



## **Annexure-2**

**(ELECTRICAL DESIGN BASIS For CNG OLS & DBS  
STATION). -DOCUMENT NO. C261162 CNG EL SOW  
4002**

 Energising Quality		<b>PROJECT NUMBER: C261162</b>		 HPOIL GAS	
<b>ELECTRICAL DESIGN BASIS for CNG OLS &amp; DBS STATIONS</b>				TOTAL SHEETS 8	
DOCUMENT NO.	C261162	CNG	EL	DB	4001
<p><b>HPOIL GAS PRIVATE LIMITED</b></p> <p><b>CITY GAS DISTRIBUTION PROJECT</b></p> <p><b>ELECTRICAL DESIGN BASIS For CNG OLS &amp; DBS STATION</b></p>					
C1	29.01.2026	ISSUED FOR TENDER	NJ	FJ	AA
<b>REV</b>	<b>DATE</b>	<b>DESCRIPTION</b>	<b>PREP</b>	<b>CHKD</b>	<b>APPR</b>



## CITY GAS DISTRIBUTION NETWORK IN NAGALAND GA

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<b>1.0 CODES &amp; STANDARDS</b>	
Electrical equipment and system design, manufacture, testing, installation and commissioning will comply with all the latest applicable standards, regulations and codes as mentioned below:	
BIS	Bureau of Indian Standards
CMIFR	Central Mining Institute & Fuel Research
OISD	Oil Industrial Safety Directives
IEEE	Institute of Electrical & Electronics Engineer
IER	The Indian Electricity Rules
ANSI	American National Standards Institute
BEE	Bureau of Energy Efficiency India
IEC	International Electrotechnical Commission
<b>2.0 SITE CONDITIONS</b>	
• Max/Min temperature	50°/2°C
• Relative Humidity	95%
• Soil Resistivity	As per Soil Analysis report
• Min. temp. for battery sizing	5°C
• Altitude above mean sea level	Less than 1000M above mean sea level
• Weather	Dry, dust storms in summer, humid / heavy rain fall during monsoon
<b>3.0 AREA CLASSIFICATION AND EQUIPMENT SELECTION</b>	
Area Classification	Zone-I & II as per IS:5572
Gas Group	IIA & IIB
Temperature Classification	T3
<b>Enclosure Protection of Equipment</b>	
<b>Installation Area</b>	IP Rating of Equipment
<b>Outdoor</b>	
All Electrical Equipment	IP-65
<b>Indoor</b>	
UPS	IP-31
MEDB	IP-42
<b>Hazardous Area</b>	
All electrical equipment	Flameproof (Ex-d)



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<b>4.0 POWER SUPPLY DETAILS</b>	
<b>Power Source:</b>	
OLS & DBS	AC supply from local grid at 11 or 33kV and stepped down to 415V, 3Ph, 4 Wire
<b>Power Supply Parameters:</b>	
Voltage	415V AC +/- 10%
Frequency	50Hz +/-5%
Phase & Wire	3Ph. & N (4W)
	1Ph. & N (2W)
Fault Level	25kA for 1 sec.- 3 Ph circuits
	6kA for 1 sec.- 1Ph Circuits
Neutral Earthing	Solidly Earthed
<b>Back-up Power Source:</b>	
At OLS	Not Envisaged
At DBS	Not Envisaged
<b>Critical Power Supply Details:</b>	
OLS/DBS	UPS. Single online with SCVS bypass with 1 hour battery backup.
Loads envisaged on UPS	INSTRUMENTATION
	SCADA
	FIRE ALARM
	DISPENSERS
	TELECOM
<b>Utilization voltage &amp; Operating philosophy:</b>	
SCADA	230V AC UPS feeder will be provided. Voltages as required for various systems will be generated from the 230V AC UPS supply. Necessary AC to DC converters in dual redundant configuration and appropriate rating will be provided by the equipment vendor.
Instrumentation	
Electrical System	<ul style="list-style-type: none"> <li>▪ 230V/415V AC from Grid Power Supply</li> <li>▪ 230V AC UPS feeder will be provided.</li> </ul>
CP system	
Air Conditioning	<ul style="list-style-type: none"> <li>▪ At control room / telecom / SCADA room 230V,1-Ph AC grid power supply</li> </ul>
Lighting/ventilation	<ul style="list-style-type: none"> <li>▪ At all locations 230V AC grid power supply</li> </ul>
Fire Alarm system	<ul style="list-style-type: none"> <li>▪ 230V AC UPS feeder will be provided. All AC to DC converters to meet the equipment requirements shall be in the scope of the equipment vendor</li> </ul>
	<ul style="list-style-type: none"> <li>▪</li> </ul>



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<b>5.0 EQUIPMENT/ELECTRICAL SYSTEM ENVISAGED AT OLS &amp; DBS:</b>	
<b>OLS &amp; DBS</b>	<p>a) Transformer</p> <ul style="list-style-type: none"> <li>• Primary Voltage 11/33kV depending upon the availability</li> <li>• Secondary Voltage: 415V, 3Φ, 4W</li> </ul> <p>b) 415V Switch Board/ MEDB for receiving normal power at Dispatch station with Energy Saving device, phase selection logic, timer for AC etc.</p> <p>c) Single Online UPS system (2kVA) with static by - pass with SMF VRLA type battery bank(for 1 hours backup) for Instrumentation, SCADA and other critical loads</p> <p>d) LT cables (Power and Control)</p> <p>e) Indoor &amp; Outdoor lighting (For Classified and Non-Classified area &amp; Buildings)</p> <p>f) Earthing and Lightning protection system</p> <p>g) Structural steel, cable tray, erection accessories etc. as required</p> <p>h) Local Control Stations (Classified type).</p> <p>i) Structural steel, cable tray, erection accessories etc. as required</p>
<b>6.0 AIR CONDITIONING AND VENTILATION</b>	
For Instrument /Control room	AC will be provided
For electrical room	Not required
For Battery Room	Adequate Ventilation through flameproof exhaust fans
<b>7.0 DISTRIBUTION BOARDS</b>	
MEDB	Fixed, Single front, floor mounted, IP-42 with surge protection device at the input terminals
UPSDB	Fixed, Single front, Wall mounted, IP-42, with surge protection device at the input terminals
All panels shall be equipped for mod-bus communication for remote monitoring. All lighting feeders shall be fed through RCCB.	



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<b>8.0 UPS</b>	
UPS type	Industrial, Single Online with SCVS bypass, in IP 31 (minimum) enclosure
<b>9.0 UPS BATTERY</b>	
Battery type	SMF VRLA
Back up time	1 hours
Battery execution	Single bank 1x100% capacity
<b>10.0 CABLES FOR ELECTRICAL SYSTEM</b>	
<b>10.1LT POWER CABLE (1.1 KV GRADE)</b>	
Conductor Size	As per Design/SOR
Insulation	XLPE
Inner Sheath	Extruded ST2 Type
Armour	Steel Strip/Wire
Outer Sheath	Extruded FRLS ST2 Type
Voltage Grade	1100 V
<b>10.2 CONTROL CABLE (1.1 KV GRADE)</b>	
Conductor Size	As per Design/SOR
Insulation	XLPE
Inner Sheath	Extruded ST2 Type
Armour	Steel Strip/Wire
Outer Sheath	Extruded FRLS ST2 Type
Voltage Grade	1100 V
<b>10.3 LIGHTING CABLE</b>	
<ul style="list-style-type: none"> <li>• 2.5 mm<sup>2</sup> stranded Copper PVC insulated wire in concealed PVC conduit will be used for lighting fixtures.</li> <li>• 3 core 2.5 mm<sup>2</sup> stranded copper cable (2XWY) will be used for flameproof fixtures.</li> <li>• 3 core 2.5 mm<sup>2</sup> stranded copper cable (2XWY) will be used from outdoor lighting DB to JB on the lighting poles and JB to lighting fixture. Flameproof Cable gland suitable for un-armoured cables shall be used for wiring/cablings from pole JB to FLP light fixture.</li> <li>• 4 mm<sup>2</sup> stranded Copper PVC insulated wire in concealed PVC conduit for 5/15 amps with socket, 20A Industrial switch-socket for Air Conditioning.</li> </ul>	



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<b>11.0 CABLING SYSTEM</b>	
Cable laying philosophy	
Paved area	Cable tray / HDPE Conduit
Unpaved area	RCC trench / Directly buried
Inside Buildings	Cable trays / PVC Conduits
Type of cable trays	Galvanized prefabricated / Site fabricated And painted
Road Crossings	MS Conduits
<b>12.0 EARTHING SYSTEM</b>	
A. Type of Earthing System	Conventional GI Pipe Electrode
B. Max Earthing Resistance	2Ω
D. Number of Earth Pits / Earth connections	<b>Minimum number of earthpits / Earth Connections as described below:</b>
<b>Equipment</b>	<b>Number of Earthpits</b>
Equipment Earthing	1
RTU/SCADA	1
Instrumentation Panel	1
Telecommunication	1
UPS	1
Transformer Body Earthing	2
Transformer Neutral Earthing	2
Compressor PLC/Control Earthing	2 nos GI pipe earth electrodes
<b>Note:</b> Additional earth pits shall be provided if required as per IS: 3043.	
E. Size of Earthing Conductor	As per OISD 149 <b>Minimum Conductor Size shall be as given below:</b>
<b>Equipment</b>	<b>Earthing Conductor Size</b>
MEDB, UPSDB etc.	50x6 mm GI Flat/ 16 mm <sup>2</sup> GI Rope
FLP-WP lights / Control Station	6 mm <sup>2</sup>
RTU, Telecom, UPS, Compressors	25x3 mm GI strip
Field Instrument	2.5mm <sup>2</sup> copper earthing wire
Mechanical Equipment/ Pipe/ Cable racks/ Structure	50x6 GI Flat
Fencing/Street light poles	25 X 3mm GI Flat/6mm <sup>2</sup> copper earthing wire
Jumper for flanges	Cu Jumper



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<b>13.0 LIGHTING SYSTEM DESIGN</b>		
Lux Level shall be as follows:		
Area	Lux Level	Lighting Technology
Control room building	500	9W,12W,15W,18W,36W LED Lights (Recessed/Surface fixtures)
Office	300	9W,12W,15W,18W,36W LED Lights (Recessed/Surface fixtures)
Battery Room	150	1x40W FTL/LED Flame-proof lighting fixture (Recessed/Surface fixtures )
Electrical Equipment room	150	9W,12W,15W,18W,36W LED Lights (Recessed/Surface fixtures)
Process Area, Pipe Racks etc.	60	LED With flame-proof fittings
<p><b>NOTES:</b></p> <ul style="list-style-type: none"> <li>i. All electrical equipment installed in hazardous area will be selected as per IS: 5571.</li> <li>ii. All electrical equipment for hazardous area will have CMIFR and PESO certification.</li> <li>iii. All electrical fixtures for Hazardous area shall be classified type (Flame proof) as per the Arc Classification given in this document and have approval of respective statutory agency as per Petroleum Act, 2002.</li> <li>iv. Applicable standard for HT Cables shall be IS-7098 Part I&amp;II.</li> <li>v. Applicable standard for LT Cables shall be IS-7098 Part I&amp;II.</li> <li>vi. Applicable Standard for Control Cables shall be IS-7098 Part I.</li> <li>vii. M.B. Lal Committee recommendation to be followed in all electrical design &amp; installations.</li> <li>viii. The equipment shall also confirm to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.</li> <li>ix. In case of any contradiction between various referred standards/specifications/data sheet and statutory regulations, the following order of priority shall govern.               <ul style="list-style-type: none"> <li>▪ Contract Agreement.</li> <li>▪ Detailed Letter of Acceptance along with Statement of Agreed Variation.</li> <li>▪ FAX/Letter of Intent.</li> <li>▪ Schedule of Rates as per enclosed LOA.</li> <li>▪ Job/Particular Specifications</li> <li>▪ Drawings</li> <li>▪ Technical/Material Specifications</li> <li>▪ Special Conditions of Contract</li> <li>▪ Instruction to bidders</li> <li>▪ General conditions of Contract</li> <li>▪ Indian Standards</li> <li>▪ Other applicable standards</li> </ul> </li> </ul>		



Energising Quality

**PROJECT NUMBER: C261162**



HPOIL GAS

**ELECTRICAL SCOPE OF WORKS**

TOTAL  
SHEETS

08

DOCUMENT NO.

C261162

CNG

EL

SOW

4002

**HPOIL GAS PRIVATE LIMITED**

**CITY GAS DISTRIBUTION PROJECT**

**ELECTRICAL SCOPE OF WORK**

**For**

**OLS & DBS STATIONS**

C1	29.01.2026	ISSUED FOR TENDER	NJ	AA	AA
<b>REV</b>	<b>DATE</b>	<b>DESCRIPTION</b>	<b>PREP</b>	<b>CHKD</b>	<b>APPR</b>



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## 1. INTRODUCTION

HPOIL Gas Private limited (HOGPL), a Joint Venture Company of HPCL & OIL has received the authorization from PNGRB vide letter PNGRB vide letter PNGRB/CGD/BID/8/2018/GA/Ambala-Kurukshetra District dated 22/02/2018, PNGRB/CGD/BID/8/2017/BEC/GA Kolhapur dated 06/03/2018 and PNGRB/Auth/ CGD(06)/(2023)/12.04 Nagaland State dated 04/03/2024 to Lay, Build and Operate City Gas Distribution networks in Ambala-Kurukshetra, Kolhapur District and Nagaland State. HOGPL (hereinafter referred as Owner), is supplying Piped Natural Gas (PNG) to domestic, commercial, and Industrial consumers and Compressed Natural Gas (CNG) to automobiles in Ambala-Kurukshetra and Kolhapur District.

The CNG Stations construction works are to be executed in Nagaland GA, awarded to HPOIL by PNGRB.

The scope shall include construction of new CNG stations.

### 1.1. Scope of Work & Supply for CNG Stations

1.1.1. Supply & Installation of 11/0.415 kV, copper wound Distribution Transformer complete with accessories and systems as mentioned below.

1.1.1.1. Distribution Transformer (as per SOR) with Double Pole, Gang switch, overhead Conductor of suitable rating and all necessary accessories for completion of work including tapping from existing HT line etc. complete as per specification, SOR and requirement of approval from respective electricity/statutory authority. All electrical work i.e., charging of transformer, pole mounted substation, tapping from battery limit of electricity board shall be carried out in supervision of respective authority including necessary approval, if required.

1.1.1.2. Double pole structure with AB Switch, Lightning arrestors, horn gap fuse, copper wire jumpers up to transformer HT terminals.

1.1.1.3. ACSR conductor, 9m MS joint/pole, Pin insulator and GI hardware etc. as required from respective state electricity board battery limit up to double pole structure inside mother station.

1.1.1.4. Cables between LT terminals of transformer & load break fuse switch unit, cable supports, double compression cable glands, lugs etc. as required.

1.1.1.5. Supply of TPN, AC-23 duty switch fuse disconnecter in outdoor type dust & weather proof steel enclosure.

1.1.2. 415V, 25 kA Single Front Indoor, fixed type, LT Panel to receive and distribute power to all electrical equipment etc. as per SLD No. **C261162-CNG-EL-SLD-4001, C261162-CNG-EL-SLD-4002, C261162-CNG-EL-SLD-4003** cable gland plate of suitable size & of minimum 3mm thickness shall

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be provided for cable termination, wherever required, for all the electrical panels (MEDB, UPSDB etc.). The MFM of MEDB shall have provision for energy metering also and valid calibration report shall be submitted of the same. Type1+Type2 Surge protection device to be provided for both incoming feeders. Both the feeders should have electrical interlock between them as shown in SLD. The MEDB should have provision to send signal to AMF panel during mains failure and on restoration of grid power to ensure auto ON/OFF of DG.

- 1.1.3.** Single online UPS (1 nos. X 100% ratings+ bypass with SCVS) 2 kVA, 230V OUTPUT, Industrial UPS with SCVS bypass. The UPS shall be industrial type i.e., having three phase input and single-phase output. The UPSDB shall have a digital meter with provision to display current and voltage ratings. The scope includes incoming cables for UPS & all outgoing cables & cabling work from UPS to UPS ACDB.

1 no. (1 X 100 %) Sealed maintenance free (SMF) VRLA battery bank as per SOR for UPS suitable for 1 hour battery back-up time, with isolator, battery rack, earthing of battery rack, complete.

Battery shall be sized with ageing factor, SoC and temperature derating factors.

- 1.1.4.** Power cable (XLPE – insulated armoured Al/Cu conductor 1/2/3/3.5/4 core cables) as per SOR. Scope includes preparation of RCC/ Buried trench, conduiting in roof/walls as required, laying of GI/HDPE pipes and laying of cables in RCC/buried trenches, pipes and cable trays etc. along with termination of cables using cable glands of proper sizes. FLP (CMIFR tested, PESO approved) type double-compression nickel-plated brass cable glands, tinned- copper lugs, clamping material etc. shall be used for cable termination in FLP street lights.
- 1.1.5.** HDPE pipes GI Cable-trays and accessories like, cable markers, identifier tags, GI saddles and all other associated accessories for cable-laying.
- 1.1.6.** Flameproof Lights suitable for outdoor and indoor lighting and flameproof exhaust fan for battery room as per SOR. GI poles of 7-meter height to be installed for street lights complete with swan neck/ bracket for lighting fixture mounting. FLP JB to be used for street light poles installed in hazardous area.
- 1.1.7.** Fabrication and supply of MS frames, supports, canopies and brackets for miscellaneous electrical equipment, including welding, supply of bolts, nuts etc. for mounting and other necessary supplies, all inclusive of painting as specified.
- 1.1.8.** Earthing & Lightning Protection system Complete with conventional GI pipe/Copper plate earth electrode, GI/Copper strips as per SOR. Maximum resistance of earthing pit shall be 2Ω. Proper

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arrangement for disconnection of each pit shall be made in order to enable measurement of resistance of each pit.

- 1.1.9. Supply, Installation, testing & commissioning of Servo controlled stabilizer suitable for outdoor mounting as per SOR.
- 1.1.10. Safety materials and Insulated Rubber Mats to withstand High Voltages as per IS 15652 to be placed in front of all Electrical panels. Safety materials as per SOR complete with all accessories required.
- 1.1.11. Emergency shutdown button to be provided in sales/office room and one flameproof emergency shutdown button each to be provided on Dispenser Island and compressor fencing. The button shall trip both the incomers to MEDB and also the UPSDB incomer.

**Note:** SLD attached with tender documents having **SLD No. C261162-CNG-EL-SLD-4001, C261162-CNG-EL-SLD-4002, C261162-CNG-EL-SLD-4003** are for tender purpose only. The Bidder shall furnish detailed SLD as per the requirements of the system. Any change, Modifications, Addition/Deletion occurs later due to system requirements shall deem to be inclusive in the price quoted by the bidder, no extra cost shall be paid for the same.

### 1.2. SCOPE OF DESIGN, ENGINEERING & RESIDUAL ENGINEERING

- 1.2.1. Submission of electrical equipment design calculations (Lighting, Earthing & Lightning, PDB, LDB etc.), Complete SLD with control scheme, detail engineering, various drawings/layouts for review and approval, preparation of cable schedules, BOM, preparation of site engineering drawings and details for installation works wherever applicable or required by the Engineer-in-charge, and submits to the Engineer-in-charge for review.
- 1.2.2. Updating and submission of all AS-BUILT drawings for all works done is in the contractor's scope.
- 1.2.3. Obtaining clearance for energizing the complete electrical facilities covered under this tender and approval of installation and drawings from the Chief Electrical Inspector of the State Government/Central Electricity Authority and other statutory authority as required. This includes equipment installed or commissioned by others within the battery limit. This is for obtaining a comprehensive approval in one go.

### 2. OTHER MISCELLANEOUS WORKS

- 2.1.1. Preparation of buried cable trenches, including, back filling, compacting providing of brick protection by second-class bricks, spreading of fine river sand, including all supplies.
- 2.1.2. The job includes repairing of all civil works damaged during installation of electrical facilities.

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- 2.1.3. The scope of work under this contract shall be inclusive of breaking of walls, floors and chipping of concrete foundations necessary for the installation of equipment, materials, and making good of the same.
- 2.1.4. Minor modifications wherever required to be done in the owner free supplied equipment / devices to enable cable entry, termination, etc.
- 2.1.5. Sealing of opening made in the walls / floors for cables trays, cables, bus ducts, etc. using acceptable practice and standards.
- 2.1.6. Supply and installation of all other accessories not specifically mentioned herein, but never the less necessary for completion of the job.
- 2.1.7. Proper Electrical Signages 415V / DANGER etc. to be displayed on the body of Electrical panel units, rooms and Equipment's.

### 3. AREA CLASSIFICATION

Hydrocarbon handling areas have been generally classified as zone 1 & 2, gas group IIA/IIB as per IS: 5572 and OISD - 113. All equipment to be installed in these areas shall be suitable for the area classification with temperature class T3, AND be approved by CCOE/PESO.

### 4. JOB SPECIFICAITONS

Various electrical works covered under this contract like equipment erection, cabling, lighting and grounding works, etc. shall be performed in accordance with specifications attached with this tender.

Erection and commissioning of equipment shall be performed in accordance with supplier's instructions and directions of the Engineer-in-charges.

The equipment/materials to be supplied by the Bidder shall conform to the requirements of the applicable specifications enclosed in the tender document.

### 5. STATUTORY APPROVAL OF WORKS

All works relating to statutory approvals of the complete installation, from competent authority like CEA, DGMS, State electricity Authority/Board etc., shall be in the scope of Bidder.

The application on behalf of the owner for submission to Electrical Inspector etc. along with copies of required certificates and drawings, complete in all respects, shall be prepared by the Bidder and submitted to the Engineer-in-charge for onward transmission well ahead of time so that the actual commissioning of equipment is not delayed for want of inspection by the Electrical Inspector. The actual liaison work shall be arranged by the bidder and necessary coordination and

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liaisons work in this respect shall be responsibility of the Bidder. However, the Owner on submission of bills along with documentary evidence shall reimburse any fee paid to the statutory Authority in this regard.

### 6. MAKES OF EQUIPMENT AND MATERIALS

All equipment / materials supplied by the Bidder shall be as per the approved vendor list enclosed with this document subject to submission of Certification and approvals.

### 7. INSPECTION, TESTING & COMMISSIONING

**7.1.1.** All the equipment supplied and installed by the Bidder shall be tested and commissioned, as required and no separate payments shall be made for the same. Any damage or defect noticed shall be brought to the notice of the engineer- in-charge and shall be rectified without any delay and no payments shall be made for rectification.

**7.1.2.** Any work not conforming to the execution drawings, specifications or codes shall be rejected forthwith and the Bidder shall carry out the rectification at his own cost.

**7.1.3.** The Bidder shall carry out all the tests as enumerated in the technical specifications and as per applicable codes and standards.

**7.1.4.** Before the electrical system is made live, the electrical Bidder shall carry out suitable tests to establish to the satisfaction of engineer-in-charge that the installation of equipment, wiring and connections have been correctly done and are in good working condition and that it will operate as intended.

**7.1.5.** All the tests shall be conducted in the presence of Owner/ Engineer-in-charge or his authorized representative unless he waives this requirement in writing. The Bidder shall arrange all testing equipment necessary to carry out the test. The tests shall be recorded on approved Performa and certified records of the tests shall be submitted to Owner/ Engineer-in-charge.

**7.1.6.** After the completion of all tests and rectification of all defects pointed out during final inspection, plant start-up trials would be commenced. During the start-up trials Bidder shall provide skilled / unskilled personnel and supervision round the clock at his cost. The number and category of workmen and duration up to which required, will be decided by the Engineer-in-charge. Any defects noticed during the start-up trial relating to the equipment supplied and work carried out by the Bidder, will be rectified by the Bidder at his own cost.

**7.1.7.** Engineer-in- charge shall have the right to get these defects rectified at the risk and cost of the Bidder if he fails to attend to these defects immediately as desired.

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7.1.8. No materials shall be supplied without TPI inspection release and Owner’s dispatch clearance.

## 8. DRAWINGS, STANDARD SPECIFICATIONS AND INSTALLATION STANDARDS

8.1.1. The equipment / materials to be supplied by the Bidder shall conform to the requirements of the applicable specifications. Also, the installation of various material / equipment shall conform to the installation standards /norms.

8.1.2. The drawings accompanying the tender documents when read with specification shall depict the electrical system of the station. These are indicative of the nature of work and issued for tendering purposes only. Purpose of these drawings is to enable the tendered to make an offer in line with the requirements of the Owner. Construction shall be as per drawings / specifications issued / approved by the Engineer-in-charge during the course of execution of work.

8.1.3. Conduit layout drawing in ceiling, wherever required, to be prepared by the Bidder and shall be submitted for approval.

8.1.4. After the job completion, Bidder shall prepare AS-BUILT drawings and documents, submit catalogues/manuals (O&M) of major brought out items like Inverter, HT Substation, Lighting fixture etc. Final certified as built drawings, documents and manuals etc. shall be submitted by the Bidder to owner in bound volume with one set in soft copy (CD) plus five sets of prints.

## 9. MEASUREMENT AND TEST EQUIPMENT

Wherever testing and measurement is required, Contractor shall propose a list of measurement and test equipment in his procedure and shall demonstrate that sufficient equipment’s will be allocated for all concurrent tasks. All measurement equipment’s shall be fit-for-purpose and, for each piece of equipment, the Contractor shall provide documentation of current third-party calibration by a recognized independent certified testing house.

## 10. SITE ACCEPTANCE TESTING

The Contractor shall implement procedures and Inspection and Test Plans (ITPs) and, in accordance with the vendor documentation, shall complete Site Acceptance Testing (SAT). All equipment shall pass SAT and the Contractor shall submit SAT documentation in order to obtain approval of the Engineer-In-Charge (EIC) to proceed for further installations commissioning.

## 11. CO-ORDINATION WITH OTHER CONTRACTORS

Owner shall be engaging with other contractors/agencies for performance of other works associated with other composite works. It shall be the responsibility of contractor to communicate, co-operate, co-ordinate and provide assistance to such agencies and sort out all

 <b>Energising Quality</b>	<b>ELECTRICAL SCOPE OF WORKS</b>	<b>Document No.</b>	<b>Rev</b>
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## CITY GAS DISTRIBUTION NETWORK IN NAGALAND GA

interface issues in consultation with Engineer-in-Charge, for carrying out scope of work of system. The Contractor shall appoint a representative to meet weekly with other contractor's representatives in the presence of the Owner/consultant. The contractor in meeting shall provide the locations to determine programming for construction and commissioning activities such that the Owner's needs for co-ordination for other contractor is not disadvantaged by one contractor's activities.

Contractor shall be entirely responsible for Co-ordination with other contractors to ensure timely execution of station works.

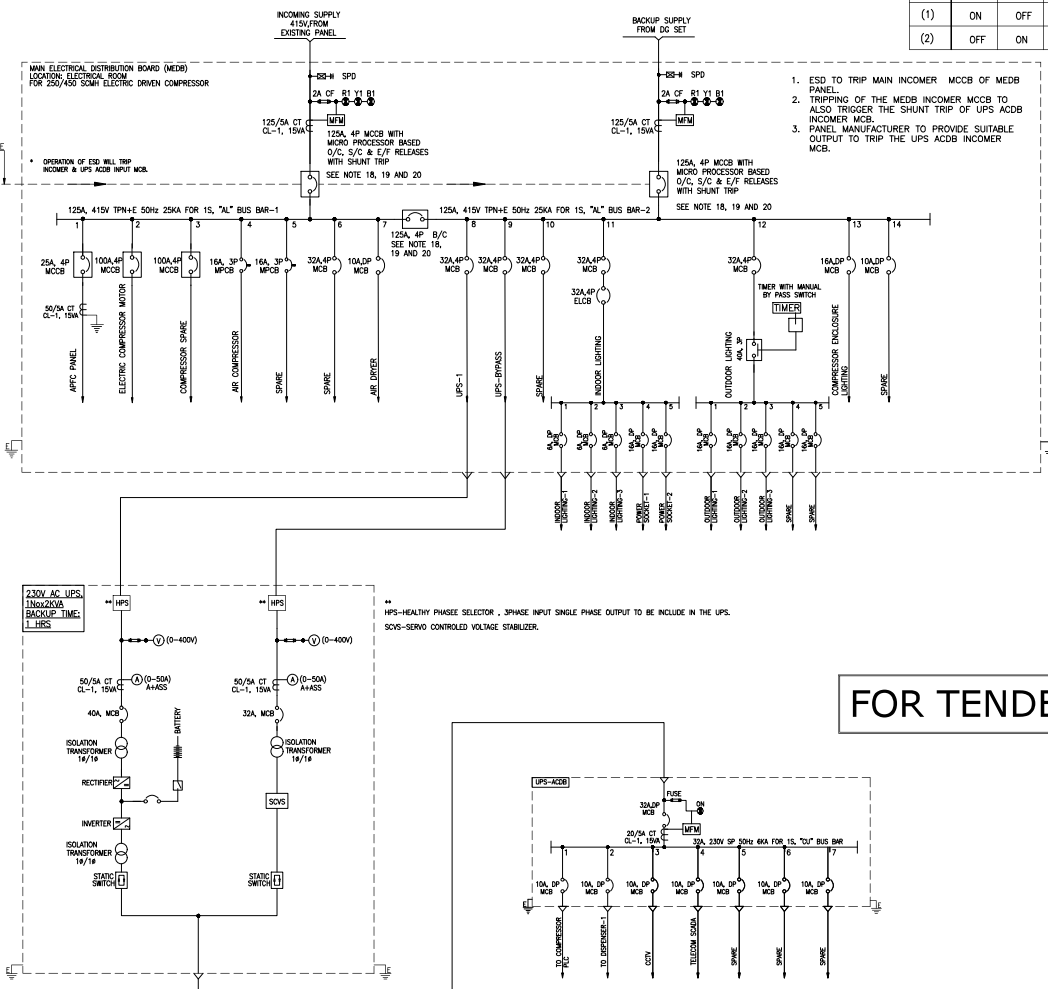
The contractor shall plan his activities requiring interfacing with other contractors / agencies well in advance and provide details to the other contractors / agencies at least one month in advance so that all interface issues can be resolved prior to actual execution of the work. All delays on account of such interface problems arising out of non-co-operation / lack of coordination by the Contractor shall be to Contractor's account.

