9 VOLTAGE, CONTROL & WINDING HEATING TRANSFORMERS

5.9.1 Voltage Transformers

- | | | | |
|----|-----------------|---|--|
| a) | Type | : | EPOXY RESIN |
| b) | System Earthing | : | ☒ Effective ☐ Non-effective |

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c) Secondary terminal voltage (phase-phase) : 110 Volt d) Accuracy class : 1.0 e) Output : As per requirement f) Winding configuration : g) Over voltage factor : 1.2(continuous) 5.9.2 Control Transformers (for contactor operation) a) Rated Primary voltage (Phase-Phase) : 415 volts b) Taps : $\pm 5\%$ in steps of 2.5% c) Minimum secondary terminal voltage (when primary voltage is minimum & transient current is maximum) : Not less than minimum pick up voltage of AC contactor d) Secondary terminal voltage : ☒ 110 V ☐ 240 V AC e) Whether separate control transformer required for individual circuit : ☐ YES ☒ NO 5.9.3 24 V Winding Heating Transformer (If required as per item 5.14 below) a) Secondary terminal voltage : 24 Volts b) Primary voltage : 415 Volts 5.10 MINIATURE CIRCUIT BREAKER 5.10.1 Application (Whether acceptable in lieu of fuses for secondary circuits) If yes, : ☒ YES ☐ NO 5.10.2 Rating : 16 Amp. 5.10.3 Short time rating : 9 KA 5.10.4 Thermal overload and magnetic short circuit protection required : YES				

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5.11 CONTROL AND SELECTOR SWITCH

5.11.1 Application :

As per schemes

5.11.2 Type

a) Control Switch :

☒ Stay put
☐ Spring return
☐ Wing knob
☐ Pistol grip

b) Selector switch :

☒ Stay put
☐ Wing knob

5.11.3 Contact rating

a) at 230V AC continuous :

Amp.

b) at 220V DC breaking :

Amp.

5.11.4 Contact development (give reference) :

5.11.5 Lockability

a) Control Selector switch :

☒ in each position
☐ with integral barrel lock & key

b) Control switch :

☒ In each position
☐ With integral barrel lock & key in neutral position

5.12 INDICATION LAMPS

5.12.1 Lens colour

a) On :

Red

b) Off :

Green

c) Auto trip :

Amber

d) Service :

Blue

e) Test :

White

f) Spring Charged :

Amber

g) Lockout relay healthy :

White

h) Phases :

Red, Yellow, Blue

5.12.2 Circuit voltage :

☐ 240 V AC
☒ 110 V DC



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[√] 220 V DC

5.13 PUSH BUTTONS

5.13.1 Voltage Grade : 415 Volt

5.13.2 No. of Contacts :

a) NO : 2

b) NC : 2

5.13.3 Contact rating

a) At 230V AC continuous : Amp.

b) At 220V DC breaking : Amp.

5.13.4 Function : START STOP RESET

a) Colour of actuator : Green Red Black

b) Type of actuator head : S M S
(S=Shrouded, M=Mushroom)

c) Lockability : N Y N
(Y=Yes, N=No)

d) Any other feature : Refer Section-C of Vol. IIB

5.14 ANTI-CONDENSATION HEATERS

5.14.1 24 V motor winding heating

a) Requirement : [] YES [] NO

If yes,

b) Applicable Rating : 30 KW
(including & below)

c) Maximum space heating : 40 % of FLC
current drawn

5.14.2 Panel space heating

a) Voltage : 240 V AC

b) Thermostat required : [√] YES [] NO

c) If b) is yes, limit : oC
of adjustability of



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temp. within panel

d) If b) is no, the min temp. to be maintained : °C

e) Separate space heater required for front and rear panels : ☒ YES ☐ NO**5.15 GENERAL PURPOSE TIMERS**

(Other than electromechanical or Electronic timers used on protection scheme)

5.15.1 Type : ☒ Electronic ☐ Static**5.15.2 No. of contacts**

a) ON time delay : (2NO + 2NC)

b) OFF time delay : (2NO + 2NC)

c) Instantaneous : (1NO + 1NC)

5.15.3 Coil voltage rating (AC) : ☐ 240 V ☒ 110 V**6.0 PAINTING****6.1 Shade**

a) Interior : RAL 7032

b) Exterior : RAL 7032

6.2 Paint Finisha) Interior : ☐ Matt ☒ Semi-glossyb) Exterior : ☒ Semi-glossy ☐ Full-glossy**6.3 Paint thickness**

(i) Spray Painting : 80 microns

(ii) Powder coating : 50 microns

7.0 O&M SPARES

7.1 Duration for which O&M spares required : 3 years



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ANNEXTURE – I

Equipment, accessories, components, materials and tests shall conform, in general, to the specifications of latest revision of applicable standards.



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ANNEXURE III
MOTOR RATINGS & DATA

MOTOR RATING (kW)	POWER FACTOR	EFFICIENCY	FLC (AMP)
1.1	0.75	0.73	2.79
2.2	0.79	0.79	4.9
3.7	0.79	0.84	7.75
5.5	0.79	0.84	11.53



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7.5	0.8	0.87	14.99
9.3	0.8	0.88	18.37
11.0	0.8	0.89	21.49
15.0	0.83	0.89	28.24
18.5	0.85	0.89	34.02
22.0	0.85	0.9	40.0
30.0	0.85	0.9	54.55
37.0	0.86	0.91	65.77
45.0	0.86	0.92	79.19
55.0	0.85	0.92	97.84
75.0	0.84	0.93	133.56
90.0	0.84	0.93	160.27
110.0	0.84	0.93	195.89
125.0	0.84	0.93	222.6
160.0	0.84	0.93	284.93

ANNEXURE IV

LIST OF E & C SPARES

S.No.	ITEM / COMPONENT	UNIT	QUANTITY
1.0	FACTORY BUILT ASSEMBLIES (PCC / MCC / DB)		
1.1	Busbar supports (horizontal)	One (1) set of 3	
1.2	Primary isolating contacts (Bus side)	One (1) set of 3	
1.3	Primary isolating contacts (Load side)	One (1) set of 3	



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1.4	Secondary isolating contacts	One (1) set of 3
1.5	Gaskets (each size)	One (1) set
1.6	Resistor (each size)	Twelve (12)
1.7	Fixed Terminal Block (control)	One (1) way
1.8	Shrouds (ACB O/G terminals)	One (1) set
1.9	Wire (for secondary wiring)	
	a) 2.5 mm ²	metres
	b) 1.5 mm ²	metres
1.10	Lugs (for secondary wiring)	Twelve (12)
1.11	Ferrules Set*	
2.0	AIR CIRCUIT BREAKER	
2.1	Shunt trip coil	One (1)
2.2	Spring charging motor	One (1)
2.3	Closing release coil	One (1)
2.4	Auxiliary switch	One (1)
2.5	Solid state trip devices (or spares thereof)	One (1) set

Set comprises of all alphabets 100 Nos. each and numerals (0-9) 100 Nos. each.

S.No.	ITEM / COMPONENT	UNIT	QUANTITY
3.0	ISOLATING SWITCH (FOR EACH RATINGS)		
3.1	Complete unit (each rating)	One (1)	
3.2	Main contact kit	One (1) set of 3	
3.3	Arc Chamber	One (1)	
4.0	POWER CONTACTORS		
4.1	Complete unit (each rating)	One (1)	
4.2	Contact coil (each size)	One (1)	
4.3	Contacts kit (main)	One (1) set of 3	



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4.4 Contacts kit (auxiliary) Set of standard number
of pairs

5.0 AUXILIARY CONTACTORS

5.1 Complete unit One (1)

5.2 Contactor coil One (1)

6.0 HRC FUSE

6.1 Fuse base (each rating) One (1)

6.2 Fuse link (each rating) Two (2)

7.0 PUSH BUTTONS

7.1 Actuator contacts One (1)

7.2 Element One (1) set

8.0 INDICATING LAMPS

8.1 Complete unit One (1)

8.2 Lens (assorted) One (1)

9.0 OTHERS

9.1 Selector & control switch
(each type) One (1)

9.2 Control transformer
(each rating) One (1)

9.3 MCB One (1) of each ating



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ANNEXURE- VII

LIST OF APPROVED SUBVENDORS

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.

- | | | |
|------------------------|---|--|
| 1. Air Circuit Breaker | : | Control & Switchgear
L&T
Siemens
GE-power |
| 2. MCCB (AC) | : | L&T
Crompton Greaves
GE-power
Siemens |
| 3. MCCB (DC) | : | Crompton Greaves |

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			L&T GE-power Siemens
4. Isolating Switch	:	L&T	Siemens Alstom Ltd. Control & Switchgear GE-power Kaycee
5. AC Contactor	:	L&T	Siemens Telemecanique BCH GE-power
6. DC Contactor	:	BHEL (BHOPAL)	Electromac Industries L&T Siemens Telemecanique GE-power
7. FUSE Base			GE-power L&T
8. FUSES			Indo-Asian
9. HRC Fuse (Base & Link)	:	L&T	Siemens GE power Control & Switchgear
10. Single Phasing Preventer	:	L&T	
11. Voltmeter	:	Automatic Electric	IMP Rishabh Industrial
12. Ammeter	:	Automatic Electric	IMP Rishabh Industrial
13. Energy Meter	:	BHEL (EDN)	SIMCO Engg.
14. Relays (other than interposing relays)	:	ABB	Alsthom(Areva)
Interposing relays	:	Jyoti	
15. Current transformer	:	Automatic Electric	Indcoil

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Kappa Electricals Pragati Electricals Precise Electricals PROYOG Silkaans Southern Electriks Control & Switchgear Siemens			
16. Voltage Transformers (VT)	:	:(Same as current Trfrs except C & S and Siemens)	
17. Control Transformers	:	Automatic Electric Indcoil Kappa Electricals Precise Electricals Silkaans Southern Electriks Logicstat	
18. Winding heating trfr	:	(Same as current Trfrs)	
19. Miniature Circuit Breaker	:	MDS Switchgear INDO ASIAN S & S Power Switchgear	
20. Control switch	:	Kaycee Alstom GE-Power	
21. Selector switch	:	Kaycee Alstom	
22. Indicating Lamp	:	Control & switchgear Alstom Essen Siemens Concord BCH GE-Power	
23. Panel space heater	:	Control & Switchgear	
24. General Purpose Timer	:	BCH L & T Alstom Electronic Automation Telemecanique	
25. Push Button	:	BCH Control & Switchgear Cands L&T	

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DOCUMENT TITLE:

**DATA SHEET-A
LV SWITCHGEAR**

SPECIFICATION NO.

VOLUME NO.

