

JOB SPECIFICATION (ELECTRICAL)

GAS TURBINE COMPRESSORS (MR No. – B240-910-KA-MR-5010)

PROJECT : INSTALLATION OF GAS TURBINE
COMPRESSOR AT GPU GANDHAR
OWNER : M/s GAIL
JOB NO. : B240

A	08.04.2019	ISSUED WITH MR	DK	SH	ANPS
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

1. Site Conditions

Maximum Ambient Temp.	:	47°C
Minimum Ambient Temp.	:	6°C
Relative Humidity	:	90 %
Equipment design Temp.	:	40°C

2. System voltage and frequency

2.1. Utilization voltage

1. 415V (nominal) 3 phase 4 wire solidly earthed neutral: This voltage shall be used for all motors above 0.37kW & upto and including 250KW as well as all other three phase loads.
2. 240V (nominal) 1 phase 3 wire 50Hz earthed: This voltage shall be used for low power single phase loads such as lighting, small power sockets, motors rated below 0.37KW etc.

2.1. Voltage and frequency variation

The following maximum variation shall be considered for equipment design:

- a) Voltage : Differing from its nominal value by not more than $\pm 10\%$.
- b) Frequency: Differing from its nominal value by not more than $\pm 5\%$.

3. Brief Description of Electrical system

- 3.1. Purchaser will provide 1 no Normal power supply from existing PCC and 1 no. Emergency power supply for feeding the GTMCC supplied by bidder along with power cables.
- 3.2. Control cabling for local push button station/local control panel shall also be provided by Purchaser.
- 3.3. The system shall be complete in all respects with required interlocks for the desired sequence of operation and controls, selections, indications and alarms etc.

4. WORKS EXCLUDED

The following works / item are excluded from the scope of the bidder:

- 4.1. Supply of 415V feeders upstream of GT MCC.
- 4.2. Supply, laying and termination of power and control cables from the Owner's switchboards in Substation to the electrical loads installed at the Compressor skid.
- 4.3. Supply, laying and termination of interface cables between Owner's switchboards in Substation and Instrumentation panels for DCS interface.
- 4.4. All cable trays / trenches for owner's cables.

5. AREA CLASSIFICATION & EQUIPMENT SELECTION

5.1. Area classification for the compressor shall be as under:

SI.No	Equipment	Type of enclosure protection
1.	910-K-151	Zone-2, IIA/IIB, T3

5.2. The minimum enclosure protection shall be:

SI.No	Equipment	Type of enclosure protection
1.	Auxiliaries for 10-K-151	
	i) MV Motors	Flame proof, Ex-d, Gas group - IIA/IIB, Temperature Class : T3
	ii) LCS/LCP	
	iii) Electric Heater	
	iv) DC motors if any	

5.3. Flameproof Ex d equipment shall meet the requirement of IS/IEC: 60079-1. All indigenous flameproof equipment (Ex d type) shall be manufactured under BIS license.

5.4. All electrical equipment for use in hazardous areas shall be certified by CIMFR, PTB, Baseefa, UL, FM or equivalent independent testing agency for the service and the area in which it can be used and shall be approved by PESO/CCOE. Copies of Hazardous area test certificates & PESO/ CCOE approval shall be furnished. As per statutory requirement in India, the approval from PESO/CIMFR must be submitted for equipment to be installed in hazardous area.

6. ENGINEERING AND JOB SPECIFIC REQUIREMENTS

6.1. Bidder shall ensure that all electrical equipment comply to site and system conditions, rating and other technical requirement as specified in the MR.

6.2. Bidder shall use this specification, datasheet, and OWNER/ EIL's standard specifications for various equipment.

6.3. The equipment shall in general conform to latest revision of statutory regulations, Indian Standards, IEC / Other international standards applicable for the country of origin of the equipment.

6.4. All equipment shall be subjected to routine and acceptance tests as per applicable specifications.

6.5. Besides these, the following requirements as detailed out in respective clauses for the equipment shall also be considered:

6.6. MV MOTOR

6.6.1. MV motors (415 V) shall conform to EIL Specification for high efficiency motors 6-51-0064, relevant clauses of EIL specification for MV VFD, 6-51-0038 (VFD Driven only), as applicable, and MV Motor data sheet no. B240-010-16-50-DS-5010/11.

6.6.2. Motors in general shall be asynchronous squirrel cage type having synchronous speed of 1500 rpm.

6.6.3. All MV motors (except crane duty motors) shall be of high energy efficiency type IE2 as per IS-12615.

6.6.4. All motors shall be provided with FRP canopy.

6.6.5. Exact cable sizes of power and control cables shall be finalized during detailed engineering. Provisions, as required in Vendor's equipment for termination of the same,

shall be made accordingly without any cost & time implications to Owner. Vendor shall supply accessories such as cable glands, lugs, etc. for the furnished cable size. In case of limitation of cable size for termination of power cables, required Flameproof Junction box suitable for Gas group IIA/IIB, Temperature class: T3 shall be provided without any cost & time implications to Purchaser.

- 6.6.6. Variation / Clarifications against the standard specification of MV Motor 6-51-0064, shall be as per the MOU agreed with EIL by respective motor manufacturer. No further deviations shall be entertained.
- 6.6.7. The VFD controlled motors shall be designed considering cooling as at lowest operating speed as defined in pump data sheet. Compliance with this aspect shall be established by the bidder during detailed engineering/drawing review stage. In this regard, bidder shall furnish combined test certificates for temperature rise in the motor surface (Identical) for the complete range of speed variation. In case, valid type tests are not available, the tests shall be conducted by the bidder without any time and cost implication. Combined test shall be applicable for identical rated VFD & motor (i.e. kw rating. Model, make of job VFD & tested VFD shall be same & in case of motor, kw rating, make & frame size shall be same). In case of combined test to be performed on job VFD & job motor, VFD panels shall be shipped to motor manufacturer's works.
- 6.6.8. Motor frame size shall be selected based on the lowest operating speed as per process requirement.