If the contractor fails to timely execution of the station work, necessary penalty clause shall be applied as per the direction of the Engineer-in-Charge.

### 12. SAFETY

The Contractor shall be responsible for implementation of a project specific Safety and Health Management Plan immediately after award of work, in line with statutory requirements. The Contractor shall be responsible for the safety at all sites including all travel to the sites and any remote offices. The safety plan shall be in compliance to all local and government safety requirements, approvals and standards and Owner's safety manual. Contractor shall depute experienced and sufficiently trained safety personal at site throughout the project phase.

 Energising Quality	<b>ELECTRICAL SCOPE OF WORKS</b>	<b>Document No.</b>	<b>Rev</b>
		C261162-CNG-EL-SOW-4002	C1
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OPERATING PHILOSOPHY			
SR.NO.	I/C-1	I/C-2	B/C
(1)	ON	OFF	ON
(2)	OFF	ON	ON

- ESD TO TRIP MAIN INCOMER MCCB OF MEDB PANEL.
- TRIPPING OF THE MEDB INCOMER MCCB TO ALSO TRIGGER THE SHUNT TRIP OF UPS ACDB INCOMER MCCB.
- PANEL MANUFACTURER TO PROVIDE SUITABLE OUTPUT TO TRIP THE UPS ACDB INCOMER MCCB.

REFERENCE DRAWINGS	
DRAWING TITLE	DRAWING NUMBER

- NOTES:-**
- ALL ELECTRICAL EQUIPMENT BE PROVIDED IN COMPLIANCE WITH LOCAL REGULATIONS AND STANDARDS.
  - THE DESIGN SHALL BE SUBJECT TO APPROVAL FROM THE LOCAL AUTHORITY.
  - THE OPERATING PHILOSOPHY SHALL BE USED FOR POWER FACTOR IMPROVEMENT AS PER REQUIREMENTS.
  - THE ESD OF ALL BUSBARS SHALL BE DOWN TO 50V FOR ALL SHUNT TRIP DEVICES AND DOWN TO 250V FOR ALL OTHER DEVICES.
  - ALL ELECTRICAL EQUIPMENT SHALL BE PROVIDED WITH A MINIMUM OF 10% OVERLOAD CAPACITY.
  - POWER FACTOR CORRECTOR SHALL BE PROVIDED TO MAINTAIN POWER FACTOR AT 0.95 LAGGING.
  - PROTECTION OF ELECTRICAL EQUIPMENT SHALL BE PROVIDED AS PER REQUIREMENTS.
  - THE DESIGN SHALL BE SUBJECT TO APPROVAL FROM THE LOCAL AUTHORITY.
  - THE OPERATING PHILOSOPHY SHALL BE USED FOR POWER FACTOR IMPROVEMENT AS PER REQUIREMENTS.
  - THE ESD OF ALL BUSBARS SHALL BE DOWN TO 50V FOR ALL SHUNT TRIP DEVICES AND DOWN TO 250V FOR ALL OTHER DEVICES.
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  - THE DESIGN SHALL BE SUBJECT TO APPROVAL FROM THE LOCAL AUTHORITY.

**LEGENDS:-**

SYMBOL	DESCRIPTION
1	125A, 4P MCB
2	125A, 4P MCB
3	125A, 4P MCB
4	125A, 4P MCB
5	125A, 4P MCB
6	125A, 4P MCB
7	125A, 4P MCB
8	125A, 4P MCB
9	125A, 4P MCB
10	125A, 4P MCB
11	125A, 4P MCB
12	125A, 4P MCB
13	125A, 4P MCB
14	125A, 4P MCB
15	125A, 4P MCB
16	125A, 4P MCB
17	125A, 4P MCB
18	125A, 4P MCB
19	125A, 4P MCB
20	125A, 4P MCB
21	125A, 4P MCB
22	125A, 4P MCB
23	125A, 4P MCB
24	125A, 4P MCB
25	125A, 4P MCB
26	125A, 4P MCB
27	125A, 4P MCB
28	125A, 4P MCB
29	125A, 4P MCB
30	125A, 4P MCB
31	125A, 4P MCB
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33	125A, 4P MCB
34	125A, 4P MCB
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36	125A, 4P MCB
37	125A, 4P MCB
38	125A, 4P MCB
39	125A, 4P MCB
40	125A, 4P MCB
41	125A, 4P MCB
42	125A, 4P MCB
43	125A, 4P MCB
44	125A, 4P MCB
45	125A, 4P MCB
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48	125A, 4P MCB
49	125A, 4P MCB
50	125A, 4P MCB

**FOR TENDER**

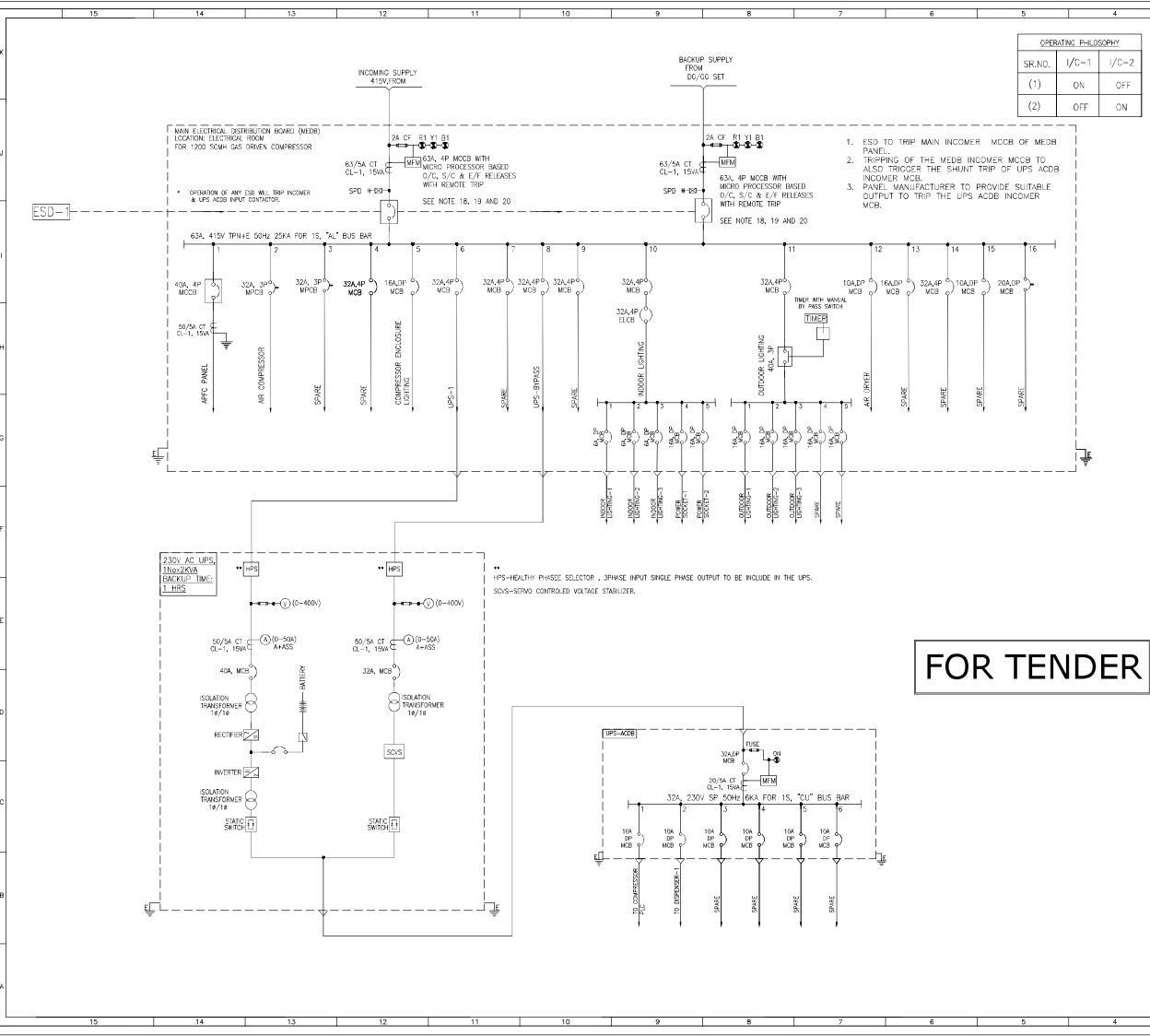
REV.	DATE	DESCRIPTION	KS	FJ	AA
01	00.02.2020	ISSUED FOR TENDER	KS	FJ	AA

CLIENT: **IPOL GAS PRIVATE LIMITED (HOGPL)**

PROJECT: **M/S. VCS QUALITY SERVICES PVT. LTD.**  
**CITY GAS DISTRIBUTION PROJECT IN NAGALAND GEOGRAPHICAL AREA**

TITLE: **TYPICAL SINGLE LINE DIAGRAM FOR 250/450 SCMH ELECTRIC DRIVEN**

SCALE	NTS	TOTAL NO. OF SHEETS	SHEET NO.	1 OF 1
REV.	JOB NO.	DRAWING NUMBER	REV.	
A1	C261162	C261162-2020-EL-04-D-4001	D1	



OPERATING PHILOSOPHY		
SR.NO.	/C-1	/C-2
(1)	ON	OFF
(2)	OFF	ON

- ESD TO TRIP MAIN INCOMER MCCB OF MEDB PANEL.
- TRIPPING OF THE MEDB INCOMER MCCB TO ALSO TRIGGER THE SHUNT TRIP OF UPS ACB INCOMER MCCB.
- PANEL MANUFACTURER TO PROVIDE SUITABLE OUTPUT TO TRIP THE UPS ACB INCOMER MCCB.

REFERENCE DRAWINGS	
DRAWING TITLE	DRAWING NUMBER
ELECTRICAL LOAD LIST	CDR/ECT/HAZ/26/4001
ELECTRICAL SCHEMATIC	CDR/ECT/HAZ/26/4001

- NOTES ->**
- ALL ELECTRICAL EQUIPMENT BE TYPICALISED IN COMPLIANCE WITH LOCAL SITE CONDITION.
  - THE METERS INSTALLED IN SOLAR POWER SET LOCAL PANEL SHALL BE DIGITAL MULTIFUNCTIONAL METERS.
  - RVA INDICATORS ARE FEED TO SCADA SYSTEM FROM MEDB FOR PANEL.
  - THE CAPACITOR BANK FEEDER SHALL BE USED FOR FUTURE POWER FACTOR IMPROVEMENT AS PER GDS REQUIREMENT.
  - THE SIZE OF ALL INSTRUMENTS SHALL BE 96mm x 96mm FOR FULL & HALF SIZE MODULES AND 72mm x 72mm FOR LOWER SIZE MODULES.
  - ALL AMMETER & VOLTMETER SHALL BE DIGITAL TYPE AND OF CLASS 1.5 ACCURACY.
  - POWER & CONTROL CABLES SHALL BE 1.14V GRADE, STRANDED COPPER / ALUMINIUM CONDUCTOR, PVC INNER SHEATH & PVC OUTER SHEATH WITH FLS CHARACTERISTICS SHALL CONFORM TO IS:6002.
  - OUTDOOR ELECTRICAL MATERIALS SHALL BE PROVIDED IN COMPLIANCE WITH THE RELEVANT HAZARDOUS AREA CLASSIFICATION.
  - THE CABLE SIZE ARE CALCULATED ACCORDING TO CABLE SIZING CALCULATION SHEET.
  - ALL INDOOR DPT SHALL BE PROVIDED WITH PDS PROTECTION AND FOR OUTDOOR DPT.
  - MCCB SHALL BE 4P, 25KA AND MCCB SHALL BE 4P, 25KA.
  - THE CONTROLS OF BATTERY BANK WITH 4 HOURS EACH SHALL BE PROVIDED FOR UPS.
  - UPS AND MAIN INCOMER MCCB WILL ALSO HAVE REMOTE START AND STOP FACILITY.
  - PANEL TO HAVE PROVISION FOR AUTO START/STOP OF DG SET ON FAILURE OF GRID SUPPLY.
  - THE NEW METER IN THE MEDB SHOULD HAVE RS-485 PORT FOR COMMUNICATION WITH SCADA SYSTEM.
  - BOTH INCOMER MCCB MUST HAVE AUXILIARY CONTACTS TO INDICATE (OFF) OPERATOR CLOSED STATUS IN SCADA.
  - THE UPS MUST HAVE RS-485 PORT ENABLED TO COMMUNICATE WITH SCADA.
  - INCOMER & BUSCOUPLER TO HAVE ELECTRICAL & MECHANICAL INTERLOCKS AND AUTOMATICALLY CHECK CONTACT FROM MEDB TO GENERATOR.
  - POTENTIAL FREE START-STOP CONTACT FROM MEDB TO GENERATOR.
  - OPERATION OF ESD WILL TRIP INCOMERS.

**LEGENDS ->**

SYMBOL	DESCRIPTION
1	CONTR. SWITCH
2	CONTR. SWITCH WITH
3	RESISTOR
4	DIODE
5	DIODE
6	DIODE
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9	DIODE
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100	DIODE

**FOR TENDER**

REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
D1	30/12/2022	ISSUED FOR TENDER	KS	EJ	AA

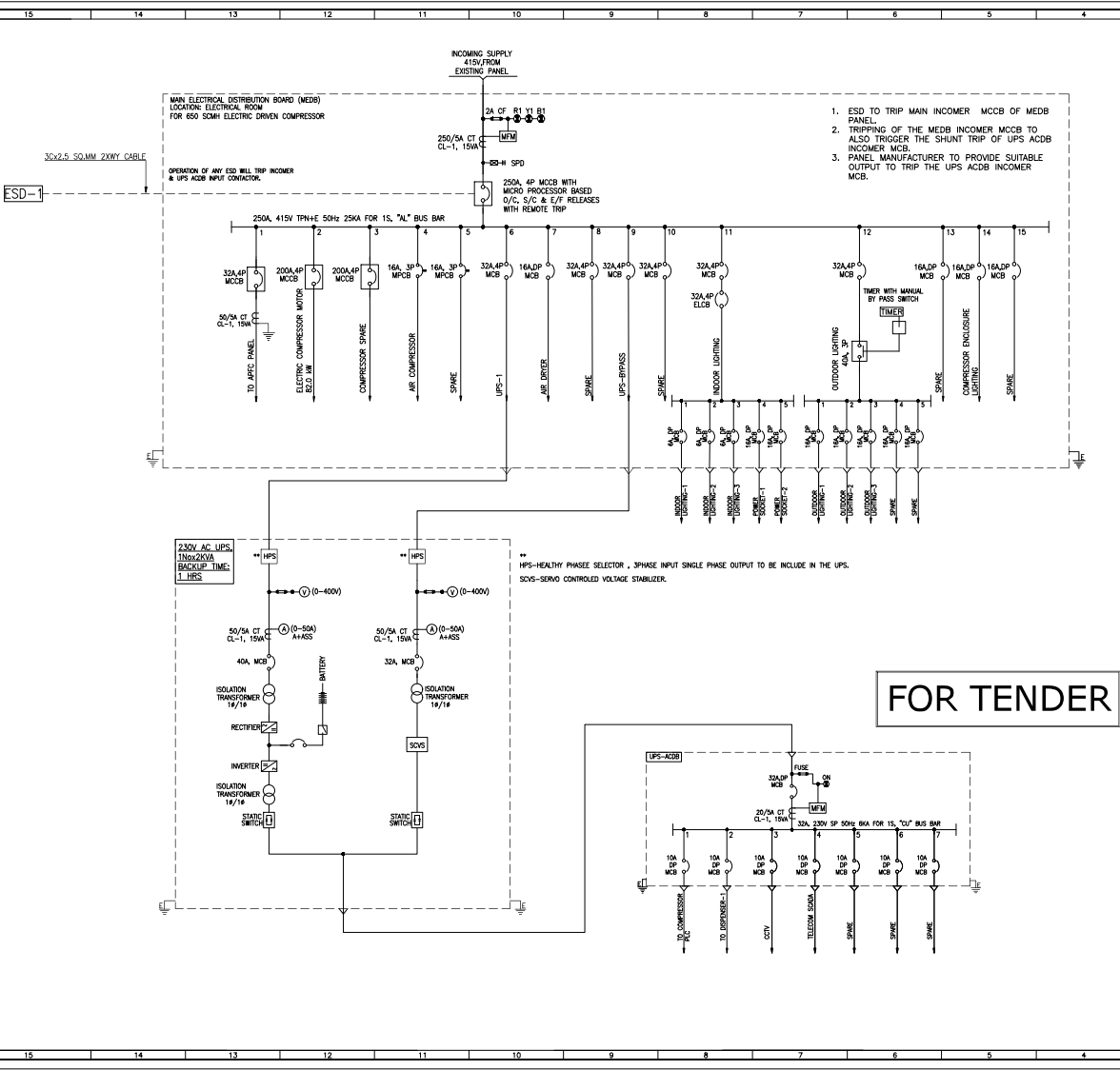
**CLIENT:** HPOL GAS PRIVATE LIMITED (HOGPL)

**PREP:** M/s. VCS QUALITY SERVICES PVT. LTD.  
Plot No. 22, Jessore Industrial Estate, DSK no. 174-175, 176 & 177, Sector 10, Gurgaon, Haryana, India. Phone: +91 122 401 8888. Email: info@vcsqs.com

**PROJECT:** CITY GAS DISTRIBUTION PROJECT IN NAGALAND GEOGRAPHICAL AREA

**TITLE:** TYPICAL SINGLE LINE DIAGRAM FOR 1200/650 SCMh GAS DRIVEN COMPRESSOR

SCALE	NTS	TOTAL NO. OF SHEETS	SHEET NO.	OF
A1		02/11/2	02/11/2	01/1



1. ESD TO TRIP MAIN INCOMER MCCB OF MEDB PANEL.
2. TRIPPING OF THE MEDB INCOMER MCCB TO ALSO TRIGGER THE SHUNT TRIP OF UPS ACDB INCOMER MCCB.
3. PANEL MANUFACTURER TO PROVIDE SUITABLE OUTPUT TO TRIP THE UPS ACDB INCOMER MCCB.

FOR TENDER

REFERENCE DRAWINGS	
DRAWING TITLE	DRAWING NUMBER
ELECTRICAL LOAD LIST	CD01/HAZ/NG/EL-AL-4000
ELECTRICAL SCHEMATIC	CD01/HAZ/NG/EL-AL-4000

**NOTES:-**

1. ALL ELECTRICAL EQUIPMENT TO BE PROVIDED BY THE CONTRACTOR UNLESS OTHERWISE SPECIFIED.
2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY APPROVALS AND PERMITS.
3. ALL WORK SHALL BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE AND OTHER APPLICABLE STANDARDS.
4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY APPROVALS AND PERMITS.
5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY APPROVALS AND PERMITS.
6. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY APPROVALS AND PERMITS.
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11. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY APPROVALS AND PERMITS.
12. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY APPROVALS AND PERMITS.
13. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY APPROVALS AND PERMITS.
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18. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY APPROVALS AND PERMITS.
19. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY APPROVALS AND PERMITS.
20. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY APPROVALS AND PERMITS.

**LEGENDS:-**

1	1.00	1.00	1.00	1.00
2	2.00	2.00	2.00	2.00
3	3.00	3.00	3.00	3.00
4	4.00	4.00	4.00	4.00
5	5.00	5.00	5.00	5.00
6	6.00	6.00	6.00	6.00
7	7.00	7.00	7.00	7.00
8	8.00	8.00	8.00	8.00
9	9.00	9.00	9.00	9.00
10	10.00	10.00	10.00	10.00
11	11.00	11.00	11.00	11.00
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46	46.00	46.00	46.00	46.00
47	47.00	47.00	47.00	47.00
48	48.00	48.00	48.00	48.00
49	49.00	49.00	49.00	49.00
50	50.00	50.00	50.00	50.00

D1	19/01/2020	ISSUED FOR TENDER	KS	FJ	AA
REV.	DATE	DESCRIPTION	PREP.	CHD.	APPD.
CLIENT: HPOL GAS PRIVATE LIMITED (HOGPL)					
PROJ: M/s. VCS QUALITY SERVICES PVT. LTD.					
PROJECT: CITY GAS DISTRIBUTION PROJECT IN NAGALAND GEOGRAPHICAL AREA					
TITLE: TYPICAL SINGLE LINE DIAGRAM FOR 650 SCMH ELECTRIC DRIVEN					
SCALE:	NTS	TOTAL NO. OF SHEETS	SHEET NO.	1 OF 1	
REV.	DATE	DESCRIPTION	PREP.	CHD.	APPD.
A1	C261162	C201/HAZ/NG/EL-AL-4000			D1



Energising Quality

**VCS Quality Services Pvt Ltd**

**STANDARD SPECIFICATION  
FOR  
DISTRIBUTION TRANSFORMER**

**VCS – SS – EL – 4002S**

02	05.03.2022	SP	RD	AA	HK
01	16.10.2019	MG	VV	AD	SK
00	05.07.2017	MG	RD	AD	SK
Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By

**UNCONTROLLED COPY** : **If printed**

**CONTROLLED COPY** : **If in soft and signed**

## 1. INTENT

- a) The intent of this standard specification is to define the general requirements for design, manufacture, assembly and testing at manufacturer's works, packing, transportation and receipt at site with all materials and accessories of distribution transformer.
- b) Tenderer to refer separate Technical Specification (TS) / SOR item details for following minimum details / requirements as part of the project needs:
  - A. Voltage grade, kVA rating and quantity of transformer
  - B. Rated voltage and frequency along with %age variations as per plant specification
  - C. Location of transformer
  - D. List of spare items

Any other item / component / equipment / accessories / services as necessary for satisfactory completion of the project shall also be covered in separate Technical specification (TS) / SOR item.

## 2. CODES & STANDARDS

The transformers shall comply with the latest edition of the following and other relevant Indian standards. In case transformer is supplied by foreign manufacturers relevant international standards shall be applicable.

IS: 2026 (Part I to IV)	Power transformers
IS: 355	Insulating oil
IS: 1271	Classification of insulating materials
IS: 2099 & IS: 3347	Bushing
IS: 2705	Current transformers
IS: 6600	Guide for loading of oil immersed transformer
IS 9147	Cable sealing boxes for oil immersed transformers
IS: 10028	Code of practice for selection, installation and maintenance of transformers
IEC 76	Transformers
IEEE	Recommended practice for electrical power distribution (Std. 141) for industrial plants.

Transformers shall also conform to the provisions of the latest revisions of the Indian Electricity rules and any other statutory regulations currently in use.

**2.1** Wherever the requirements in this specification are in conflict with any of the above Standards, the requirements under this specification shall be binding.

**2.2** In case any contradiction between various referred standards/specification/data sheets and statutory regulation etc. the following order of priority shall be govern -

- 2.2.1 Schedule of rates
- 2.2.2 Design Basis
- 2.2.3 Scope of work/Job specification
- 2.2.4 Data Sheet
- 2.2.5 Standard specification
- 2.2.6 Codes & standard

**3. ENVIRONMENTAL CONDITIONS**

The transformers shall be designed and constructed for continuous operation at full load under the climatic and environmental conditions as described in the specification “Design Basis-Electrical”.

**4. TECHNICAL DATA**

The technical data of the transformers are defined in the data sheets. The Contractor has to guarantee the fulfillment of these requirements.

**4.1. GENERAL REQUIRMENTS**

**4.2. Components and Equipment**

The Contractor has to take care that all components and equipment are selected considering easy maintenance, simple and quick diagnosis and long maintenance intervals.

All components and equipment shall be designed for continuous duty at rated load and under the given climatic conditions. Standard industrial high-performance systems and components of supplier’s standard lists shall be used as far as possible. Components and equipment of same kind and type shall be selected for equivalent functions. The interchangeability must be guaranteed.

**4.3. Tagging**

All components, equipment and installations shall receive the

respective tagging plates, labels etc. which have to be of extremely durable material resistant against the environmental conditions. For further requirements, reference is made to specification “Design Basis-Electrical”.

#### **4.4. TECHNICAL REQUIREMENTS - EQUIPMENT**

##### **4.4.1. OIL TYPE DISTRIBUTION TRANSFORMER**

##### **4.4.1.1. Electrical Design**

- Generally as per IS 2026 - 1977.
- 3 phase, core type, oil filled
- Rated output, voltage ratio, vector group shall be as specified in technical particulars for design.
- Rated frequency 50 Hz, + 4%, -6%.
- Insulation level shall be designed according to the voltages specified below.

Sl. No.	Description	415V System	3.3 kV System	6.6 kV System	11 kV System	33 kV System
1.	Nominal system voltage (kV)	0.415	3.3	6.6	11	33
2.	Max. system voltage (kV)	0.433	3.6	7.2	12	36
3.	One minute power frequency withstand voltage (kV)	3	10	28	35	75
4.	Peak impulse test withstand voltage (kV)	-	40	60	75	170
5.	Clearance in Air (mm)					
	Phase to Earth	25	60	100	120	Specify
	Phase to Phase	32	75	120	150	
6.	External Clearance for					
	LV bushings in Air (mm)	40		Specify		
	HV bushings in Air (mm)	75				
	Phase to Earth				240	320
Phase to Phase			255		350	
7.	Clearance in Air (mm) for transformers with air filled cable-end box/connection chamber, the phase to-phase					
	Phase to Earth	20			80	220
	Phase to Phase	25			130	350

- Transformer shall be capable of delivering rated current at an applied voltage up to 105% rated voltage without exceeding the temperature limits.
- Overload capacity of the transformer shall be as per IS 6600 - 1972 unless

otherwise specified.

- Shall be operable at its rated capacity at any voltage within + 10% of rated voltage of the particular tap.
- Permissible maximum temperature at rated output and principal tap at the ambient temperature of 50 deg. C

a)	Top oil (by thermometer)	85 deg C
b)	Windings (by resistance method)	95 deg. C
c)	Maximum hot spot temperature	105 deg. C

Transformers shall be designed to withstand the thermal and dynamic stresses due to short circuits at its terminals. The duration of short circuit shall be 5 seconds.

- The maximum temperature at the end of the specified duration shall not be more than 250 deg. C with the temperature prior to short circuit corresponding to maximum permissible overload.
- Designed for suppression of harmonics especially 3rd and 5th.
- All transformers shall be located outside the bay in Transformer pen with road access and transformer removal through a truck entry. Necessary provision for Transformers Transportation, Heat dissipation & oil drainage shall be taken care of by Tenderer. All transformers located outside the bay shall be connected with the ECR through necessary cable tunnel / cable trench/ cable basement.
- Transformer shall be designed for a maximum flux density of 1.6 Tesla at 110% primary voltage. Magnetizing current shall be limited to 1%.
- Transformer shall have necessary signal interface to Plant automation system. Operation status of transformer shall be input to fault diagnosis system of automation. So sufficient signal contacts shall be provided on transformer side.
- Grilled door with wicket entry door for ONAN transformer shall be provided along with necessary ventilation (preferably exhaust fans).

#### **4.4.1.2. Magnetic Circuit**

- Low loss CRGO silicon steel shall be used.
- Laminations shall be annealed in a non-oxidizing atmosphere to relieve stresses and restore the original magnetic properties of CRGO sheets after the

cutting and punching operations.

- CRGO sheets shall be coated with insulation varnish compatible with the sealing liquid.
- Insulation to withstand annealing temperature as high as 850 Deg. C and shall reduce eddy current to minimum.
- Ducts to be provided to ensure adequate cooling.
- Core, framework and clamps arranged and tightened to securely hold laminations in order to prevent any settling or displacement in case of heavy shocks during transport, handling or short circuits.
- Flux density under specified over voltage or frequency conditions shall be within the maximum permissible for the laminations.
- Transformers shall be designed to withstand 110% over fluxing corresponding to rated voltage.

#### **4.4.1.3. Windings**

- Material shall be electrolytic grade work hardened copper of high proof stress with more numbers of radial supports.
- Shall be pre-compressed, press board, pre-stabilization of coil.
- Completed core and winding to be vacuum dried in full vacuum and impregnated immediately.
- Shall be braced to withstand shocks due to rough handling, and forces due to short circuit, switching or other transients.
- Permanent current carrying joints in winding and leads shall be brazed.
- Coils shall be supported using dried and high-pressure compressed wedge type insulation spacers.
- Insulating materials shall be compatible with transformer liquid under all service conditions.
- Leads to the terminal board and bushings shall be rigidly supported.

#### **4.4.1.4. Insulation**

Inter turn and inter coil insulation shall be designed such that dielectric stress is uniformly distributed throughout the windings under all operating conditions.