SECTION :

REV NO. : 00 DATE:

SHEET : 23 OF 27

		Siemens Tecknic Controls Hotline Switchgears
26. Breaker Operation Counter	:	Kaycee
27. Breaker switch	:	Kaycee L & T
28. Neutral Link	:	L&T Siemens
29. Cable Gland	:	Arup Engg. & Foundry Works Commet Brass Products Electrmac Industries Allied Traders & Exporters Baliga Lighting Eqpt. Elexpro Electricals Incab Sunil & Co.
30. Cable Lugs	:	Dowells Universal Machines
31. DC Switch	:	Kaycee Siemens GE-Power
32. Fixed terminals	:	Control & Switchgear Connect well Elemex Technoplast
33. Lighting Switch	:	Anchor Ellora
34. Limit switch	:	Concord Siemens
35. Sockets	:	Anchor Crompton Greaves
36. Terminal drawout	:	Control & Switchgear L&T Alstom Siemens
37. Thermostat	:	Automatic Instrumentation



DOCUMENT TITLE:

DATA SHEET-A
LV SWITCHGEAR

SPECIFICATION NO.
VOLUME NO.
SECTION :
REV NO. : **00** DATE:
SHEET : 24 OF 27

B) LOCAL PUSHBUTTON STATION AND LOCAL STARTER

(TICK AS APPROPRIATE)

1. Requirement : ☐ Local starter
: ☐ Local Push Button Station
: ☒ Both

2.0 TECHNICAL PARTICULARS FOR LOCAL STARTER

- 2.1 Voltage rating (V) : 415 V
& frequency (Hz) : 50 Hz
Fault level (KA) : 50 KA
2.2 **Motor rating(s) (KW)** : **REFER BOM**
2.3 Enclosure sheet

	DOCUMENT TITLE:		SPECIFICATION NO.
	DATA SHEET-A LV SWITCHGEAR		VOLUME NO.
			SECTION :
			REV NO. : 00 DATE:
			SHEET : 25 OF 27
	Steel thickness (mm)	:	2 mm
2.4	Degree of protection of enclosure	:	IP-54 for indoor IP-55 for outdoor
2.5	Cable entry	:	Top/Bottom
2.8	COMPONENT RATINGS		[As per requirements]
2.8.1	Contactor	:	
2.8.1.1	Category of duty	:	AC3
2.8.1.2	Coil voltage (V)	:	110 V AC
2.8.1.3	Short time rating	:	50 KA
2.8.4	Power cable size	:	-----LATER-----
3.0	LOCAL PUSH BUTTON STATION		
3.1	Push button station type	:	Refer BOM
3.2	Stop push button type (cl.4.7.1 section-D, vol. IIB)	:	As per sec-C, vol. IIB
3.3	Push button station	:	Sheet steel/Die cast aluminium
3.4	Thickness of enclosure	:	2 mm for sheet steel 3 mm for die cast aluminium
3.5	Aluminium alloy (for enclosure) grade	:	-----as per IS-----
3.7	Degree of protection of enclosure	:	IP-55 for outdoor IP-54 for indoor
3.8	Control cable size & Number of cores	:	-----LATER-----
3.9	Cable entry	:	Top/Bottom
4.0	COMMON REQUIREMENTS FOR LOCAL CONTROL STATIONS		
4.1	Design Ambient (°C)	:	50° C
4.2	Environment	:	[√] Tropical [] Marine [] Hazardous
4.3	Designation List	:	---- LATER--
4.4	PAINTING		
4.4.1	Paint finish shade	:	

	DOCUMENT TITLE:		SPECIFICATION NO.
	DATA SHEET-A LV SWITCHGEAR		VOLUME NO.
			SECTION :
			REV NO. : 00 DATE:
			SHEET : 26 OF 27
Exterior	:	RAL7032	
Interior	:	RAL7032	
4.4.2 Paint thickness	:	50-60 microns	
4.5 COMPONENT RATING			
4.5.1 Push button	:		
4.5.1.1 Type	:		
4.5.1.2 Breaking current rating (A) at voltage (V)	:	____A at ____V	
4.5.1.3 Function	:		
4.5.1.4 Actuator colour	:		
4.5.1.5 No. of contacts	:	2NO+2NC	
4.5.1.6 Colour			
Start P.B.	:	Green	
Stop P.B.	:	Red	
4.5.2 CONTROL & SELECTOR SWITCH		N.A	
4.5.2.1 Current rating (A)			
4.5.2.2 Make & carry current (A)	:		
4.5.2.3 Break current at voltage (V)	:		
4.5.2.4 Make and type	:		
4.5.2.5 Number of contacts	:		
4.5.3 INDICATION LAMPS			
4.5.3.1 Function & lens colour	:	ON—RED OFF--- GREEN	
4.5.3.2 Working voltage (V)	:	240 V	
4.5.4 AMMETERS		N.A	
4.5.4.1 Type	:		
4.5.4.2 Size (mm x mm)	:		
4.5.4.3 Burden for remote ammeter (if any)	:		
4.5.4.4 CT secondary rating (A)	:		

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DATA SHEET-A
LV SWITCHGEAR

SPECIFICATION NO.
VOLUME NO.
SECTION :
REV NO. : **00** DATE:
SHEET : 27 OF 27

4.5.4.5 Number of terminals for
External connection & spare :

4.6 Earth conductor size (Sq.mm/SWG) :



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR 1.1 kV
PVC POWER CABLES**

SPECIFICATION NO.

VOLUME

SECTION

REVISION 1

DATE:

SHEET 1 OF 4

DATA SHEET-A

DS-AI. SPECIFIC TECHNICAL REQUIREMENTS

1.0	Type of Cable	Flame Retardant Low Smoke (FRLS)	
2.0	Standard applicable in general	IS: 1554 PART (I)	
3.0	Voltage Grade	1.1kV	
4.0	Number of cores, cross sectional area of conductors and quantities	As per BOQ, Annexure-A to Section-C	
5.0	Formula for calculating short circuit current for different durations	$I_{sh} = k A / \sqrt{t}$ where, I_{sh} = Short circuit current in kA t = Fault clearing time in sec. K = a constant = 0.069 for Aluminium conductor HRPVC insulation = 0.104 for copper conductor HRPVC insulation = 0.076 for Aluminium conductor PVC insulation = 0.115 for copper conductor PVC insulation	
6.0	Installation Conditions for specified current rating		
(a)	ambient air temperature	40 deg. C	
(b)	ground temperature	30 deg. C	
(c)	depth of laying of cables buried in ground	75 cm	
(d)	Thermal resistivity of soil	150 deg. C cm/W	
7.0	CONDUCTOR		
(a)	Material	Aluminium	Copper
	Grade and Class	Stranded, H2, Class 2	Stranded, Un-tinned (plain) annealed high conductivity, Class 2
(b)	Standard Applicable	IS: 8130	
(c)	Shape	Circular / shaped as per IS	
(d)	Min. number of strands	As per Table-2 of IS: 8130	
8.0	INSULATION		
(a)	Material	PVC type-A/C	
(b)	Standard Applicable	IS: 1554 Part-I	
(c)	Continuous withstand temperature	70°C/ 85 °C	
(d)	Short-circuit withstand temperature	160°C	
(e)	Method of application	By extrusion; sleeve extrusion not permitted.	
9.0	CORE IDENTIFICATION	Colour coding as per IS.	
10.0	INNER SHEATH (applicable for multi core		



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR 1.1 kV
PVC POWER CABLES**

SPECIFICATION NO.

VOLUME

SECTION

REVISION 1

DATE:

SHEET 2 OF 4

	cables only)	
(a)	Material	PVC Type <i>ST1/ ST2</i> as per IS: 5831
(b)	Colour	<i>Black</i>
(c)	Whether FRLS	<i>No</i>
(d)	Fillers	Acceptable
(e)	Material of fillers (if permitted)	Same as inner sheath (Material of filler to be compatible with that of inner sheath)
(f)	Method of application	
(1)	Multi-core cables:	
(i)	With fillers	<i>Pressure/Vacuum extruded</i>
(ii)	Without fillers	<i>Pressure extruded</i>
11.0	ARMOUR (where applicable)	
(a)	Material:	
(i)	Single core cables	Aluminium Round Wire H4 grade to IS: 8130
(ii)	Multi-core cables	Galvanised Steel <i>Round Wire / Formed wire</i> armour conforming to (i) Type 'a/' 'b' as per Table- 5 of IS 1554-I and (ii) IS 3975 as per project requirements.
(b)	Minimum Coverage	90%
(c)	Gap between armour wires	Shall not exceed one armour wire space (No cross-over/ over-riding)
(d)	Breaking load of joint	95 % of normal armour
12.0	OUTERSHEATH	
(a)	Material	PVC Type <i>ST1/ ST2</i> as per IS: 5831
(b)	Colour	<i>Black</i>
(c)	Whether FRLS	Yes
(d)	Method of application	Extruded
(e)	Marking	<i>Cable size (cross section area and no. of cores) and voltage grade @ 5m (by embossing) Letters FRLS @ 5m (by embossing) Manufacturer's name and/ or trade name, and year of manufacture @ 5m (by embossing) Progressive sequential marking @ 1m. (by embossing/ printing).</i>
13.0	FRLS CHARACTERISTICS	
(a)	Oxygen index	Min 29 (As per ASTM D 2863)
(b)	Temperature index	Min. 250°C
(c)	Acid gas generation	<i>Max. 20% (as per IEC-754-1)</i>
(d)	Smoke density rating	<i>60% (As per ASTM D2843)</i>
(e)	Flammability Test	As per IEC: 60332 Part-3-23 <i>Cat-B/</i> IS-1554-I/ Swedish chimney (where applicable)
14.0	TOLERANCE ON OUTER DIAMETER	Up to 30mm; + 1.5mm Above 30mm; + 5% or + 2mm, whichever is less.
15.0	MINIMUM BENDING RADIUS	
(a)	Single core cables	15 x O.D.
(b)	Multi core cables	12 x O.D.



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR 1.1 kV
PVC POWER CABLES**

SPECIFICATION NO.

VOLUME

SECTION

REVISION 1

DATE:

SHEET 3 OF 4

16.0	SAFE PULLING FORCE	
(a)	Aluminium conductor cable	30 N/ sq. mm.
(b)	Copper conductor cable	50 N/ sq. mm.
17.0	CABLE DRUMS	
(a)	Type & construction	As per IS 10418
(b)	Standard drum length	500m (±) 5% / 1000m (±) 5%. (as specified in BOQ)

DS-AII. TYPE/ ACCEPTANCE TEST REQUIREMENTS**A. Type Test Conduction:**

- Tests for which an asterisk sign (*) is indicated in the 'Conduction Required as Type Test' column shall be conducted on one size of cable to be selected by purchaser at the time of testing as type tests. The same may be witnessed by BHEL/ Owner, for which due notice shall be given by the vendor.