6.7. MV SWITCHBOARD

- 6.7.1. MV switchboard/MCC supplied for feeding the various loads of Gas Turbine Compressor shall be located in Substation 1. The MV switchboard shall be compartmentalized and draw-out type.
- 6.7.2. Variation / Clarifications against the standard specification of MV Switchboard 6-51-0018, shall be as per the MOU agreed with EIL by respective motor manufacturer. No further deviations shall be entertained.
- 6.7.3. MV Switchboard shall have two incomers and bus couplers. Ratings of outgoing feeders and their configuration shall be inline with the hardware datasheet document no. B240-910-16-50-DS-5014, Component datasheet document no. B240-910-16-50-DS-5015 and other EIL specifications attached.
- 6.7.4. Incomer at GT MCC incomer shall be suitable for fault level of 50 kA (for 1 sec.). At least 20% spare outgoing feeders, subject to a minimum of 1 of each type shall be provided in GT MCC switchboard. For FVNR/FVR feeders, type and rating designation (e.g. FVNR-15, FVR-15, FVNR-15 HD etc. as per M.V. switchboard data sheet) shall be considered for working out number of spares. For switch fuse feeders, switch rating shall be considered for working out number of spares. Feeders in MCC shall be rated suitably considering 20% margin.
- 6.7.5. Bidder shall furnish a list of control cables to be provided by owner for signals exchanged between Bidder supplied equipment and Bidder supplied field equipment/PLC, during detail engineering.
- 6.7.6. Bidder shall furnish the maximum operating power demand of GTC MCCs for which owner's incoming cable has to be sized, during detail engineering.
- 6.7.7. The distance between GTC-MCC (located in substation 1) and GTC battery limits shall be taken as 900m (approx.). The exact distance shall be worked out during detail engineering. There shall be no cost & time implication on account of this

6.8. DC SYSTEM

- 6.8.1. DC system envisaged shall meet the technical requirements of Datasheet no. B240-16-50-DS-5016 and EIL standard specification for DC System document no. 6-51-0019 and Inspection test plan 6-81-1019.
- 6.8.2. DC system shall be redundant system with 1 x 100% batteries as per Option-I of EIL specification for DC System document no.6-51-0019.
- 6.8.3. Batteries shall be Ni-Cd type with sufficient backup time. Backup time shall be decided by bidder based on the GT requirement. This time shall be adequately sufficient for Machine safety requirements.
- 6.8.4. All interconnecting cables among battery, Charger and DCDB shall be in bidder's scope.
- 6.8.5. DC System including DCDB shall be located in switchgear hall of substation1 and their batteries shall be located in the battery room of substation1. Distance between battery and charger shall be around 100m. Exact length shall be worked out during detailed engineering.
- 6.8.6. Separate DC system for instrumentation DC load if any specifically required by bidder shall be in bidder's scope. However the same shall be located in switchgear hall of Substation1. The distance between substation 1 and control room shall be of the order of 400m.

6.9. VARIABLE FREQUENCY DRIVE PANEL

- 6.9.1. The VFD system having converter input voltage rated 415V shall conform to EIL specification 6-51-0038 and datasheet no. B240-010-16-50-DS-5012.
- 6.9.2. Operator console on VFD (external port will be provided) shall have facility/port to connect external hardware such as Laptop etc. Console shall have facility for upload and download all parameter settings from one drive to another identical drive for start up and operation. All the load parameters shall be visible at this operator console. In addition to that, manual alteration of load parameter can also be possible through this operator console.
- 6.9.3. Bidder shall ensure that, entire VFD module & its components (i.e. rectifier, inverter etc.) shall be procured from single manufacturer only.
- 6.9.4. No by-pass feature is required in VFD panels as motor shall NOT be operated in DOL mode.
- 6.9.5. Following mentioned facilities/provision (min.) shall be provided in offered VFD panels:-

Interface with LCS

- Local start push button
- Local stop push button
- Local/remote selection switch with locking facility
- Run indication lamp
- Trip indication lamp
- Ready to start indication lamp
- Ammeter (range: 0 to 150% of full load current of motor)

Interface with PLC/DCS

- Start/stop
- Start permissive.

Accordingly, control schematic of VFD panel shall be prepared.

- 6.9.6. Following indications/controls are to be provided in the facia panel of VFD
- a) Emergency STOP
 - b) One no. emergency push button with locking arrangement to trip upstream feeding breaker
 - c) Other control/metering/indication requirements as mentioned in EIL specification (6-51-0038)
- 6.9.7. For VFD panel, owner shall not provide any auxiliary power supply. Whatever is required shall be derived with in VFD only.
- 6.9.8. VFD shall be rated for the full capacity of the drives being fed from VFD.
- 6.9.9. VFD shall be suitable for operation in non-air-conditioned environment at rated design ambient temperature.
- 6.9.10. Requirement of dedicated clean earth for VFD system (if any) and separate protective earthing is not envisaged. Vendor to confirm.
- 6.9.11. 240V, 1-Phase power supply to the motor space heater shall be derived from VFD. Necessary arrangement for these supplies shall be made available by vendor in VFD panels.

6.10. LOCAL CONTROL STATIONS

- 6.10.1. Flameproof control stations (IP-55) for all motors, emergency stop push buttons for motors as required for plant operation and safety etc., shall be provided by the vendor in accordance with standard specification no. 6-51-0006.
- 6.10.2. Outdoor area Local control stations shall have FRP canopies for additional weather protection.
- 6.10.3. Following facilities shall be provided as a minimum on LCP/LCS:
- i). Start/Stop push buttons for all motors
 - ii). Ammeters for motor above 5.5kW.
 - iii). L-O-R (Local-Off-Remote) Selector switches as required.
 - iv). For LCS of Main Compressor Motor:
 - v). Field ammeter shall be analogue type with mark of full load current (FLC) and 150% overload.
 - vi). Field RPM meter shall be analogue type with mark from 0-110% of rated speed.