#### **4.4.1.5. Tank**

- Welded thick gauge plates stiffened and reinforced to withstand without deformation all stresses applied during transport and operation or short circuit conditions.
- Oil tight welds and joints
- Fully assembled transformer with its radiators, conservator and other fittings shall withstand for one hour a pressure corresponding to twice the normal head of liquid or to the normal pressure plus 35 kN/sq. m, whichever is higher, measured of the base of the tank.
- Plates shall be protected internally against corrosion due to insulating liquid.
- Provided with inspection opening and cover/(with handling equipment) to provide access to bushing connections.
- Form of cover shall be such as to prevent any stagnant water deposit and to drain gas bubbles towards the Buchholz relay
- Tank (with radiators when welded to tank) shall be capable of withstanding of 250 mm of mercury vacuum.

#### **4.4.1.6. Conservator and Breather**

- Conservator mounted on frame, integral with tank in such a manner that under all conditions and the lowest oil level the bushings remain under the head of liquid.
- Conservator volume shall be sufficient to maintain oil seal from ambient to oil temperature of 90 deg. C
- Oil filling hole with cap and a drain valve to drain the oil completely shall be provided. One end of the conservator shall be bolted into position so that it can be removed for cleaning purposes.
- Silica gel breather with inspection window and oil seal shall be mounted at 1.4 m from ground level and connected to conservator.
- Prismatic type oil level gauge with maximum and minimum levels marked. One 150 mm diameter dial type magnetic level gauge with alarm and trip contacts shall also be provided.

#### **4.4.1.7. Buchholz Relay**

- Double float relay as per IS 3677 - 1985.
- Shut off valves on either side of the Buchholz relay

- Pot cocks at the top and bottom of relay drain plug, inspection window, calibrated scale, terminal box with oil tight double compression type brass gland.
- Potential free, self-reset independent alarm and trip contacts, rated to make, break and carry minimum 2 amps at 220 V DC. No auxiliary relay shall be used to multiply the contacts. Contacts are to be wired to the marshalling box.
- All alarm and trip contacts of transformer fault shall be wired to HTCB directly and individually.

#### **4.4.1.8. Cooling**

##### **4.4.1.8.1. General**

The cooling system provided may be either of the following or a mixed system of these, as specified.

- ONAN - Oil Natural, Air Natural

##### **4.4.1.8.2. Radiators**

Radiators may be detachable type directly mounted or separately mounted flanged, gasketed and bolted connections shall be used for connecting the radiators to the tank.

The following accessories shall be provided for each radiator/radiator bank:

- a) Top and bottom shut off valves and blanking plates.
- b) Bottom drain plug and top filling plug, air release plug
- c) Lifting lugs
- d) Thermometer pockets with thermometers in the inlet and outlet pipes (for separately mounted radiator banks).
- e) Top and bottom filter valves for each separately mounted radiator bank.

##### **4.4.1.8.3. Forced Air System**

- The fans shall be mounted in a suitable enclosure to ensure protection against rain.
- Galvanized wire mesh guard shall be provided.

##### **4.4.1.9. Valves and connections**

- Valves of sluice type with hand wheels
- Made of gun metal

- Clear indication of open and closed position
- Provided with blanking plates or screwed plugs
- Padlocking facility to lock in closed/open position.

#### 4.4.1.10. Terminations

It shall be possible to withdraw the transformer easily after disconnecting the connections without disturbing the cable terminations.

##### ***For cable termination***

- Air insulated cable box suitable for the type and number of cables specified.
- Air insulated disconnection chamber with inspection opening
- Compression type brass cable glands with tinned copper lugs
- Bolted type gland plates.
- Sealing kits with associated accessories like stress relieving cones, insulating tape, trifurcating boot, HT insulating tape, etc.

##### ***For bus duct termination***

- When bus duct termination is specified, flanged throat shall be provided to suit the bus duct. Flange ends and inspection openings shall have weatherproof gaskets.

#### 4.4.1.11. Bushings

- Conforming to IS 3347 Part 5 - 1979, Part 3 - 1988 and 2099 - 1986.
- Minimum rated current of line and bushings shall be 1.5 times rated current of the corresponding windings
- Clamps and fittings made of steel or malleable iron shall be hot dip galvanized.
- Bushings rated 400 Amps and above shall have non-magnetic clamps and fittings only.
- Neutral bushings shall be provided as required for earthing of neutral point.

#### 4.4.1.12. Bushing current Transformers (Where applicable)

- CTs for earth fault shall be provided on the neutral end.
- Removable at site without opening transformer tank cover/active parts.
- Secondary leads shall be brought to a weatherproof terminal box and from there to the marshalling box.

#### 4.4.1.13. Oil temperature Indicator

- 150 mm dial type thermometer with manual reset maximum reading pointer. There shall also be two potential free contacts for alarm and trip signals. The alarm and trip settings shall be independently adjustable. The temperature sensing element mounted in a pocket of oil shall be connected to the indicator through capillary tubing. Contact rating at 110V DC shall be minimum 2 amps. All alarm and trip contacts of transformer fault shall be wired to HTCB directly and individually.

#### 4.4.1.14. Winding Temperature Indicator

- a) Local winding temperature indicator (WTI) shall have a 150-mm diameter dialtype indicator with a manual reset maximum reading pointer. There shall be two potential free contacts for alarm and trip signals. For transformers with forced cooling, another set of contacts shall be provided to start/stop the forced cooling system automatically. The settings for closing/opening of each contact shall be independently adjustable. Contact rating at DC11, 220 V DC shall be minimum 2 amps. The device shall be complete with lamp, sensing element, image coil, calibration device, auxiliary CTs etc. as required.
- b) Remote winding temperature indicator with resistance type temperature detector shall be provided additionally.
- c) All alarm and trip contacts of transformer fault shall be wired to HTCB directly and individually.

#### 4.4.1.15. Marshalling box

- a) All outgoing connections from the transformer i.e., Buchholz relay, temperature indicators, level indicators, CT secondary, fault contacts for annunciation, shall be wired to a marshalling box.
- b) Degree of protection of enclosure shall be minimum IP 52 for indoor and IP 55 for outdoor type transformers.

#### 4.4.1.16. Earthing

- All metal parts of the transformer with the exception of individual core laminations, core bolts, and clamping plates shall be maintained at fixed potential by earthing.
- Two tinned copper earthing terminals to be provided
- One end of bushing CTs shall be earthed.

#### **4.4.1.17. List of fittings and Accessories**

- Identification plate
- Rating and diagram plates (kVA rating, No load HV/LV voltage, Amperes – HV/LV, Insulation level HV/LV, Type of cooling, frequency, Impedance HV/LV, Vector group & diagram, Weight of core & winding, weight of oil & total weight, Oil in liters, year of manufacture, Tapping positions & CT details etc.)
- HV Box & LV Boxes with bottom support channel.
- First fill of oil as per IS-335, 1993 with 10% excess in drums
- Cooling system complete with accessories as specified
- Off-circuit tap switch as specified
- Conservator with oil level gauge
- Silica gel Dehydrating breather
- Buchholz relay with alarm and trip contact
- Oil filter valves at top and bottom of tank
- Drain off valve at lowest location to allow complete draining
- Oil sampling device at top and bottom
- Pressure release device
- Pockets with thermometers for oil temperature and winding temperature indicators
- Bar type level gauge with alarm contacts
- HV, LV and neutral bushings.
- Bushing CTs as specified
- Dial type winding temperature indicator with maximum reading pointer and alarm and trip contacts
- Tank Lifting lugs with complete transformer
- Jacking pads with hauling eyes
- Earthing terminals/earthing pad/earthing bar with pin type epoxy insulator
- Inspection window with cover
- By-directional rollers/flanged wheels as specified
- Marshalling box.
- Assignment for foundation details

#### **4.4.1.18. Off-Circuit Tap Switch**

- i) Externally hand operated with easily accessible links.
- ii) Designed for sustained over current of at least 150% of the rated current of the winding.

- iii) Shall not occupy any intermediate position between clearly marked tap position.
- iv) Capable of repeated operation and withstanding short circuit forces.
- v) Tap position indication diagram
- vi) Inspection and/or repair shall not require removal of transformer core from tank.

**4.4.1.19. List of Spares as part of supply:**

- i) Bi-directional flat rollers
- ii) Porcelain Bushings
- iii) Buchholz relay
- iv) Magnetic oil gauge
- v) Silica gel breather
- vi) Pressure relief valve
- vii) Radiator valve
- viii) Tap changer contacts
- ix) Temperature sensors
- x) Oil level/flow indicator
- xi) Terminal lugs
- xii) Gaskets etc.

Itemized unit prices for the following spares shall be indicated in the offer. Recommended quantities for two years of operation shall also be indicated in the offer.

**4.5. Technical Particulars**

Particulars	KVA Rating
Specification	IS 2026, Part I - 1977 Part II - 1977 Part III - 1981 Part IV - 1977
Type	Three phase, core type, oil filled
Duty	Indoor
Voltage HV/LV	33 or 11 or 6.6 / 0.433 kV
Frequency	50 Hz
No. of phase	3
Continuous rating	KVA rating
Insulation class	Class A
Cooling	ONAN
Winding connection	Delta / Star

Vector group	Dyn 11
LV Neutral grounding	Solidly earthed
System earthing	33Kv – unearthed/ resistance earthed as per plant guidelines
	11 kV – unearthed/ resistance earthed as per plant guidelines
	6.6 kV – unearthed/resistance earthed as per plant guidelines
	415 V - Solidly earthed
Percentage impedance	As per IS:2026 – Part – I – Latest revision
Termination	33Kv or 11kV or 6.6 kV – Cable
	415 V –Busduct/ LT cable as per TS

Particulars	KVA Rating
Temperature rise over 50 deg C ambient temp	
Particulars	KVA Rating
a) Top oil (measured by Thermometer)	35 deg C
b) In winding (measured by Resistance method)	45 deg C
Tap changer	Off Circuit on primary side
Range	±5%
Total tap positions	5
Taps above nominal voltage	2
Taps below nominal voltage	2
Voltage per step variation	2.5 %
Tap change controls	Local Manual
Impulse test withstand voltage	As per IS 2026, Part III- Latest revision
One minute dry and wet power frequency withstand voltage	- do -
Induced over voltage withstand voltage	- do -
Withstand time without injury for 3 phase short circuit at terminals	5 Secs.
Parallel operation	Suitable for parallel operation with transformers of similar ratings
Short circuit level designed for H.V terminal	As per short circuit calculation
LV neutral bushing CT for E/F protection	1 no.
Auxiliary supply voltage overload capacity Radiators	240V AC As per IS 6600-1972 Detachable type

**4.5.1 Details to be furnished in datasheet of transformer:**

- I. Name of manufacturer
- II. Service
- III. Standard
- IV. kVA rating
- V. Rated voltage (HV/LV)
- VI. Rated Current (HV/LV)
- VII. Rated Frequency
- VIII. Number of phases
- IX. Connection (HV/LV)
- X. Vector group

- XI. Tappings (Range & number of taps)
- XII. Ambient temperature, Temperature rise of oil, winding & hot spot temperature
- XIII. Type of cooling
- XIV. Total loss at rated voltage at principal tapping, rated current and frequency (in kw).
- XV. Component losses (No-load losses & load losses)
- XVI. Impedance voltage at rated current for principal tapping
- XVII. Reactance at rated current & at rated frequency
- XVIII. Insulation level:
- XIX. Power frequency withstand voltage (HV/LV)
- XX. Induced over voltage withstand voltage
- XXI. No load current at rated voltage & rated frequency
- XXII. Flux density @100% & @110% of rated voltage
- XXIII. Current density
- XXIV. Efficiency at 75 deg C at UPF at full load/ 75% load / 50% load
- XXV. Regulation at full load at 75 deg C at UPF, 0.8PF
- XXVI. Class of insulation of winding
- XXVII. Type and details of insulation material
- XXVIII. Material of conductor
- XXIX. Core Lamination
- XXX. HV Bushing – Rated voltage & current
- XXXI. LV Bushing – Rated voltage & current
- XXXII. Neutral Bushing - Rated voltage & current
- XXXIII. Weights – Core & winding. Tank fittings & accessories, Transformer oil & Total weight
- XXXIV. Overall dimensions (Length, breadth & height)
- XXXV. Un-tanking height
- XXXVI. Painting
- XXXVII. Minimum air clearance – Phase to phase & Phase to earth
- XXXVIII. Maximum efficiency
- XXXIX. Load at which maximum efficiency occurs (%age of full load)
- XL. Short time rating of HV & LV winding
- XLI. Permissible over loading of HV & LV windingxl) Noise level
- XLII. External short circuit withstand capacity (MVA) and duration (Seconds)

## **6.0 DRAWINGS & DOCUMENTS**

Vendor shall furnish all data/drawings/documents specified in the vendor data requirement. Approval of the drawing shall not relieve the

manufacturer of his responsibility to equipment conforming to the relevant specification and standards or for any mistakes, errors or omissions in the drawing.

**6.1 Following minimum information shall be furnished with bid:**

- a) Clause wise deviations, if any, to the specifications.
- b) Guaranteed technical particulars as per data sheet.
- c) Transformer type test reports
- d) Efficiency & voltage regulation of offered transformer (At Unity, 0.8, 0.6 PF)
- e) Recommended list of spares for 2 years operation and maintenance.

**6.2 Following Drawings & Documents shall be submitted after award of contract for approval:**

- i) List of drawings
  - a) Overall General arrangement drawing
  - b) Rating and diagram plate
  - c) GA of Marshalling box
  - d) Wiring drawing of Marshalling box
  - e) H.V. cable box assembly
  - f) L.V. busduct assembly
  - g) Technical Datasheet
  - h) Bill of material
  - i) QAP, Internal Test Certificates and Inspection Certificates
- ii) Instruction manuals for erection, testing and commissioning.
  - a) Instruction manual shall give step by step procedure for:
    - Erection, testing and commissioning
    - Operation
    - Maintenance and
    - Repair
  - b) Operation and Maintenance Manual
    - Recommended procedure for routine maintenance
    - Tests for checking of proper functioning
    - Diagnostic trouble shooting/ fault location charts

- c) Storage, conservation and re-commissioning Manual
- d) Safety Manual

Note: - Instruction manuals shall contain:

- a) Manufacturer's catalogues with ordering specification for all items
- b) List of consumables with specifications, brand names and annual consumption figures
- c) Procedure for ordering spares.
- d) Drawings relevant for erection, operation, maintenance and repair of the equipment.
- e) List of special tools and tackles

## **7.0 PACKING**

Some parts of the transformer may be detached for protection during transportation. The equipment shall be properly packed. Special notations such as fragile, this side up, center of gravity, etc. shall be clearly marked on the package.

## **8.0 COMPLETENESS OF EQUIPMENT**

All fittings, accessories or apparatus which may not have been specially mentioned in this specification but which are otherwise necessary for satisfactory working of Transformer shall be deemed to have been included in the scope of supply.

## **9.0 INSPECTION & TESTING:**

The owner or his authorized representatives may visit the works during manufacture of equipment to assess the progress of work as well as to ascertain that only quality raw materials are used for the same. He shall be given all assistance to carry out the inspection.

The contractor shall submit Quality Assurance Plan (QAP) for respective equipment within three weeks of award of contract. Owner's representative shall be given minimum two weeks advance notice for witnessing the final testing.

Inspection and testing of equipment shall be carried out by the owner/consultant at the works of the contractor on final product to ensure conformity of the same with the acceptable criteria of technical specification, approved drawings and reference national/ international standards.

QAP shall be prepared and furnished by the contractor in VCS Form. Test certificates including test records and performance data etc. shall be furnished

by the vendor.

Inspection will be carried out on the basis of the purchaser's drawings/  
manufacturer's approved drawings and instructions contained in the QAP.

QAP shall generally cover the following tests:

- Visual
- Dimensional
- Fitment & alignment
- Measurement of IR Value – Before HV test & after HV test
- High voltage test/ dielectric test
- Routine test as per relevant IS/other standard
- Type test as per relevant IS/other standard
- Impulse test HT
- Test certificates of bought out items
- Paint shade verification
- Operational & functional check
- Verification of BOM

**Type tests:**

- Measurement of winding resistance
- Measurement of voltage ratio & check voltage vector relationship
- Measurement of impedance voltage/short circuit impedance and load loss
- Measurement of no-load loss and current
- Measurement of insulation resistance
- Dielectric test
- Temperature rise
- Tests on on-load tap changer if appropriate

**Routine tests:**

- Measurement of winding resistance
- Measurement of voltage ratio & check voltage vector relationship
- Measurement of impedance voltage/short circuit impedance and load loss
- Measurement of insulation resistance
- Dielectric test
- Tests on on-load tap changer if appropriate

**Special tests:**

- Dielectric test
- Measurement of zero sequence impedance of three phase transformers
- Short circuit test
- Measurement of acoustic noise level
- Measurement of harmonics of the no-load current
- Measurement of power

All the transformers shall be subjected to the routine tests as per IS 2026 at manufacturer's works. Type test certificates for similar design have to be submitted for approval. Test procedures as specified in IS-2026 shall be adopted.



Energising Quality  
**VCS Quality Services Pvt Ltd**

**STANDARD SPECIFICATION  
FOR  
UNINTERRUPTED POWER SUPPLY**

**VCS – SS – EL – 4011S**

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### ABBREVIATIONS

AC	Alternating Current
ACDB	AC Distribution Board
Ah	Amp Ampere
BS	British Standard
CD	Compact Disk
CEA	Central Electricity Authority
CFL	Compact Fluorescent Lamp
CRCA	Cold Rolled Cold Annealed
DC	Direct Current
DCS	Distributed Control System
DG	Diesel Generator
EMC	Electromagnetic compatibility
Hz	Hertz
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IGBT	Insulated Gate Bipolar Transistor
IP	Ingress Protection
IS	Indian Standards
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MCCB	Moulded Case Circuit Breaker
MR	Material Requisition
MSL	Mean Sea Level
NEMA	National Electrical Manufacturers Association
Ni-Cd	Nickel Cadmium
PCB	Printed Circuit Board
PIV	Peak Inverse Voltage
SMPS	Switch Mode Power Supply
PVC	Poly Vinyl Chloride
RFI	Radio Frequency Interference
UPS	Uninterrupted Power Supply
SPN	Single Phase Neutral
VDE	Verband Deutscher Electrotechniker
VRLA	Valve Regulated Lead Acid

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## 1.0 SCOPE

The scope of this specification is to define the requirements of design, manufacture, testing, packing and dispatch of static Uninterrupted Power Supply (UPS) system.

## 2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of latest revision of following standards:

IS 5	Colors for ready mixed paints and enamels
IS:1248	Direct acting indicating analogue electrical measuring (Part 1,2,4 and 9) instruments and accessories
IS:7204 (Part 1 to 4)	Stabilized power supplies D.C. output
IS: 12021	Control transformers for switchgear and control gear for voltages not exceeding 1000V AC
IS: 13314	Solid state inverters run from storage batteries
IS: 13703 (Part 1,2&4)	Low voltage fuses for voltage not exceeding 1000V AC or 1500V DC
IS: 13947 (Part-5/ Sec-2)	Low voltage switchgear and control gear specification
IEC-60146-1-1	General requirement & line commutated inverters (specification of basic requirements)
VDE-0875	German EMC directive for broadband interference generated by appliances
IEEE-519	Recommended practices and requirements for harmonic control in electrical power system

2.2 In case of imported equipments, standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.

2.3 The equipment shall also conform to the provisions of CEA regulations with latest amendments and other statutory regulations currently in force in the country.

2.4 In case Indian standards are not available for any equipment, standards issued by IEC/BS/VDE/IEEE/NEMA or equivalent agency shall be applicable.

2.5 In case of any contradiction between various referred standards/ specifications/ data sheets and statutory regulations, the most stringent requirement shall prevail and owner's/ EIL's decision in this regard will be final and binding.

### **3.0 GENERAL REQUIREMENTS**

- 3.1 The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.
- 3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment at least for 10 years from the date of supply.
- 3.3 Vendor shall give a notice of at least one year to the end user of equipment and EIL before phasing out the product/spares to enable the end user for placement of order for spares and services.
- 3.4 The UPS system shall be an integrated system comprising static rectifiers, battery, static inverters, static switches, manual by pass switch, AC distribution board, voltage stabilizer in bypass, isolating and protection devices and all other equipment/ accessories required for completeness of the system whether specifically mentioned herein or not, but necessary for completeness and satisfactory performance of the system.
- 3.5 The UPS system shall be suitable to feed all loads connected to the output, which are primarily instruments, DCS, computers, disc drives and other SMPS equipment leading to high crest factor of the load.
- 3.6 The inverter shall be transistorized (IGBT) type or with the latest proven technology. All components shall be of a high quality and reliability that satisfy with the requirements of a secure AC power to vital equipment with respect to performance, controlling, monitoring and safeguarding function in continuously operating petrochemical process units, petroleum refineries, gas processing facilities, utility and other miscellaneous industrial plants. Components shall be capable of withstanding the thermal and dynamic stresses resulting from internal and external short circuits and switching surges etc.
- 3.7 The design of the UPS shall be such as to minimize the risk of short circuits and shall ensure human and operational safety.
- 3.8 The vendor shall be responsible for design, engineering and manufacturing of the complete system to fully meet the intent and requirements of this specification and enclosed data sheets. Selection, sizing and suitability of all equipment and components used for UPS system shall be vendor's responsibility.
- 3.9 The UPS shall be single phase or three phase system as indicated in the data sheets.
- 3.10 The batteries shall meet the requirement of battery Data Sheet/ battery specifications attached with the bid document.

### **4.0 SITE CONDITIONS**

The UPS system shall be suitable for installation and satisfactory operation in a closed building with restricted natural air ventilation in tropical, humid and corrosive atmosphere. The UPS system shall be designed to operate under site conditions as specified in the data

sheet. If not specifically mentioned therein, design ambient temperature of 40°C and altitude not exceeding 1000m above MSL shall be considered for the UPS.

## 5.0 TECHNICAL REQUIREMENTS

### 5.1 Input Power Supply

5.1.1 The UPS shall be suitable for input power supply as defined in the data sheet. If not specified therein the UPS shall be suitable for the following input power supply.

Voltage            415V± 10% or 230V ± 10%

Frequency        50 Hz± 5%

In addition to above variations, the input voltage may be subject to transient variations comprising voltage dip to 80% of normal voltage during motor start-up and voltage interruption during short circuit as well as frequency variations due to large motor start up. UPS system shall be designed to operate satisfactorily while deriving the input power from an emergency diesel/ gas generator set.

UPS system shall also operate satisfactorily on input power supply having the ratio of negative to the positive sequence components not exceeding 5% and total harmonic distortion of not more than 5%.

Total Harmonic Distortion is the ratio in percentage of r.m.s. value of the Harmonic content to the r.m.s. value of the fundamental component of alternating quantity.

5.1.2 The manufacturer shall specify the current rating of input feeder to UPS from client switchboard based on 150% overload at minimum battery voltage and including the UPS efficiency.

5.1.3 The UPS shall be designed to ensure that harmonic components in the input current are limited as per IEEE519. Suitable filters as required shall be provided.

### 5.2 UPS Configuration and Operational requirements

The UPS system shall have one of the following basic configurations as specified in data sheet and drawings.

#### 5.2.1 Single UPS with Bypass

In UPS system having this configuration, a single rectifier and inverter shall be provided. Under normal conditions when AC mains power is available, the rectifier shall simultaneously feed DC power to inverter as well as for float/rapid charging of the battery.

The AC supply to loads shall be fed from inverter output. In case of any fault in the inverter, the load shall be automatically transferred to stabilized bypass supply and retransfer of load from stabilized bypass supply to the inverter shall be possible in auto as well as in manual mode.

In case of AC input power failure or battery charger failure, the battery shall supply power to inverter without any interruption. The charger shall be designed for simultaneously feeding complete inverter load and for float/rapid charging the battery to its rated capacity. Charger shall be equipped with 'On Line' automatic as well as manual charging facility.

### **5.2.2 Parallel Redundant UPS with bypass (With 1x100% battery)**

In UPS system having this configuration, two sets of rectifiers and inverters shall be provided. Under normal conditions, when AC mains power is available, both the rectifiers shall operate in parallel and supply DC power for float/rapid charging the battery and simultaneously to inverters. In case of failure in one rectifier, the other rectifier shall feed the complete load and the battery without any interruption.

In case of incoming supply failure or failure of both rectifiers, the battery shall feed the inverters without any interruption. Each rectifier shall be designed for simultaneously feeding complete inverter load and float/rapid charging of the battery to its rated capacity. Each rectifier shall be equipped with 'On Line' automatic as well as manual charging facility.

Normally both inverters will be synchronized with each other and with stabilized bypass supply. Both inverters shall operate in parallel and share the load equally.

The load sharing controls shall not be subject to common mode failure and any failure of the load sharing controls shall not result in the loss of vital power.

When a disturbance/fault occurs in any one of the inverters, the faulty unit shall automatically get disconnected and the entire load shall be fed from the other inverter. In case both the inverters develop a fault, the complete load shall be transferred to stabilized bypass supply through the static switches and retransfer of load from stabilized bypass supply to the inverter shall be possible in auto as well as in manual mode.

### **5.2.3 Parallel Redundant UPS with bypass (With 2x50% batteries)**

In UPS system having this configuration, two sets of rectifiers and inverters shall be provided. Under normal conditions, when AC mains power is available, both the rectifiers shall operate in parallel and supply DC power for float/rapid charging the 2 x 50% batteries and simultaneously to inverters. In case of failure in one rectifier, the other rectifier shall feed the complete load and the battery without any interruption.

In case of incoming supply failure or failure of both rectifiers, the 2 x 50% batteries shall feed the inverters without any interruption. Each rectifier shall be designed for simultaneously feeding complete inverter load and float/rapid charging of the 2 x 50% batteries to its rated capacity. Each rectifier shall be equipped with 'On Line' automatic as well as manual charging facility.

Normally both inverters will be synchronized with each other and with stabilized bypass supply. Both inverters shall operate in parallel and share the load equally.

The load sharing controls shall not be subject to common mode failure and any failure of the load sharing controls shall not result in the loss of vital power.

When a disturbance/fault occurs in any one of the inverters, the faulty unit shall automatically get disconnected and the entire load shall be fed from the other inverter. In case both the inverters develop a fault, the complete load shall be transferred to stabilized bypass supply through the static switches and retransfer of load from stabilized bypass supply to the inverter shall be possible in auto as well as in manual mode.

#### **5.2.4 Hot Stand-by Redundant UPS with bypass**

In UPS system having this configuration, the arrangement of rectifiers/inverters and the operating philosophy is same as described in Cl.5.2.2 and Cl.5.2.3 above, except that only one inverter shall be operating at one time. The other inverter shall not be sharing the load but shall be synchronized with the running inverter and stabilized bypass supply and remain ready to accept the load in case of fault in the running inverter. Retransfer of load from stabilized bypass supply to the inverter shall be possible in auto as well as in manual mode

#### **5.2.5 Dual Redundant UPS**

In UPS system having this configuration, the arrangement of rectifiers/inverters and the operating philosophy is same as described in Cl.5.2. 1 above except that there shall be two nos. identical, fully independent, 100% rated, single UPS with bypass and output connected to individual ACDB.

5.2.6 In all UPS configurations, the facility for uninterrupted manual transfer in either direction through static switches shall also be provided.

5.2.7 For ease of maintenance, it shall be possible to isolate inverters and static switches from load through manually operated make before break switches. In case of larger rating UPS, where it is not possible to provide one power switch with make before break feature, combination of breakers with the control scheme having make before break logic may be provided which ensures momentary paralleling before tripping of selected breaker.

### **5.3 UPS Design and Performance Requirements**

5.3.1 Incoming AC supply shall be converted to DC through three phase full wave-controlled rectifiers. The rectifiers shall operate according to the constant voltage current limiting principle and shall incorporate a "Soft Start" feature to gradually accept load on initial energizing.

5.3.2 The rectifier section of the UPS system shall be capable of precise regulation to prevent damage to the battery. The output voltage of rectifier's DC bus without the battery shall

be stabilized to within  $\pm 1\%$  of set value during load variation between 0 to 100% of the rectifiers and specified mains input supply voltage variation.

- 5.3.3 Suitable protection shall be provided in the control circuits to guard against instability of phase-controlled rectifiers due to electrical oscillations, which may be present in the input supply as caused by emergency DG set.
- 5.3.4 The UPS system including the stabilized by-pass shall be galvanically isolated from input power supply system by providing double wound transformers having copper winding. All transformers shall be natural air cooled, dry type suitable for location inside the panel. All rectifiers shall also have a double wound transformer at its input.
- 5.3.5 An RFI filter shall be provided. The production of radio frequency interference voltage shall not exceed the value of suppression grade N' as defined in VDE-0875. The performance of UPS system shall not get affected or in any way be degraded by the use of portable radio transmitter receiver in the vicinity of the UPS system and or UPS room.
- 5.3.6 Transient/surge protection circuit shall be provided in the input circuit to rectifiers to protect the UPS from surges & voltage spikes.
- 5.3.7 The UPS system shall be designed to draw power from mains supply at a minimum power factor of 0.85 while working at rated load in normal operating UPS configuration.
- 5.3.8 The UPS shall be provided with automatic sequence and power walk in circuit(s) with time delay of up to 15 sec. such that the rectifiers and inverters can start operating automatically when incoming AC power is restored allowing the UPS to be loaded automatically.
- 5.3.9 UPS system offered with DC-DC buck boost converter in DC link circuit may be considered acceptable as per manufacturer standard proven practice. DC-DC converter shall be with same IGBTs as provided in inverter circuit.
- 5.3.10 Facility for initial charging of batteries shall also be provided at a voltage level recommended by the battery manufacturer. The inverters may be disconnected during initial charging of the battery.
- 5.3.11 For battery sizing, the following factors shall be considered unless specified otherwise in the data sheet
- Load Power Factor of 0.8
  - Minimum ambient temperature as specified in Data sheet
  - Battery current = 
$$\frac{\text{Inverter rated kVA} \times \text{Rated load p.f}}{\text{Inverter efficiency} \times \text{End cell voltage} \times \text{No of cell}}$$
At 50% load on each inverter for parallel redundant UPS.
  - Aging factor of 0.8
  - Back up time of 30 minutes in case of mains power failure unless specified otherwise in SOR/data sheet

- f. Minimum end cell voltage for lead acid/VRLA battery 1.75 V per cell and 1.0 V per cell for Ni-Cd battery.
- g. Battery state of charge factor of 0.95

5.3.12 The rectifiers/chargers shall be designed to completely charge the Lead acid and Nickel cadmium batteries in a maximum time of 10 hours after complete discharge and at the same time meeting the inverter input requirements, when the inverter is delivering its rated output at 0.8 power factor. Facilities shall be provided to initiate battery rapid charge operation by manual & automatic means. An auto charging sequence should be provided for the rapid and float charging based on current sensing. Battery charger for VRLA battery shall be sized to provide boost charging of the battery up to 90% of rated Ampere-hours within a duration of 24 hours and to 100% within 4 days. In addition to above, the charging shall be transferred from rapid to float mode after a preset time adjustable through 0-24 hours timer as back up protection against over charging.