B. Acceptance Test Conduction:

- Tests for which a hash sign (#) is indicated in the 'Conduction Required as Acceptance Test' column shall be conducted as acceptance tests.
- Sampling:
Sampling for acceptance tests shall be as per Appendix-A (Clause 15.2.1) of IS: 1554 Part-I.

<u>S. No.</u>	<u>TEST</u>	<u>APPLICABLE FOR</u>	<u>CONDUCTION REQUIRED AS</u>	
			<u>Type Test</u>	<u>Acceptance Test</u>
1.0	Tests for Conductor			
	Annealing test	Copper conductor only	*	#
	Tensile test	Aluminium conductor only	*	#
	Wrapping test	Aluminium conductor only	*	#
	Resistance test	Al/Cu	*	#
2.0	Tests for Armour Wires			
	Measurement of dimensions	Aluminium wire & GS wire	*	#
	Tensile test	Aluminium wire & GS wire		#
	Elongation test	GS wire only	*	#
	Torsion test	GS round wire only	*	#
	Resistance test	Aluminium wire & GS wire	*	#
	Zinc coating test	G. S. wires only	*	#
	Wrapping Test	Aluminium wires only	*	#
3.0	Physical Tests for PVC Insulation & PVC sheath			

	DOCUMENT TITLE TECHNICAL SPECIFICATION FOR LT CONTROL CABLES	SPECIFICATION NO.	
		VOLUME II B	
		SECTION -D	
		REVISION 00	DATE:
		SHEET 1 OF 3	

DATASHEET A

SPECIFIC TECHNICAL REQUIREMENTS

- | | | |
|--|---|--------------------------------------|
| 1.0 Type of cable | : | FRLS |
| 2.0 Standard applicable | : | IS:1554 Part-I (in general) |
| 3.0 Voltage designation of cables | : | 1.1 kV |
| 4.0 Number of cores and cross sectional area | : | As per BOQ, Annexure-A to Section-C. |

5.0 CONDUCTOR

- | | | |
|------------------------|---|---|
| a) Material | : | Copper, plain annelaed high conductivity, class-2 |
| b) Strands | : | (Min.) 7 |
| c) Applicable standard | : | IS : 8130 |

6.0 INSULATION

- | | | |
|--|---|--|
| a) Material & Standard | : | PVC, Type A (IS:5831) |
| b) Continuous withstand temperature | : | 70° C |
| c) Short circuit withstand temperature | : | 160° C |
| d) Method of Application | : | By extrusion (sleeve extrusion not permitted) |
| e) Volume resistivity | : | As per relevant standards |

7.0 IDENTIFICATION OF CORES

- | | | |
|---------------------------------|---|--|
| a) Control cables upto 5 core | : | Colour coded as per IS : 1554 (Part-I) |
| b) Control cables above 5 cores | : | By numbering as per IS:1554 (Part-I)
Insulation to have black colour. |

	DOCUMENT TITLE TECHNICAL SPECIFICATION FOR LT CONTROL CABLES	SPECIFICATION NO.	
		VOLUME II B	
		SECTION -D	
		REVISION 00	DATE:
		SHEET 2 OF 3	

8.0 INNER SHEATH (for all armoured cables & multi-core unarmoured cables)

- | | | | |
|----|-------------------------|---|---------------------------|
| a) | Material & Standard | : | PVC Type ST 1 (IS : 5831) |
| b) | Colour | : | Black |
| c) | Whether FRLS | : | NO |
| d) | Fillers | : | Acceptable |
| e) | Material of fillers | : | Same as innersheath. |
| f) | Method of application : | | |
| | i) with fillers | : | Pressure/Vacuum Extruded |
| | ii) without fillers | : | Pressure Extruded. |

9.0 ARMOUR(WHEREVER APPLICABLE)

- | | | |
|------|-----------------------------------|--|
| (i) | Material: | |
| a) | Multicore cables | :Galvanised steel wire/formed wire conforming to IS : 3975, Min. coverage of 90% |
| b) | Single core cable (IF APPLICABLE) | :Hard drawn Aluminium conforming to IS : 8130. |
| (ii) | Breaking load of joint | : 95% of normal armour |

10.0 OUTER SHEATH

- | | | | |
|----|---------------------|---|---------------------------|
| a) | Material & Standard | : | PVC Type ST 1 (IS : 5831) |
| b) | Application | : | Extruded |
| c) | Colour | : | Black |
| d) | Whether FRLS | : | YES |

	DOCUMENT TITLE TECHNICAL SPECIFICATION FOR LT CONTROL CABLES	SPECIFICATION NO.	
		VOLUME II B	
		SECTION-D	
		REVISION 00	DATE:
		SHEET 3 OF 3	

11.0 CHARACTERISTICS OF FRLS SHEATH

- | | | | |
|----|----------------------|---|--|
| a) | Oxygen index | : | Min. 29 (As per ASTM D 2863) |
| b) | Temperature Index | : | Min. 250° C at room temperature. |
| c) | Acid gas generation | : | Max. 20% (As per IEC-754-1) |
| d) | Smoke density rating | : | Max. 60% (As per ASTM D 2843) |
| e) | Flammability Test | : | As per IEC-332-Part-III (Category-B), IEEE-383 & Swedish Chimney test as per SS:424-1475 |

12.0 TOLERANCE ON OUTER DIAMETER

- | | | | |
|----|------------------|---|-------------------------------------|
| a) | Upto 30 mm O.D. | : | (+/-) 1.5 mm |
| b) | Above 30 mm O.D. | : | (+/-) 5% or 3 mm whichever is less. |

13.0 STANDARD DRUM LENGTH : 1000 m (+/-) 5%

14.0 PROGRESSIVE SEQUENTIAL LENGTH MARKING TO BE PROVIDED ON OUTER SHEATH

: YES @ 1 metre

15.0 DRUM MARKINGS

: Manufacturer's name and/or trade name, Year of manufacture, Type of cable and the voltage class, Nominal cross sectional area of conductor and number of cores, Letter HR in case of HR PVC insulated cables, Letter FRLS Applicable in case of FRLS cables.

**STANDARD CABLE PARAMETERS FOR INSTRUMENTATION CABLE**

Parameter	0.5 mm ² (I & OS) type-F	0.5 mm ² (OS) type-G
Mutual Capacitance (max.) at 0.8 kHz, nF/Km	120	100
Conductor Loop Resistance (max.), Ohm / Km	73.4	73.4
Insulation Resistance (min), M Ohm/ Km	100	100
Cross Talk attenuation (min) at 0.8kHz, dB	60	60
Characteristic impedance(max.) at 1 kHz	320	340
Attenuation (max.) at 1 kHz db/Km	1.2	1.2

Notes

1. The voltage grade of Instrumentation cable shall be 225 V (peak value).
2. Cable parameters indicated above are at 20 degC (+/- 3 deg C).



TECHNICAL SPECIFICATION FOR ABOVE GROUND EARTHING & LIGHTNING PROTECTION MATERIALS

SPECIFICATION NO. PE-TS-XXX-509-E003
VOLUME NO. : II-B
SECTION : D
REV NO. : 0 DATE :
SHEET : 1 OF 2

TECHNICAL DATASHEET-A

1.0 APPLICABLE STANDARDS:

- | | | |
|----|--|----------|
| a) | For Hot rolled carbon sheets & strips. | IS: 2062 |
| b) | For Mild Steel Wire | IS: 280 |
| c) | For Surface Pre-treatment | IS: 2629 |
| d) | For Hot dip galvanising of steel | IS: 2629 |
| e) | For Hot dipped galvanised coating on round steel wires | IS: 4826 |
| f) | For Testing of zinc coating | IS: 2633 |
| g) | For Determining of mass of zinc coating | IS: 6745 |
| h) | For Rolling & cutting tolerances of hot rolled steel products | IS: 1852 |
| i) | For Hot dip zinc coating on structural steel & other allied products | IS: 4759 |
| j) | For Tubes, Tubulars and other Wrought Steel Fittings | IS: 1239 |

2.0 GALVANIZED MS MATERIALS FOR ABOVE GROUND EARTHING AND LIGHTNING PROTECTION SYSTEMS

- | | | |
|----|-----------|-----------------------|
| a) | Material: | Hot Rolled Mild Steel |
| b) | Type: | Hot-dip galvanized |

3.0 SURFACE TREATMENT

Galvanising:

- | | | |
|----|----------------------------------|---------------------------------------|
| a) | Pre-treatment | As per IS 2629 prior to galvanization |
| b) | Type | Hot dip galvanization. |
| c) | Applicable Standard | IS 2629 |
| d) | Minimum thickness: | |
| | i) MS flats 5mm thick & over | 75 microns (minimum) |
| | ii) MS flats under 5mm thickness | 60 microns (minimum) |



**TECHNICAL SPECIFICATION FOR
ABOVE GROUND EARTHING & LIGHTNING
PROTECTION MATERIALS**

SPECIFICATION NO. PE-TS-XXX-509-E003
VOLUME NO. : II-B
SECTION : D
REV NO. : 0 DATE :
SHEET : 1 OF 2

- | | |
|--|----------------------------|
| iii) Pipes/ conduits with thickness 5 mm & over. | 75 microns (minimum) |
| iv) Pipes/ conduits with thickness under 5mm | 60 microns (minimum) |
| v) GI Wire | 20 Microns (Medium coated) |
- e) Min. weight :
- | | |
|--|---------------------|
| i) MS flats 5mm thick & over | 610 gms. / sq. mtr. |
| ii) MS flats under 5mm thickness | 460 gms. / sq. mtr. |
| iii) Pipes/ conduits with thickness 5 mm & over. | 610 gms. / sq. mtr |
| iv) Pipes/ conduits with thickness under 5mm. | 460 gms. / sq. mtr |
| v) GI Wire | 150 gms. / sq. mtr |

		QUALITY PLAN	CUSTOMER :			PROJECT			SPECIFICATION :				
			BIDDER/ : VENDOR			TITLE QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			NUMBER :				
									SPECIFICATION TITLE				
SHEET 1 OF 2		SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION		VOLUME III			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS	
1	2	3	4	5	6	7	8	9	P	W	V		
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-		
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-		
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	2	-	-		
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUFR'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-		
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1			NOTE -1 & NOTE-3
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-		NOTE -1 & NOTE-3
BHEL			PARTICULARS			BIDDER/VENDOR							
			NAME										
			SIGNATURE										