6.11. MISCELLANEOUS

- 6.11.1. Equipment like Lube oil filling pump, lubricating oil centrifuge, gas turbine washing system, trolley mounted pumps etc. shall be complete with flame proof motors and their flameproof starters suitable for use in **Zone-2, Gas group (as applicable), Temp class T3**, with armored copper conductor trailing cable. Motor starter shall have motor protections, other hardware such as switch, fuse, contactor and BMR etc.
- 6.11.2. Trolley mounted pumps shall be powered from a nearby 5 pin socket to be supplied by bidder.
- 6.11.3. Equipment earthing shall be done at 2 points and both earth connections shall be brought to an earth plate to be provided on the skid by the bidder. Further, Purchaser shall connect from skid earth plate to main plant earth grid.
- 6.11.4. All motors shall be earthed by two different connections using flexible braided GI wires with proper lugging.

- 6.11.5. All electrical equipment including cables, lighting fixtures etc. inside the turbine enclosure shall be suitable for the maximum temperature inside the turbine enclosure.
- 6.11.6. Gas turbine enclosure shall be provided with interior flameproof lighting fixtures wired to a switch mounted outside the enclosure. Flameproof 15A (SPN+E) power receptacles (Plug and socket) shall also be provided. Lighting fixtures shall be LED Type with mechanical protection and other accessories. Armoured cables shall be used inside the enclosure.
- 6.11.7. All imported equipment must be of reputed make and the equipment must have been operating satisfactorily for atleast 8000 hours and must have been supplied and in operation at minimum 2 installations.
- 6.11.8. Lux level for lighting design shall be as follows;
 - a. Instt and control faces: 300 Lux (Locally mounted on skid)
 - b. Turbine enclosure: 150 Lux.
- 6.11.9. Single point power supply (415V AC supply) shall be considered for oil filling pump, Lubrication oil centrifuge, gas turbine washing system. Further distribution to skid mounted electrical equipment shall be within the skids.
- 6.11.10. All material for aviation lights and lightning protection of all tall structures (stacks etc.) shall be included in bidder's scope.
- 6.11.11. Vendor shall supply Nickel plated brass double compression cable glands and tinned Cu crimping type lugs for equipment supplied by them. No cost / time implication shall be applicable on account of this). For outdoor equipment, double compression type Nickel plated brass flameproof cable glands shall be supplied. The size of cable glands supplied shall be appropriate to the size of cable.
- 6.11.12. All cable glands/ adapters/ blocking plugs for hazardous area equipment shall meet the requirements of IS/IEC: 60079-0.
- 6.11.13. All nuts and bolts shall be of stainless steel SS-304.
- 6.11.14. Prefabricated FRP canopy shall be provided for all outdoor equipment.
- 6.11.15. All hardware necessary for interfacing control system signals with Purchaser's motor starters shall be in bidder's scope. Bidder shall furnish a sketch for the signals to be exchanged between Purchaser's motor starters and bidder's local control panels (if any).
- 6.11.16. Bidder shall furnish a list of control cables to be provided by Purchaser for signals exchanged between Purchaser's motor starters and Bidder supplied field equipment and control room equipment.
- 6.11.17. All interconnecting cables between bidder's electrical equipment within bidder's scope shall be provided along with cable supporting materials like cable glands, lugs, cable supports, cable tags, ferrules, etc.
- 6.11.18. Exact cable sizes of power and control cables shall be finalized during detailed engineering. Provisions, as required in Vendor's equipment for termination of the same, shall be made accordingly without any cost & time implications to Owner.

7. INSPECTION AND TESTING AT MANUFACTURER'S WORKS

All major electrical equipment and material shall be subject to inspection by owner/ EIL/TPIA or authorized representative at manufacturers' works. Contractor/Vendor/ Sub-Vendor shall furnish all necessary information concerning the supply to owner/ EIL.

Type, routine and acceptance tests to be conducted on all equipment shall include all tests as specified in standard specifications, data sheets and ITPs enclosed with the MR.

All the equipment offered shall have valid type test certificates of recognized testing house such as CPRI, CMRI, BASEEFA or equivalent and valid CCOE approval.

8. Makes of Electrical Equipment/Component

The make of all electrical equipment shall be as below:-

	Equipment	Acceptable makes
1	AC MV VFD	ABB Limited, Asea Brown Boveri Ltd (Abb Ltd) Baldor Electric Company Cg Power & Industrial Solutions Ltd. Danfoss Industries Pvt Ltd. Eurotherm Del India Pvt Ltd. Hitachi Hirel Power Electronics Pvt Ltd. Karl E Brinkmann Gmbh L & T Mediensa Corp Nidec Asi Spa Rockwell Automation India Pvt Ltd Siemens Ag Siemens Ltd Siemens Allis Energy Products Toshiba Corp Vacon Controls & Drives Pvt Ltd Vacon Oyj
2	MV Motor (Indigenous)	ABB Limited Bharat Bijlee Limited Crompton Greaves Ltd. Laxmi Hydraulics. Pvt Ltd Kirloskar Electric Co Limited Marathon Electric Motor I Ltd
3	MV Motor (Imported)	Asea Brown Boveri Ltd (Abb Ltd) Nidec Asi Spa. Cemp Srl. Ge Power Conversion France Sas Ge Canada Hitachi Ltd. Hyundai Heavy Industries Ltd Jeumont Sa / Framatone Anp Lloyd Dynamowerke Gmbh & Co Ltd Loher Gmbh. Siemens Ag Toshiba Corporation. Toshiba Mitsubishi Electric Ind Co System Weg Equipamentos Eletricos S.A. Weg Euro Idndustria Electrica Sa

	Equipment	Acceptable makes
. 4	Flameproof control stations/Junction box/Plugs/Sockets	Baliga Lighting Equipments (P) Limited. Flexpro Electricals Pvt Ltd. Flameproof Equipment pvt.Ltd. Fcg Power Industries Pvt Ltd. Fcg Flameproof Control Gears P. Ltd. Petroleum Safety Products Ind. Pvt. Ltd. Kaysons Techno Equipment P Ltd. Pepperl & Fuchs Manufacturing (India) Pvt Ltd Sudhir Switchgears Pvt Ltd.
. 5	MV Switchboard	ABB india Ltd, Controls & Schematics, GE Industrial Pvt Ltd. L & T Schneider Electric India Pvt Ltd. Siemens Ltd.
. 6	DC System	Amara Raja Power Systems Borri Spa Chhabhi Electricals Pvt Ltd. Chloride Power Systems And Solutions Dubas Engineering Pvt Ltd. Hbl Power System Ltd Masstech Controls Pvt Ltd. Universal Instrument Mfg Co Pvt Ltd
.	Battery Ni-Cd	Amco SAFT India LTD HBL Power System Ltd
.	Flameproof Lighting Fixture	Baliga Lighting Equipments (P) Limited. Bajaj Electricals Ltd Flexpro Electricals Pvt Ltd. Flameproof Equipments Pvt.Ltd. Fcg Power Industries Pvt Ltd. Fcg Flameproof Control Gears P. Ltd. Petroleum Safety Products Ind. Pvt. Ltd. Kaysons Techno Equipment P Ltd. Pepperl & Fuchs Manufacturing (India) Pvt Ltd Sudhir Switchgears Pvt Ltd.