5.3.13 The rectifiers shall be sized based on the maximum inverter input load when inverter is delivering its rated output at 0.8 rated power factor and recharge the battery to nominal rated capacity of the battery. The DC load imposed by the inverters shall be considered under the most severe operating conditions where only one rectifier is operating but the UPS load is equally shared by all the inverters. The rating of each rectifier shall be not less than the value calculated as follows:

For Lead Acid Batteries = Inverter input current\* + 0.14Ah (10 hr. Rating of the battery)

For Nickel-Cadmium Batteries = Inverter input current\* + 0.2Ah (5 hr. Rating of the battery)

For VRLA Batteries = Inverter input current\* + 0.2Ah (10 hr. Rating of the battery)

\*where Inverter input current =  $\frac{\text{Rated kVA capacity of UPS} \times \text{Rated load power factor}}{\text{Battery charging voltage} \times \text{Inverter efficiency}}$

5.3.14 The DC rectifiers shall sense the battery charging current and adjust the DC bus voltage to maintain the charging current to preset level. A separate current limit circuit shall also be provided for adjustment of battery current. The rectifiers shall be protected against reverse battery connection at DC link voltage bus. Subsequent to a discharge cycle when battery is connected to rectifier, the battery current shall be monitored, controlled and limited to set value automatically irrespective of the inverter input current.

5.3.15 The battery may be taken out of service for maintenance, during which period it shall be possible for the inverter to continue operation by drawing power from the rectifier. Ripple content at the DC link shall not exceed 2% even with battery disconnected.

5.3.16 Battery/ DC link shall be provided with a sensitive earth leakage detection.

5.3.17 The inverter shall be of the current limiting type (short circuit proof) and have nominal output voltage and frequency as specified in the data sheet. The inverter output voltage and frequency shall not exceed the operational tolerances, as measured at the output

terminals of the unit during the following conditions of UPS loading:

- Load variations between 0- 100% of the rated output of UPS
- Load power factor over the range of 0.7 lagging to unity
- Load current waveform having a relative harmonic content varying between 0 and 50%, the latter waveform having a crest factor not exceeding 2.5 and individual harmonics not exceeding the following values.

3rd harmonic	44 % of fundamental
5th harmonic	33 % of fundamental
7th harmonic	18 % of fundamental
9th harmonic	7 % of fundamental
11th harmonic	10 % of fundamental

The Relative harmonic content is the ratio of the r.m.s. value of the harmonic content to the r.m.s. value of the total non-sinusoidal periodic waveform i.e. relative harmonic content.

$$\sqrt{1 - \left( \frac{\text{rms value of the fundamental component of current or voltage}}{\text{rms value of total waveform of current or voltage}} \right)^2}$$

- DC input voltages over the range corresponding to battery rapid charge and battery discharge operation during the specified discharge times.

The UPS output voltage waveform shall be sinusoidal with a relative harmonic content not exceeding 5% for both linear and nonlinear loads.

5.3.18 The inverter shall control the output voltage of the UPS such as to maintain synchronism with the mains bypass voltage during variations in mains frequency up to the limits specified.

During variations in mains frequency exceeding these limits, the inverter shall revert to internal frequency control.

5.3.19 It shall be possible to vary the inverter output voltage sleeplessly within  $\pm 5\%$  of the specified output voltage. This adjustment shall be possible to be made when the inverter is in operation

5.3.20 The steady state output voltage and frequency (free running) variation of inverters shall not exceed  $\pm 1\%$  from the set value for specified input power supply conditions from no load to full load condition and load power factor variation from 0.7 lag to 1.0.

- 5.3.21 The UPS system shall be able to operate satisfactorily on rated loads (in kVA) with power factors in the range of 0.7 lag to 1.0. The overall efficiency of the UPS system shall not be less than 80% at rated load and 0.8 pf.
- 5.3.22 The UPS shall have capacity to deliver a minimum overload of 125% for 10 minutes and 150% for 1 minute. UPS shall be provided with current limit circuit to avoid excessive loading beyond its permissible overload withstand capability.
- 5.3.23 The inverters shall be 'phase locked' to the stabilized bypass power supply as long as stabilized bypass supply frequency remain within  $\pm 4\%$  of nominal. When bypass supply frequency variation exceeds the above limits, the inverters shall be de-linked from mains. Free running frequency tolerance limit shall not exceed  $\pm 1\%$ . Facility shall also be provided for adjustment of range of synchronizing frequency.
- 5.3.24 Unless otherwise specified, the UPS system output voltage variation shall not exceed  $\pm 10\%$  and complete recovery to normal steady state shall be within 0.1 Sec. The phase angle disturbance shall be less than  $120^\circ \pm 3\%$  in case of 3 phase inverter. The above requirement shall be complied for following transient disturbances.
- 100% step load and unload (For single UPS and hot stand by UPS)
  - 50% step load (for parallel redundant UPS)
  - Momentary interruption in power supply
  - Load transfer to stabilized bypass supply
  - Complete load transfer to other healthy inverter when one of the two parallel inverters develop a fault.
- 5.3.25 For 3phase UPS system, the maximum output voltage and angle variation between the phases should not exceed 6% and 3 degrees respectively even under the condition of 100% unbalanced loading of the 3-phase output.
- 5.3.26 UPS system shall be suitable for both floating output or earthing of one leg / star point in case of single phase/ three-phase system respectively.
- 5.3.27 The stabilized bypass supply shall be designed to regulate the output voltage within  $\pm 2\%$  of the rated voltage over complete range of load from no load to full load and for specified input supply voltage variation. The type of Voltage stabilizer in stabilized bypass supply shall be as indicated in data sheet
- 5.3.28 The stabilized bypass supply shall have a continuous current rating equivalent to the rated output of the UPS unit and be capable of conducting a current ten times the rated output for the duration more than the fault clearing time of the type of fuse provided. The load transfer devices shall comprise of continuously rated static elements in both inverter and stabilized bypass supply.

5.3.29 Adequately rated static switches in required number & configuration shall be provided in the inverter(s) output and stabilized bypass supply to ensure positive isolation of faulty inverter section such that the other inverter and bypass circuits do not feed into the fault leading to under voltage / trip. The short time rating of all the static switches shall be at least 10 times the rated output for the duration more than the fault clearing time of the type of fuse provided.

5.3.30 Facility shall be provided to manually and automatically initiate transfer of the load from inverters to the stabilized bypass supply and from stabilized bypass supply to the inverters. Under voltage and over voltage, sensing levels to initiate transfer shall be adjustable. The maximum transfer time between inverters and bypass supply shall not exceed 4 msec and 20 msec in synchronous and asynchronous mode respectively.

5.3.31 The criteria for load transfer:

A. Load transfer from inverter to the stabilized bypass supply shall be as follows:

I. The load transfer shall only be possible when:

- The stabilized bypass output voltage is within  $\pm 5\%$  of rated UPS output voltage.
- The mains bypass frequency is within  $\pm 4\%$

II. Auto-transfer of the load from inverter to stabilized bypass supply shall be initiated when:

- The inverter output voltage drops below 95% of nominal output voltage under steady state condition and/or if the inverter output voltage falls below 90% of the nominal value under transient conditions.

OR

- The inverter output voltage exceeds  $\pm 105\%$  of the nominal output voltage under steady state condition and/or if the inverter output voltage reaches  $\pm 110\%$  of the nominal value under transient conditions.

OR

- The inverter output current exceeds its tolerable limits.

B. Retransfer offload from stabilized bypass supply to the inverter shall be as follows

I. The load transfer shall be possible when

- The inverter output voltage is within  $\pm 5\%$  of nominal output voltage for more than 5 sec. and inverter output and stabilized bypass supply are synchronized.

Retransfer of load from stabilized by pass to the inverter shall be done manually only unless otherwise specified in the data sheet.

If automatic retransfer of load to the inverter is specified in the data sheet, then the retransfer of load to the inverter shall be inhibited following four automatic transfers of load to stabilized by pass within a period of 5 minutes.

- 5.3.32 All breakers shall be adequately rated for continuous rating as well as breaking capacity as applicable. Paralleling of breaker/ switch/ contactor poles to achieve the required current rating is not acceptable. All output isolating device shall be double pole type.
- 5.3.33 All electronic power devices including thyristors, transistors (IGBTs), diodes etc. shall be rated under operating conditions for approximately 200% of the maximum current carried by the device. All other electrical components such as transformers, reactors, breakers, contactors, switches, bus bars etc. shall be rated for at least 125% of the maximum required rating. No electronic device shall be subjected to PIV greater than 50% of its rated value.
- 5.3.34 All the thyristors, power transistors, diodes and other electronic devices of UPS shall be protected with high-speed semiconductor fuses. Ft co-ordination between fuse and semi-conducting power devices shall be ensured.
- 5.3.35 The outgoing circuits of ACDB shall be protected by semiconductor fuses. Each inverter shall be designed to clear a fault in any of the branch circuits up to a minimum rating of 25% of the system capacity without the assistance of the stabilized bypass supply. In case of any fault in branch circuits, the load connected to the healthy circuits shall not get affected. The fault clearing time shall be less than 4 msec.
- 5.3.36 All PCBs shall be provided with a transparent epoxy coating for environmental protection and topicalization. They shall I be suitably located away from heat sources.
- 5.3.37 All electronic control and monitoring printed circuit cards shall be installed in standardized electronic equipment frames and shall be fitted with suitable means for easy removal. The frames shall incorporate guides for PCBs to facilitate correct insertion of PCB's and shall allow access to the wiring side of the connectors. All PCBs shall be placed in a manner to avoid replacement of a PCB by a wrong spare PCB. Monitoring points shall be provided on each of the PCB's and the PCB shall I be firmly clamped in position so that vibration or long usage do not result in loose contacts. Failure of each PCB shall I be indicated by visual alarms. Visual fault diagnostics shall preferably identify faults up to various sections in the card
- 5.3.38 Forced ventilation of panel, if provided, shall be supplemented by 1 00% redundant fan. In normal operation, normal & redundant fans shall run together. The power supply for the fans shall be tapped from the inverter output. However, the rating of the UPS as specified in the data sheet shall be the net output of UPS after deducting power consumption for fans etc. However in case of non-operation of 50% of running fans the UPS output shall not be affected. The fans shall be arranged to facilitate removal of faulty fan for maintenance without requiring system shutdown. All fans shall be equipped with monitoring facilities to provide an alarm in the event of fan failure.
- 5.3.39 Maximum noise level from UPS system at 1-meter distance, under rated load with all

normal cooling fans shall not exceed 75 dBA.

#### **5.4 Construction**

5.4.1 Rectifier/charger and inverter, stabilized bypass supply and static switch sections shall be suitably housed in sheet steel panels complete with all interconnections.

UPS panels, ACDB and cell booster enclosures shall be fabricated from structural/CRCA sheet steel. The frames shall be fabricated by using minimum 2mm thick CRCA sheet steel while the doors and covers shall be made from 1.6 mm thick CRCA sheet steel. Wherever, required suitable stiffeners shall be provided.

The panels shall be free standing, fitted with suitable louvers for ventilation and cooling fans as required. Hinged doors shall be provided at the front and back with dust tight gaskets. Inter-panel sheet steel barriers shall be provided. The enclosure shall provide minimum IP-31 degree of protection, if not specified otherwise in the data sheet. The maximum and minimum operating height of the switches shall be 1800 mm and 300 mm respectively.

5.4.2 Power cables shall be with aluminium/ copper conductors and control cables shall be with copper conductors. All the cable connections shall be from bottom and front of the panel, if not specified otherwise in the data sheet. A removable bolted gland plate shall be provided along with single compression type nickel-plated brass cable glands for external cable connections. Clamp type terminals shall be used for connection of all wires up to 10 mm<sup>2</sup> • Bolted type terminals suitable for cable lugs shall be provided for wire size above this. Tinned copper lugs for all external connections shall be provided with the panels. Terminals shall be provided for all external connections. Interconnection cables for cubicles located side to side shall be supplied. All interconnecting cables, as required between UPS system and ACDB, UPS system and batteries shall be in the scope of vendor.

5.4.3 Bus bars shall be used in all power circuits which are rated above 100 Amp. Copper conductors PVC/XLPE insulated cables or wires of 660V grade shall be used for power circuits rated less than 100 Amp. Bus bars shall be color-coded and live parts shall be shrouded to ensure complete safety to personnel intending routine inspection by opening the panel doors. All the equipment inside the panel and on the doors shall have suitable name plate and device tag numbers as per the schematic diagram. All wires shall be ferruled and terminals shall be numbered.

5.4.4 MCCBs and load break power switches shall be mounted inside the panel. The control switches shall be rotary type mounted on the door and shall be externally operable. An 11W LED lamp controlled through a door switch shall be provided for illumination in each panel. All instruments shall be analogue/digital, switchboard type, back connected, 72 x 72 mm. square (for Analogue type). Analogue instruments shall be preferred. Analogue instruments' scale shall have red mark indicating maximum permissible operating rating.

Separate test terminals shall be provided for measuring and testing of the equipment to check the performance.

- 5.4.5 A suitably sized earth bus shall be provided at the bottom of the panels including ACDB running through the panels line up with provision for earth connection at both ends to purchaser's main earth grid. The minimum size of earth bus shall be 25 x 3 mm<sup>2</sup> copper (or equivalent aluminium). All potential free metallic parts of various equipments shall be earthed suitably to ensure safety.
- 5.4.6 All panels shall be of same height so as to form a panel line up which shall have good aesthetic appearance. ACDB can be of different height that of UPS panels.
- 5.4.7 Inside the panels, the controls connections shall be done with 660V grade PVC/XLPE insulated wires having stranded copper conductors. 1.5 mm<sup>2</sup> size wires shall normally be used for circuits with control fuse rating of 10 Amp. or less. For control circuit having fuse of 16 Amps, 2.5 mm<sup>2</sup> size wires shall be used. Control wiring for electronic circuits shall be through flat ribbon cable or through copper wire minimum of 0.5 mm dia.
- 5.4.8 All control wiring shall preferably be enclosed in plastic channels or otherwise neatly bunched together. Each wire shall be identified at both ends by PVC ferrules. Ferruling of wires shall be as per relevant IS.
- 5.4.9 All metal surfaces shall be thoroughly cleaned and de-greased to remove mill scale, rust, grease and dirt. Fabricated shall be pickled and then rinsed to remove any trace of acid. The under-surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. The under-surface shall be made free from all imperfections before undertaking the finished coat.
- 5.4.10 After preparation of the under-surface, the panels shall be spray painted with two coats of epoxy- based final paint or shall be powder-coated. Spray painted finished panels shall be dried in stoving ovens in a dust-free atmosphere. Panel finish shall be free from imperfections like pinholes.

## **5.5 Cell Booster**

- 5.5.1 Cell booster shall be suitable for charging not only the new cells before being introduced to the battery bank but also any treatment to be given to the individual weak cells. Quantity of such boosters shall be as defined in the MR. Cell booster shall be suitable for 240 V  $\pm$  10%, 50 Hz  $\pm$  3% SPN input power supply. Cell booster output voltage shall be in the range of 0-1 8V and 0-1 2V for Lead Acid and Nickel Cadmium batteries respectively. Cell booster current rating shall be as under:

For Lead Acid battery = 0.14 x Ah of cell (10 hr. Rating of the cell)

For VRLA battery = 0.2 x Ah of cell (10 hr. Rating of the cell)

For Ni-Cd battery = 0.2 x Ah of cell (5 hr. Rating of the cell)

Cell booster shall have heavy duty switch fuse or MCCB on AC incomer and DC output, AC voltmeter, DC ammeter and voltmeter, indicating lamp for AC/ DC power ON. The output voltage and current of cell booster shall have manual control using a suitably rated variac or a full wave controlled rectifier bridge. Suitable interlock shall be provided, to ensure that the variac/ controlled rectifier is at its minimum position while switching on the cell booster. Cell booster shall be portable type with wheels. Each cell booster shall be supplied with 5 m long flexible copper conductor, PVC insulated and braided cable for AC incomer power supply and DC output connection to the battery.

## **5.6 A.C. Distribution Board**

Sheet steel enclosed AC distribution board shall be provided. It shall accommodate AC feeders as indicated in the data sheet. The distribution board shall be floor mounted fixed type with compartmentalized construction unless otherwise indicated in the data sheet. The switchboard shall be provided with two incomers (one from UPS & another from Bypass supply) with adequately rated Switch/MCCB/ACB. It shall be possible to operate the switches without opening the doors. Switches shall be provided with door interlock. Vertical cable alley of minimum 200mm width with suitable supports shall be provided for the termination of outgoing cables. Suitable supports shall be provided for supporting incoming and outgoing cables. All outgoing switches shall be air insulated load break type. Fuses on outgoing feeders shall be fast acting semiconductor type and cable entry shall be from bottom. Isolation transformers (if required) shall be mounted inside ACDB. HRC fuses shall be provided for isolation transformer feeders. The gland plate of the distribution board shall be non-magnetic type where single core cables are used as specified in the data sheet. Cable glands shall be of brass and single compression type and cable lugs shall be of tinned copper

## **5.7 Alarm, Control, Indication and Metering Requirements**

If not specified otherwise in the data sheets, following schedule shall be followed for alarm, control, indication and annunciation. Any additional devices/features considered necessary for reliable operation and maintenance shall also be included in various panels and same shall be highlighted separately. An illuminated one line diagram indicating operational status shall be provided on the front of the panel. Metering, indications, audio-visual alarm shall be provided. Parameters/ information indicated shall be available by menu driven LCD display or by other means directly or indirectly.

### **5.7.1 Metering**

#### **5.7.1.1 Rectifier**

- a. Incoming line voltages (For all the three phases).
- b. Input line currents.(For all the three phases)
- c. DC voltage at each rectifier output

d. Battery current

5.7.1.2 Inverters

- a. AC voltage at each inverter output (AC voltages for 3 phase inverter)
- b. AC current at each inverter output (AC currents for 3 phase inverter)
- c. Frequency meter at each inverter output

5.7.1.3 Stabilized bypass supply

- a. Frequency meter for incoming supply.
- b. Voltmeter with selector switch for incoming supply.
- c. Ammeter with selector switch for incoming supply

5.7.1.4 ACDB

- a. Voltmeter (voltmeter selector switch shall also be provided for 3 phase inverter).
- b. Ammeter (ammeter selector switch shall also be provided for 3 phase inverter).
- c. Power factor meter

5.7.2 **Indications**

All indicating lamps shall be LED type. LEDs provided for indication shall be cluster type with adequate brightness and minimum 2Nos LEDs chips per light. LEDs shall be connected in parallel and each LED chip having diameter not less than 3 mm. LEDs shall be provided for following-

- a. AC mains 'ON' - Rectifier.
- b. AC mains 'ON' - Bypass

5.7.2.1 Rectifiers (for each rectifier)

- a. Rectifier output 'ON'
- b. Battery on float charge
- c. Battery on rapid charge

5.7.2.2 Inverters (for each inverter)

- a. DC input 'ON'
- b. Load on inverter.
- c. Inverter synchronized with mains

5.7.2.3 Load on bypass

5.7.3 **Audio-Visual Alarm (separately for each circuit)**

- a) Mains failure
- b) Battery charger failure
- c) Battery fault
- d) Inverter temperature high
- e) Low voltage from inverter

- f) Load on bypass
- g) Inverter overloaded
- h) All power Fuse failures
- i) DC earth fault

5.7.3.1 Two no's changeover contacts shall be wired to the terminal strip, 1 no for common remote alarm of ' UPS fault' in owner's panel and 1 no for ' load on bypass supply' annunciation.

5.7.3.2 UPS shall also be provided with provision to hook up all indication and audio visual alarm, as specified in clause no.: 5.7.2 and 5.7.3 above, with owner's PC through RS232/RS485 / fiber optic port through serial interface

#### 5.7.4 Controls

- a. All the switches for starting, shut down and testing sequence
- b. Primary input circuit breakers for feeding chargers, bypass line and DC bus from battery including backup protection.
- c. Inverter ON/OFF switch (to initiate inverter operation)
- d. Static switch transfer test Push Button

### 5.8 Reliability

All necessary care shall be taken in selection, design, manufacture, testing and commissioning of the equipment for ensuring high system reliability. Following design consideration shall be taken into account to ensure maximum availability of the system.

- 5.8.1 There shall be no common device, between main and redundant units (e.g. master oscillators etc.) in order to ensure that the failure of the same does not cause shutdown of more than one unit.
- 5.8.2 It shall be possible to take out any individual power circuit for maintenance without affecting the total UPS supply.
- 5.8.3 Series-parallel combination of smaller devices to achieve required rating shall not be acceptable.
- 5.8.4 Vendors shall offer their nearest higher standard size that will meet the requirement of the specified UPS rating.

### 5.9 Fault Diagnostic Unit

If specified in the data sheet, each UPS set shall have provision for adding microprocessor based ' ON line' fault diagnostic unit. This shall supervise the UPS operation continuously. It shall identify and locate faults immediately so that corrective action can be taken. Fault Diagnostic unit shall be compatible to hook up with owner's PC through RS232/RS485 interface. The software shall be provided on a CD ROM.

The. Fault diagnostic unit shall have provision for automatic print out facilities for time, input/output voltages, currents, frequency as a minimum under the following conditions-

- UPS power source changeover from mains to battery
- UPS power source changeover from battery to mains.
- Changeover from inverter to stabilized bypass supply and vice versa.
- Changeover from one inverter to other inverter.
- Changeover time in case of inverter to stabilized bypass supply and from one inverter to other inverter.
- UPS failure.
- Type of failure incident along with diagnostic report.

In addition to the above, any other feature which vendor feels may be useful shall be provided and highlighted separately.

If any Additional equipment (e.g. bin connector, adaptor cards etc.) are required for connecting this unit with UPS system as well as with owner's PC, the same are also to be included in the vendor's scope

## **6.0 INSPECTION, TESTING AND ACCEPTANCE**

- 6.1 During fabrication, the equipment shall be subjected to inspection by EIL / Owner or by an agency authorized by the Owner. Manufacturer shall furnish all necessary information concerning the supply to EIL/ Owner's inspector. Tests shall be carried out at manufacturer's works under his care and expense.
- 6.2 For testing requirement, Inspection and test plan for uninterrupted power supply system (6-81-1017) shall be followed

## **7.0 SITE ACCEPTANCE TESTS**

Vendor shall furnish Site Acceptance Tests procedure to be followed. Final acceptance testing along with the batteries shall be done at site. It shall be Vendor's responsibility to arrange necessary instruments and tools as required by their commissioning engineer for these tests.

## **8.0 PACKING AND DESPATCH**

All the equipment shall be divided in to several shipping sections for protection and ease of handling during transportation .The equipment shall be properly packed for transportation by ship/rail or trailer. The equipment shall be wrapped in polyethylene sheets before being placed in wooden crates /cases to prevent damage to the finish. Crates /cases shall have skid bottoms for handling. Special notations such as *Fragile*, *This side up*, center of gravity, 'weight', ' Owner's particulars', 'PO nos.' etc. shall be clearly marked on the package together with other details as per purchase order. The equipment may be stored outdoors for long periods before installation. The packing shall be completely

suitable for outdoor storage in areas with heavy rains and high ambient temperature unless otherwise agreed. In order to prevent movement of equipment/ components within the crates, proper packing supports shall be provided. A set of instruction manuals for erection, testing and commissioning, a set of operation and maintenance manuals and a set of final drawings shall be supplied along with the shipment duly enclosed in a waterproof cover.



Energising Quality

## VCS Quality Services Pvt. Ltd

### STANDARD SPECIFICATION FOR SEALED MAINTENANCE FREE VRLA BATTERIES

**VCS – SS – EL - 4042**

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<b>REVISION RECORD</b>						
Rev.	Revision Date	Prepared by	Checked by	Approved by	Authorized by	Revision Description
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01	16.10.2019	MG	VV	AD	SK	New revision system updated
02	14.03.2022	SP	RD	AA	HK	New revision system updated

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## **ABBREVIATION**

BIS/IS	Bureau of Indian standards
IEC	International Electro-Technical Commission
BS	British Standards
IEEE	Institute of Electrical and Electronics Engineers
NEMA	National Electrical Manufacturers Association
OISD	Oil Industries Safety Directorate
CCE	Chief Controller of Explosive
DGMS	Director General Mines Safety
IE Rules	Indian Electricity Rules
CPRI	Central Power Research Institute
DC	Direct Current
Ah	Ampere hour
PVC	Poly Vinyl Chloride
VRLA	Valve-regulated lead-acid

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## **1.0 SCOPE**

The intent of this Specification is to define the design, manufacture, testing & supply of stationary SEALED MAINTENANCE FREE VRLA batteries for DC power system /AC UPS application.

## **2.0 REFERENCE DOCUMENTS**

2.1 The equipment shall comply with the requirements of the latest revision of the following Standards issued by BIS (Bureau of Indian Standards) unless otherwise specified.

IS-15549	Stationary SEALED MAINTENANCE FREE VRLA batteries
ANSI T1 330	SEALED MAINTENANCE FREE VRLA Batteries used in the telecommunication Environment.
ASTM D2863	Test method for measuring the minimum oxygen concentration to support candle like combustion of plastics (Oxygen Index).
IEC 60896-21	Stationary lead-acid batteries - Part 21: VRLA types -Methods of test
IEC 60896-22	Stationary lead-acid batteries - Part 22: VRLA types- Requirements
IEC-60068-2	Environmental testing

2.2 The equipment shall also conform to the provisions of CEA regulations with latest amendments and other statutory regulations currently in force in the country.

2.3 In case of imported equipment, Standards of the country of origin shall be applicable if these Standards are equivalent or more stringent than the applicable Indian Standards.

2.4 The equipment shall also conform to the provisions of Indian Electricity Rules and other statutory regulations currently in force in the country.

2.5 In case Indian Standards are not available for any equipment, Standards issued by IEC/ BS/ VDE/ IEEE/ NEMA or equivalent agency shall be applicable.

2.6 In case of any contradiction between various referred Standards / Specifications / Data Sheets and statutory regulations, the following order of priority shall govern:

- a. Statutory regulations.
- b. Data Sheets.
- c. Job Specification.
- d. Standard Specification.
- e. Codes and Standards.

## **3.0 DEFINITIONS**

For the purpose of this document, the words and expressions listed below shall have the meanings assigned to them as follows:

OWNER / COMPANY                      OWNER of the particular Project (Project Specific).

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CONSULTANT	The party which is doing engineering, procurement, construction, pre-commissioning and assistance for commissioning, monitors and controls the overall project management.
BIDDER / SUPPLIER / VENDOR	The party(s) which manufactures and / or supplies material, equipment, technical documents / drawings and services to perform the duties specified by Contractor.

#### **4.0 MATERIALS**

- 4.1 The terminal posts shall be suitable for acidic condition operation. The terminals shall be suitable for short circuit current and specified discharge current without damage to the cell as a result of terminal heating.
- 4.2 Stationary SEALED MAINTENANCE FREE VRLA cells shall be designed to withstand the mechanical stresses encountered during normal transportation and handling.

#### **5.0 DESIGN**

##### 5.1 General Requirements

- 5.1.1 The offered equipment shall be brand new with state-of-the-art technology and proven field track record. No prototype equipment shall to be offered.
- 5.1.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 3 years from the date of supply.
- 5.1.3 Vendor shall give a notice of at least one year to the end user of equipment before phasing out the product/ spares to enable the end user to place order for spares and services.

##### 5.2 Technical Requirements

- 5.2.1 The standard rated ampere hour capacity of the cell/ battery shall be at a reference temperature of 27°C, constant current discharge at 10 hours rate (C10) and an end cell voltage of 1.85V/cell.
- 5.2.2 The SEALED MAINTENANCE FREE VRLA cell/battery shall be suitable for float duty operation with a constant voltage permanently applied to its terminals which is sufficient to maintain it in a state close to full charge and shall be designed to supply load in the event of normal power supply failure. Type of plate construction for batteries shall be as per the Data Sheet.
- 5.2.3 The components such as containers, lids, covers and seals used in manufacture shall meet the Fire, flame and smoke resistance rating as defined in IS 15549 and have an oxygen Index of at least 28 in accordance with ASTM D-2863.