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE			SPECIFICATION : NUMBER :			
				BIDDER/ : VENDOR		QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION : TITLE :			
		SHEET 2 OF 2		SYSTEM		ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION		VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-	
NOTES: 1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON 2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. 3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY. <u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY												
BHEL			PARTICULARS		BIDDER/VENDOR				BIDDER'S/VENDORS COMPANY SEAL			
			NAME									
			SIGNATURE									
			DATE									

		QUALITY PLAN		CUSTOMER :			PROJECT TITLE		SPECIFICATION : NUMBER :			
				BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03		SPECIFICATION : TITLE			
		SHEET 1 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION		VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	
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	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	-DO-	3	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	-DO-	-DO-	-DO-	INSPEC. REPORT	3	-	2	
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, UN-EVENNESS ETC.	-DO-	3	-	-	
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	MANFR'S DRG./SPEC BOOK	RELEVANT IS/SPEC.	SUPPLIERS TC & LOG	3	-	2	
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK	3	-	2	
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	MANFR'S DRG./SPEC	RELEVANT IS/	SUPPLIER'S TC	3	-	2	
		3.DIMENSIONS	MA	MEASUREMENT	100%	MANUFR'S DRG.	MANUFR'S DRG.	LOG BOOK	3	-	2	
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	LOG BOOK	3	-	2	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN SHEET 3 OF 9		CUSTOMER :		PROJECT			SPECIFICATION :				
				BIDDER/		TITLE			NUMBER :				
				VENDOR		QUALITY PLAN			SPECIFICATION :				
		SYSTEM		NUMBER PED-506-00-Q-007, REV-03			TITLE			SECTION			
				ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			VOLUME III						
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS	
									P	W	V		
1	2	3	4	5	6	7	8	9	10			11	
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC. 2. OTHER CHARACTERISTICS	MA MA	VISUAL TEST	100% SAMPLE	- MANUF'S SPEC.	NO VISUAL DEFECTS MANUF'S SPEC.	INSPT. REPORT LOG BOOK AND OR SUPPLIER'S TC	3 3	- -	2 2		
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND. 2.DIMENSIONS INCLUDING BURS HEIGHT 3. ACCEPTANCE TESTS	MA MA MA	VISUAL MEASUREMENT ELECT. & MECH TESTS	100% SAMPLE -DO-	- MANUFR'S DRG. . MANUF'S SPEC./ RELEVANT IS	NO VISUAL DEFECTS (FREE FROM BURS) MANUFR'S DRG. RELEVANT IS	LOG BOOK -DO- SUPPLIER'S TC	3 3 3	- - -	- 2 2		FOR MV MOTOR INSULATION/VARNISH THICKNESS SHALL BE MORE THAN THE BURS HEIGHT
1.9	CONDUCTORS	1. SURFACE FINISH 2.ELECT. PROP. & MECH. PROP	MA MA	VISUAL ELECT. & MECH.TEST	100% SAMPLES	- RELEVANT IS/ BS OR OTHER STANDARDS	FREE FROM VISUAL DEFECTS RELEVANT IS/ BS OR OTHER STANDARDS	LOG BOOK SUPPLIERS TC & VENDOR'S INSPN. REPORTS	3* 3	- -	2* 2		* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY BHEL/CUSTOMER.
BHEL			PARTICULARS			BIDDER/VENDOR							
			NAME										
			SIGNATURE										
			DATE										
												BIDDER'S/VENDORS COMPANY SEAL	

		QUALITY PLAN SHEET 4 OF 9	CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
			SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION VOLUME III			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	
1.10	BEARINGS	3.DIMENSIONS	MA	MEASUREMENT	-DO-	-DO-	-DO-	Log Book	3	-	2	
		1.MAKE & TYPE	MA	VISUAL	100%	MANFR'S DRG./ APPROVED DATASHEET	MANFR'S DRG./ APPROVED DATASHEET	-DO-	3	-	2	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	BHEL DATA SHEET	BHEL DATA SHEET BEARING MANUF'S CATALOGUES	-DO-	3	-	2	
		3.SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	2	
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-DO-	-DO-	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	-DO-	MANUF'S SPEC./ BHEL SPEC.	MANUF'S SPEC./ BHEL SPEC.	-DO-	3	-	2	
		4.HV/IR	MA	-DO-	100%	-DO-	-DO-	-DO-	3	-	2	
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	MANUF'S DRG/SPECS	MANUF'S DRG./ SPECS.	-DO-	3	-	-	
		2.SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE									
BIDDER'S/VENDORS COMPANY SEAL												

		QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :		
				BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE		
		SHEET 5 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION		VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
2.0	IN PROCESS											
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNES	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3/2	2	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	2	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVENT SPEC./ ASTM-E165	MANUFR'S SPEC./ BHEL SPEC./	-DO-	2	-	1	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC./BHEL SPEC./ RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		3.SHADE	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-	-DO-	Log Book	2	-	-	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN		CUSTOMER :			PROJECT			SPECIFICATION :		
				BIDDER/ :			TITLE			NUMBER :		
				VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE		
SHEET 6 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	MANUFR'S SPEC.	MANUFR'S SPEC.	Log Book	2	-	-	(FOR MOTORS OF 2MW AND ABOVE) * ON 10% RANDOM SAMPLE
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-DO-	-DO-	Log Book	2	-	-	
		3.CORE LOSS & HOTSPOT	MA	ELECT.TEST	-DO-	-DO-	-DO-	Log Book	2	1*	1	
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	MANUFR'S SPEC./BHEL SPEC.	MANUFR'S SPEC./BHEL SPEC.	Log Book	2	-	-	FOR MV MOTOR
		2.CLEANLINESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.RESISTANCE	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
		5.INTERTURN INSULATION	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		6.SURGE WITH STAND AND TAN. DELTA TEST	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
2.6	IMPREGNATION	1.VISCOSITY	MA	PHY. TEST	AT STARTING	-DO-	-DO-	Log Book	2	-	-	THREE DIPS TO BE GIVEN
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-DO-	-DO-	Log Book	2	-	-	
		3.NO. OF DIPS	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE									
									BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN SHEET 7 OF 9		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :		
				BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE		
				SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	10	11	12	
2.7	COMPLETE STATOR ASSEMBLY	4.DURATION	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	VERIFICATION FOR MV MOTOR ONLY
		1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-DO-	-DO-	Log Book	2	-	-	
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.SOUNDNESS	CR	MALLET TEST & UT	-DO-	-DO-	-DO-	Log Book	2		1	
		3.HV	MA	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2		1	
2.9	COMPLETE ROTOR ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	-DO-	MFG SPEC./ ISO 1940	MFG. DWG.	Log Book	2		1	
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	-DO-	MFG. SPEC.	MFG. SPEC.	Log Book	2		1	
2.10	ASSEMBLY	1.ALIGNMENT	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.WORKMANSHIP	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.AXIAL PLAY	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.DIMENSIONS	MA	-DO-	-DO-	MFG.DRG./ MFG SPEC.	MFG. DRG/ RELEVANT IS	Log Book	2	-	-	
		5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2	-	-	
		6. RTD, BTD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2		1	
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE									
									BIDDER'S/VENDORS COMPANY SEAL			

		QUALITY PLAN SHEET 8 OF 9		CUSTOMER :		PROJECT			SPECIFICATION :			
				BIDDER/ :		TITLE			NUMBER :			
				VENDOR		QUALITY PLAN			SPECIFICATION :			
SYSTEM		NUMBER PED-506-00-Q-007, REV-03			TITLE			SECTION			VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC.	MA	ELECT.TEST	1/TYPE/SIZE	IS-325/ BHEL SPEC./ DATA SHEET	IS-325/ BHEL SPEC./ DATA SHEET	TEST REPORT	2	1*	1	* NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1 ^s	1	\$ NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	2	1 ^s	1	\$ NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPC. REPORT	2	1	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	RELEVANT IS	BHEL SPEC. AND DATA SHEET	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1 ^s	1	\$ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1 ^s	1	\$ NOTE - 2
		8. NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	2	1 ^s	1	\$ NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	IS-3682 IS-8239 IS-8240	IS-3682 IS-8239 IS-8240	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	BHEL SPEC. & DATA SHEET	BHEL SPEC. & DATA SHEET	TC	2	1 ^s	1	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY \$ NOTE - 2
BHEL			PARTICULARS		BIDDER/VENDOR							
			NAME									
			SIGNATURE									
			DATE					BIDDER'S/VENDORS COMPANY SEAL				

		QUALITY PLAN SHEET 9 OF 9		CUSTOMER :		PROJECT TITLE			SPECIFICATION : NUMBER :			
				BIDDER/ VENDOR		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
				SYSTEM		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION VOLUME III			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
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 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, THESE TEST MAY NOT BE REPEATED. 4 WHEREVER CUSTOMER IS INVOLVED IN INSPECTION, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. <u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY												
BHEL			PARTICULARS			BIDDER/VENDOR						
			NAME									
			SIGNATURE									
			DATE									
									BIDDER'S/VENDORS COMPANY SEAL			

14 POWER AND CONTROL CABLES (INCLUDING CABLE TRAYS)

14.1 Type Test

The contractor is required to carry out all type tests as per relevant IEC / International Standards on one apparatus of each type of similar rating and shall submit the reports to the employer. The type test may not be mandatory if similar equipment has been type tested and test certificates for relevant tests are accepted by the employer.

Type test reports of the following items shall be submitted for acceptance with adequate details/drawings to establish equivalence with the offered type:

- ◆ All type of cables, termination kits and accessories,
- ◆ Conduits, ducts, channels etc.,
- ◆ Cable trays and supports.

14.2 Shop Test

The Power & Control Cable and Cable Tray shall be acceptance & routine tested as per relevant IEC with latest amendments. Following shop tests shall be carried out on Power & Control Cable by the manufacturer at their works as per IEC: 502, IS: 7098, IS: 1554:-

- Annealing Test (For Cu)
- Tensile Test (For Al)
- Wrapping Test (For Al)
- Conductor Resistance Test
- Tests for thickness of Insulation & Sheath
- T.S. & E.B. of Insulation & Sheath
- Hot Set Test for Insulation (XLPE Cable only)
- Insulation Resistance Test
- High Voltage Test (At Room Temp.)
- Partial Discharge Test (for Screened XLPE Cable only)

The following FRLS tests are to be conducted as per the referred standards:

- HCL gas evolution test (IEC - 754.1),
- Oxygen Index (ASTM-D-2863),
- Temperature Index (ASTM-D-2863),
- Smoke density test (ASTM-D-2863),
- Flammability test (IEC-332.1),
- Swedish Chimney test (SS-424 14 75),
- Ladder Test (IEEE-383),
- Heat Shock Test (IS:1554) &
- Anti Rodent & Termite Test.