NOTES:

- Bidder may procure material from any of the Owner/EIL approved vendors. However, current validity and range of approval as per EIL enlistment letter, work-load, stability and solvency needs to be verified by the bidder before placement of order.
- Makes of items not covered above shall be subject to Owner/EIL's approval.
- Bidder may procure material from any of the Owner/ EIL approved vendors. However current validity and range of approval as per EIL enlistment letter, work load, stability and solvency needs to be verified by the bidder before placement of order. Intimation for the same shall be furnished along with PTR.
- VFD panel shall be procured from OEM only. Channel partner/system house shall not be acceptable.**

9. LIST OF ATTACHMENTS:

SINo.	Title	Document No.	Rev.
1.	Data Sheet – MV Motors (DOL)	B240-910-16-50-DS-5010	A
2.	Data Sheet – MV Motors (VFD)	B240-910-16-50-DS-5011	A
3.	Data Sheet – MV Variable Frequency Drive	B240-910-16-50-DS-5012	A
4.	Data Sheet – MV Switchboard	B240-910-16-50-DS-5013	A
5.	Data Sheet for MV Switchboard Hardware Datasheet	B240-910-16-50-DS-5014	A
6.	Data Sheet – Load Data Format	B240-910-16-50-DS-5017	A
7.	Data Sheet Component Datasheet	B240-910-16-50-DS-5015	A
8.	Data Sheet Battery & Charger	B240-910-16-50-DS-5016	A
9.	Vendor Data Requirement	B240-910-16-50-VR-5010	A
10.	Specification for Flameproof Control stations	6-51-0006	5
11.	Specification for MV Switchboard	6-51-0018	5
12.	Specification for battery charger	6-51-0019	5
13.	Specification for MV Voltage Variable Frequency Drive System	6-51-0038	2
14.	Specification for stationary nickel cadmium batteries	6-51-0047	3
15.	Specification for MV Induction Motors	6-51-0064	1
16.	Specification for field inspection, testing and commissioning of electrical installations	6-51-0087	3
17.	Inspection & Test Plan for Flameproof Control stations	6-81-1006	3
18.	Inspection & Test Plan for MV Switchboard	6-81-1018	3
19.	Inspection & Test Plan for battery charger	6-81-1019	3
20.	Inspection & Test Plan for MV Motors	6-81-1032	5
21.	Inspection & Test Plan for MV Variable Frequency Drive System	6-81-1038	2
22.	Inspection & Test Plan for battery(Nickel Cadmium)	6-81-1047	2

Project	PMC Services for Installation of GTC at GAIL, Gandhar			Client	GAIL - NOIDA
Unit	New Comprssor area at Gandhar-GPU	Location		Job No.	B240
				Unit No.	910

PURCHASER'S DATA

A. Site Conditions		
1.	Maximum Ambient Temperature	°C 47
2.	Minimum Ambient Temperature	°C 6
3.	Design Ambient Temperature	°C 40
4.	Relative Humidity	% 90
5.	Altitude	mm <1000
6.	Environment:	Humid & Highly corrosive
B. Technical particulars		
1.	Motor Tag no.:	LATER
2.	Driven Equipment name:	
3.	Voltage:	V 415 +/- 10 %
4.	Phase:	Three
5.	Frequency:	Hz 50 +/- 3 %
6.	Fault level:	kA 50
7.	Method of starting:	D.O.L
8.	Winding Connection:	Delta
9.	No of Terminals:	6
10.	Cable size:	mm ² LATER
11.	Cable type:	
12.	Temperature rise:	°C 75
13.	Cooling:	IC411
14.	Insulation class:	F
15.	Temperature rise Limited to insulation class	B
16.	Hazardous area classification:	Zone2
17.	Dust classification	NA
18.	Gas group:	IIA/IIIB
19.	Dust Group	
20.	Type of explosion protection:	Ex(d)
21.	Prestart purging for Ex(n) motor	Not Required
22.	Type of ingress protection:	IP 55
23.	Color shade:	632 as per IS 5
24.	Thermistors:	Not Required
25.	RTD:	Not Required
26.	BTd:	Not Required
27.	RTD/BTD monitoring device:	Not Required
28.	Applicable specification:	6-51-0064
29.	Efficiency:	IE 2

DRIVEN EQUIPMENT MANUFACTURER's DATA

1.	Suggested motor rating:	kW	
2.	Manufacturer:		
3.	BkW at Full load:	kW	
4.	kW:at end of Curve	kW	

A			KINDO DEEPAK KARTIC		
Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By

Project	PMC Services for Installation of GTC at GAIL, Gandhar			Client	GAIL - NOIDA
Unit	New Comprssor area at Gandhar-GPU	Location		Job No.	B240
				Unit No.	910

5.	Speed:	RPM	
6.	Rotation of eqpt. from coupling end:		
7.	Driven equipment:		
8.	Coupling type:		
9.	Torque required starting	mkq	
	Torque required Maximum	mkq	
10.	GD2 of eqpt including flywheel	kqm ²	
	excluding flywheel:	kqm ²	
11.	thrust Up:	kg	
	thrust Down:	kg	
12.	Starting condition:		