- 5.2.4 Each cell/battery shall have a separate container of 2.0V (nominal voltage). The cell container shall be made of high strength acid resistant material and designed to withstand mechanical stresses, shocks, vibrations and shall be consistent with the life of the battery.
- 5.2.5 The design of SEALED MAINTENANCE FREE VRLA cell shall be such that regulating valve shall not allow the gas (air) to enter into the cell but shall allow the gas to escape from the cell above certain internal pressure which shall not lead to deformation or cause container to crack or cause failure of seals or shall not cause bulging/ cracking of cell cover.
- 5.2.6 The hydrogen released from SEALED MAINTENANCE FREE VRLA cells shall be sufficiently low to make these cells suitable for use in office, control rooms and equipment environments. The gas leakage rate of the cell shall not exceed 0.05cm<sup>3</sup>/hr at 27°C and 101.3kpa
- 5.2.7 SEALED MAINTENANCE FREE VRLA stationary cells/battery shall be designed to withstand the mechanical stresses encountered during normal transportation and handling.
- 5.2.8 The terminal posts shall be casted of lead alloy with copper/brass insert for enhancement of conductivity. The terminals shall be suitable for maximum discharge current and short circuit current without damage to the cell as a result of terminal heating. The temperature of the SEALED MAINTENANCE FREE VRLA cells shall be sufficiently low to prevent thermal runaway (critical condition arising due to constant voltage charging).
- 5.2.9 On float, the cell/battery shall be suitable for being recharged to 90% of ampere hours within 24 hours and to 100% within 4 days
- 5.2.10 Ampere hour of the battery shall be selected based on the following:
- Minimum site ambient temperature of 10°C or as defined in the Data Sheet.
  - Discharge duty cycle.
  - End cell voltage.
  - Ageing factor of 0.8
  - Design margin of 10%, if not defined in the Data Sheet
  - Capacity rating factor.
- 5.2.11 Number of cells and end cell voltage shall be decided by the Vendor on the basis of maximum permissible voltage to the load when batteries are float charged while feeding the Load and minimum DC system voltage. However, the number of cells and end cell voltage shall be as per the Data Sheet, unless otherwise specified.
- 5.2.12 The battery shall be suitable for being boost charged to fully charged condition from fully discharged condition within 10 hours, unless otherwise specified.
- 5.2.13 Battery assembly shall be supplied fully charged condition.
- 5.2.14 The following information shall be permanently marked on the cell.
- Nominal voltage

- b. Name of manufacturer/model reference
- c. Rated capacity in ampere hours (Ah) with End Cell Voltage
- d. Voltage for float operation at 27°C with tolerance of  $\pm 1\%$ , Month and year of manufacture
- e. Polarity Marking.

5.2.15 Each set of battery shall be supplied with all the accessories, including, but not limited to the following:

- a. Battery stands in formation as per Data Sheet. Mild steel stand pretreated and epoxy painted /PVC coated.
- b. Inter cell, inter row and interbank connectors and end take offs. These shall be of tin plated copper/flexible-insulated copper cable.
- c. Stand insulator & Portable voltmeter for cell voltage measurements.
- d. Cell number plates, Lugs for cable termination.
- e. Other accessories and their quantity as per Data Sheet.

### 5.3 Performance

SEALED MAINTENANCE FREE VRLA Stationary batteries shall have been type tested to meet the performance requirements for each design and Ah rating of cells as per the relevant Indian standard referred in clause 2.1 above.

### 5.4 Site condition

SEALED MAINTENANCE FREE VRLA stationary cell/battery shall be suitable for operating satisfactorily in humid and corrosive atmosphere found in fertilizer plants, refineries, CNG stations, petrochemical and gas processing plants, metallurgical plants and other industrial plants. Service conditions shall be as specified in the data sheets/job specification. If not specifically mentioned therein, a design ambient temperature of 45°C and an altitude not exceeding 1000m above MSL shall be considered, with minimum temperature of 10°C for battery sizing.

## 6.0 FABRICATION

- 6.1 Flame arrestor shall be mounted on the cell so that all the vented gases diffuse through the arrestor to the outside environment. The construction of the arrestor shall be such that hydrogen burning on the external surface of the arrestor shall not propagate back into the cell to cause explosion.
- 6.2 Each cell shall have a separate container. The cell container shall be of high strength alkali resistant material and designed to withstand mechanical stresses, shocks and vibrations. The cell container shall be translucent /transparent.

## 7.0 INSPECTION AND TESTING

- 7.1 Batteries shall be subject to inspection by Consultant/Owner or by an agency authorized by the Owner to assess the progress of work. The manufacturer shall furnish all the necessary information concerning the supply to Consultant/Owner's representative.
- 7.2 Consultant/Owner's Representative shall be given free access in the works from time to time for stage wise inspection and progress reporting. Four weeks advance notice shall

be given to witness the final routine tests and other tests as agreed upon.

7.3 The routine, acceptance & type testing shall be carried out as per Inspection & test plan for stationary SEALED MAINTENANCE FREE VRLA battery. Routine tests shall be conducted on each cell/battery. Acceptance tests & Type tests shall be conducted on few Cells/batteries as per relevant Indian standard. Battery load test shall also be performed at site after installation as part of commissioning

7.4 Following tests shall be carried out as a minimum for each Ah rating of cells/battery:

**a. Routine test**

- i. Physical examination test.
- ii. Polarity and absence of short circuit.
- iii. Dimension, Mass and layout.
- iv. Marking and packing.

**b. Acceptance test**

- i. Marking and packing.
- ii. Verification of dimensions.
- iii. Test for Ah capacity
- iv. Test for voltage during discharge
- v. Internal resistance test.

**c. Type test**

- i. Verification of constructional requirement.
- ii. Test for voltage during discharge.
- iii. Test for Ah capacity.
- iv. Test for charge retention/loss of capacity if specified in the data sheet.
- v. Air pressure test.
- vi. Ampere hour and Watt-hour efficiency test.

7.5 Battery duty cycle test to meet the load cycle requirement shall also be performed at site after installation as part of commissioning unless otherwise defined in the Data Sheet.

## **8.0 MARKING, PACKING AND SHIPMENT**

8.1 All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for transportation by ship/rail or trailer. The equipment shall be wrapped in polythene sheets before being placed in crates/cases to prevent damage to finish. Crates/cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Centre of gravity', 'Weight', 'Owner's particulars', 'PO nos.' etc., shall be clearly marked on the package together with other details as per purchase order.

The equipment may be stored outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage in areas with heavy rains/high ambient temperature, unless otherwise agreed.



Energising Quality

## VCS Quality Services Pvt Ltd

### STANDARD SPECIFICATION FOR MV SWITCHBOARD

**VCS – SS – EL - 4005**

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**ABBREVIATION**

BIS/IS:	Bureau of Indian standards
IEC:	International Electro-Technical Commission
BS:	British Standards
IEEE:	Institute of Electrical and Electronics Engineers
NEMA:	National Electrical Manufacturers Association
OISD:	Oil Industries Safety Directorate
CCE:	Chief Controller of Explosive
DGMS:	Director General Mines Safety
IE Rules:	Indian Electricity Rules
CPRI:	Central Power Research Institute
SWG:	Switchgear
CRCA:	Cold Rolled Cold Annealed
PCC:	Power Control Centre
PMCC:	Power and Motor Control Centre
MCCB:	Molded Case Circuit Breaker
MCB:	Miniature Circuit Breaker
MCC:	Motor Control Centre
CT:	Current Transformer
PT:	Potential Transformer
PVC:	Polyvinyl chloride

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## **1.0 SCOPE**

This specification covers the requirements of design, manufacture, testing, packing and supply of Fixed / draw out type Medium Voltage Switchboards.

## **2.0 REFERENCE DOCUMENTS**

2.1 The equipment shall comply with the requirements of latest revision of following standards issued by BIS unless otherwise specified.

- IS 5: Colors for ready mixed paints and enamels
- IS 772: AC Electricity Meters
- IS 1248: Direct acting electrical indicating instruments
- IS 2705: Current transformers
- IS: 2824: Method for determining the comparative tracking index of solid insulating materials under moist conditions
- IS: 3156: Voltage transformers
- IS: 3231: Electrical relays for power systems protection.
- IS: 3618: Phosphate treatment of iron and steel for protection against corrosion,
- IS: 5082: Material data for aluminum bus bars.
- IS: 5578: Guide for marking of insulated conductor.
- IS: 6005: Code of practice of Phosphating of iron and steel.
- IS: 8623: Factory built assemblies of switchgear and control gear for voltages up to and including 1000V AC and 1200V DC. Part -II particular requirements for busbar trucking systems (bus ways).
- IS: 11353: Guide for uniform system marking and identification of conductors and apparatus terminals.
- IS: 13703: Medium voltage fuses.
- IS: 13947: LV Switchgear and control gear

2.2 In case of imported equipment's, standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.

2.3 The equipment shall also conform to the provisions of Indian Electricity Rules and other statutory regulations currently in force in the country.

2.4 In case Indian Standards are not available for any equipment, standards issued by IEC/BS / VDE/ IEEE/ NEMA or equivalent agency shall be applicable.

2.5 In case of any contradiction between various referred Standards / Specifications / Data Sheet and statutory regulations the following order of priority shall govern:

- a. Local Statutory regulations
- b. Data Sheets
- c. Job Specifications
- d. Standards Specification
- e. Codes and Standards

### **3.0 DEFINITIONS**

For the purpose of this document, the words and expressions listed below shall have the meanings assigned to them as follows:

OWNER / COMPANY	OWNER of the particular Project (Project Specific).
CONSULTANT	The party which is doing engineering, procurement, construction, pre-commissioning and assistance for commissioning, monitors and controls the overall project management.
BIDDER / SUPPLIER / VENDOR	The party(s) which manufactures and / or supplies material, equipment, technical documents / drawings and services to perform the duties specified by Contractor.

### **4.0 MATERIALS**

- 4.1 The frame, of individual vertical panels shall be fabricated using pressed and cold rolled sheet steel. The sheet steel used for panel shall be of minimum 2mm (14SWG) CRCA except that the doors and covers may be made of 1.6mm (16SWG) CRCA. Wherever required, stiffeners shall be provided to increase stiffness of large size doors and covers.
- 4.2 Bus bars shall be of high conductivity electrolytic aluminum /copper supported on insulators made of non-hygroscopic, non-inflammable material with tracking index equal to or more than that defined in Indian standards.
- 4.3 All hardware shall be corrosion resistant. All joints and connections of the panel members shall be made by zinc passivated cadmium plated high quality steel bolts, nuts and washers.

## **5.0 DESIGN**

### **5.1 GENERAL REQUIREMENTS**

- 5.1.1 The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.
- 5.1.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment at least for 15 years from the date of supply.
- 5.1.3 Vendor shall give a notice of at least one year to the end user of equipment and consulted before phasing out the product/spares to enable the end user for placement of order for spares and services.

### **5.2 TECHNICAL REQUIREMENTS**

- 5.2.1 Medium & Low voltage switchboard shall be metal enclosed fully draw out, free standing, floor mounting, compartmentalized, modular type suitable for indoor installation only, otherwise specified in datasheet or project specification.
- 5.2.2 The switchboard enclosure shall be dust and vermin proof and shall provide a degree of protection not less than IP-42.
- 5.2.3 The switchboard shall be assembled out of vertical panels of uniform height in single line up.
- 5.2.4 It shall be possible to extend the switchboards, in either direction at a later date. Ends of bus bars shall be suitably drilled for this purpose. Panels at extreme ends shall have openings, which shall be covered with plates screwed to the panel. Details of drilled holes in bus bar and openings in the panels, provided for future extension shall be clearly shown in the vendor drawings.
- 5.2.5 The switchboard shall be designed to ensure maximum safety during operation, inspection, connection of cables, relocation of outgoing circuits and maintenance, with the bus bar system energized and without taking any special precautions.
- 5.2.6 Adequate means shall be provided to prevent shorting of power and / or control terminals due to accidental dropping of maintenance tools etc. inside the switchboard. Checking and removal of components shall be possible without disturbing adjacent equipment.

### **5.3 SPECIFIC REQUIREMENTS OF AIR CIRCUIT BREAKER PANELS**

- 5.3.1 The breaker panels shall have distinct bus bar, breaker and cable compartments.
- 5.3.2 The design of each compartment shall be such as to prevent movement of vermin from a particular compartment to any other compartment of the panel when the breaker is withdrawn and compartment door is closed.

- 5.3.3 Blanking plates shall be provided for each circuit breaker compartments, which would be used after installation, to cover the openings in the event of taking out the breaker outside the compartment.
- 5.3.4 In order to minimize accidental access and avoid accidents due to falling tools, all the outgoing links shall be shrouded.
- 5.3.5 Outgoing Air circuit breaker can be mounted in a maximum of two-tier execution while the incoming/bus coupler Air circuit breaker shall be in single tier execution only.

#### 5.4 CABLE COMPARTMENT

- 5.4.1 Separate compartment totally enclosed from all sides shall be provided for cable termination, on the rear side. Access to cables shall be from the rear side after opening the cabling compartment door.
- 5.4.2 The incoming / outgoing cable termination shall be staggered for each circuit and barriers of sheet steel or insulating material shall be provided between termination of two circuits such that maintenance on one circuit could be carried out while the other circuit is live. Suitable clamping arrangements shall be provided for cables and cable termination. Terminal blocks shall not be used for supporting the cables.
- 5.4.3 The incoming supply for PCC/ PMCC panels shall be through top entry bus ducts or through bottom entry cables unless specified otherwise. The outgoing cables shall have bottom entry unless specified otherwise.
- 5.4.4 The cable terminations shall be suitably sized for receiving specified number of cables per termination and provision shall be made for terminating each outgoing cable with a separate bolted connection. In case the total number of cables entering a particular panel cannot be accommodated in the cabling compartment of the panels an extension panel of full height shall be added to the cabling compartment for accommodating extra cables.

#### 5.5 CIRCUIT BREAKER COMPARTMENT

- 5.5.1 The circuit breaker compartment shall be fully draw out. Suitable guides shall be provided to facilitate easy withdrawal of the circuit breaker.
- 5.5.2 The current transformers for the ammeter/protection circuits shall be mounted on the fixed portion of the compartment. However, current transformers associated with built-in releases may be mounted on the breaker trolley.
- 5.5.3 All terminals except wiping/sliding type control terminals shall be shrouded with plastic covers to prevent accidental contact. For direct termination - clip on shrouded type terminals shall be provided.
- 5.5.4 There shall be three positions for the draw out trolley viz:
- a. "Service" position - In this position both power and control circuits shall be connected. This shall be the normal operating position of the circuit breaker.

- b. "Test" position - The power contacts shall be disconnected in this position but the control connections shall not be disturbed, it shall be possible to close and trip the breakers in this position.
- c. "Draw out" Position - both power and control circuits shall be disconnected in this position and breaker removed from the cubicle.

5.5.5 The circuit breaker shall be lockable in "service" and "test" positions. Safety shutters shall be provided when the breaker is in withdrawn/draw out position.

5.5.6 The earth connection must remain connected in "Test" position; Earthing of the unit shall be done with a "pin" or with scrapping earth connections.

5.5.7 The earth connection shall make before the main power / control contacts make and break after the power /control contacts are disconnected. Earthing connection through a plug and socket connection shall not be acceptable.

## 5.6 INTERLOCKS

Following interlocks shall be provided:

5.6.1 Compartment doors shall be interlocked against opening when breaker is in closed condition. However, it shall be possible to defeat this interlock for inspection purposes.

5.6.2 It shall not be possible to push "in" a drawn-out circuit breaker in closed condition or withdraw a circuit breaker in closed condition.

5.6.3 It shall be possible to operate a circuit breaker only in the defined "Full in" or "service" and "test" position inside the panel. It shall not be possible to operate the breaker in intermediate positions while inserting or withdrawing circuit breaker.

5.6.4 Any unused circuit breaker compartment shall be fully equipped and provided with compartment door, vertical busbars and control terminals/wiring etc., such that the same could be used for housing outgoing breakers in future without any modifications to the panel.

## 5.7 SPECIFIC REQUIREMENTS OF NON-AIR CIRCUIT BREAKER FEEDERS

5.7.1 The design of draw out feeder modules shall not change for single front or double front execution. Separate vertical bus bars shall be provided for each front side modules.

5.7.2 All identical feeder modules shall be interchangeable.

5.7.3 Each vertical panel shall have a separate cable alley. The width of this cable alley shall be sufficient to accommodate all the cables and shall have free access for cable terminations and in any case shall not be less than 200mm minimum. Cable alleys shall be provided with suitable doors.

5.7.4 Sheet steel barriers shall be provided between individual compartments and cable alley. This barrier shall be provided with opening for power and control connections and it shall be possible to safely carryout maintenance work on cable connections to any one circuit in the cable alley with the busbars and the adjacent circuits live.

- 
- 5.7.5 Maintenance and connection of cables to any modules shall be possible without having to take out the modules from its position from the panel.
- 5.7.6 The outgoing feeder trolleys for draw out type switchboard shall be fully draw out and shall have the following features.
- a. It shall be possible to withdraw the trolley without having to unbolt or unscrew any power and control connections to the equipment mounted on the withdrawable trolley.
  - b. Both power and control connections shall be draw out type. All line and bus PTs shall be in draw out execution only. However, outgoing modules having size more than half of the useful vertical height of the panel may be in mixed combination of draw out/fixed type.
  - c. Control supply transformer modules with burden higher than 2.5KVA may be in fixed execution.
  - d. The trolley withdrawal shall be by means of crank and screw arrangement. Alternatively movement on guided rollers may also be acceptable. Plug in operation shall be independent of manual force.
  - e. For draw out type feeders of size equal to or greater than half the useful vertical height of panel, positive clamping arrangement shall be provided on the top portion of the trolley in addition to clamping arrangement at the bottom, to ensure all round positive pressure on the power draw out contacts once the trolley is plugged in.
  - f. Power draws out contacts shall preferably be located towards the bottom portion of each trolley. The trolley shall be lockable in fully plugged in position and devices shall be provided to ensure positive plugging in. In test position, power contacts shall be totally isolated and a device shall be provided for indication of test position.
  - g. The incomer and bus tie feeders with load break switches rated 800A and above may be in fixed execution.
- 5.7.7 Various compartment sizes in a vertical panel shall be multiples of a basic dimension. However the minimum module size for switch fuse feeder and motor starter/contactors feeder shall not be less than that defined in Data Sheet/Job Specification. Vertical bus bars shall be pre-drilled at regular intervals for complete flexibility for changes in size of modules.
- 5.7.8 All switch drives other than rotary control switches, shall be lockable in both 'ON' and 'OFF' positions.
- 5.7.9 The Switches / Molded case circuit breakers / MCB shall be interlocked with the compartment door to prevent opening of the door when the Switch/ Molded case circuit breaker is in 'ON' position and to prevent switching on when the door is open. A defeat mechanism for this interlock shall also be provided.
- 5.7.10 The maximum height of the operating handle and switches shall not exceed 1900 mm and the minimum height not below 300 mm.

5.7.11 Unused modules in the panel shall be fully equipped with hinged door, power and control terminals for starter modules and cradle for future use.

## 5.8 SWITCHGEAR MODULES

5.8.1 Switchboard shall be completely lined up in one straight row with the type and quantities of feeders as defined in switchboard Data Sheet. Generally the feeders of three main categories are identified as circuit breaker, motor starters and switch-fuse,

5.8.2 Starter modules required for motor control shall be of following types and internal control wiring of all starter modules of each type shall be identical for all ratings.

FVNR Full voltage non -reversing starter with minimum 18 control terminals.

FVR Full voltage reversing starter with minimum 24 control terminals.

FVNR HD Full voltage non -reversing heavy duty starter with long starting time such as for compressors and fans etc., with minimum 18 control terminals.

5.8.3 Switchgear /contactor feeder modules shall be of following types and internal control wiring of all modules of each type shall be identical for all ratings.

MCCB Molded case circuit breaker.

MPCB Motor Protection circuit breaker

MCB Miniature circuit breaker

ELCB Earth leakage circuit breaker

RCCB Residual current circuit breaker

5.8.4 Type of modules for fixed type switchboard shall be similar to above specified draw out modules except that the modules shall be of fixed type.

5.8.5 Minimum 2000 VA control transformer shall be provided for each bus section of the PMCC/MCC switchboard having contactor control feeders and each transformer shall be sized for the entire switchboard. For switchboard having two bus sections and coupled by bus tie shall have manual changeover switch for the control transformers.

5.8.6 To facilitate site modification due to changes in motor KW ratings and to minimize spares inventory, overload relays and power fuse links shall meet the following requirements.

a. All bimetal overload relays shall be separately mounted type with connecting links rated for the maximum rating of the contactor in a starter module.

b. Bimetal overload relays of various current ranges required for motors likely to be connected to a contactor must be identical in dimension for inter-changeability. In case offered relays are with different dimension for any particular starter module, special mounting plate suitable for mounting different relays shall be provided in all the modules of that size.

c. Heavy duty starters shall be provided with saturable type current transformer

operated overload relays only, which shall be suitable for motor starting time of 15-60 seconds.

- d. All contactor-controlled starter feeders shall meet the requirements of type-2 co-ordination as per IS: 13947.

## 5.9 SWITCHGEAR COMPONENTS

### 5.9.1 CIRCUIT BREAKER

- a. Circuit breakers shall be air brake, 3 pole and draw out type. However Circuit breaker for generator incomer shall be with four poles unless specified otherwise.
- b. The circuit breakers shall be provided with mechanically operated emergency tripping device. This device shall be available on the front of the panel. Mechanically operated 'closing' device shall be provided for all breakers. However mechanical closing shall be inhibited for all breakers in service position.
- c. The circuit breakers shall be provided with minimum 4 NO + 4 NC contacts, wired and available for Purchaser's use.
- d. Circuit breakers Open and closed positions; Service and test locations and spring charged condition shall also be indicated mechanically in addition to electrical indications.
- e. Unless otherwise specified, all circuit breakers in the switchboard shall be provided with electrical power operating mechanism. Wherever circuit breakers are provided in place of Isolators, Breaker can be manually operated type.

### 5.9.2 OPERATING MECHANISM

- a. Electric power operating mechanism shall be motor wound spring charged stored energy type. However, manual-operating mechanism may be of the spring charging stored energy type or the spring assisted type. For circuit breakers with electrical power operating mechanism, provision shall also be made for manual spring charging. Closing time of circuit breakers with manual operating mechanism shall be independent of the speed of the operating handle.
- b. All stored energy operating mechanism shall be equipped with following features.
  - i. Failure of springs, vibrations or shocks shall not cause unintended operation of breaker or prevent intended tripping operation.
  - ii. Closing of circuit breakers shall be prevented unless the spring is fully charged.
- c. All electrical power operating mechanisms shall be suitable for remote operation and shall be equipped with following features.
  - i. Provided with universal motor operable on AC or DC control supplies.
  - ii. Provided with emergency manual charging facility. The motor shall be automatically, decoupled (mechanically) once the manual-charging handle is inserted.
  - iii. Closing operation of circuit breaker shall automatically initiate charging of the spring for the next closing operation without waiting for tripping of circuit breaker.
  - iv. Closing operation shall be completed once the closing impulse is given and the

first device in the control scheme has responded even though the control switch / Push Button is released provided no counter trip impulse is present.

- v. Circuit breaker trip and closing coils in case of electrically operated breakers and trip coil in case of mechanically operated breakers and circuit breaker indication shall be suitable for satisfactory operation on a control supply system indicated in data sheets/job specification.
- vi. Circuit breakers shall be provided with anti-pumping and trip free feature.
- vii. Circuit breakers shall be provided with operation counters.
- viii. Releases are not required to be provided with breakers where relays are used. However, breaker having AC control supply voltage shall be provided with under voltage release unless specified otherwise.

### 5.9.3 SWITCHES

- a. All switches or fuse switches shall be air break type provided with quick make/break manual operating mechanism. The operating handle shall be mounted on the door of the compartment having the switch.
- b. Rating of switches for starter module shall meet the requirements of AC-23 duty as per IS: 513947 and minimum rating shall be as specified in job specification/data sheets.

### 5.9.4 FUSES (shall be used as per client requirements only)

- a. Fuses shall be non-deteriorating HRC cartridge link type.
- b. Power fuses shall be pressure fitted type and shall preferably have ribs on the, contact blades to ensure good line contact.
- c. It shall be possible to handle fuses during off load conditions with full voltage available on the terminals. Wherever required, fuse pullers shall be provided. The fuse base shall be so located in the modules to permit insertion of fuse pullers and removal of fuse links without any problem.

### 5.9.5 CONTACTORS

- a. The contactors shall be air break type, equipped with three main contacts and minimum 1NO+1NC auxiliary contacts: The main contacts of a particular contactor for motor starter module shall have AC-3 or AC-4 ratings as specified in Data Sheet.
- b. Unless specified otherwise, the coil of the contactor shall be suitable for operation on 240 V, I Phase, AC supply and shall work satisfactorily between 65 to 110% of the rated value.

### 5.9.6 THERMAL OVERLOAD RELAY

- a. Bimetal relays shall be provided for protecting the motor from thermal overload.
- b. Bimetal relays shall be manually reset type with the reset push button brought out on the front of the panel. The reset push button shall be capable of being operated without opening the compartment door.
- c. Bimetal relays shall be positive acting ambient temperature compensated type with

adjustable setting range.

- d. Bimetal relays shall have built-in single phasing prevention feature, which operate even with 50% rated current at the time of single phasing.

#### 5.9.7 MOULDED CASE CIRCUIT BREAKERS

- a. MCCBs shall be provided with spring assisted quick make/ break manually operated trip free mechanism. Wherever specified, MCCB shall be suitable for remote tripping operation and the tripping device shall be suitable for the specified control supply voltage.
- b. MCCBs shall be provided tripping device with inverse time characteristic for over load protection and instantaneous characteristics for short circuit protection and MCCB rated above 125A shall preferably have adjustable settings.
- c. 'ON' and 'OFF' position of the operating handle of MCCB shall be displayed and the operating handle shall be mounted on the door of the compartment housing MCCB.
- d. Each MCCB shall be provided with minimum 1 NO + 1 NC auxiliary contact and 1NO contact for tripping indication/alarm for Purchaser's use.
- e. MCCBs shall be provided with solenoid/ Motorized closing mechanism to make them suitable for remote closing operation if specified. The closing solenoid/motor shall be suitable for specified (control supply voltage).
- f. MCCB's as part of motor starter module shall be current limiting type and type tested for type-2 coordination as per IS: 13947.

#### 5.9.8 RELAYS

- a. All the protective relay shall be provided as per OISD/Engineering standard guideline as per utilization of Electrical panels requirements.
- b. All the type of relay shall be numerical only otherwise static or electromagnetic type if specified in the Data Sheet/Job Specification.
- c. All electromagnetic protective relays shall be back connected, of draw out type, suitable for flush mounting, and fitted with dust-tight covers. Alternatively, "plug-in" type relays will also be acceptable. Auxiliary relays are acceptable in fixed execution.
- d. The protective relay cases shall have provision at the front for "testing and calibration" purposes. It shall be possible to test the relays without disconnecting the wiring and without withdrawing the relays. The insertion of the test plug shall automatically short circuit the CTs and permit extension of external power supply to the relay.
- e. Each protective relay shall be provided with minimum 2 nos. potential free contacts of required configuration.
- f. Each tripping relay shall be lockout type with hand reset coil cut-off contact. The tripping relay shall be suitable for satisfactory operation from 50 % to 110 % of the specified control supply voltage.
- g. Protective relays shall be preferably mounted on the front side and upper part of the panel and mounting of relays on the lower portion shall be avoided.

#### 5.9.9 INSTRUMENT TRANSFORMERS (CTS/PTS)

- a. Current transformers shall generally conform to IS: 2705 and any special requirement with respect to Numerical relay shall be taken care by the Vendor.
- b. For general guidance the Vendor shall note that the protective current transformers shall have an accuracy class "5 P" and an accuracy limit factor greater than "10 ". However CTs for restricted earth fault shall be of class "PS". Vendor shall co-ordinate the knee point voltage, magnetizing current for PS class CTs to avoid saturation and mismatching of CTs provided at another end by other Vendor.
- c. Current transformers for instruments shall have an accuracy class 1.0 and accuracy limit factor less than 5.0. However accuracy class of 3.0 is acceptable for CT's meant for remote ammeters.
- d. The current transformers in breaker feeders shall be capable of withstanding the applicable peak momentary short circuit and the symmetrical short circuit current for 1.0 second.
- e. The voltage transformers shall be cast resin type transformers and PT shall generally conform to IS: 3156. PT shall be provided with HRC fuses on primary side and Miniature circuit breakers with auxiliary contact on the secondary side.

#### 5.9.10 MEASURING INSTRUMENTS

- a. Multifunction meter shall be used for all incomer & specified outgoing feeders.
- b. All measuring instruments shall be of 96 x 96, mm and 72 x 72 mm square pattern, flush mounting type for incomer and outgoing feeders respectively in the switchboard.
- c. All auxiliary equipment such as shunts transducers, CT's PT's etc. as required shall be included in the supply of the switchboard.
- d. All AC ammeters and voltmeters shall be of moving iron type with accuracy class of 1.5 as per IS: 1248. Ammeters for motor feeders shall have a non-linear compressed scale at the end to indicate motor starting current and red mark for the full load current.
- e. The KW/KWH meters shall be suitable to measure unbalanced loads on 3 phases 4-wire system. Test terminal block shall be provided for KWH meters. The accuracy class of KW/KWH meters shall be a minimum of 2.5.
- f. Digital meters shall be provided if specified in Job Specification/Data Sheets. All digital meter shall be high reliable, accurate, compact and self-powered. Digital meter data shall be saved in case of power failure. Field programming from front of the meter shall be possible and shall be RS232/485 port in case specified in the Job Specification/Data Sheet.