Following test on Cable Trays as per relevant IS

- Galvanization Test
- Load Capacity Test (Deflection Test)

The details of tests are given in Model Quality Assurance Plan of Power and Control Cables including Cable Trays.

14.3 Field Test

All field tests including tests during installation, pre-commissioning, commissioning 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 six (6) months before start of relevant testing, for approval of the Employer.

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:

- Cabling checking,
- Continuity checking,
- Meggar testing in accordance with the applicable codes and standards,
- Resistance checking.
- Insulation resistance measurement,
- Verification of phase order,
- HV test

15. ~~11 KV AND 415 V SWITCHGEAR, AUXILIARY AND STATION TRANSFORMERS~~

15 (a) 11 KV SWITCHGEAR

15(a).1 Type Test

The contractor is required to carry out all type tests as per relevant IEC / International Standards on one apparatus of each type of similar rating and shall submit the reports to the Employer. The type test may not be mandatory if similar equipment has been type tested and test certificate(s) for relevant tests are accepted by the Employer.

15(a).2 Shop Test

The 11 KV Switchgear shall be routine tested as per relevant IEC with latest amendments. Following shop tests shall be carried out by the manufacturers at their works:-

- Visual & BOM Check
- Scheme Checking
- Insulation Resistance Test
- High Voltage Test.
- **Circuit breaker:**
 - Measurement of resistance of the main circuits,
 - Operating mechanism test,
 - One-minute power frequency voltage dry withstand test on the main circuit,
 - Voltage withstand test on control and auxiliary circuits.
- **Voltage transformer:**
 - Verification of terminal markings and polarity,
 - Power frequency test on primary and secondary winding separately, measurement of partial discharges,
 - Determination of error according to the requirements of the appropriate accuracy class,
 - Over voltage inter turn tests.

- **Current transformer:**

- Verification of terminal marking and polarity,
- High voltage power frequency test on primary and secondary, measurement of partial discharges,
- Determination of error according to the requirement of the appropriate accuracy class,
- Over voltage inter turn test.

The details of tests are given in Model Quality Assurance Plan of 11KV Switchgear.

15(a).3 Field Test

All field tests including tests during installation, pre-commissioning, commissioning, field acceptance tests shall be conducted by the Contractor, in presence of representative of the Employer.

Procedure to be adopted for conducting the operational, pre-commissioning, commissioning, performance and field acceptance test shall submitted well in advance, at least six(6) month before start of relevant testing, for approval by the Employer.

Following inspections/ tests shall be performed:

- Functional and operational tests
- Measurement of the Insulating Resistance of the different power and control circuits, including cables, instruments and apparatus, against earth
- Contact resistance measuring of all Circuit Breakers

15(b) 415 V SWITCHGEAR, ~~AUXILIARY AND STATION SERVICE TRANSFORMERS~~

15(b).1 Type Test

The contractor is required to carry out all type tests as per relevant IEC / International Standards on one apparatus of each type of similar rating and shall submit the reports to the Employer. The type test may not be mandatory if similar equipment has been type tested and test certificates for relevant tests are accepted by the Employer.

15(b).2 Shop Test

The UAT, SST and 415 V Switchgear shall be routine tested as per relevant IEC with latest amendments. Following shop tests shall be carried out by the manufacturer at their works:-

Test on Power Transformer, Oil Filled Transformer, Dry Type Transformer as per IEC: 60726 & IEC 60076 are as follows:-

- Measurement of Winding Resistance.
- Measurement of Voltage Ratio/ Check of Polarity/Vector Relationship.
- Measurement of No Load Losses.
- Measurement of Magnetizing Current (before and after Dielectric Test).
- Measurement of Insulation Resistance and Polarization Index.
- Separate Source Voltage Withstand Test.
- Induced Over Voltage Withstand Test.
- Partial Discharge Test.
- Determination of sound level.
- Determination of transient voltage transfer characteristics.

Following Tests on 415 V Cubicle assembly as per relevant IEC:

- Visual & BOM Check,
- Scheme Checking,
- Insulation Resistance Test
- High Voltage Test.

The details of tests are given in Model Quality Assurance Plan of 415 V Switchgear, Auxiliary & Station Service Transformer.

15(b).3 Field Test

All field tests including tests during installation, pre-commissioning, commissioning 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 six (6) months before start of relevant testing, for approval of the Employer.

15(b).3.1 Tests during installation and pre commissioning

At least following inspections/ tests shall be performed:-

15(b)3.1.1 Transformers

- Correct functioning of the various protection systems.
- Inspection of the insulation to earth of the various parts of the transformers.
 - Phase order checking.
 - Measurement of the winding resistance.
 - Measurement of capacitance and $\tan\delta$.
 - Ratio test.
 - Measurement of the no load current at 415 V.
 - Measurement of impedance at low voltage.
 - Calibration and setting of WTI.
 - Transformer operation at no load for 24 hours (voltage, no load current, temperature measurement and noise),
 - Final IR values between windings and winding and earth,
 - Measurement of the magnetising current at U_r ,
 - Checking of Neutral Earthing & Shorting of unused CTs.

15(b)3.1.2 415 V switchgear

- 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,
- Verification of component temperatures,
- 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,
- Other test as suggested by the Contractor and/or the Employer at site

	TITLE	SPECIFICATION NO.
		VOLUME II B
		SECTION D
		REV NO. 00 DATE 29.05.15
		SHEET 1 OF 2

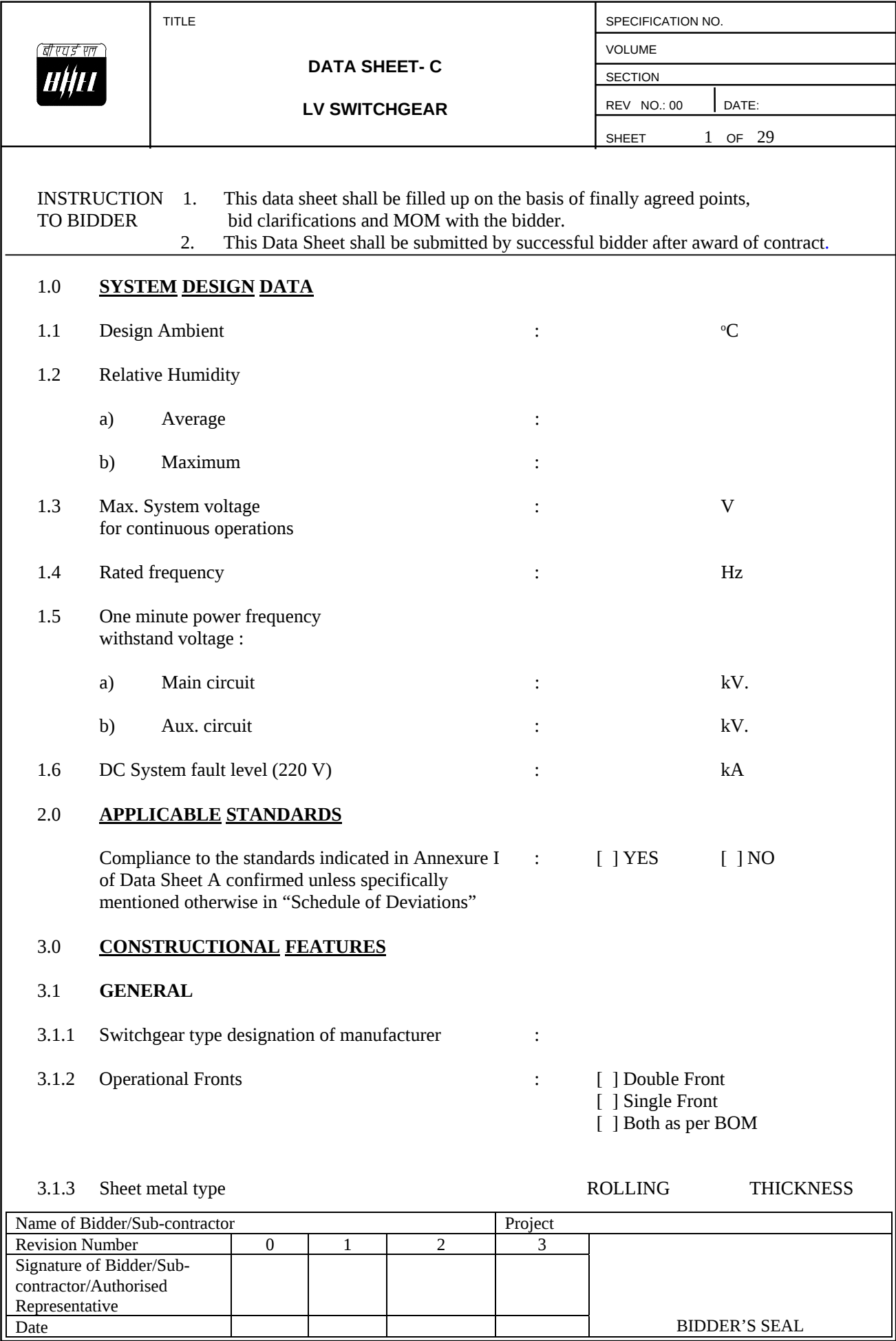
S. No.	Description		Data to be filled by successful bidder
A.	General		
1	Manufacturer & country of origin		
2	Motor type		
3	Type of starting		
4	Name of the equipment driven by motor & Quantity		
5	Maximum Power requirement of driven equipment		
6	Rated speed of Driven Equipment		
7	Design ambient temperature		
B.	Design and Performance Data		
1	Frame size & type designation		
2	Type of duty		
3	Rated Voltage		
4	Permissible variation for		
5	a	Voltage	
6	b	Frequency	
7	c	Combined voltage & frequency	
8	Rated output at design ambient temp (by resistance method)		
9	Synchronous speed & Rated slip		
10	Minimum permissible starting voltage		
11	Starting time in sec with mechanism coupled		
12	a) At rated voltage		
13	b) At min starting voltage		
14	Locked rotor current as percentage of FLC (including IS tolerance)		
15	Torque		
	a) Starting		
	b) Maximum		
16	Permissible temp rise at rated output over ambient temp & method		
17	Noise level at 1.0 m (dB)		
18	Amplitude of vibration		
19	Efficiency & P.F. at rated voltage & frequency		
	a) At 100% load		
	c) At 75% load		