MOTOR MANUFACTURER's DATA

1.	Rating:	kW	
2.	Manufacturer:		
3.	No. of poles:		
4.	Frame designation:		
5.	Full load speed:	RPM	
6.	Mounting:		
7.	Full load torque (FLT):	mkq	
8.	Starting torque:	% of FLT	
9.	Break down or pull out torque:	% of FLT	
10.	Full load current (FLC):	A	
11.	Starting current at 100% voltage:	% of FLC	
12.	Rotation viewed from coupling end:		
13.	Starting time at 75% voltage:	sec.	
	100% voltage:	sec.	
14.	Locked rotor withstand time (cold/hot) at,		
	75% voltage	sec.	
	100% voltage:	sec.	
15.	Time (Te) for Increased Safety Motor at 100% Voltag	sec.	
16.	Heating/Cooling Time Const. (min.)	min	
17.	Space heater - voltage & power:		
18.	Efficiency at 75% Load:	%	
	100% Load: voltage:	%	
19.	Power factor at 75%/ Load:		
	100% Load:		
	starting		
20.	Moment of inertia, GD2:	kqm ²	
21.	NDE bearing type & no		
22.	DE bearing type & no.:		
23.	Type of lubrication:		
24.	Weight of motor:	kq	

A			KINDO DEEPAK KARTIC		
Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By

Project	PMC Services for Installation of GTC at GAIL, Gandhar			Client	GAIL - NOIDA
Unit	New Comprssor area at Gandhar-GPU	Location		Job No.	B240
				Unit No.	910
25.	Thermisters, quantity	no.			
	make: type:				
26.	RTD, quantity:	no.			
	make: type:				
27.	BTD, quantity	no.			
	make: type:				
28.	Shaft voltage:	V			
29.	Critical speed, 1st/2nd stage:	RPM			
30.	Canopy:				

Notes

- 1 Recommended list of maintenance spares for two years operation shall include the following as minimum: (a) Bearing DE/NDE one set, (b) Terminal box coverwith screws, (c) Fan, (d) Terminal block
- 2 Cable glands to be supplied with motors shall meet all requirements as pe IS/IEC-60079.
- 3 For Approved makes of motors refer else where in the MR..
- 4 Starting time calculations shall be based on operating conditions specified on Material Requisition eg. open valve ccondition/closed valve condition, at no load/full load, as applicable.
- 5 Temperature class shall be T3.

A			KINDO DEEPAK KARTIC		
Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By

Project	PMC Services for Installation of GTC at GAIL, Gandhar			Client	GAIL - NOIDA
Unit	New Comprssor area at Gandhar-GPU	Location		Job No.	B240
				Unit No.	910

PURCHASER'S DATA

A. Site Conditions		
1.	Maximum Ambient Temperature	°C 47
2.	Minimum Ambient Temperature	°C 6
3.	Design Ambient Temperature	°C 40
4.	Relative Humidity	% 90
5.	Altitude	mm <1000
6.	Environment:	Humid & Highly corrosive
B. Technical particulars		
1.	Motor Tag no.:	
2.	Driven Equipment name:	
3.	Voltage:	V 415 +/- 10 %
4.	Phase:	Three
5.	Frequency:	Hz 50 +/- 3 %
6.	Fault level:	kA 50
7.	Method of starting:	V.S.D
8.	Winding Connection:	Delta
9.	No of Terminals:	6
10.	Cable size:	mm ² LATER
11.	Cable type:	
12.	Temperature rise:	°C 75
13.	Cooling:	IC411
14.	Insulation class:	F
15.	Temperature rise Limited to insulation class	B
16.	Hazardous area classification:	Zone2
17.	Dust classification	NA
18.	Gas group:	IIA/IIB
19.	Dust Group	
20.	Type of explosion protection:	Ex(d)
21.	Prestart purging for Ex(n) motor	Not Required
22.	Type of ingress protection:	IP 55
23.	Color shade:	632 as per IS 5
24.	Thermistors:	Required
25.	RTD:	Not Required
26.	BTd:	Not Required
27.	RTD/BTD monitoring device:	Not Required
28.	Applicable specification:	6-51-0064
29.	Efficiency:	IE 2

DRIVEN EQUIPMENT MANUFACTURER's DATA

1.	Suggested motor rating:	kW	
2.	Manufacturer:		
3.	BkW at Full load:	kW	
4.	kW:at end of Curve	kW	

A			KINDO DEEPAK KARTIC		
Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By

Project	PMC Services for Installation of GTC at GAIL, Gandhar			Client	GAIL - NOIDA
Unit	New Comprssor area at Gandhar-GPU	Location		Job No.	B240
				Unit No.	910

5.	Speed:	RPM	
6.	Rotation of eqpt. from coupling end:		
7.	Driven equipment:		
8.	Coupling type:		
9.	Torque required starting	mkq	
	Torque required Maximum	mkq	
10.	GD2 of eqpt including flywheel	kqm ²	
	excluding flywheel:	kqm ²	
11.	thrust Up:	kg	
	thrust Down:	kg	
12.	Starting condition:		

MOTOR MANUFACTURER's DATA

1.	Rating:	kW	
2.	Manufacturer:		
3.	No. of poles:		
4.	Frame designation:		
5.	Full load speed:	RPM	
6.	Mounting:		
7.	Full load torque (FLT):	mkq	
8.	Starting torque:	% of FLT	
9.	Break down or pull out torque:	% of FLT	
10.	Full load current (FLC):	A	
11.	Starting current at 100% voltage:	% of FLC	
12.	Rotation viewed from coupling end:		
13.	Starting time at 75% voltage:	sec.	
	100% voltage:	sec.	
14.	Locked rotor withstand time (cold/hot) at,		
	75% voltage	sec.	
	100% voltage:	sec.	
15.	Time (Te) for Increased Safety Motor at 100% Voltag	sec.	
16.	Heating/Cooling Time Const. (min.)	min	
17.	Space heater - voltage & power:		
18.	Efficiency at 75% Load:	%	
	100% Load: voltage:	%	
19.	Power factor at 75%/ Load:		
	100% Load:		
	starting		
20.	Moment of inertia, GD2:	kqm ²	
21.	NDE bearing type & no		
22.	DE bearing type & no.:		
23.	Type of lubrication:		
24.	Weight of motor:	kq	