#### 5.9.11 CONTROL SWITCHES

- a. All control switches shall be rotary type, having a cam operated contact mechanism. Switch shall have pistol grip handles for circuit breaker control and knob type handle for other applications.
- b. Ammeter selector switches shall have make before break feature on its contacts. The selector switch shall generally have 4 positions for reading 3 phase currents and fourth position for off. The voltmeter selector switch shall also have 4 positions, three positions shall be used to measure phase to phase voltage and fourth shall be OFF position.

#### 5.9.12 PUSH BUTTONS:

Push button colors shall be as follows:

- a. Stop /open/emergency : Red
- b. Start/close : Green
- c. Reset/test : Yellow / Black /white

#### 5.9.13 INDICATIONS

- a. Clustered LED type indicating light with minimum 8mm diameter size shall be provided for indications.
- b. Breaker positions (Close, Open, spring-charged, test position, service position) electrical indications, with colors as given below, shall also be provided:

- Breaker `Close' : Red lamp
- Breaker 'Open' : Green lamp
- Breaker auto-trip : Amber lamp
- Trip circuit healthy : White lamp
- Spring charging : Blue lamp

- c. Outgoing feeder (Close, Open, trip) electrical indications, with colors as given below, shall also be provided:

- 'Close' : Red lamp
- 'Open' : Green lamp
- `Trip' : Amber lamp

#### 5.9.14 AUXILIARY RELAYS/CONTACTORS

Auxiliary relays/contactors shall generally be used for interlocking and multiplying contacts. Auxiliary contacts shall be capable of carrying the maximum anticipated current.

#### 5.9.15 TIMERS

For re-acceleration duty, timers unless otherwise stated, shall be pneumatic type and shall have adjustable time setting of 0-60 seconds, alternatively static timer may be considered. The time settings, where specified, shall be accurately set before dispatch of the switchboard. Timer provided for control of capacitor feeder shall have minimum setting of 0-5 minutes.

#### 5.9.16 MINIATURE CIRCUIT BREAKER

- a. MCB shall provide high mechanical and electrical life, reliable protection of circuits

against overload and short circuit and shall have minimum breaking capacity of 9KA unless otherwise specified. Positive ON/OFF indication shall be provided.

- b. Earth leakage circuit breaker shall have earth sensitivities range 30mA to 300mA unless otherwise specified.
- c. Residual current circuit breaker shall have sensitivities range 30mA to 300mA unless otherwise specified

## **6.0 FABRICATION**

- 6.1 All identical equipment and corresponding part shall be fully interchangeable.
- 6.2 The frame, of individual vertical panels shall be fabricated using pressed and cold rolled sheet steel. The sheet steel used for panel shall be of minimum 2mm (14SWG) CRCA except that the doors and covers may be made of 1.6mm (16SWG) CRCA. Wherever required, stiffeners shall be provided to increase stiffness of large size doors and covers.
- 6.3 The switchboard shall be provided with integral base frame for each vertical panel. The switchboard integral base frame shall be suitable for tack welding.
- 6.4 All openings, covers and doors shall be provided with neoprene Gaskets. Removable blanking plates shall be provided to cover the openings in the event of withdrawing the feeder modules. Number of blanking plates shall be 10% of each module size with a minimum of one number.
- 6.5 All hardware shall be corrosion resistant. All joints and connections of the panel members shall be made by zinc passivated cadmium plated high quality steel bolts, nuts and washers.
- 6.6 Suitable removable type eyebolts shall be provided for the lifting of the panel/shipping section. These bolts, when removed shall not leave any opening in the panels.
- 6.7 Non-magnetic cable gland plates shall be provided for termination of single core cables.
- 6.8 The switchboard shall be formed using distinct vertical panels each comprising of following compartments.
  - 6.8.1 A metal enclosed horizontal bus bar compartment running at top unless otherwise specified. Individual feeder modules in multitier mode.
  - 6.8.2 Vertical bus bars serving all feeder modules in the vertical panel.
- 6.9 CABLE TERMINATION COMPARTMENT
  - 6.9.1 Perforated sheet steel/insulating material enclosed horizontal auxiliary bus bars for control, interlock, indication and metering wiring running horizontally.
  - 6.9.2 Metal sheets shall be provided between two adjacent vertical panels running up to full useful height of the switchboard.
  - 6.9.3 MCC shall be of single/double front execution as specified in Data Sheet/Job Specification. However Circuit breaker panels and fixed type switchboard shall be in

single front execution only.

6.9.4 Motor starter and switch fuse modules shall not be accommodated at front and rear of ACB Incomer and bus coupler panel.

6.9.5 All metering and protection equipment associated with a particular circuit as specified in Data Sheet shall be housed in separate and independent compartment earmarked for that particular circuit and in the fixed portion of the vertical panel in case of breaker panels.

6.9.6 All auxiliary devices for control, reset, indication, measurement and protection such as push buttons, control and selector switches, indicating lamps, measuring instruments and protective relays shall be mounted on the front side of the respective compartment. The design shall be such that all power on/off or start / stop and relay reset operations shall be performed without opening the panel door.

#### 6.10 SPACE HEATERS

6.10.1 The switchboard panels shall be provided with space heaters to prevent moisture condensation. The space heater shall be located in the bottom part of each panel and shall be supplied from 240 V AC auxiliary bus for space heater. The space heater shall be provided with a thermostat having adjustable setting and double pole miniature circuit breaker.

#### 6.11 AUXILIARY BUS BARS

6.11.1 Auxiliary bus bars each of minimum size 18-mm<sup>2</sup> copper shall be provided for following applications. Exact number of bus bars shall depend on various control, metering and auxiliary power distribution requirement.

6.11.2 Panel space heater supply and motor space heater supply.

6.11.3 Control supply for breaker tripping, closing and indication circuits.

6.11.4 Control supply for breaker spring charging motors, motor starter control and indication circuit. AC potential supply for energy meters, voltage operated relays etc.

6.11.5 Tee-off connectors shall be used for distributing auxiliary supply to each vertical panel. Rubber grommets shall be used for all wire entries to make the entries dust and vermin proof.

6.11.6 Provision to hook up of external DC control supply to be provided either in bus PT panel or bus coupler panel.

#### 6.12 BUS BAR

6.12.1 Bus bars shall be of high conductivity electrolytic aluminum /copper supported on insulators made of non-hygroscopic, non-inflammable material with tracking index equal to or more than that defined in Indian standards.

6.12.2 The main bus bars shall have uniform current ratings throughout their length as specified in Data Sheet/Job Specification. The current rating of the neutral shall be half that of the phase bus bars, Removable neutral links shall be provided on feeders to permit isolation

of the neutral bus bar.

- 6.12.3 Both horizontal and vertical bus bars, bus joints and supports shall be capable of withstanding dynamic and thermal stresses of the specified short circuit currents for 1 second, The short circuit capacity of the neutral bus bars shall be in line with IS:13947.
- 6.12.4 Only zinc passivated or cadmium plated high tensile strength steel bolts, nuts and washers shall be used for all bus bar joints and supports. The hot spot temperature of bus bars including joints at design ambient temperature shall not exceed 95° C for normal operating conditions.
- 6.12.5 The current rating as defined for switchboard and components in Data Sheet/Job Specification are for design ambient temperature at site conditions and for being inside the cubicle at fully loaded condition. The Vendor shall suitably derate the nominal rating to suit the above condition.
- 6.12.6 All bus bars shall be insulated with heat shrunk PVC sleeves of 1100 V grade. Red, yellow and blue color shall be used for phase bus bars and black color shall be used for neutral bus bars; Removable type shrouds shall be provided for joints.
- 6.12.7 Minimum clearance between live parts, between live parts/neutral to earth shall be 19 mm, however clearances between terminals at components shall be as per applicable individual standards for components.
- 6.12.8 Interconnections between the main bus bars and individual units shall be made by using aluminum bus bars of adequate rating. These interconnections of the vertical bus bars shall be in separate compartment and fully shrouded.
- 6.12.9 Vertical bus bars for circuit breaker panels shall be sized depending upon the rating and number of breakers per vertical panel. However Vertical bus bars of all other panels shall be of uniform cross section, Size of vertical bus bars shall not be less than 500 mm<sup>2</sup> aluminum per phase or equivalent copper for panels rated above 25kA.

### 6.13 WIRING AND TERMINALS

- 6.13.1 Inside the cubicles, the wiring for control, signaling, protection and instrument circuits shall be done with BIS approved, PVC insulated, flame retardant type, copper conductor wire. The insulation grade shall be 660 V. The wiring shall preferably be enclosed in plastic channels or neatly bunched, together.
- 6.13.2 PVC insulated copper conductor of cross section 1.5 mm<sup>2</sup> may normally be used provided the control fuse rating is 10 amps or less. For 16 amps control fuse circuit 2.5mm<sup>2</sup> copper conductor shall be used. Each wire shall be terminated at a separate terminal. C.T. Circuit wiring shall be done with 2.5mm<sup>2</sup> Copper conductor.
- 6.13.3 Shorting links/suitable-shortening arrangement for shorting CT. secondary shall be provided. Each wire shall be identified at both ends by PVC ferrules.
- 6.13.4 Inter panels wiring within each shipping section shall be switchboard Vendor's responsibility. For wiring between shipping sections, Vendor shall provide terminal blocks on adjoining shipping sections and supply suitable umpiring wires. Interpanel wiring shall be taken thorough PVC sleeves or rubber grommets.

- 6.13.5 A minimum of 10% spare terminals shall be provided on each terminal block.
- 6.13.6 Conductors shall be terminated with adequately sized compression-type lugs for connection to equipment terminals and strips. Stranded conductors shall be soldered at the ends before connections are made to the terminals. Sufficient terminals shall be provided on each terminal block to ensure that not more than one outgoing wire is connected per terminal.
- 6.13.7 Terminal strips shall preferably be separated from power circuits by metal barriers or enclosures. All spare contacts of auxiliary relays, timers, etc. shall be wired up to the terminals.
- 6.14 EARTHING
- 6.14.1 All panels shall be connected to a tinned copper / GI earth bus bar running throughout the length of the switchboard.
- 6.14.2 The minimum earth bus size shall be 30x6 mm<sup>2</sup> copper for fault level up to 31.5kA and 50x6 mm<sup>2</sup> copper for fault level above 31.5kA,
- 6.14.3 All doors and movable parts shall be earthed using flexible copper connections to the fixed frame of the switchboard. Provision shall be made to connect the earthing bus bar to the plant earthing grid at two ends.
- 6.14.4 All non-current carrying metallic parts of the mounted equipment shall be earthed. Minimum 4 no's, 10 mm diameter bolts with nuts shall be provided on the earth bus for termination of fourth core of cable per vertical panel.
- 6.15 NAME PLATE
- 6.15.1 A nameplate with the switchboard designation shall be fixed at the top of the central panel. A separate nameplate giving details for each feeder compartment of all panels shall be provided.
- 6.15.2 The nameplates for feeder compartments shall be in two parts. One part shall have necessary details pertaining to the compartments number of vertical panel of the switchboards, The other parts shall be removable and shall contain all details regarding the feeder number for drives/equipment controlled by the particular module as per approved single line diagram.
- 6.15.3 Blank nameplates shall be provided for all spare and vacant modules.
- 6.15.4 Nameplate or polyester adhesive stickers shall be provided for each equipment mounted inside the switchboard, Special warning plates shall be provided on removable covers or doors giving access to cable terminals and bus bars.
- 6.15.5 Special warning labels shall be provided inside the switchboards also, wherever considered necessary. Identification tags shall be provided inside the panels matching with those shown on the circuit diagram.
- 6.15.6 Engraved nameplates shall preferably be of 3 ply (Black-White Black) lamicoide sheets or anodized aluminum. However back engraved Perspex sheet nameplates may also be acceptable. Nameplates shall be fastened by screws and not by adhesives.

## 6.16 PAINTING

- 6.16.1 All metal surfaces shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid, The under surface shall be prepared by applying a coat of phosphate paint and coat of yellow zinc chromate primer, The under surface shall be made free from all imperfections before undertaking the finishing coat.
- 6.16.2 After preparation of the under surface, the switchboard shall be spray painted with two coats of epoxy based final paint or shall be powder coated.
- 6.16.3 Color shade of final paint shall be 631 as per IS:5 unless otherwise specified.
- 6.16.4 The finished panels shall be dried in stoving ovens in dust free atmosphere. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint etc. Vendor shall supply final paint (1 liter per switchboard) in non-returnable container for final touch up at site.
- 6.16.5 All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust formation. If these parts are moving elements, then they shall be greased.

## 7.0 INSPECTION AND TESTING

- 7.1 During fabrication, switchgear shall be subject to inspection by Consultant / Owner or by an agency authorized by the Owner. Manufacturer shall furnish all necessary information concerning the supply to Consultant / Owners inspectors.
- 7.2 All routine and acceptance tests shall be carried out at Manufacturer's work under his care and expense.
- 7.3 Type tests, if specified shall be performed. Short circuit test shall be performed at CPRI or equivalent approved testing agency and heat run test may be performed at manufacturer's works. Heat run test shall be performed at least on one incomer and two outgoing vertical panels of the ordered switchboard.
- 7.4 Type and shop tests shall be witnessed by an inspector of Consultants / Owner or of an agency authorized by the Owner. Prior notice of minimum 4 weeks shall be given to the Inspector for witnessing the tests.

## 7.5 ACCEPTANCE TESTS

Acceptance tests shall be as follows:

- 7.5.1 A general visual check shall be carried out. This shall cover measurement of overall dimension, location, number and type of devices, location and connection of terminals etc.,
- 7.5.2 Manual and electrical operation of Circuit Breakers. / Relays shall be checked under the worst conditions of auxiliary supply voltage.
- 7.5.3 Dry insulation test with power frequency voltage shall be conducted for the main and auxiliary circuits.

- 7.5.4 Insulation resistance of the main and auxiliary circuits shall be checked before and after power frequency voltage withstand test.
- 7.5.5 Operation check shall be carried out for every control function /interlocks as per the schematic diagrams by manually simulating fault conditions and operation of control switches/relays etc.
- 7.5.6 For equipment bought from other sub-suppliers, certified test reports of tests carried out at the manufacturers works shall be submitted. Normally all routine tests as specified in the relevant standards shall be conducted by the sub-supplier at his works.
- 7.5.7 Interchangeability of similar modules shall be checked on a random basis. This may be done on one module of each size.

## **8.0 MARKING, PACKING AND SHIPMENT**

- 8.1 All the equipment shall be divided into several shipping sections for protection and ease of handling during transportation. The equipment shall be properly packed for selected mode of transportation i.e., by ship/rail or trailer.
- 8.2 The panels shall be wrapped in air bubble polyethylene sheets before being placed in wooden crates /cases to prevent damage to the finish. Crates /cases shall have skid bottoms for handling. Special precaution notations such as Fragile, this side up, center of gravity, weight, Owner's particulars, Purchase number etc. shall be clearly marked on the package together with other details as per purchase order.
- 8.3 The equipment may be stored outdoors for long periods before installation. The packing should be suitable for outdoor storage in areas with heavy rains and high ambient temperature unless otherwise agree.







Energising Quality

## VCS Quality Services Pvt Ltd

### STANDARD SPECIFICATION FOR MEDIUM AND HIGH VOLTAGE CABLES

**VCS – SS – EL - 4007**

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## **ABBREVIATION**

BIS/IS:	Bureau of Indian standards
IEC:	International Electro-Technical Commission
BS:	British Standards
IEEE:	Institute of Electrical and Electronics Engineers
NEMA:	National Electrical Manufacturers Association
OISD:	Oil Industries Safety Directorate
CCE:	Chief Controller of Explosive
DGMS:	Director General Mines Safety
IE Rules:	Indian Electricity Rules
CPRI	Central Power Research Institute
PVC	Polyvinyl chloride
XLPE	Cross Linked Poly Ethylene

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## 1.0 SCOPE

This Specification along with Data Sheets covers requirements for design, manufacture, testing at works and supply of Flame Retardant PVC/XLPE cables and cable jointing / terminating accessories for medium and high voltage systems.

## 2.0 REFERENCE DOCUMENTS

2.1 The cables and cables jointing & terminating accessories shall comply with the latest edition of the following standards as applicable:

IS: 1554:	PVC insulated (heavy duty) electric cables.
IS: 7098:	cross linked polyethylene insulated PVC sheath
IS: 8130:	Conductors for insulated electric cables and flexible cords
IS: 5831:	PVC insulation and sheath of electric cables
IS: 3975: 10810 (Part 41)	Mild steel wires, strips and tapes for armoring of cables Methods of testing cables: Mass of zinc coating on steel armor.
IS: 209:	Specification of zinc
IS: 3961:	Recommended current ratings for cables: part-2 PVC Insulated and PVC sheathed heavy duty cables.
IS: 10418:	Drums for electric cables
IS: 10462(Pt-1):	Fictitious calculation method for determination of dimension of protective coverings of cables: part – I electrometric and thermoplastic insulated cables.
IS: 10810(Pt-58):	Oxygen index test
IS: 10810(Pt-61):	Flame retardant test
IS: 10810(Pt-62):	fire resistance test bunched cables.
IS: 13573:	Joints and termination for polymeric cables for working voltages from 6.6 KV up to and including 33 KV.
IEC: 60332-3:	Test on electric cables under fire conditions
IEC: 60502:	Extruded solid dielectric insulated power cables for rated Voltages from 1 KV up to 30 KV.
IEC: 60540&60540A:	Test methods for insulation and sheaths of electric Cables.
ASTM: D2863:	Standard method of test for flammability of plastics using oxygen index method.

ICEA S-61-402:	Thermoplastic insulated wire and cable for transmission and Distribution of electrical energy
NEMA-WCS:	Distribution of electrical energy
ICEA. S-66-S24:	Cross-linked thermosetting polyethylene insulated wire
NEMA-WC7:	Cable for transmission of electrical energy.

**2.2** The cables and accessories shall also conform to the provisions of Indian electricity rules and other statutory regulations as applicable.

**2.3** In case of any contradiction between various referred Standard/Specification/Data sheet and statutory regulations, the following order of priority shall govern:

- a. Statutory regulations
- b. Data Sheets
- c. Job specifications
- d. Standard specification
- e. Codes and standards

### **3.0 DEFINITIONS**

**3.1** For the purpose of this document, the words and expressions listed below shall have the meanings assigned to them as follows:

OWNER / COMPANY	OWNER of the particular Project (Project Specific).
CONSULTANT	The party which is doing engineering, procurement, construction, pre-commissioning and assistance for commissioning, monitors and controls the overall project management.
BIDDER / SUPPLIER / VENDOR	The party(s) which manufactures and / or supplies material, equipment, technical documents / drawings and services to perform the duties specified by Contractor.

### **4.0 MATERIALS**

#### **4.1 PVC CABLES**

4.1.1 The core insulation shall be with PVC compound applied over the conductor by Extrusion and shall conform to the requirements of type 'A' compound as per IS: 5831.

#### **4.2 XLPE CABLES**

4.2.1 The core insulation shall be with cross linked polyethylene insulating compound dry cured, applied by extrusion it shall be free from voids and shall withstand all mechanical and thermal stresses under steady state and transient operating conditions.

## 5.0 DESIGN

### 5.1 PVC CABLES

- 5.1.1 All power/control cables for use on medium voltage systems shall be heavy-duty type, 650/1100 V grade with aluminum / copper conductor, PVC insulated, inner-sheathed, armored and overall PVC sheathed unless specified otherwise in Data Sheet.
- 5.1.2 The conductors shall be solid for conductor of nominal area up to and including 6mm<sup>2</sup> and stranded beyond 6mm<sup>2</sup>. Conductors of nominal area less than 16 mm<sup>2</sup> shall be circular only. Conductors of nominal area 16 mm<sup>2</sup> and above may be circular or shaped as per IS 8130. Cables with reduced neutral conductor shall have sizes as per Table 1 of IS 1554 (Part-1).
- 5.1.3 The core insulation shall be with PVC compound applied over the conductor by extrusion and shall conform to the requirements of type 'A' compound as per IS: 5831. The thickness of insulation and the tolerance on thickness of insulation shall be as per Table 2 of IS: 1554 (Part-1). Control cables having 6 cores and above shall be identified with prominent and indelible numerals on the outer surface of the insulation. Color of the numbers shall contrast with the color of insulation with a spacing of maximum 50 mm between two consecutive numbers. Color coding for cables up to 5 cores shall be as per Indian Standards.
- 5.1.4 The inner sheath shall be applied over the laid-up cores by extrusion and shall be of PVC conforming to the requirements of Type ST-1 PVC compound as per IS: 5831. The minimum thickness of inner sheath shall be as per IS: 1554 (Part-1). Single core cables shall have no inner sheath.
- 5.1.5 If armoring is specified for multicore cables in the Data Sheet, the same shall be by single round galvanized steel wires where the calculated diameter below armoring does not exceed 13 mm and by galvanized steel strips. where this dimension is greater than 13 mm. Requirement and methods of tests for armor material and uniformity of galvanization shall be as per IS - 3975 and IS -10810 (Part 41). The dimensions of Armor shall be as per method (b) of IS - 1554 (Part -1). If armoring is specified for single core cables in the Data Sheet, the same shall be with H4 grade hard drawn aluminum round wire of 2.5 mm diameter.
- 5.1.6 For mining cables, the size and type of armor shall be such that the combined conductance of armor shall be equivalent to 75 percent of the conductance of the largest conductor of the cable.
- 5.1.7 The outer sheath for the cables shall be applied by extrusion and shall be of PVC compound conforming to the requirements of type ST-I compound as per IS 5831. The minimum and average thickness of outer sheath for unarmored cables and minimum thickness of outer sheath for armored cables shall be as per IS:1554 (Part-I).
- 5.1.8 If Heat Resisting PVC cables are specified in the Data Sheet, the following shall be the requirements:
- a. It shall be possible to continuously operate the cable at a maximum conductor temperature of 85°C. PVC compounds used for HR PVC cables shall be as follows:

- i. Conductor insulation Type C
- ii. Inner sheath Type ST 2
- iii. Outer sheath Type ST 2

## 5.2 XLPE CABLES

- 5.2.1 Power cables for 3.3kV up to and including 33kV systems shall be aluminum/copper conductor, XLPE insulated, sheathed, armored and overall PVC sheathed.
- 5.2.2 The conductors shall be stranded and compacted circular for all cables.
- 5.2.3 All cables rated 3.8/6.6kv and above shall be provided with both conductor screening and insulation screening. The conductor shall be provided with non-metallic extruded semi conducting screen.
- 5.2.4 The core insulation shall be with cross linked polyethylene insulating compound dry cured, applied by extrusion it shall be free from voids and shall withstand all mechanical and thermal stresses under steady state and transient operating conditions. It shall conform to the properties given in Table-I of IS 7098-(Part 2).
- 5.2.5 The insulation screen shall consist of non metallic extruded semi conducting compound in combination with a non magnetic metallic copper screen. Unless specified otherwise, the copper screen for all the three cores together shall be capable of carrying the single line to ground fault current value and the duration specified in the Data Sheet.
- 5.2.6 The conductor screen, XLPE insulation and insulation screen shall all be extruded in one operation by 'Triple Extrusion' process to ensure perfect bonding between the layers. The core identification shall be by colored strips or by printed numerals.
- 5.2.7 The inner sheath shall be applied over the laid up cores by extrusion and shall conform to the requirements of type ST 2 compound of IS: 5831. The extruded inner sheath shall be of uniform thickness. In case of single core cables, there shall be extruded inner sheath between insulation metallic screen and armoring.
- 5.2.8 For multicore cables, the armoring shall be by galvanized steel strips as per method (b) of IS7098 (Part-2). If armoring is specified for single core cables in the Data Sheet, the same shall be with H4 grade hard drawn aluminum round wire of 2.5 mm diameter.
- 5.2.9 The outer sheath of the cables shall be applied by extrusion over the armoring and shall be of PVC compound conforming to the requirements of Type ST 2 compound of IS: 5831. The minimum and average thickness of outer sheath for unarmored cables and minimum thickness of outer sheath for armored cables shall be as per IS: 7098 (Part-2)
- 5.2.10 The thickness of the insulation, inner sheath shall be governed by values given in IS: 7098 (Part -2).
- 5.2.11 Where specified, 1100V grade power cables shall also be XLPE insulated and shall meet the requirement specified in IS-7098 (Part-1).

## **6.0 FABRICATION**

- 6.1** The cables shall be suitable for laying in trays, trenches, ducts, and conduits and for underground-buried installation with uncontrolled backfill and possibility of flooding by water and chemicals.
- 6.2** Outer sheath of all PVC and XLPE cables shall be black in color and the minimum value of oxygen index shall be 29 at 27 + 2 ° C. In addition suitable chemicals shall be added into the PVC compound of the outer sheath to protect the cable against rodent and termite attack.
- 6.3** All cables covered in this Specification shall be flame retardant (FR) unless specified otherwise in the Data Sheet. The outer sheath of PVC and XLPE cables shall possess flame propagation properties meeting requirements as per IS-10810 (Part-62) category AF.
- 6.4** Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter. The embossing /engraving shall be legible and indelible.
- 6.5** The overall diameter of the cables shall be strictly as per the values declared by the manufacturer in the technical information subject to a maximum tolerance of  $\pm 2$  mm, up to overall diameter of 60mm and  $\pm 3$ mm for beyond 60mm.
- 6.6** PVC / Rubber end caps shall be supplied free of cost for-each drum with a minimum of eight per thousand meter length. In addition, ends of the cables shall be properly sealed with caps to avoid ingress of water during transportation and storage.
- 6.7** The cables used in installations under, the jurisdiction of Director General of. Mines and Safety (DGMS) shall be of copper conductor only, and, shall have valid DGMS approvals, for the specified locations. The word "Mining Cable" shall be embossed /engraved on the cable outer sheath as per the applicable Indian Standards.

## **7.0 INSPECTION AND TESTING**

- 7.1** The cables shall be tested and inspected at the manufacturer's works. All the materials employed in the manufacture of the cable shall be subjected, both before and after manufacture, to examination, testing and approval by Consultant /Owner Manufacturer shall furnish all necessary information concerning supply to Consultant/ Owner's inspectors. The inspector shall have free access to the manufacturer's works for the purpose of inspecting the process of manufacture in all its stages and he will have the power to reject any material, which appears to him to be of unsuitable description or of unsatisfactory quality. The Vendor shall give at least 2 weeks advance notice to the Purchaser, regarding the date of testing to enable him or his representative to witness the tests.

### **7.2 CABLES**

- 7.2.1** After completion of manufacture of cables and prior to dispatch, the cables shall be subjected to type, routine, acceptance and special tests as detailed below. Consultant/Owner reserves the right to witness all tests with sufficient advance notice from Vendor. The test reports for all cables shall be got approved from the Engineer before dispatch of the cables.

- 7.2.2 All routine tests, acceptance tests, type tests and additional type tests for improved fire performance shall be carried out as listed in IS:1554 (Part 1), and IS:1098 (Part 2) on PVC and XLPE insulated cables respectively.
- 7.2.3 The test requirements for PVC insulation and sheath of cables shall be as per latest revision of IS: 5831.
- 7.2.4 Test for Resistance to Ultra Violet Radiation: This test shall be carried out as per DIN 53387 or ATM-G-53 on outer sheath. The retention value of tensile strength and ultimate elongation after the test shall be minimum 60% of tensile strength and ultimate elongation before the test. Test certificates with respect to this test (not older than one year) from recognised testing laboratory to be furnished for review by Consultant before dispatch clearance of cables. In case test certificates are not available, test is to be conducted by Vendor at his own cost in any recognized test laboratory or in house testing laboratory, before dispatch clearance of cables. Sampling for this test is to be done randomly once for each order, provided outer sheath remains same.
- 7.2.5 Acceptance tests as per IS-1554 (Part-I) and IS-7098 (Part-2) and the following special tests to be performed on the cables as per sampling plan. These tests are required to be witnessed by Consultant/owner before dispatch of cables.
- a. Accelerated water absorption test for insulation as per NEMA - WC - 5. (For PVC insulated cables) and as per NEMA WC - 7 (for XLPE insulated cables). Test certificates with respect to this test (not older than one year) from recognized testing laboratory to be furnished for review by Consultant before dispatch clearance of cables. In case test certificates are not available, test is to be conducted by Vendor at his own cost in any recognized test laboratory or in house testing laboratory, before dispatch clearance of cables. Sampling for this test is to be done randomly once for each order, provided type of insulation remains same.
  - b. Dielectric Retention Test: The dielectric strength of the cable insulation tested in accordance with NEMA WC - 5 at  $75 \pm 1^\circ \text{C}$  shall not be less than 50 % of the original dielectric strength. (For PVC insulated cables). Test certificates with respect to this test (not older than one year) from recognized testing laboratory to be furnished for review by Consultant before dispatch clearance of cables. In case test certificates are not available, test is to be conducted by Vendor at his own cost in any recognized test laboratory or in house testing laboratory, before dispatch clearance of cables. Sampling for this test is to be done randomly and once for each order.
  - c. Oxygen Index Test: The test shall be carried out as per ASTM D2863 or applicable Indian Standard specifications. Sampling to be done for every offered lot/size as per sampling plan.
  - d. Flammability Test: The test shall be carried out on finished cable as per IS - 10810 (part 61 & 62). Sampling for these tests is to be done randomly once for each order, provided outer sheath remains same. The acceptance criteria for tests conducted shall be as under.
    - i. Part-61-The cable meets the requirement if there is no visible damage on the test specimen within 300 mm from its upper end.