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S. No.	Description	Data to be filled by successful bidder
	c) At starting	
C.	Constructional Features	
1	Method of connection of motor driven equipment	
2	Applicable Standard	
3	DOP of Enclosure	
4	Method of cooling	
5	Class of insulation	
6	Main terminal box	
	a) Type	
	b) Power Cable details (Conductor, size, armour/unarmour)	
	c) Cable Gland & lugs details (Size, type & material)	
	d) Permissible Fault level (kArms & duration in sec)	
7	Space heater details (Voltage & watts)	
8	Flame proof motor details (if applicable)	
	a) Enclosure	
	b) suitability for hazardous area	
	i Zone	O / I / II
	ii Group	IIA / IIB / IIC
9	No. of Stator winding	
10	Winding connection	
11	Kind of rotor winding	
12	Kind of bearings	
13	Direction of rotation when viewed from NDE	
14	Paint Shade & type	
15	Net weight of motor	
16	Outline mounting drawing No (To be enclosed as annexure)	
D.	Characteristic curves/ drawings (To be enclosed for motors of rating $\geq 55\text{KW}$)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

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a)	Non-load bearing covers	:	☐ Hot	☐ Cold	mm
b)	Non-load bearing partitions	:	☐ Hot	☐ Cold	mm
c)	Load bearing members	:	☐ Hot	☐ Cold	mm
d)	Frames	:	☐ Hot	☐ Cold	mm
e)	Doors	:	☐ Hot	☐ Cold	mm
f)	Withdrawable units	:	☐ Hot	☐ Cold	mm

3.1.4	Rating above which louvers are provided	:	A
-------	---	---	---

3.1.5	Degree of Protection of switchboards with modules in service and all doors closed.	
-------	--	--

a)	Without louvers	:
b)	With louvers	:

3.1.6	Method of power connection from busbars to module	:	☐ Rigid busbars ☐ Insulated conductor
-------	---	---	--

3.1.7	Minimum size of primary power conductors	
-------	--	--

a)	Copper	:	mm ²
b)	Aluminium	:	mm ²

3.1.8	Spare modules considered as per Data Sheet A / BOM	:	☐ YES ☐ NO
-------	--	---	--

3.2	DRAWOUT MODULES
-----	------------------------

3.2.1	Type of execution of modules (functional unit)
-------	--

a)	Circuit breaker unit (Incoming & outgoing)	:	☐ Withdrawable ☐ Fixed
b)	MCCB unit (Incoming)	:	☐ Withdrawable ☐ Fixed
c)	Switch-Fuse & Contactor (Incoming)	:	☐ Withdrawable ☐ Fixed

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- d) Switch or Switch-Fuse (Incoming) : ☐ Withdrawable ☐ Fixed
- e) MCCB unit (Outgoing) : ☐ Withdrawable ☐ Fixed
- f) Contactor starter unit (Outgoing) : ☐ Withdrawable ☐ Fixed
- g) Switch-Fuse unit (Outgoing) : ☐ Withdrawable ☐ Fixed
- h) Incoming Voltage Transformer (VT) : ☐ Withdrawable ☐ Fixed
- i) BUS VT : ☐ Withdrawable ☐ Fixed
- j) Control Transformer : ☐ Withdrawable ☐ Fixed
- k) Space Heater : ☐ Withdrawable ☐ Fixed
- l) Alarm : ☐ Withdrawable ☐ Fixed
- m) DC Supply : ☐ Withdrawable ☐ Fixed

3.2.2 Rating upto which withdrawable units applicable, if specified in 3.2.1 b), d), e) and g) above. : A

3.2.3 Facility for functional testing of withdrawable modules provided for:

- a) Incomer Circuit Breaker : ☐ YES ☐ NO
- b) Outgoing Circuit Breaker : ☐ YES ☐ NO
- c) Contactor controlled units : ☐ YES ☐ NO
- d) Bus - Couplers Circuit Bkr. Controlled : ☐ YES ☐ NO

3.3 BUSBARS & CONNECTIONS

3.3.1 Busbar material

- a) Phase & Neutral
- i. Material : ☐ Copper ☐ Aluminium
- ii. Grade :
- b) Earth
- i. Material : ☐ Copper ☐ Aluminium

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	:	[] Galvanised MS
ii. Grade	:	
3.3.2 Support material	:	
3.3.3 Fault Level	:	kA
3.3.4 Max. temperature for short time rating	:	°C
3.3.5 Short time current		
a) For switchboards fed thru ACB / MCCB	:	kA, sec.
b) For switchboards fed thru HRC Fuses	:	kA, sec.
3.3.6 Momentary rating	:	kA (peak)
3.3.7 Type of joints	:	☐ Silver plated ☐ Non-silver plated ☐ Both
3.3.8 Temperature Rise		
a) Design ambient	:	°C
b) Temp. rise (max.) for		
i. Silver plated joints	:	°C
ii. Non-silver plated joints	:	°C
3.3.9 Whether HRPVC sleeving provided	:	☐ YES ☐ NO
3.3.10 Whether shrouds on busbar tap offs provided	:	☐ YES ☐ NO
3.3.11 Applicable method of colour coding for black PVC sleeving	:	
3.3.12 Busbar clearances in air (minimum)		
a) Phase-Phase	:	mm
b) Phase-Earth	:	mm
3.3.13 Spacing between supports	:	mm
3.3.14 Spacing between busbars	:	mm

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3.4

SECONDARY WIRING AND TERMINALS

3.4.1

Voltage grade of wires

:

V

3.4.2

Conductor material of wire

a)

Power wiring

:

b)

Control wiring

:

3.4.3

Sizes of wires

a)

Power wiring (min.)

:

mm²

b)

CT leads

:

mm²

c)

Other control wires

:

mm²

3.4.4

Insulation material of wires

:

3.4.5

Colour code of wires conforms to Section D

:

[] YES

[] NO

3.4.6

Type of lugs used for internal wiring

:

3.4.7

Minimum current rating of terminal block

:

A

3.4.8

Is shrouding inherent feature for live parts of terminal block for -

a)

Secondary isolating contacts

:

[] YES

[] NO

b)

:

[] YES

[] NO

c)

:

[] YES

[] NO

3.4.9

Number of ways per block of terminals

:

3.4.10

Standard mounting of terminal blocks

:

3.4.11

Whether terminals for CTs provided with shorting facility

:

[] YES

[] NO

3.4.12

Whether disconnectable link type short circuiting terminals provided for secondary injection

:

[] YES

[] NO

3.4.13

Spare terminals as percentage of total terminals

:

%

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3.5 AUXILIARY BUSES

3.5.1 Provision of following as applicable to various switchboards

- | | | | | |
|----|------------------------|---|--------------------------------|--------------------------------|
| a) | AC Control Bus | : | ☐ 240 V | ☐ 110 V |
| b) | DC Control Bus | : | ☐ 220 V | ☐ 110 V |
| c) | 24V AC Wdg. htg. Bus | : | ☐ YES | ☐ NO |
| d) | 240V AC Space htg. Bus | : | ☐ YES | ☐ NO |
| e) | Alarm Bus | : | ☐ YES | ☐ NO |

3.6 CONTROLS, INDICATIONS & ALARMS

3.6.1 Means for simulation testing provided : ☐ YES ☐ NO

3.6.2 Scope considered for interposing relays for remote command interface : ☐ Mounting & wiring only
☐ Supply, mounting & wiring

3.6.3 No. of contacts and rating at 230 V AC (make & carry) and 220 V DC (breaking)

NO + NC RATING (A)
 (AC) (DC)

- | | | |
|------|---------------------|---|
| a) | Air Circuit Breaker | |
| i. | Internal use | : |
| ii. | Purchaser's use | : |
| iii. | Releases | |
| | A. Overload | : |
| | B. Short Circuit | : |
| | C. Under Voltage | : |
| | D. Earth Fault | : |
| b) | MCCB | : |

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- c) Switches :
- d) Power Contactors :
- e) Thermal Overload Relay :
- f) Single Phasing Preventer :
- g) Push Button :
- h) Miniature Circuit Bkr. :
- i) Control switches :
- j) Selector switch :
- k) Timer :
 - i. ON delay :
 - ii. OFF delay :
 - iii. Instantaneous :

3.7 CABLING AND TERMINATIONS

- a) Cable Entry : ☐ BOTTOM ☐ TOP ☐ REAR
- b) Cable Sizes as per enclosed annexure II (Data Sheet A) considered : ☐ YES ☐ NO
- c) Type of incoming connections from transformer to PCC : ☐ Bus Trunking ☐ Cable ☐ Bus Duct

3.8 EARTHING

3.8.1 Size of earth bus (min.) : mm²

3.9 LABELING

3.9.1 Inscriptions, material and locations as per specification confirmed, specifically mentioned otherwise in "Schedule of Deviations" : ☐ YES ☐ NO

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3.9.2 Thickness of anodised aluminium sheet : mm 4.0 <u>SWITCHGEAR MAIN ASSEMBLIES</u> 4.1 <u>AIR CIRCUIT BREAKERS</u> 4.1.1 Rated voltage : V 4.1.2 Maximum voltage at which circuit-breaker can operate continuously : V 4.1.3 Number of Poles : ☐ Three ☐ Four 4.1.4 No. of breaks per pole : 4.1.5 Clearances in air : a) Between phases : mm b) Live parts to earth : mm 4.1.6 Symmetrical (RMS) interrupting capacity at rated voltage. : kA 4.1.7 Rated breaking capacity at service voltage : MVA 4.1.8 Momentary making current : kA (peak) 4.1.9 Short time rating : kA, sec. 4.1.10 Short circuit performance category : 4.1.11 Derating factor for operation under site conditions : 4.1.12 Operating mechanism : ☐ Motor wound spring ☐ Manual ☐ Direct acting ☐ Shunt trip ☐ Both of above 4.1.13 Operation counter provided : ☐ YES ☐ NO <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <tr> <td colspan="4" style="width: 50%;">Name of Bidder/Sub-contractor</td> <td colspan="2" style="width: 50%;">Project</td> </tr> <tr> <td style="width: 25%;">Revision Number</td> <td style="width: 12.5%;">0</td> <td style="width: 12.5%;">1</td> <td style="width: 12.5%;">2</td> <td style="width: 12.5%;">3</td> <td rowspan="4" style="width: 37.5%; text-align: center; vertical-align: middle;"> BIDDER'S SEAL </td> </tr> <tr> <td>Signature of Bidder/Sub-contractor/Authorised Representative</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Date</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td colspan="5"></td> </tr> </table> 274 of 628						Name of Bidder/Sub-contractor				Project		Revision Number	0	1	2	3	BIDDER'S SEAL	Signature of Bidder/Sub-contractor/Authorised Representative					Date									
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4.1.14 Auxiliary voltage for

a)	Spring charging motor	:	V DC
b)	Closing release coil	:	V DC
c)	Shunt trip coil	:	V DC