A			KINDO DEEPAK KARTIC		
Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By

Project	PMC Services for Installation of GTC at GAIL, Gandhar			Client	GAIL - NOIDA
Unit	New Comprssor area at Gandhar-GPU	Location		Job No.	B240
				Unit No.	910
25.	Thermisters, quantity	no.			
	make: type:				
26.	RTD, quantity:	no.			
	make: type:				
27.	BTD, quantity	no.			
	make: type:				
28.	Shaft voltage:	V			
29.	Critical speed, 1st/2nd stage:	RPM			
30.	Canopy:				

Notes

- 1 Recommended list of maintenance spares for two years operation shall include the following as minimum: (a) Bearing DE/NDE one set, (b) Terminal box coverwith screws, (c) Fan, (d) Terminal block
- 2 Cable glands to be supplied with motors shall meet all requirements as pe IS/IEC-60079.
- 3 For Approved makes of motors refer else where in the MR..
- 4 Starting time calculations shall be based on operating conditions specified on Material Requisition eg. open valve ccondition/closed valve condition, at no load/full load, as applicable.
- 5 Temperature class shall be T3.

A			KINDO DEEPAK KARTIC		
Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By

DATA SHEET FOR A.C. VARIABLE FREQUENCY DRIVE SYSTEM (New Comprssor area at Gandhar-GPU)

PROJECT : PMC Services for Installation of GTC at GAIL, Gandhar

OWNER : GAIL

JOB NO. : B240

A	08.04.2019	ISSUED WITH MR	DK	SH	ANPS
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

DATA SHEET

PART – I (PURCHASER'S DATA)

RATING AND JOB REQUIREMENTS

1. Reference standards : EIL Spec. 6-51-0049
2. Rated output capacity : *
3. Rated output voltage : 415V, 3 phase, 50Hz
4. Motor Details
 - a) Drive system : Single/~~Multiple~~
 - b) Type of motor : Sq-Cage induction motor
 - c) KW rating : *
 - d) No. of motors : 1 No. for each Drive (As per motor data sheet)
 - e) Starting condition : Soft start
 - f) Frequency range : *
 - g) Voltage range : *
 - h) Full load current : *
 - i) Full load PF
 - At lowest KW : *
 - At Highest KW : *
 - j) Starting current : *
 - k) Load torque details : Vendor to Furnish
5. **SITE CONDITIONS:**
 - a) Amb. Temperature : 47 deg C max. , 5deg C min. (VFD to be designed for 45 deg C)
 - b) Altitude : Less than 1000 m above MSL
 - c) Humidity : 87%
 - d) Storage temperature : -
 - e) Indoor/Outdoor : Indoor (In substation)
VFD shall be suitable for continuous operation at design ambient of 45 deg C
 - f) Installation area : Substation 1

*** Vendor to furnish**

5. INPUT POWER SUPPLY SYSTEM CONDITIONS

- | | | |
|----|-----------------------|------------------|
| a) | No. of phases | :Three (4 wires) |
| b) | AC input voltage | :415 V |
| c) | Voltage fluctuation | :±6% |
| d) | Rated frequency | :50Hz |
| e) | Frequency fluctuation | :±3% |
| f) | System fault level | :NA |

6. SYSTEM REQUIREMENTS

- | | | | |
|----|--|---|------------------|
| a) | Speed range required | : | * |
| b) | Adjustment of speed | : | Auto/Manual/Both |
| c) | Speed Reference by measurement of the stator voltage frequency through voltage transformer | : | * |
| d) | Reference Signal | | |
| | 4-20 mA | : | Yes |
| | 0-10 V | : | - |
| e) | Soft start feature | : | Yes |
| | Starting current | : | 100-150 % |
| f) | By pass bkr. or Starter | : | Required |
| g) | Acceleration time | : | * |
| | Deceleration time | : | * |
| h) | Short time voltage dip | : | 80% |
| i) | Harmonic limit on input | : | As per spec. |
| j) | Fault diagnostic | : | Required |
| k) | Braking | : | * |

- l) Regeneration : *
- m) Any other requirement : Distance between VFD and motor shall be considered as 800m.

NOTES:

1. 240V, 1-Phase power supply to the motor space heater shall be taken from VFD. Necessary arrangement for these supplies shall be made available in VFD panels.
2. Vendor to furnish the duly filled-in data sheet for each type / rating of VFD for post order review.
3. Testing of motor for use with offered make of VFD Controller shall confirm to EIL spec. 6-51-0038 .

PART - II

TECHNICAL DATA FROM MANUFACTURER

1. Manufacturer's reference :
Model No.
2. Rating :
3. Applicable code/standards :
4. Speed range :
5. Speed reference :
6. Input power supply ratings :
 Voltage : $\pm$ %
 Frequency : $\pm$ %
7. Overload capability :
 a) 125% In for : minutes
 b) 150% In for : secs.
 c) Inrush current 250% In for : secs.
8. Overall efficiency :
9. Overall power factor at :
 a) 100% load :
 b) 75% load :
 c) 50% load :
 d) 25% load :
10. AC Output :
 a) Output voltage :
 b) Voltage accuracy :
 c) Rated frequency range :
 d) Frequency :
 e) Voltage unbalance :

- f) Field supply voltage :
- g) Max. field current :
11. Transient voltage :
- a) fluctuation ratio :
- b) Its recovery time :
12. Transient Torque
- 12.1 Max. Transient air gap torque/ duration :
- 12.2 Max. Transient torque/ duration :
- Same shall be furnished at the coupling of VSDS, accounting for the motor and the driven equipment in the case of a two and a three phase short-circuit at the motor terminal.
13. Wave form distortion factor :
(% harmonics) in output/
Input waveform.
- (Number of harmonics and magnitude of each harmonic generated shall be furnished).
14. Output short ckt. Capability :
and duration.
15. Deration of motor at :
- a) Maximum speed :
- b) Minimum speed :
16. Permissible No. of starts
- | | | |
|------|---|-----------------------|
| Hot | : | Uniformly distributed |
| Cold | : | in one hour |
17. Controls
- a) System Start :
- b) System Stop :
- c) Speed Raise :
- d) Speed Lower :
- e) Drive frequency setting :