- ii. Part-62-The maximum extent of the charred portion measured on the test sample should not have reached a height exceeding 2.5 m above the bottom edge of the burner at the front of the ladder.
- e. Test for rodent and termite repulsion property: The Vendors shall furnish the test details to analyses the property by chemical method. Sampling to be done for every offered lot / size as per sampling plan.

### **7.3 CABLE ACCESSORIES**

Type tests should have been carried out to prove the general qualities and design of a given type of termination / jointing system as, per IS-13573. The type test certificates from independent testing laboratory shall be submitted before dispatch.

### **8.0 MARKING, PACKING AND SHIPMENT**

**8.1** Cables shall be dispatched in non-returnable wooden or steel drums of suitable barrel diameter, securely battened, with the takeoff end fully protected against mechanical damage. The wood used for construction of the drum shall be properly seasoned, sound and free from defects. Wood preservatives shall be applied to the entire drum. Ferrous parts used shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit or storage.

**8.2** On the flange of the drum, necessary information such as project title, manufacturer's name, type size, voltage grade of cable, length of cable in meters, drum no, cable code, BIS certification mark, gross weight etc. shall be printed. An arrow shall be printed on the drum with suitable instructions to show the direction of rotation of the drum.

Unless otherwise specified, Cables shall be supplied in drum lengths as follows:

#### **8.2.1 MV CABLES**

- a. Multicore power cables up to 6mm<sup>2</sup> : 1000m
- b. Multicore power cables from 10mm<sup>2</sup> up to 300mm<sup>2</sup> : 500m
- c. Single core power cables up to 630 mm<sup>2</sup> : 1000m
- d. Control cables up to 61 cores : 1000m

#### **8.2.2 HV POWER CABLES – UPTO 11KV (E) GRADE**

- a. Three core cables up to 400 mm<sup>2</sup> : 500m
- b. Single core cables up to 400 mm<sup>2</sup> : 1000m
- c. Single core cables above 400 mm<sup>2</sup> and up to 630 mm<sup>2</sup> : 750m

#### **8.2.3 HV POWER CABLES – ABOVE 11KV(E) GRADE AND UPTO 33KV(E)**

- a. Three core cables up to 300 mm<sup>2</sup> grade : 350 m
- b. Single core cables up to 400 mm<sup>2</sup> : 1000m
- c. Single core cables above 400 mm<sup>2</sup> and up to 1000 mm<sup>2</sup> : 500m

**8.2.4** A tolerance of plus or minus 3 % shall be permissible for each drum. However overall tolerance on each size of cable shall be limited to  $\pm 2\%$ . Offers with short/non-standard

lengths are liable for rejection. If non-standard drum lengths are specified in the Data Sheet, the same shall be supplied.

## **9.0 SPARES & ACCESSORIES**

**9.1** The termination and straight through jointing kits for use on the systems shall be suitable for the type of cables offered as per this Specification.

**9.2** The accessories shall be supplied in kit form. Each component of the kit shall carry The manufacturer's mark of origin.

**9.3** The kit shall include all stress grading, insulating and sealing materials apart from conductor fittings and consumable items. An installation instruction sheet shall also be included in each kit.

**9.4** The contents of the accessories kit including all consumable shall be suitable for storage without deterioration at a temperature of 45° C, with shelf life extending to more than 5 years.

## **9.5 TERMINATING KITS**

**9.5.1** The terminating kits shall be suitable for termination of the cables to an indoor switchgear or to a weatherproof cable box of an outdoor mounted transformer / motor. For outdoor terminations, weather shields/sealing ends any other accessories required shall also form part of the kit. The terminating kits shall be from one of the makes / types mentioned in the Data Sheet.

## **9.6 JOINTING KITS**

The straight through jointing kits shall be suitable for installation on overhead trays, concrete lined trenches, and ducts and for underground burial with uncontrolled backfill and possibility of flooding by water and chemicals. These shall have protection against any mechanical damage and suitably designed to be protected against rodent and termite attack. The inner sheath similar to that provided for cables shall be provided as part of straight through joint. The jointing kits shall be from one of the makes / types mentioned in the Data Sheet.




ENERGISING QUALITY

## VCS QUALITY SERVICES PRIVATE LIMITED

### STANDARD SPECIFICATION FOR SERVO STABILIZER

**VCS – SS – EL - 4053**

00	23.10.2017	ISSUED AS STANDARD				
Rev. No	Date	Purpose	Prepared By	Checked By	Approved By	Approved By



## **ABBREVIATION**

BIS/IS:	Bureau of Indian standards
IEC:	International Electro-Technical Commission
BS:	British Standards
IEEE:	Institute of Electrical and Electronics Engineers
NEMA:	National Electrical Manufacturers Association
OISD:	Oil Industries Safety Directorate
CCE:	Chief Controller of Explosive
DGMS:	Director General Mines Safety
IE Rules:	Indian Electricity Rules
CPRI:	Central Power Research Institute
MR:	Material Requisition
AVR:	Automatic Voltage Regulator
AMF:	Automatic Start On Mains Failure
AC:	Alternating Current
KVA:	Kilo Volt Ampere
DOL:	Direct On Line
DG.SET:	Diesel Generator Set
DC:	Direct Current
TPN:	Triple Pole Neutral
CT:	Current Transformer
PT:	Potential Transformer
RTD:	Resistance Temperature Detection



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## 1.0 SCOPE

This specification defines the minimum requirements for the supply of servo-controlled voltage stabilizer and associated electrics suitable for installation in unclassified / safe area.

Unless otherwise specified in the Material Requisition (MR) / Data Sheet the Servo Stabilizer and associated electrics shall be complete with:

- a. Input MCCB, Output MCCB and a Manual bypass arrangement with MCCB, control systems, oil tank and first fill of oil.
- b. Any other part / accessories not specifically mentioned above but considered necessary for safe and reliable operation.
- c. Servo stabilizer shall also conform to the provisions of the latest revisions of the Indian Electricity rules and any other statutory regulations currently in use.
- d. Wherever the requirements in this specification are in conflict with any of the above Standards, the requirements under this specification shall be binding.
- e. In case any contradiction between various referred standards/specifications/data sheets and statutory regulation etc the following order of priority shall be govern -
  - A. Schedule of rates
  - B. Design Basis
  - C. Scope of work
  - D. Job Specification & Data Sheet
  - E. Standard specification Codes & standard

## 2.0 REFERENCE DOCUMENTS

The equipment shall comply with the requirements of latest revision of following standards:

- IS - 5: Colours for ready mix paints and enamels
- IS - 2253: Designation for type of construction and mounting arrangement of rotating electrical machines.
- IS - 4691: Degree of protection provided by enclosures of Rotating Electrical Machinery.
- IS - 4722: Rotating electrical machines.
- IS - 4728: Terminal marking and direction of rotation for rotating electrical machinery.
- IS - 4889: Methods of determination of efficiency of rotating electrical machines.
- IS - 6362: Designation of Methods of Cooling of Rotating Electrical Machines
- IS - 7132: Guide for testing synchronous machines.
- IS - 7306: Methods of determining synchronous machines quantities from tests.
- IS - 7372: Lead acid storage battery for motor vehicle.
- IS - 7816: Guide for testing of insulation resistance of rotating machines.
- IS - 12065: Permissible limits of noise level for rotating electrical machines.



- IS – 12075: Mechanical vibration of rotating electrical machines with shaft heights 56 mm and higher - measurements, evaluation and limits of vibration severity.
- IS – 12802: Temperature rise measurement of rotating electrical machines.
- IS – 13364: AC Generators up to 20 KVA driven by reciprocating internal Part-I combustion engine.
- IS – 13364: AC Generators above 20 and up to 1250 KVA driven by reciprocating Part-II internal combustion engine.
- IS – 13947: Low voltage Switchgear and Control gear General Rules.

In case of imported equipments standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian Standards.

The equipment shall also conform to the provisions of Indian Electricity rules and other Statutory Regulations currently in force in the India.

In case Indian standards are not available for any equipment, standards issued by IEC/BS/VDE/IEEE/NEMA or equivalent agency shall be applicable.

In case of any contradiction between various referred Standards/Specifications/Data Sheet and statutory regulations the following order of priority shall govern:

- a. Statutory Regulations.
- b. Data Sheets.
- c. Job Specification.
- d. Standard specification.
- e. Codes and Standards.

### **3.0 DEFINITIONS**

For the purpose of this document, the words and expressions listed below shall have the meanings assigned to them as follows:

OWNER / COMPANY	OWNER of the particular Project (Project Specific).
CONSULTANT	The party which is doing engineering, procurement, construction, pre-commissioning and assistance for commissioning, monitors and controls the overall project management.
BIDDER / SUPPLIER / VENDOR	The party(s) which manufactures and / or supplies material, equipment, technical documents / drawings and services to perform the duties specified by Contractor.



#### 4.0 ENVIRONMENTAL CONDITIONS

The Servo stabilizer shall be designed and constructed for continuous operation at full load under the climatic and environmental conditions as described in the technical specification under below clauses,

#### 5.0 TECHNICAL DATA

The technical data of the Servo stabilizer are defined in the technical specifications. The Contractor has to guarantee the fulfillment of these requirements.

#### 6.0 GENERAL REQUIRMENTS

This specification describes the design of a copper wound, high efficiency, Servo stabilizer. The Servo stabilizer shall be copper wound (of purity min 99.97%), ONAN, servo controlled, three phase stabilizer with automatic/manual operation designed for input voltage range 360 to 480 and output voltage of 415+/-3% with frequency +/-5% of AC supply suitable for continuous duty performance at ambient temperature 0-55 degree Celsius. The rate of correction of voltage shall greater than 20V/Sec to support harmonic rich non-linear loads while maintaining safe operating.

The stabilizer shall be suitable for semi outdoor conditions and shall have self-supporting structure with top lifting arrangement.

##### 6.1 Components and Equipment

The Contractor has to take care that all components and equipment are selected considering easy maintenance, simple and quick diagnosis and long maintenance intervals.

All components and equipment shall be designed for continuous duty at rated load and under the given climatic conditions. Standard industrial high-performance systems and components of supplier's standard lists shall be used as far as possible. Components and equipment of same kind and type shall be selected for equivalent functions. The interchangeability must be guaranteed.

##### 6.2 Tagging

All components, equipment and installations shall receive the respective tagging plates, labels etc which have to be of extremely durable material resistant against the environmental conditions. For further requirements, reference is made to technical specification.

#### 7.0 TECHNICAL REQUIRMENTS

The Servo stabilizer shall be as per following technical specification.

- A. Step less Voltage correction and high speed without over shoot/ hunting.
- B. Push Button to raise I lower output voltages.
- C. Easily replaceable plug-in circuit card.
- D. Potentiometer to adjust output voltage of phase on Front Panel.
- E. Rugged, Heavy duty A.C. step synchronous motor for greater reliability and longer life.
- F. Online serviceability with inter changeable plug-in Control Card.
- G. High accuracy, No load to full load.
- H. High performance integrated circuit based, control system.
- I. Mains on indication on front panel.
- J. Other features as per following table:

DESIGN	Minimum Requirements
--------	----------------------



	Servo stabilizer with output sensing feedback system for capacity (60 & 300 KVA)
INSTRUMENT TYPE	Outdoor Floor Mounting
TYPE OF COOLING	Oil Natural Air Natural Cooling as per IS 2026-Part II with Latest amendments
INPUT	320-500V, 3 Phase, 4 Wire AC
OUTPUT	415V $\pm$ 3%, 3 Phase, 4 Wire AC
OUTPUT VOLTAGE REGULATION	AC Phase voltage 3Ph 50Hz, UNBALANCED SUPPLY
SUPPLY FREQUENCY	50 Hz
INSULATION RESISTANCE	Class F Insulation with 5 megohms or higher measured at 500 V at room temperature not exceeding 55°C
PROTECTION	A. Under Voltage/ Over Voltage with earth fault protection along cut-off feature B. Time delay & Single phasing C. Overload cut-off through MCCB D. Short Circuit
WAVEFORM DISTORTION	None
EFFICIENCY	Better than 98% on full load
OPERATION	Automatic with manual by pass/on load switch
SPEED OF CORRECTION	> than 20 V/ Sec
PERFORMANCE	Free from HUNTING during operation
METERING	Should have analogue Voltmeter and Ammeter with selector switch to indicate input/ output parameters
TYPE OF LOAD	Unbalanced
CONFORMANCE	Servo stabilizer should fully conform to latest version of IS: 9815 Standard/The variable Auto stabilizer shall conform to latest IS: 5142 up to latest amendments.
AMBIENT TEMPERATURE	0° to 55° C
OVERLOAD CAPACITY	120% for 25 minutes with no performance deterioration and no long terms effects
Motor Drive	Motor Drive Heavy Duty AC Step Synchronous Motor
Acoustics	Less than 50DB

## 8.0 IMPORTATNT NOTES

Following points to be taken care by the supplier during design and manufacturing of stabilizer.

- 8.1 The Servo stabilizer shall be high quality Low loss CRGO Laminations, totally dry power coated from outside and zinc chromate painted from inside. The panel should be screen printed. The unit shall be housed in steel case of suitable thickness having wheels with sturdy construction to withstand the rigorous shifting movement, repair works and handling. The unit shall be supplied with the first fill of transformer oil conforming to IS 355 amended up to date.
- 8.2 The Servo stabilizer shall be placed in semi outdoor/ confined compartment with flap/hinge type doors, where only two sides will be accessible and open to free air for ventilation. The other two sides shall be very close to compartment walls and free air ventilation will be obstructed. This aspect should be taken care during design of windings.



- 8.3 Temperature rise & terminal marking of the windings shall be as per IS 11171:1985. SC withstand ability of stabilizer shall be as per IS 2026:1977.
- 8.4 2 Nos earthing point shall be provided at the bottom of the stabilizer for earthing of stabilizer enclosure.
- 8.5 The Servo stabilizer shall have a suitable breather with leak proof de sludging and drain valve, gauge for oil level with minimum level marking etc.
- 8.6 The Servo stabilizer shall have inbuilt suitable tripping arrangement against input voltage beyond specific range and to start automatically after time delay when the specified range of input voltage is restored in the system.
- 8.7 Stabilizer shall be provided bi-directional roller with locking arrangement for easy movement.
- 8.8 All hardware used for stabilizer assembly shall be zinc plated & passivated.
- 8.9 Stabilizer shall be provided with suitable rating plate, diagram plate & lifting lugs. Supplier to ensure that lifting lugs have sufficient safety factor and high tensile strength suitable to take stabilizer load.
- 8.10 Cable terminal identification label (1U, 1V, 1W, 2U, 2V, 2W & 2N1, 2N2) of approximate 60 x 60mm size to be provided near glands for identification
- 8.11 Only tinned copper or phosphor bronze washer / spacer to be used. Also, phosphor-bronze screws shall be used, wherever required.
- 8.12 Tubular insulators are not acceptable. Only epoxy insulators to be used, wherever required.
- 8.13 Enclosure sheet for stabilizer shall not be less than 2mm thick sheet steel with louvers at all sides.
- 8.14 Instruments & Controls
  - 8.14.1 Output voltage setting (by potentiometer in Auto Mode & by 'Raise' / 'Lower' Push Button in Manual Mode).
  - 8.14.2 Operation: Auto or Manual with by-pass mechanism.
  - 8.14.3 The Servo stabilizer shall have built-in protections against the following abnormal line and load conditions with suitable audio and visual indications:
    - 8.14.4 Over voltage / under voltage / overload I short circuit / single phasing
    - 8.14.5 Indications and metering: Suitable LED lamp indications for Input Voltage 'High/ 'Low' cut off, Mains ON & Output indicator, AC Voltmeter & Ammeter (Analogue) with selector switch for Input and Output.
    - 8.14.6 The Servo stabilizer shall have built-in provisions for surge suppression.
    - 8.14.7 The Servo stabilizer shall have built-in soft start circuitry to limit in-rush current during start up.
    - 8.14.8 The control circuits shall be IC based solid-state, without relay.

## **9.0 RATING PLATE**



Stainless steel / Anodised aluminum rating plate shall have information as per IS 11171-1985. Following minimum information to be provided necessarily on the rating plate.

- A. Transformer type
- B. IS followed
- C. Manufacturers name
- D. Manufacturers SI No for the transformer
- E. Year of manufacturing
- F. Class of insulation
- G. Max possible temperature rise
- H. No of Phases
- I. Rated Frequency
- J. Rated Voltage including tapping
- K. Rated current for each winding
- L. Connection symbol
- M. Vector group
- N. Type of cooling
- O. Total weight
- P. Relevant Information of AC Stepless Synchronous Servo Motor

#### **10.0 ROUTINE & TYPE TESTS:**

The stabilizer may be subjected to following tests as per IS 11171-1985 / IS 2026-1977/8447- 1989 witnessed client's representative for acceptance.

- i. Measurement of winding resistance
- ii. HV side in all taps
- iii. LV side
- iv. Measurement of voltage ratio and checking of voltage vector relationship.
- v. Measurement of impedance voltage, short circuit impedance & load losses.
- vi. Measurement of no-load loss & current.
- vii. Separate source voltage with stand test
- viii. Induced voltage with stand test
- ix. Temperature rise test
- x. Measurement of IR
- xi. Core and Bolt test
- xii. Leakage Current Test
- xiii. Test for rate of correction
- xiv. Locked rotor test for servo motor

#### **11.0 DOCUMENTS/INFORMATION TO BE SUBMITTED ALONG WITH OFFER:**

Following information or documents to be furnished by the supplier along with offer:

- i. Type of stabilizer



- 
- ii. Rating of stabilizer
  - iii. Primary Winding Details
  - iv. Secondary Winding Details
  - v. Reference standard/s
  - vi. No of Phases
  - vii. Rated Frequency
  - viii. Vector Group
  - ix. Type of Cooling
  - x. Impedance Voltage
  - xi. Tapping on HV
  - xii. Enclosure type
  - xiii. No Load losses at rated voltage
  - xiv. No load current at rated voltage
  - xv. Total losses (Cu+ Iron) at rated load
  - xvi. Insulation class
  - xvii. Insulation level
  - xviii. Average temp rise of windings over
  - xix. Ambient temp (50 Degree)
  - xx. Winding material
  - xxi. Efficiency at unity PF at full load
  - xxii. Efficiency at unity PF at half load
  - xxiii. Percentage Regulation at unity PF
  - xxiv. Percentage Regulation at 0.8 PF (Lag)
  - xxv. Approx, weight of stabilizer in Kg

## **12.0 WARRANTY:**

Supplier shall provide the guarantee / warrantee for the offered stabilizer for 12 months from the date of commissioning or 18 months from the date of supply, whichever is earlier.



Energising Quality

## VCS Quality Services Pvt Ltd

# STANDARD SPECIFICATION FOR FLAME PROOF LIGHTING AND POWER PANELS

**VCS – SS – EL - 4013**

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Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By

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**ABBREVIATION**

BIS/IS	Bureau of Indian standards
IEC	International Electro-Technical Commission
BS	British Standards
IEEE	Institute of Electrical and Electronics Engineers
NEMA	National Electrical Manufacturers Association
OISD	Oil Industries Safety Directorate
CCE	Chief Controller of Explosive
DGMS	Director General Mines Safety
IE Rules	Indian Electricity Rules
CPRI	Central Power Research Institute
TPN	Triple Pole Neutral
SPN	Single Pole Neutral
FRP	Fiber Reinforced Concrete
SS	Stainless Steel
GI	Galvanized Iron

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## **1.0 SCOPE**

This Specification covers the requirements of design, manufacture, testing, packing and supply of flameproof Lighting and Power panels/ accessories suitable for installation in locations handling flammable liquids and gases.

## **2.0 REFERENCE DOCUMENTS**

2.1 The equipment shall comply with the requirements of latest revision of the following standards issued by BIS (Bureau of Indian Standards), unless otherwise specified:

IS-5:	Colors for ready mixed paints and enamels.
IS-1248 (Parts 1 & 2):	Direct acting indicating analogue measuring instruments and their accessories.
IS-2148:	Flameproof enclosures for electrical apparatus.
IS-5571:	Guide for selection of electrical equipment for hazardous areas
IS-8828:	Specifications for Circuit breakers for Over current protection for household and-similar installations
IS-12640:	Residual current operated circuit breakers.
IS-13346:	General requirements for electrical apparatus for explosive gas atmosphere.
IS-13408 (Part-1):	Code of practice for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining applications or explosives processing and manufacture).
IS-13947 (Parts 1 & 5):	L.V. Switchgear and Control gear.

2.2 Imported equipment shall conform to the International Standards such as IEC/ BS/ VDE/ NEMA or equivalent.

2.3 The equipment shall also conform to the provisions of Indian Electricity Rules and other statutory regulations currently in force in the country.

2.4 In case Indian Standards are not available for any equipment; Standards issued by IEC/BS/VDE/ NEMA or equivalent agency shall be applicable.

2.5 In case of any contradiction between various referred Standards/ Specifications/ at a Sheet and statutory regulations, the following order of decreasing priority shall govern:

- a. Statutory Regulations
- b. Data Sheets
- c. Job Specification
- d. Standard Specification

- e. Codes and Standards.

### **3.0 DEFINITIONS**

- 3.1 For the purpose of this document, the words and expressions listed below shall have the meanings assigned to them as follows:

OWNER / COMPANY	OWNER of the particular Project (Project Specific).
CONSULTANT	The party which is doing engineering, procurement, construction, pre-commissioning and assistance for commissioning, monitors and controls the overall project management.
BIDDER / SUPPLIER / VENDOR	The party(s) which manufactures and / or supplies material, equipment, technical documents / drawings and services to perform the duties specified by Contractor.

### **4.0 MATERIALS**

- 4.1 The enclosures of the lighting and power panels shall be made of cast light metal alloy and shall be free from frictional sparking hazard. The magnesium content in the alloy shall be as per IS-13346.

### **5.0 DESIGN**

#### **5.1 GENERAL REQUIREMENTS**

- 5.1.1 The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.

#### **5.2 POWER SUPPLY**

- 5.2.1 Unless otherwise specified, lighting and power panels shall be suitable for 415V, 50Hz, three phase and neutral (TPN) incoming supply and outgoing circuits for 240V, single phase and neutral (SPN).
- 5.2.2 For lighting and power panels falling under the jurisdiction of DGMS, the following additional requirements shall apply:
- The phase-to-phase voltage shall not exceed 250 volts.
  - The panels shall have 415V, three phase, 4-wire system.
  - Earth leakage protection shall be provided for all outgoing circuits, which shall isolate both poles.

#### **5.3 TECHNICAL REQUIREMENTS**

##### **5.3.1 COMPOUND SPECIFICATION**

- Busbars in the lighting and power panels shall be made of high-conductivity copper and shall be supported by non-hygroscopic insulators. Busbars shall be color coded for identification of phases and neutral.

- b. Unless otherwise specified, the incomer shall have one no. 4 pole 32A MCB isolator (without overload and short-circuit release) and one no. 4 pole ELCB. ELCB's shall have a maximum sensitivity of 30mA.
- c. Unless otherwise specified, the outgoing feeders shall be provided with double pole 10A MCBs having overload and short-circuit releases.
- d. Unless otherwise specified, all MCBs (except isolators) and ELCBs shall be with 9kA (M9. category) interrupting capacity.
- e. The ELCB. shall be hand reset type one no. door mounted reset push button shall be provided.
- f. The operating knobs (ON/ OFF/ RESET) shall be. provided with a suitable rack and pinion arrangement for operating them smoothly from outside.

### 5.3.2 TERMINAL & WIRING

- a. The panels shall be provided with sufficient number of terminals. More than 2 wires per terminal shall not be permitted. If required, additional terminal with shorting link may be used. Unless otherwise specified, the terminals for termination of incoming and outgoing external cables shall be suitable for termination of up to 70 mm<sup>2</sup> and 6 mm<sup>2</sup> copper conductors respectively. Terminals shall be suitable for termination of solid conductors upto 6 mm<sup>2</sup> and stranded conductors above 6 mm<sup>2</sup>. Wherever lugs are required for cable termination, tinned copper type lugs shall be provided.
- b. All internal wiring in lighting and power panels shall employ adequately sized, 660V grade, PVC insulated copper conductor wires, color coded for phase, neutral and earth, with minimum conductor sizes as below:
  - i. Incomer            16 mm<sup>2</sup>
  - ii. Outgoing        2.5 mm<sup>2</sup>

## 6.0 FABRICATION

- 6.1 The enclosures of the lighting and power panels shall be made of cast light metal alloy and shall be free from frictional sparking hazard. The magnesium content in the alloy shall be as per IS-13346. The temperature of external surfaces shall be limited to 200°C, unless otherwise specified. The enclosures shall be sized to facilitate easy maintenance and heat dissipation.
- 6.2 The panels shall be suitable for use in outdoor open locations and shall have IP-55 degree (minimum) of protection. They shall preferably be provided with integral canopy. However, where the enclosure has been certified without integral canopy, a separate canopy can be accepted. The separate canopy shall be made of at least 14 SWG (2mm) galvanised sheet steel or FRP. The canopy shall be suitable for providing protection against rain from top and two sides.
- 6.3 The lighting and power panels shall be provided with gaskets made of non-inflammable and self-extinguishing material.
- 6.4 The enclosures shall be treated and prepared for painting with two coats of epoxy paint with final colour shade (both internal and external) as below:

Flame proof (Gas group IIA/IIB) : Dark admiralty grey shade 632 of IS-5

Flame proof (Gas group IIC) : Light yellow shade 355 of IS-5

- 6.5 A warning inscription "Isolate power supply elsewhere before opening" shall be provided on each enclosure. The warning inscription shall be embossed on the enclosure or a separate warning plate with above inscription shall be fixed to the enclosure with screws. The warning shall be of nickel plated brass or stainless steel. accessories like nuts, bolts, washers etc. shall be made of stainless steel SS-304.
- 6.6 All the non-current carrying metallic parts of the panel shall be inherently bonded together. Each lighting and power panel shall be provided with two earthing studs with lugs on the exterior of the panel enclosure suitable for termination of 10 mm diameter GI wire rope.
- 6.7 Each outgoing feeder shall be provided with distinct terminals for phase, neutral and earth. The terminal block enclosures shall be adequately sized to properly terminate the cables by taking into account the required bending radii of cable cores and shall have the following minimum gland to terminal distances.

<b>Conductor size</b>	Up to 2.5mm <sup>2</sup>	Above 2.5mm <sup>2</sup> & up to 10mm <sup>2</sup>	Above 10mm <sup>2</sup> & up to 35mm <sup>2</sup>	Above 35mm <sup>2</sup> & up to 70mm <sup>2</sup>
<b>Distance</b>	40 mm	60 mm	100 mm	150

- 6.8 The panels shall be provided with suitably sized cable entries at the bottom/ sides, for incoming and outgoing cables. Panels shall be complete with double compression type nickel plated brass flameproof cable glands. Flameproof nickel plated brass sealing plugs shall be supplied, for plugging the unused cable entries. The quantity of sealing plugs shall be equal to 20% of the total number of outgoing cable entries.
- 6.9 The panels shall have external fixing lugs for mounting on wall or column. The holes, provided on these lugs shall be of oblong type.
- 6.10 A nameplate indicating TAG No. shall be provided on each panel Nameplates shall also be provided for each incoming and outgoing feeder Separate nameplate shall also be provided to indicate the details of testing agency (PESO or equivalent), test certificate no. with date, statutory approval no. with date and agency (PESO/ OISD/ DGFASLI/ DGMS), BIS license number and date, applicable gas group etc. The nameplates shall be engraved on 3 ply. black white black lami cold Sheds using square cutters. Black engraved per spex sheet nameplate shall also be acceptable. Nameplates shall be fixed by screws and shall not be pasted. In case the standard details given above are embossed on the enclosures, the same need not be repeated on the name plate.

## **7.0 INSPECTION AND TESTING**

- 7.1 During fabrication, the equipment shall be subjected to inspection by Consultant/ Owner -or by an agency authorized by the Owner, if specified/ agreed in Inspection Test Plan. Manufacturer shall furnish all necessary information concerning the supply to Consultant

/ Owner's inspector. All routine/ acceptance tests shall be carried out at manufacturer's works under his care and expense. .

- 7.2 Type test certificates from CIMFR or equivalent test house, applicable PESO/ CCOE/ DOFASLI/ DGMS approval, certificates, BIS license and original drawings referred in type test Certificates shall be shown to the inspection agency on demand during inspection. The certificates and BIS license must be valid at the time of dispatch.
- 7.3 Test certificates of bought out components shall be shown to the inspection agency on demand during inspection.
- 7.4 All equipment shall be subjected to various acceptance tests as per standards but not limited to the following:
- a. General visual inspection
  - b. Dimensional inspection
  - c. Verification of electrical operations
  - d. Dielectric tests
  - e. Routine pressure test as per IS-2148
  - f. Any other routine and acceptance test as per applicable Standards.
- 7.5 Type tests shall be carried out if specified in Data Sheet/ job Specification.

## **7.6 CERTIFICATION**

- 7.6.1 The equipment shall have test certificates issued by recognized independent test house (PESO/OISD/ CPRI/ ERTL/ Baseefa/ LCIE/ UL/ FM or equivalent). All indigenous equipment shall conform to Indian standards and shall be certified by Indian testing agencies. All equipment (indigenous & imported) shall also have valid statutory approvals as applicable for the specified location. All indigenous flameproof equipment shall have valid BIS license and parking as required by statutory authorities.