4.1.15 Limits of voltage for satisfactory operation of the following devices as %age of normal voltage

a)	Spring charging motor	:	%
b)	Closing release coil	:	%
c)	Shunt trip coil	:	%

4.1.16 Spring charging motor details

a)	Rating	:	kW
b)	Rated voltage	:	V
c)	Rated current	:	A
d)	Speed	:	r.p.m.
e)	Insulation class	:	
f)	Spring charging time	:	sec.
g)	Max. temperature rise over specified ambient	:	°C

4.1.17 Maximum temp. of the main contacts with rated continuous current (After considering derating for site conditions)

:

°C

4.1.18 Type of main contacts

:

4.1.19 Material of main contacts

:

4.1.20 Type of arcing contacts

:

4.1.21 Material of arcing contacts

:

4.1.22 Whether contacts are silver plated

:

[] YES

[] NO

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If yes,

4.1.23 Thickness of silver plating :

4.1.24 Contact pressure :

4.1.25 Maximum number of auxiliary contacts that can be fitted :

4.1.26 Whether NO & NC contacts interchangeable at site : ☐ YES ☐ NO

4.1.27 Maximum number of secondary isolating contacts that can be fitted :

4.1.28 Power required for closing at

a) Normal voltage : Watts/VA

b) 80% normal voltage : Watts/VA

4.1.29 Power required for tripping

a) Normal voltage : Watts/VA

b) 50% normal voltage : Watts/VA

c) Trip circuit consumption (With supervision lamp) : Watts/VA

4.1.30 Are the circuit breakers trip free : ☐ YES ☐ NO

4.1.31 Type of release (where applicable) : ☐ Static ☐ Electromagnetic

4.1.32 Provision of releases for specified function

a) PCC incomer

i. Overload : ☐ YES ☐ NO

ii. Short Circuit : ☐ YES ☐ NO

If Yes,

With timer : ☐ YES ☐ NO

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- iii. Under Voltage : ☐ YES ☐ NO
If yes,
 With timer : ☐ YES ☐ NO
- iv. Earth Fault : ☐ YES ☐ NO
If Yes,
 With timer : ☐ YES ☐ NO
- b) MCC incomer
- i. Overload : ☐ YES ☐ NO
- ii. Short Circuit : ☐ YES ☐ NO
If Yes,
 With timer : ☐ YES ☐ NO
- iii. Under Voltage : ☐ YES ☐ NO
If yes,
 With timer : ☐ YES ☐ NO
- iv. Earth Fault : ☐ YES ☐ NO
If Yes,
 With timer : ☐ YES ☐ NO
- c) Outgoing Feeder
- i. Overload : ☐ YES ☐ NO
- ii. Short Circuit : ☐ YES ☐ NO
If Yes,
 With timer : ☐ YES ☐ NO
- iii. Under Voltage : ☐ YES ☐ NO
If yes,
 With timer : ☐ YES ☐ NO
- iv. Earth Fault : ☐ YES ☐ NO
If Yes,
 With timer : ☐ YES ☐ NO
- d) Bus - Coupler
- i. Overload : ☐ YES ☐ NO

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ii.	Short Circuit	:	☐ YES	☐ NO
	If Yes,	:	☐ YES	☐ NO
	With timer	:	☐ YES	☐ NO
iii.	Under Voltage	:	☐ YES	☐ NO
	If yes,	:	☐ YES	☐ NO
	With timer	:	☐ YES	☐ NO
iv.	Earth Fault	:	☐ YES	☐ NO
	If Yes,	:	☐ YES	☐ NO
	With timer	:	☐ YES	☐ NO

4.1.33 Release setting range

a)	Overload	:	%
b)	Short circuit	:	%
c)	Under Voltage	:	%
d)	Earth Fault	:	%

4.1.34 Release time delay

a)	Short circuit	:	sec.
b)	Under Voltage	:	sec.
c)	Earth Fault	:	sec.

4.1.35 Min. recommended grading time between consecutive circuit breakers fitted with

a)	Electromagnetic relays	:	msec.
b)	Solid state releases	:	msec.

4.1.36 Means provided for remote indication of individual function for above releases

:	☐ YES	☐ NO
---	------------------------------	-----------------------------

4.1.37 Whether following anti-pumping features provided

a)	Mechanical	:	☐ YES	☐ NO
b)	Electrical	:	☐ YES	☐ NO

4.1.38 Whether programmable secondary isolating contact provided

:	☐ YES	☐ NO
---	------------------------------	-----------------------------

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4.2 CONTACTOR STARTER UNITS (DIRECT-ON-LINE)

4.2.1 Max. Motor rating upto which contactor starter considered : kW

4.2.2 Type of short circuit device : ☐ HRC Fuse ☐ MCCB

4.2.3 Locked rotor protection provided : ☐ YES ☐ NO

4.2.4 Type of co-ordination between SCPD & other starter components as per IS: 8544. : ☐ a ☐ b ☐ c

4.2.5 Whether secondary isolating contacts are self-isolating self-aligning type : ☐ YES ☐ NO

4.3 SWITCH-FUSE UNITS

4.3.1 Breaking capacity at 110 % rated voltage and 0.3 power factor :

4.3.2 Short time rating : kA, sec.

4.4 MOULDED CASE CIRCUIT BREAKERS (MCCB)

4.4.1 Application

a) Contactor Starter : ☐ YES ☐ NO

b) Other circuits : ☐ YES ☐ NO

c) If Yes for b)
Provided for rating upto : A

4.4.2 Rated voltage : V

4.4.3 Number of poles :

4.4.4 Derating factor for site ambient conditions :

4.4.5 Minimum clearances in air

a) Between poles : mm

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b)	Live parts to frame	:		mm
4.4.6 Construction materials of				
a)	Frame	:		
b)	Main contacts	:		
c)	Arcing contacts	:		
4.4.7	Whether contacts are plated	:	☐ YES	☐ NO
If yes,				
4.4.8	Material of plating	:		
4.4.9	Main contact pressure	:		
4.4.10 Maximum temperature rise over ambient for				
a)	Main contacts	:		°C
b)	Other moulded parts	:		°C
4.4.11	Short time rating	:		kA, sec.
4.4.12	Rated short circuit duty	:		
4.4.13	Rated breaking capacity (rms) at 415 V	:		kA
4.4.14	Rated making current	:		kA (peak)
4.4.15 On/Off operation				
a)	Manual	:	☐ YES	☐ NO
b)	Remote power operated	:	☐ YES	☐ NO
4.4.16 Releases provided				
a)	Overload	:	☐ YES	☐ NO
b)	Under voltage	:	☐ YES	☐ NO
c)	Short circuit	:	☐ YES	☐ NO

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4.4.17 Whether MCCBs are suitable for use without Short Circuit and/or Overload release without impairing its function in any way

4.4.18 Whether comparison of I Vs T plot of MCCB and fuse will automatically ensure discrimination between the two in S/C and O/L region
If no,

4.4.19 State the other consideration for achieving discrimination

4.4.20 Type of coordination with the characteristics of other devices as per IS: 8544, when used as SCPD with contactor

4.4.21 Whether coordination indicated above verified by the test

4.4.22 Whether MCCB is suitable for direct switching on to motor
If yes,

4.4.23 Utilization category as per IS: 2959

4.4.24 Whether shunt trip provided
If yes,

a) Nominal voltage

b) Voltage variation range

c) Energisation power

4.4.25 Whether solenoid closing operation provided
If Yes,

a) Nominal voltage

b) Voltage variation range

c) Energisation power

: [] YES [] NO

: [] YES [] NO

:

: [] a [] b [] c

: [] YES [] NO

: [] YES [] NO

:

: [] YES [] NO

:

: V [] AC [] DC

: %

: VA

: [] YES [] NO

: V [] AC [] DC

: %

: VA

5.0 **SWITCHGEAR COMPONENTS**

5.1 **ISOLATING SWITCH**

5.1.1 Rated voltage : V

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5.1.2	No. of poles	:	
5.1.3	Minimum thermal rating	:	A
5.1.4	Are switches suitable for breaking locked rotor current of the motor of maximum rating controlled by the switches	:	[] YES [] NO
5.1.5	Derating factor for site ambient conditions	:	
5.1.6	Utilization category for main contacts	:	
5.1.7	Temperature rise over ambient for main contacts when carrying rated current for site condition	:	°C
5.2	POWER CONTACTORS		
5.2.1	Short time rating	:	kA, sec.
5.2.2	Rated voltage of main contacts	:	V
5.2.3	Rated voltage of auxiliary		
	a) AC	:	V
	b) DC	:	V
5.2.4	Coil voltage (nominal)	:	☐ 110 V AC 50 Hz ☐ 220/240 V AC 50 Hz ☐ 110 V DC ☐ 220 V DC
5.2.5	Permissible supply voltage variation w.r.t. nominal coil voltage	:	%
5.2.6	Drop out voltage for coil	:	V
5.2.7	No. of poles for main contactor	:	
5.2.8	Insulation class for winding of electromagnet	:	
5.2.9	Temperature rise over ambient	:	°C

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for coil winding

5.2.10 Minimum thermal rating when : A
used in power circuit

5.2.11 Utilization category

a) Reversible motor :

b) Non-reversible motor :

5.2.12 Type of hold-in mechanism :
[] Electrically held
[] Mechanical latch-in**5.3 HIGH RUPTURING CAPACITY (HRC) FUSES**

5.3.1 Whether fuse mounted in the insulated carrier : [] YES [] NO

5.3.2 Rupturing capacity

a) AC : kA

b) Dc : kA

5.3.3 Temperature rise over : °C
ambient at rated current**5.4 THERMAL OVERLOAD RELAY**

5.4.1 Range : %

5.4.2 Resetting : [] Hand [] Self
[] Both with changeover facility

5.4.3 Whether ambient compensated : [] YES [] NO

If yes,
Compensated upto ambient of : °C

5.4.4 Single phasing prevention feature provided : [] YES [] NO

5.5 SINGLE PHASING PREVENTER (SPP)

(To be filled up where separate SPP is considered)

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5.5.1

Applicable above motor rating

:

kW

5.5.2

Delay time

:

sec.