- f) Auto/manual operation :
- i) At panel :
- ii) At remote control :
- g) Local/ remote operation for controls :
- i) At panel :
- ii) At remote :
- h) Jog mode :
- i) Reversing :
- j) Dynamic brake :
- k) Remote bkr. Trip :
- l) Motorised potention for reference value selection :
- m) Electronic Ramp function :
- n) Speed and current controller :
18. Rectifier/ Inverter
- a) Make :
- b) Type/Model No. :
- c) i) Diodes/GTOs configuration :
- ii) Total No. of Diodes/GTOs :
- d) i) Overall converter efficiency for complete range :
- Plot of efficiency Vs. speed shall be furnished. :
- ii) Converter efficiency at 100%, 75%,50% load and unity power factor. :

- iii) Efficiency of Inverter:
at 100%, 75%, 50% load at
unity power factor
- e) Overall P.F. of complete :
system plot of P.F. Vs speed
shall be furnished.
- f) Cooling system
- i) Type :
- ii) Redundancy :
in cooling Units
- g) Type of feed back for speed :
control
- h) Speed control accuracy :
- i) List of controls provided :
at the front of panel
- j) List of status measuring :
devices provided at the
front of Panel
- k) List of status indication :
and Annunciation provided
19. Type of Electronic Card :
mounting arrangement.
20. **DIMENSION**
- a) Length :
- b) Height :
- c) Depth :
- d) Weight of cubicle :
- (Dimensional details of all panels shall be furnished).
21. Degree of protection for :
enclosure.
22. Paint shade :
23. Heat output of Panel :

24. Whether Air Conditioning is required for these panels. :
25. Control supply voltage and Aux. Power requirement :
26. **Main Transformer** :
- a) Make :
- b) Type of Transformer : Oil Filled/ Dry Type/Cast resin type
- c) KVA Rating :
- d) Voltage ratio :
- e) Vector group :
- f) Impedance :
- g) Overall dimension (L&B&X) :
27. DC Reactor
- a) Make :
- b) Type :
- c) Rating :
- d) Type of cooling :
- e) Overall Dimensions :
- f) Heat output :
- g) Inductance of the reactor :
- h) Air Core/Iron Core :
- i) Efficiency :
28. Local control panel Required as per spec. : No
29. Any other requirement :

Generated through Electrical Datasheet system (Copyrights EIL - All rights reserved)

Project	PMC Services for Installation of GTC at GAIL, Gandhar			Client	GAIL - NOIDA
Unit	New Comprssor area at Gandhar-GPU	Location		Job No.	B240
				Unit No.	910

4.	Degree of protection	
5.	CB panel	
	Overall weight	
	Incomer	
	Outgoing	
	Overall dimensions	
	Length*Depth*Height	
6.	Overall dimensions of MCC/ contactor controlled feeder panel	
	Length*Depth*Height	
7.	Overall dimensions of each PCC	
	Length*Depth*Height	
8.	Overall dimensions of each PMCC/ EPMCC	
	Length*Depth*Height	
9.	Overall dimensions of each MCC	
	Length*Depth*Height	
10.	Overall dimensions of each ASB	
	Length*Depth*Height	
11.	Overall dimensions of each LDB	
	Length*Depth*Height	
12.	Largest shipping section:	
	Max. overall weight	
	Length*Depth*Height	
13.	Recommended clearances for SWBD	
	Front*Rear*Above	
14.	Shock loading on foundation	
15.	Max. size/no. of cables that can be terminated	
	with rear extension	
	without rear extension	
16.	Size of rear extension panel	
17.	Clearance in air	
	Phase to Phase	
	Phase to Earth	
18.	Main horizontal bus bar	
	Bus bar current rating at	
	design ambient temp.	
	Main bus bar size	
	Main bus bar material	
	Main bus bar location	
19.	Vertical bus bars	
	Bus bar current rating at	
	design ambient temp.	
	Bus bar size	
	Bus bar material	
	Bus bar location	
20.	Insulating material	

A			KINDO DEEPAK KARTIC		
Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By

Project	PMC Services for Installation of GTC at GAIL, Gandhar			Client	GAIL - NOIDA
Unit	New Comprssor area at Gandhar-GPU	Location		Job No.	B240
				Unit No.	910

21.	Earth bus bar size	
	Material	
22.	1min power freq voltage	
23.	Short circuit	
	1 second	
	Peak dynamic	
24.	Whether adaptor panel required	
	between PCC/MCC panel	
	If Yes, furnish dimensions	
B. Circuit breaker		
1.	Type designation	
2.	Make	
3.	Mounting	
4.	No. of poles/phases	
5.	Current rating (in air)	
6.	Current rating (inside panel	
	at design temperature)	
7.	Short time rating (1 sec)	
8.	Sym breaking capacity	
	% DC component	
9.	Peak making capacity	
10.	Power frequency withstand	
11.	Impulse withstand voltage	
12.	Duty cycle	
13.	Total opening time	
14.	Total closing time	
15.	Power requirement	
	Opening	
	Closing	
	Spring charge motor	
16.	Time for spring charging	
17.	Breaker is trip free	
18.	Closing mechanism	
19.	Provision of manual spring charging	
20.	Tripping mechanism	
21.	Mechanical trip PB provided	
22.	Mechanical ON/OFF indicator provided	
23.	Operation counter provided	
24.	Time taken for spring charging	
25.	No. of auxiliary contacts	
26.	Derating required for capacitor switching	
C. Contractor		
1.	Type designation	
2.	Make	
3.	Rated Voltage	
4.	Rated current	

A			KINDO DEEPAK KARTIC		
Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By

Generated through Electrical Datasheet system (Copyrights EIL - All rights reserved)

Project	PMC Services for Installation of GTC at GAIL, Gandhar	Client	GAIL - NOIDA
----------------	---	---------------	--------------

Unit	New Comprssor area at Gandhar-GPU	Location		Job No.	B240	Unit No.	910
-------------	-----------------------------------	-----------------	--	----------------	------	-----------------	-----