## **8.0 MARKING, PACKING AND SHIPMENT**

- 8.1 All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for the selected mode of transportation, i.e. by ship/ rail-or trailer and shall be wrapped in air bubble polythene sheets before being placed in crates/ cases to prevent damage to finish. The crates/ cases shall have skid bottom for handling. Special notations such as `Fragile', This side up, `Center of gravity', `Weight', `Owner's particulars', `PO no.' etc, shall be clearly marked on the packages together with other details as per Purchase Order.
- 8.2 The equipment may be stored in a covered shed for long periods before installation. The packing should be suitable for such storage.



Energising Quality

## VCS Quality Services Pvt Ltd

# STANDARD SPECIFICATION FOR LIGHTING FITTINGS FOR HAZARDOUS LOCATION

### VCS – SS – EL - 4014

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01	16.10.2019	MG	VV	AD	SK
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## **ABBREVIATION**

BIS/IS	Bureau of Indian standards
IEC	International Electro-Technical Commission
BS	British Standards
IEEE	Institute of Electrical and Electronics Engineers
NEMA	National Electrical Manufacturers Association
OISD	Oil Industries Safety Directorate
CCE	Chief Controller of Explosive
DGMS	Director General Mines Safety
IE Rules	Indian Electricity Rules
CPRI	Central Power Research Institute
CIMFR	Central Institute of Mines and Fuel Research
MSL	Mean Sea Level
BIS/IS	Bureau of Indian standards
IEC	International Electro-Technical Commission
BS	British Standards

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## **1.0 SCOPE**

- 1.1** The intent of this specification is to define the requirements of lighting fixtures and accessories suitable for installation in classified hazardous locations.

## **2.0 REFERENCE DOCUMENTS**

- 2.1** In general the equipment covered by this Specification shall, unless otherwise specified, conform to the latest edition of Indian Standards/International Standards but not limited to the following:

- |    |                          |  |
|----|--------------------------|--|
| a. | IS-2148                  | Flameproof enclosures for electrical apparatus   |
| b. | IS-5572<br>(Part-1)      | Classification of hazardous area (other than mines) for electrical installation.                   |
| c. | IS-5571                  | Guide for selection of electrical equipment for hazardous areas.                                   |
| d. | IS-8239                  | Classification of maximum surface temperature of electrical equipment for use in explosive         |
| e. | IS-6381                  | Construction and testing of electrical apparatus with type of protection                           |
| f. | IS-8289                  | Electrical equipment with type of protection 'n'.  |
| g. | IS-2206<br>(Part 1 to 4) | Flameproof electric lighting fittings (well glass and bulk head type, fittings using glass tubes). |
| h. | IS-8224                  | Electrical lighting fitting for division 2 areas.  |
| i. | IS-1913<br>(Part-I)      | General and safety requirements for Luminaires.  |

Wherever the requirements in this specification are in conflict with any of the above Standards, the requirements under this specification shall be binding.

## **3.0 DEFINITION**

For the purpose of this document, the words and expressions listed below shall have the meanings assigned to them as follows:

OWNER / COMPANY	OWNER of the particular Project (Project Specific).
CONSULTANT	The party which is doing engineering, procurement, construction, pre-commissioning and assistance for commissioning, monitors and controls the overall project management.
BIDDER / SUPPLIER / VENDOR	The party(s) which manufactures and / or supplies material, equipment, technical documents / drawings and services to perform the duties specified by Contractor.

## **4.0 DESIGN**

### **4.1 GENERAL**

4.1.1 The equipment shall be suitable for installation and satisfactory operation in classified hazardous locations in tropical, humid and corrosive atmosphere as prevalent in refineries/petrochemical plants or as specified in Material Requisition/ Data Sheet. If not specifically mentioned therein, design ambient temperature of 40°C and altitude not exceeding 1000 m above MSL shall be considered.

4.1.2 Unless otherwise specified, equipment shall be suitable for 220 - 250 volts, single Phase and neutral, 50Hz. +3% power supply.

4.1.3 All equipment shall be tested and certified by independent authority for use in specified gas group locations. Certification number/data and gas group/temperature classification must be indicated on the manufacturer's name plate on each item. All flameproof equipments shall have BIS marking which must be indicated on the manufacturer's name plate. All equipment for use in hazardous area shall be approved by PESO/CCOE/DGMS as applicable.

### **4.1.4 POWER SUPPLY**

Unless otherwise specified, equipment shall be suitable for 220 – 250 volts, single phase and neutral, 50Hz  $\pm$  3% power supply.

## **5.0 FABRICATION (TECHNICAL REQUIREMENT)**

5.1 All equipment shall be suitable for use in outdoor open locations and shall have IP-55 degree (minimum) of protection.

5.2 The body of the lighting fixtures, control gear box and junction boxes shall be of cast aluminum LM-6 alloy and shall be free from frictional sparking hazard. The temperature rise of external surfaces shall be limited to 200°C, unless otherwise specified.

### **5.3 LIGHTING FIXTURES**

5.3.1 The construction of lighting fixture shall be such that replacement of lamp or any normal maintenance of fixture shall not affect their suitability for use in classified area.

5.3.2 Glass used for lighting fixture shall be clear suitable for use under conditions involving exceptional risk of mechanical damage.

5.3.3 Well glass lighting fixture for zone-2 classified area shall meet requirement of IS6381. Mechanical strength of well glass shall satisfy requirement of IS-2206 (for type A glass) for flame proof lighting fixtures and IS-6381 for Div.2 lighting fixtures. All well glass fixtures shall be provided with a galvanized steel wire protective cage having mesh dimensions not exceeding 50mm.

5.3.4 Glass used for aviation and navigational lighting fixture shall be colored in itself. Painted glass shall not be accepted.

- 
- 5.3.5 Glass shall be of approved make or as specified in Material Requisition.
- 5.3.6 The fixing parts of the enclosure which is to be opened for replacement of bulb shall be so fastened that they can be unfastened only with special tools. All fixtures shall carry a special warning inscription in English "Isolate supply elsewhere before opening".
- 5.3.7 All lighting fixtures which are not certified as flameproof construction but approved for use in Zone-2 area shall have approved enclosed break lamp holder and complete enclosure certified as having restricted breathing type construction. Lamp holder shall be screw type.
- 5.3.8 All lighting fixtures suitable for discharge lamps shall be provided with one 3/4 "ET threaded entry and supplied with approved type double compression nickel plated brass cable gland.
- 5.3.9 All lighting fixtures suitable for incandescent lamps shall be provided with two 3/4 "ET threaded entry. Two entries shall be used for looping of circuit wherever required. The fixtures shall be supplied with approved type two double compression nickel plated brass cable glands and one threaded plug for sealing unused entry.
- 5.3.10 The top of all well glass lighting fixtures shall be identically drilled / threaded to facilitate the installation on pole/column or ceiling.
- 5.3.11 All flood lighting fixtures shall be supplied with adjustable mounting arrangement both in horizontal and vertical plane.
- 5.4 CONTROL GEAR BOX
- 5.4.1 Lighting fixtures suitable for discharge lamps shall be provided with power factor correction capacitor, choke starter to be housed in separate control gear box. The choke shall be copper wound. The complete control gear shall have power factor not less than 0.9. All components shall be of approved make or as specified in Material Requisition.
- 5.4.2 Control gear box shall be provided with three 3/4 ET threaded entry (Incoming supply to lighting fixture and for looping to other Fixture/Control gear box). The control gear box shall be supplied with approved type three double compression nickel plated brass cable glands and one threaded plug for sealing unused entry.
- 5.4.3 Control gear box for flame proof fixtures shall be flameproof type and for div.2 or increased safety fixtures shall be increased safety type unless specified otherwise in the material requisition.
- 5.5 JUNCTION BOXES
- 5.5.1 The junction boxes shall be 3 way or 4 way type as specified in material requisition. All junction boxes for looping of single phase lighting circuits using cables up to 4mm shall be minimum 100mm diameter in size. Each junction box shall be complete with requisite number of ET threaded cable entries and with approved type double compression nickel plated brass cable glands and one threaded plug for sealing unused cable entry.
- 5.6 TERMINALS & WIRING

- 5.6.1 All equipments shall be provided with sufficient number of terminals. More than 2 wires per terminal shall not be permitted. If required, additional terminal with shorting link may be used. Each terminal for external cable connection shall be suitable for termination of 4mm<sup>2</sup> copper conductor or as specified in material requisition using crimped type tinned copper lugs. All terminals shall be of non sparking, anti-loosening design such that they do not produce any arc or spark in normal operation.
- 5.6.2 Flexible wires used for internal wiring shall be minimum 1.5mm<sup>2</sup> copper conductor and connections, shall be done using crimped type tinned copper lugs.
- 5.6.3 Terminals shall be of approved make or as specified in Material Requisition.
- 5.6.4 All equipments on single phase supply shall be provided with an independent earth terminal inside the enclosure for connecting the earth core of the cable and shall have facility for looping.
- 5.6.5 All the hardwares shall be cadmium plated whereas clamps and supporting brackets shall be hot dip galvanized. The galvanizing shall be 610gms/m for clamps and 900gms/m<sup>2</sup> for supporting brackets. All gaskets shall be of neoprene.
- 5.6.6 External surfaces of all the equipment's shall be treated and prepared for painting with two coats of epoxy paint to shade 632 as per IS-5.

## **6.0 INSPECTION, TESTING & ACCEPTANCE**

- 6.1 During fabrication, the equipment shall be subjected to inspection by Consultant / Owner or by an agency authorized by the Owner. Manufacturer shall furnish all necessary information concerning the supply to Consultant /Owner's inspector. Tests shall be carried out at manufacturer's works under his care and expense. 4 weeks prior notice shall be given before date of commencement of test for witnessing by Consultant /Owner's authorized representative. The test certificate indicating test result shall be furnished.
- 6.2 CMRS test certificates along with CCE/DGFASLI/DGMS approval certificates as applicable shall be furnished for each type of fixture. All equipments shall be routine tested as per applicable Indian standards.
- 6.3 During inspection, facility shall be provided for impact testing of random sample. One well glass of each fixture type from each lot shall be tested for impact strength

## **7.0 PACKING & SHIPMENT**

- 7.1 The equipment shall be shipped to site packed in wooden crates. They shall be wrapped in polyethylene sheets before being placed in crates to prevent damage to the finish. The crates shall have skid bottoms for handling.

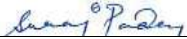





Energising Quality

## VCS Quality Services Pvt Ltd

### STANDARD SPECIFICATION FOR CABLE INSTALLATION

**VCS – SS – EL - 4024**

Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By
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## **ABBREVIATION**

BIS/IS	Bureau of Indian standards
OISD	Oil Industries Safety Directorate
CCE	Chief Controller of Explosive
CEA	Central Electrical Authorities
GI	Galvanized Iron
MS	Mild Steel
FLP	Flam Proof
RCC	Reinforced Concrete Cement
PV	Poly Vinyl Chloride

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## **1.0 SCOPE**

**1.1** This Specification defines the requirements for supply of materials, wherever applicable, installation, testing and commissioning of cable installation.

## **2.0 REFERENCE DOCUMENTS**

**2.1** The work shall be carried out in the best workman like manner in conformity with this Specification, Installation standards, layout drawings, the latest edition of relevant Specifications, codes of practice of Bureau of Indian Standards and OISD Standards listed below:

SP: 30 (BIS) Special Publication - National Electrical Code.

IS:1255 Code of practice for installation and maintenance-of power cables up to and including 33 KV rating.

IS:10810 Method of Test for cables; Part 43 Insulation resistance. (Part 43)

IS:10810 Method of Test for cables; Part 45 High voltage test. (Part45)

OISD 147 Inspection and safe practice during electrical installation

OISD I 73 Fire prevention and protection system for electrical installation

**2.2** In addition to the above it shall be ensured that the installation conforms to the requirements of the following as applicable:

- a. Indian Electricity Act and Rules.
- b. Regulations laid down by CEA/Electrical Inspectorate.
- c. Regulations laid down by CCE/DGMS/DGFASLI (as applicable).
- d. The Petroleum rules (Ministry of Industry Government of India).
- e. Any other regulations- laid down by central/state/local authorities and insurance agencies

## **3.0 DEFINITION**

For the purpose of this document, the words and expressions listed below shall have the meanings assigned to them as follows:

OWNER / COMPANY	OWNER of the particular Project (Project Specific).
CONSULTANT	The party which is doing engineering, procurement, construction, pre-commissioning and assistance for commissioning, monitors and controls the overall project management.
BIDDER / SUPPLIER / VENDOR	The party(s) which manufactures and / or supplies material, equipment, technical documents / drawings and services to perform the duties specified by Contractor.

## **4.0 DESIGN**

### **4.1 MATERIAL SPECIFICATIONS**

All materials and hardware to be supplied by the contractor shall be new, unused and of best quality and shall conform to the latest Specifications of Bureau of Indian Standards.

### **4.2 CABLE TRAYS**

These shall be ladder type trays either prefabricated hot dip galvanized sheet steel trays or site fabricated angle iron painted trays as specified in job Specification.

### **4.3 PRE-FABRICATED HOT DIPPED GALVANISED TRAYS**

The cable trays shall comply with the requirements specified in Installation std.

### **4.4 SITE FABRICATED ANGLE IRON TRAYS**

4.4.1 Angle iron cable trays shall be fabricated from standard rolled angle iron sections of size 75x75x8 for runners for supporting spans limited to 3000 mm. Cross support shall be 25 x 6 mm MS flat for tray width up to 500 mm and 32 x 6 mm flat for tray of more than 500 mm wide and spacing between two cross supports shall not exceed 250 mm.

4.4.2 Vertical supports for both the prefabricated and site fabricated type trays shall be fabricated out of ISMC 100 and horizontal supports shall be with 65 x 65 x 6 mm angle iron sections. Outer most tier of all vertical cable trays shall be covered with GI sheet for protection against physical damage to cables.

4.4.3 Cable racks and trays shall be covered by removable top covers on upper most tier allowing adequate ventilation in following cases where:

- a. Mechanical damage of cables is likely to occur during maintenance in the plant.
- b. Oil or spillage of chemicals can be expected.
- c. Protection from exposure to sun is required.

4.4.4 GI cover sheet shall allow adequate ventilation to the cables and shall be in standard length of 3000 mm, flanged on both sides for fixing on cable tray. Covers shall be complete with required GI hardware's.

### **4.5 CABLE GLANDS**

4.5.1 Cable glands shall be of nickel plated brass unless otherwise specified. The single compression type cable glands shall be used for \_indoor. -panels/equipment, (e.g., Substation, control room etc.). The cable glands for outdoor terminations shall be weather protected, double compression type and shall have PVC shroud for additional weather protection. Cable glands forming a part of relevant FLP enclosure shall be FLP type, tested by CMRI or any other recognized independent testing laboratory and approved by CCE/DGMS or any other statutory authority as applicable. Indigenous FLP glands shall have valid BIS license as per the requirements of statutory authorities. The size of the cable glands supplied shall be appropriate to the size of cable so that flame proofness of glands is retained.

4.5.2 Entry thread of cable gland shall be compatible to the entry thread provided in the equipment (BS, ET, NPT, and PG as applicable). If required, suitable reducers/adopters shall be used.

#### 4.6 CONNECTORS

Power cable terminations shall be made with crimped type tinned copper solder less lugs which shall be suitable for the cable size mentioned in cable schedule.

#### 4.7 FERRULES

Ferrules shall be of approved type and of size to suit core size mentioned and shall be employed to designate the various cores of control cable by the terminal numbers to which the cores are connected, for ease of identification.

### **5.0 INSTALLATION**

#### 5.1 CABLE LAYING (GENERAL)

5.1.1 Cable installation shall include power, control, lighting, fire alarm, telephone and communication cables. These shall be laid in trenches/ cable trays as detailed in the cable layout drawings. Cable routing given on the cable layout drawings shall be checked in the field so as to avoid interference with structures, heat sources, drains, piping, air-conditioning duct etc. Any change in routing shall be -done to suit -the field conditions wherever deemed necessary, 'after obtaining approval of Engineering-charge.

5.1.2 High voltage, medium voltage power and control cables shall be separated from each other by adequate spacing or by running through independent pipes, trenches or cables trays, as shown on layout drawings/installation standards, Details of-cable routes and, cable spacing not shown in detail on these drawing shall be determined by the Contractor and approved by the Engineer in charge.

5.1.3 When single core cables are laid in flat formation, the individual cable fixing clamps and spacers shall be of non-magnetic material. As a general practice, the sheath of single core cables shall be earthed at one point to keep sheath at earth potential unless otherwise stated. Single core cables, when laid in trefoil formation shall be braced by suitable clamps at a distance, not exceeding 3 meters along the cable routing.

5.1.4 If straight through joints are required to be provided on single core cables, armor shall be broken at joints as per manufacturer's recommendations. For single core cables armor shall be earthed at one end for the cable run length as per manufacturer's recommendation.

5.1.5 The Telephone, Communication and Fire alarm cables shall run on instrument trays/ducts/ trenches in the units. Wherever these are not available, cables shall be taken in, a separate trench/tray with a min spacing of 600mm from power, and control cables but in any case, such separation shall not be less than 300mm.

5.1.6 Telephone, fire alarm and plant communication cables shall be directly buried in road berm area, (unless otherwise specified in cable layout drawings). These cables shall cross power cables preferably at right angles. Streetlighting cables shall be laid on the other side of road berm area.

- 5.1.7 The lengths indicated in the cables schedule are only approximate. The contractor shall ascertain the exact length of cable for a particular feeder by measuring at site. All cable routes shall be carefully measured. Before the start of cable laying, the contractor shall prepare cable drum schedule and get that approved by Engineer-in-charge to minimize/avoid straight through joints and then the cables cut to the required lengths, leaving sufficient lengths for the terminations of the cable at both ends. The various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. Extra loop length shall be given for feeder cables where required as per the directions of Engineer-in-charge to meet contingencies.
- 5.1.8 Cables shall be laid in directly buried trench or in RCC trench (underground trench) or in cable tray along pipe sleepers or in overhead trays as shown on cable layout drawings.
- 5.1.9 Overhead trays shall be installed 2700-mm (minimum) above grade level. At road crossings overhead trays shall be installed at 7000mm (minimum) above grade level or cables shall be routed cable tray culvert/ Electrical Road crossings as per layout drawings. Sufficient care shall be taken while laying cables to avoid formation of twist, sharp bend etc. in order to avoid mechanical injuries to cables. Rollers shall be used for pulling of cables.
- 5.1.10 Cable installation shall provide minimum cable bending radii as recommended by cable manufacturer.
- 5.1.11 Cables shall be neatly arranged in the trenches / trays in such a manner that crisscrossing is avoided and final take off to the motor / switchgear is facilitated. Arrangement of cables within the trenches / trays shall be in line with cable layout drawings. Cable routing between cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. Pipe sleeves shall be laid at an angle of maximum 45 to the trench wall. Bending radii of pipes shall not be less than 8D. It is to be ensured that both the ends of GI, pipe sleeves shall be sealed with approved weather proof sealing plastic compound after cabling. In places where it is not possible, cables shall be laid in smaller branch trenches.
- 5.1.12 All cables shall be identified close to their termination point by cable tag numbers as per cable schedule. Cable tag numbers shall be punched on aluminum straps (2mm thick, 20 mm wide and of enough length) securely fastened to the cable and wrapped around it.
- 5.1.13 Each underground cable shall be provided with cable tags of lead securely fastened every 30 m of its underground length with at least one tag at each end before the cable enters/leaves the ground. In unpaved areas, cable trenches shall be identified by means of cable markers as per installation drawing. These cable markers shall be placed at location of changes in the direction of cables and at intervals of not more than 30 m and also at cable straight through, joint locations.
- 5.1.14 All temporary ends of cables must be protected against dirt and moisture to prevent, damage to the insulation. For this purpose, ends of cables shall be taped with an approved PVC end cap or rubber insulating tape.
- 5.1.15 Each row of cables shall be laid in place and before covering with sand. All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/lined trench. Every cable shall be given an insulation

test in presence of Engineer-in-charge/Owner before filling the cable trench with sand  
Any cable which is found defective shall be replaced:

- 5.1.16 Where cables pass through, foundation walls, the necessary openings shall be provided in advance for the same by another agency. However, should it become necessary to cut holes in existing structures for example floor slab etc., the electrical contractor shall determine their location and obtain approval of the Engineer-in-charge before carrying out the same.
- 5.1.17 Cables for road crossings shall be taken through ERC (Electrical Road Crossing) as shown in the cable layout drawings.
- 5.1.18 At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends.
- 5.1.19 Wherever cable trench crosses storm water, waste water channel/drain, cables shall be taken through PVC/RCC pipes. Where cables are required to cross drains of depth more than 1200 mm, cables shall be taken over the drain on cable trays supported suitably using ISMC 150/200 sections.
- 5.1.20 Ends of cables leaving trench shall be coiled & capped and provided with protective cover till such time the final termination to the equipment is completed.

## 5.2 CABLES LAID DIRECT IN GROUND

- 5.2.1 Cables shall be laid underground in excavated cable trenches where specified in cable layout drawings. Trenches shall be of sufficient depth and width for accommodation of all cables. Cables shall be properly spaced and arranged with a view of heat dissipation and economy of design. Maximum number of cable layers in trench shall be preferably limited to 5 layers.
- 5.2.2 Minimum depth of cable trench shall be 750 mm for medium voltage and 900 mm for H.V. Cables. The depth and the width of the trench shall vary depending upon the number of layers of cables as per Installation Standard.
- 5.2.3 Cables shall be laid in buried trenches depth as shown in the cable layout drawings. It is to be insured by the contractor that the bottom of buried trenches shall be cleared of all rocks, stones and sharp objects before cables are placed. The trench bottom shall be filled with a layer of sand. This sand shall be leveled and cables laid over it. These cables shall be covered with 150 mm of sand on top of the largest diameter cable and sand shall be lightly compacted. A flat protective covering of 75 mm thick second-class red bricks shall then be laid and the remainder of the trench shall then be back filled with soil, rammed and leveled.

## 5.3 CABLES LAID IN CONCRETE TRENCH

- 5.3.1 Cables shall be laid in 3 or 4 tiers in concrete trench as shown on layout drawings. Concrete cables trenches shall be filled with sand in hazardous area to avoid accumulation of hazardous gases and oil. RCC covers of trenches shall be effectively sealed to avoid ingress of chemical and oil in process area. Removal of concrete covers where required for the purpose of cable laying and reinstating them in their proper position after cables are laid shall be done by electrical contractor.

- 5.3.2 All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water.
- 5.4 Above ground cables
- 5.4.1 Cables installed above grade shall run in cable trays, clamped on walls, ceiling or structures and shall be run parallel or at right angles to beams, walls or column. Cable routing shall be planned to be away from heat sources such as hot piping, gas, water, oil drainage piping, air conditioning duct etc. Each cable shall contain only one layer of cables as far as possible for power cables. However control may be laid in double layer in the cable trays.
- 5.4.2 Individual cable or small group of cables (up to 3 to 4 cables) which run along structures / walls etc. shall be clamped by means of 16 SWG GI saddles on 25 x 6 mm saddle bars. Alternatively small group of cables can be taken through 100/150 mm slotted channel tray / ISMC 100. Cables shall be supported so as to prevent sagging. In general, distance between supports shall be approximately 300mm for cables upto 25 mm diameter and maximum 450 mm for cables larger than 25mm dia. To prevent the sagging of cables.
- 5.4.3 Cable laid on supporting angle in cable trenches structures, columns and vertical run of cable trays shall be suitably clamped by means G.I. saddles /clamps, whereas cables in horizontal run of cable trays shall be tied by means of nylon cords. Distance between supporting angles shall not exceed 600 mm.
- 5.4.4 All cable trays (other than galvanized trays) and supporting steel structures. shall be painted before laying of cables. The under surfaces shall be properly degreased, dedusted, descaled and cleaned. The painting shall be done with one coat of red oxide zinc chromate primer. Final painting shall be done with two coats of approved bituminous aluminum paint unless otherwise specified.
- 5.4.5 Where cables rise from trench to motor, lighting panel, control station, junction box etc., they shall be taken in GI pipe for mechanical protection up to a minimum of 300 mm above grade. Cable ends shall be carefully pulled through conduit to prevent damage to cable.
- 5.4.6 All G.I. Pipes shall be laid as per layout drawings and site conditions. Before fabrication of various profiles of pipes by hydraulically operated bending machine (which is to be arranged by the contractor) all the burrs from the pipes shall be removed. GI Pipes having bends shall be buried in soil / concrete in such a way that the bend shall be totally concealed. For G.I. pipes buried in soil, bitumen coating shall be applied on the buried lengths, Installation of G.I. pipes shall be undertaken well before paving is completed and necessary coordination with paving agency shall be the responsibility of Electrical Contractor.
- 5.4.7 Following guide shall be used for sizing of G.I. pipe.
- a) 1 cable in a pipe - 53% of pipe cross-sectional area occupied by cables.
  - b) 2 cables in a pipe - 31% of pipe cross-sectional area occupied by cables.
  - c) 3 cables in a pipe - 43% of pipe cross-sectional area occupied by cables

d) And above cables in a pipe - 40% of pipe cross-sectional: area occupied by cables.

5.4.8 After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/bitumen/suitable sealing compound. Alternatively, rubber bushes shall be employed for the purpose of sealing

## 5.5 TERMINATIONS

5.5.1 All PVC cables up to 1100V grade shall be terminated at the equipment by, means of compression type cables glands suitable for the cable size. They shall have a screwed nipple with conduit electrical threads and check nut. The cables shall be identified close to their termination points at both the ends of cable (cable numbers shall be punched on aluminum 2mm thick and securely fastened to the cable, Wrapped around it) and also along the, route at recommended intervals, by cable tag numbers.

5.5.2 All cable entries for outdoor termination shall be preferably through bottom. Outdoor cable termination through top of equipment shall not be permitted.

5.5.3 Power cables cores wherever color coding is not available shall be identified with red, yellow and blue PVC tapes. Where copper to aluminum connections is made, necessary bimetallic washers shall be used.

5.5.4 In case of control cables, all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules suitable for core size. Wire numbers shall be as per schematic/ wiring/inter-connection diagram. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends, for future use. For trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the Switchgear/ Control panels and Control Switches

5.5.5 Contractor shall drill holes for fixing glands wherever necessary. Gland plate shall be of nonmagnetic material/ aluminum sheet in case of single core cables. All unused cable entries on equipment/panels shall be plugged/sealed.

5.5.6 The cable shall be terminated at electrical equipment /switchboards through glands of proper size. The individual cores shall then be dressed and taken along the cables ways or shall be fixed to the panels with polyethylene straps. The cable glanding shall be done as per manufacturer's instructions. Cable armor shall not be exposed after termination is complete.

5.5.7 In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom close fit holes shall-be drilled in the gland plate for all the cables in one line, then gland plate shall be split in two parts along the center line of holes. After fixing bottom plate, uncovered cable holes/gaps shall be sealed with cold settings compound.

5.5.8 Crimping of lugs to cable leads shall be done by hand crimping / hydraulically operated tool as per requirement Insulation of the leads shall be removed before crimping. Conductor surface shall be cleaned and shall not be left open. Suitable conducting jelly shall be applied on the conductor lead. Lugs shall enclose all strands of cable core. Cutting of strands shall not be allowed.

- 5.5.9 The contractor shall bring to the notice of Engineer-in-charge any mismatch in cable glands, lugs provided with the equipment vis-a-vis to the cable size indicated in cable schedule for taking corrective action.
- 5.5.10 The cable joints in-power and control tables shall be avoided as far as possible. In case a joint is unavoidable, the following shall be insured:
- The number of joints shall be restricted to minimum as far as possible,
  - The location of joints shall be identified with permanent markers.
  - No joints shall be allowed in hazardous areas without the approval of Engineer-in-charge
- 5.5.11 The jointing and termination of medium voltage power cables shall be carried out by trained personnel only. Jointing and termination of high voltage cables shall be done by skilled and experienced jointer duly approved by Engineer-in-charge. Only type tested termination kits of approved make shall be used.
- 5.5.12 No unauthorized repairs modifications shall be carried-out on the hazardous area equipment terminal boxes and junction boxes. Damaged enclosures of hazardous area equipment shall bring to the notice of Engineer-in-charge by Contractor. After termination is complete all the bolts, nuts, hardware of terminal box shall be properly placed in its position and tightened.
- 5.5.13 Where required, cable sealing boxes intended to be used with the apparatus shall be filled with solid setting type bituminous compound unless otherwise specified.

## **6.0 TESTING AND COMMISSIONING**

- 6.1** Field testing and commissioning of electrical installation shall be carried out as per Standard Specification.
- 6.2** Before energizing the insulation resistance of every-circuit-shall-be measured from phase to phase, phase to neutral and from phase/neutral to earth.
- 6.3** Where splices or terminations are required in circuits rated above 650 volts, insulation resistance of each length of cable shall be measured before splicing and or /terminating. After completion of splices and /or terminations measurements shall be repeated.
- 6.4** The insulation resistance of directly buried cables shall be measured before cable trenches are backfilled. Measurements shall be repeated after back filling.
- 6.5** For cables up to 1.1 kV grade 1000VMegger and for H.V. Cables 2.5 kV / 5 kV Megger shall be used.
- 6.6** D.C. High Voltage test shall be conducted on cables given below after installation. .
- 6.7** All 1100 volts grade cables in which straight through joints have been made.
- 6.8** All cables above 1100 V grade.
- 6.9** The D.C. High Voltage test shall be performed as detailed below in the presence of the Engineer in charge or his authorized representative only,