5.5.3

Setting (%age of FLC)

:

%

5.5.4

Resetting

:

[] Hand

[] Self

5.6

INSTRUMENTS AND METERS

5.6.1

Provision of ammeter for motor rating above

:

kW

5.6.2

Voltmeter

a)

Shape

:

b)

size

:

mm x mm

c)

Accuracy class

:

d)

Voltage coil rating

:

V

e)

Angle of deflection

:

deg.

f)

Scale length

:

mm

5.6.3

Ammeter

a)

Shape

:

b)

size

:

mm x mm

c)

Accuracy class

:

d)

Current coil rating

:

A

e)

Angle of deflection

:

deg.

f)

Scale length

:

mm

5.6.4

Energy Meters

a)

Shape

:

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b) size : mm x mm c) Accuracy class : d) Current coil rating : A e) Voltage coil rating : V f) Angle of deflection : deg. g) Scale length : mm h) Hours of operation : hours 5.7 RELAYS 5.7.1 Type : ☐ Static ☐ Electromagnetic 5.7.2 Coil Rating a) Current coil : ☐ 1 A ☐ 5 A b) Voltage : V 5.7.3 Means for in-built testing provided : ☐ YES ☐ NO 5.7.4 Minimum grading time recommended between consecutive breakers fitted with the relays : msec. 5.8 CURRENT TRANSFORMERS 5.8.1 Secondary Rating : ☐ 1 A ☐ 5 A 5.8.2 Output : VA 5.8.3 Accuracy class (metering) : 5.8.4 Accuracy class (protection) : 5.8.5 Accuracy limit factor (ALF) : 5.8.6 Type of Primary winding : ☐ Bar ☐ Wound						
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5.8.7	Primary current rating	:	A
5.8.8	Instrument security factor	:	
5.8.9	Specific data for CTs required for differential Protection		
a)	Knee point voltage (Vk)	:	V
b)	Exciting current at Vk/2	:	A
c)	Secondary resistance	:	ohms
5.8.10	Short time rating	:	kA, sec.
5.8.11	Momentary current	:	kA
5.8.12	Insulation material	:	
5.8.13	Class of insulation	:	
5.8.14	Max. temperature rise over ambient for the winding	:	°C
5.8.15	Whether capable of carrying rated primary current for 1 minute with the secondary winding open circuited	:	[] YES [] NO
5.9	VOLTAGE, CONTROL & WINDING HEATING TRANSFORMERS		
5.9.1	Voltage Transformers		
a)	System Earthing considered	:	[] Effective [] Non-effective
b)	Secondary terminal voltage (phase-phase)	:	V
c)	Insulation material	:	
d)	Class of insulation	:	
e)	Accuracy class	:	
f)	Output	:	VA

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g) Winding configuration : [] 3, 1 ϕ [] 3 ϕ [] V

h) Over voltage factor

i. continuous :

ii. 30 seconds :

i) Max. temperature rise of winding over ambient : °C

5.9.2 Control Transformers (for contactor operation)

a) Rated Primary voltage(Phase-Phase) : V

b) Taps : %

c) Minimum secondary terminal voltage (when primary voltage is minimum & transient current is maximum) : V

d) Secondary terminal voltage : [] 110 V [] 240 V

e) Whether separate control transformer considered for individual circuit : [] YES [] NO

5.9.3 24 V Winding Heating Transformer (If applicable as per Data Sheet A)

a) Secondary terminal voltage : V

b) Primary voltage : V

5.10 MINIATURE CIRCUIT BREAKER

(Data to be filled up if applicable)

5.10.1 Breaking capacity : kA

5.10.2 Thermal overload and magnetic short circuit protection provided : [] YES [] NO

5.11 CONTROL AND SELECTOR SWITCH

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5.11.1 Control Switch

- a) Type : ☐ Stay put
☐ Spring return
☐ Wing knob
☐ Pistol grip
- b) Voltage grade : V
- c) No. of positions :
- d) Lockability : ☐ In each position
☐ with integral barrel lock
& key in neutral position
- e) No. of poles / ways :
- f) Angular movement : deg.

5.11.2 Selector Switch

- a) Type : ☐ Stay put
☐ Wing knob
- b) Voltage grade : V
- c) No. of positions :
- d) Lockability : ☐ in each position
☐ with integral barrel lock
& key
- e) No. of poles/ ways :
- f) Angular movement : deg.

5.12 INDICATION LAMPS

- 5.12.1 Voltage grade : V
- 5.12.2 Series resistor value used as economy ohms resistor or dropping resistor for supervision :
- 5.12.3 Circuit voltage : ☐ 220/240 V AC
☐ 110 V DC
☐ 220 V DC

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5.12.4 Lens colour as per Data Sheet A. : ☐ YES ☐ NO

5.12.5 Diameter of lamp : mm

5.12.6 Wattage consumption of lamp

a) With resistor : Watts

b) Without resistor : Watts

5.13 PUSH BUTTONS

5.13.1 Voltage Grade : V

5.13.2 No. of Contacts : (NO + NC)

5.13.3 Function : START STOP RESET

a) Colour of actuator :

b) Type of actuator head : S/M S/M S/M
(S=Shrouded, M=Mushroom)

c) Lockability : Y/N Y/N Y/N
(Y=Yes, N=No)

5.14 ANTI-CONDENSATION HEATERS

5.14.1 24 V motor winding heating

a) Applicable Rating(including & below) : kW

b) Maximum space htg. current (%age of FLC) considered for the sizing of transformer : %

5.14.2 Panel space heating

a) Voltage : V AC

b) Thermostat provided : ☐ YES ☐ NO

c) If b) is yes, limit of adjustability of temp. within panel : °C

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- d) If b) is no, the min temp. to be maintained : °C
- e) Separate provision for front and rear panels considered : [] YES [] NO

5.15 GENERAL PURPOSE TIMERS

(Other than electromechanical & Electronic timers used in protection)

- 5.15.1 Coil voltage rating (AC) : [] 220 V [] 110 V
- 5.15.2 Limits of voltage variation : %
- 5.15.3 Time delay range : sec.
- 5.15.4 Type of delay mechanism : [] Pneumatic
[] Electronic
[] Electromechanical
- 5.15.5 Repeat accuracy :

6.0 PAINTING**6.1 Shade**

- a) Interior : as per IS:5
- b) Exterior : as per IS:5

6.2 Paint Finish

- a) Interior : [] Matt [] Semi-glossy
- b) Exterior : [] Semi-glossy [] Full-glossy

- 6.3 Paint thickness (min.) : microns

7.0 MAKE AND TYPE OF COMPONENTS

EQUIPMENT

MAKE

TYPE DESIGNATION
OF MANUFACTURERNo. OF YEARS
IN SERVICE

1. Air Circuit Breaker | | | |

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---	2.	MCCB (AC)				
---	3.	MCCB (DC)				
---	4.	Isolating Switch ¹				
---	5.	AC Contactor				
---	6.	DC Contactor				
---	7.	HRC Fuse (base & link) ¹				
---	8.	Single Phasing Preventer ¹				
---	9.	Voltmeter				
---	10.	Ammeter				
---	11.	Energy meter				
---	12.	Relays				
---	i.	Thermal O/L				
---	ii.	Inverse Time Over Current				
---	iii.	Definite Time Over Current				

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iv.	Motor Protection				

v.	Inverse Time Earth Fault				

vi.	Definite Time Earth Fault				

vii.	Interposing Relay				

viii.					

13.	CT				

14.	VT				

15.	Control Transformer				

16.	Winding Heating Transformer				

17.	MCB				

18.	Control Switch				

19.	Selector Switch				

20.	Indicating Lamps				

21.	Panel space Heater				

22.	Gen. Purpose Timer				

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23. Push Buttons

24. Breaker operation counter

25. Breaker switch

26. Neutral link

27. Cable gland

28. Cable lugs

29. DC switch

30. Fixed terminals

31. Lighting switch

32. Limit switch

33. Sockets

34. Terminal drawouts

35. Thermostat

8.0 SPARES**8.1 O&M Spares**

a) Period for which O&M spares offered : years

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b) Whether additional O&M offered (other than those indicated) : ☐ YES ☐ NO 8.2 Start-up spares a) Whether E & C spares offered : ☐ YES ☐ NO b) Whether any additional start-up spares offered for purchaser's consideration : ☐ YES ☐ NO 9.0 DOCUMENTATION Whether following furnished as per clause 12.3 Section D. a) Typical sectional drawing : ☐ YES ☐ NO b) Schematic drawings for each functional unit : ☐ YES ☐ NO c) Wire routing, termination and numbering details : ☐ YES ☐ NO d) Type test Certificates of switchboard, circuit-breakers and components : ☐ YES ☐ NO e) Final Quality Plans with signatures and seal on each sheet : ☐ YES ☐ NO f) Catalogues / Technical leaflets of switchboard and components : ☐ YES ☐ NO g) Bar chart of activities and their schedules : ☐ YES ☐ NO The above documents shall be submitted in the form of Annexures - A to Annexure - G in the exact order listed above along with Data Sheet C.						
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	TITLE	SPECIFICATION NO.			
		PVC POWER CABLES			
		VOLUME			
		SECTION			
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DATASHEET C

GUARANTEED TECHNICAL PARTICULARS (TO BE SUBMITTED BY SUCCESSFUL BIDDER)

- 1.1 Name of manufacturer :
- 1.2 Place of Manufacture :
- 2.1 Current rating of cables conforms to :
- 2.2 Short circuit rating conforms to :
- 3.1 Formula for calculating short circuit current for different durations as per Clause-5 of Data Sheet-A :

OR

Whether curve for short time current v/s time for different cables enclosed :

4.0 INFORMATION TO BE FILLED IN FOR EACH SIZE CABLE IN THE FORM OF TABLE

- 4.1 No. of cores x size :
- 4.2 Base current ratings (*) based on Clause 6.0 of Data Sheet-A
- a) In air : Amp
- b) In ground : Amp
- c) ducts : Amp
- 4.3 Short circuit rating : kA, sec.
- 4.4 a) D.C. resistance of conductor at 20 deg. C : ohm/km
- b) A.C. resistance of conductor at 70/85 deg. C : ohm/km
- c) Reactance of cable at normal frequency : ohm/km

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

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4.5 CONDUCTOR

- a) Material type & grade :
- b) Shape of conductor :
- c) No & dia of wires in each core before stranding : no x mm

4.6 PVC INSULATION

- a) Type :
- b) Minimum & Nominal thickness of insulation : mm

4.7 PVC *ST1/ ST2* INNERSHEATH

- a) Thickness (min.) : mm
- b) Method of application
- 1) Multi-core cables
- i) With fillers :
- ii) With out fillers : Pressure Extruded
- c) Type of fillers (if used) : PVC type *ST1/ ST2* as per IS 5831
- Shape of fillers (if used) :
- d) Colour :

4.8 ARMOUR

- a) Material
- i) Single core cables :
- ii) Multi-core cables :
- b) Size/ dimensions :
- c) Minimum no. of wires :
- d) Maximum resistivity of GS wire :
- e) Maximum resistivity of Aluminium round wire :

4.9 PVC *ST1/ ST2* FRLS OUTERSHEATH

- a) Minimum thickness of outer sheath : mm

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			