2.	Type	
3.	Rated voltage	
4.	Rated current	
5.	Rated frequency	
6.	No. of poles	
7.	Derating factor for operation under site conditions	
8.	Rated 10 sec short time rating	
9.	Rated breaking capacity at service voltag	
10.	No. of operations at full fault	
11.	No. of operations at partial fault	
12.	No. of guaranteed mech. operations	
13.	1 min dry p.f with stand voltage	
14.	Shunt trip feature (for MCCB only)	
15.	Operating voltage range for MCCB shunt trip	

Eil Notes

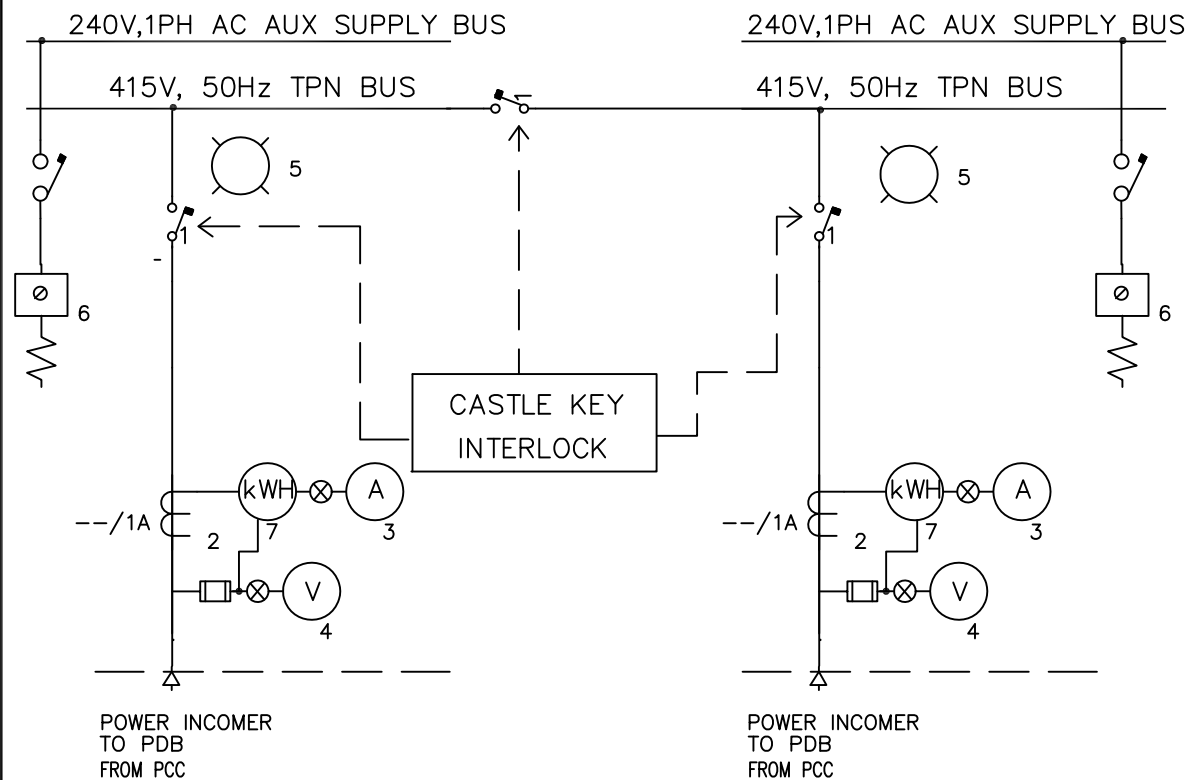
- 1 Vendor shall furnish dimensions of various switchboards, CB panels and dummy/adaptor panels separately.
- 2 Switchboard offered shall be of proven design and shall have been successfully type tested. Type test certificates for an exactly identical design of offered switchboard shall be furnished by bidders. These test reports shall be not more than 5 years old, as on the final bid opening date. In case these type tests have not been conducted during the last 5 years, bidder shall conduct these type tests on the offered design of switchboard before despatch without any extra cost and delivery impact.
- 3 Vendor shall furnish technical particulars of various switchboards separately.

A			KINDO DEEPAK KARTIC		
Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By

The drawing, design and details given on this format are the property of ENGINEERS INDIA LIMITED. They are merely loaned on the borrower's express agreement that they will not be reproduced, copied, exhibited or used except in the limited way permitted by the lender to the borrower for the intended use. EIL-1650-Mv ic_mcc_asb_ldb.dwg Rev.0. A4-210x297.

REV	DATE	PURPOSE	BY	CHKD	APPRV
A	09.04.2019	ISSUED WITH MR	DK	SH	ANPS
PROJECT: PMC SERVICES FOR INSTAL-LATION OF GTC AT GAIL, GANDHAR					
CLIENT: M/S GAIL GANDHAR					

EQUIPMENT DATA(FOR EACH INCOMER)			
ITEM NO.	NEMA NO.	QTY.	DESCRIPTION
1	-	1	ISOLATOR (TPN) SUITABLE FOR 50 KA (1SEC)
2	-	3	METERING CT, CL-1, 10VA
3	-	1	AMMETER WITH 4WAY SELECTOR SWITCH.
4	-	1	VOLTMETER WITH 4WAY SELECTOR SWITCH & FUSE
5	-	3	R Y B INDICATING LAMPS - LED TYPE
6	-	1	PANEL SPACE HEATER WITH MCB AND THERMOSTAT
7	-	1	KWH METER



NOTES

- 1. THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE . ALL THE ITEMS "EQUIPMENT DATA" AND IN SPECIFICATION 6-51-0018 SHALL BE IN VENDOR'S SCOPE.
- 2. MCCB FOR GTMCC SHALL BE SUITABLE FOR THE SYSTEM FAULT LEVEL 50KA(1SEC)
- 3. KWH METER SHALL BE PROVIDED FOR EACH INCOMER OF PDB IRRESPECTIVE OF RATING.
- 4. FOR THE OTHER REQUIREMENTS OF RELAYS AND METERS, INCLUDING SEPARATE METERS AND MULTIFUNCTION METER,



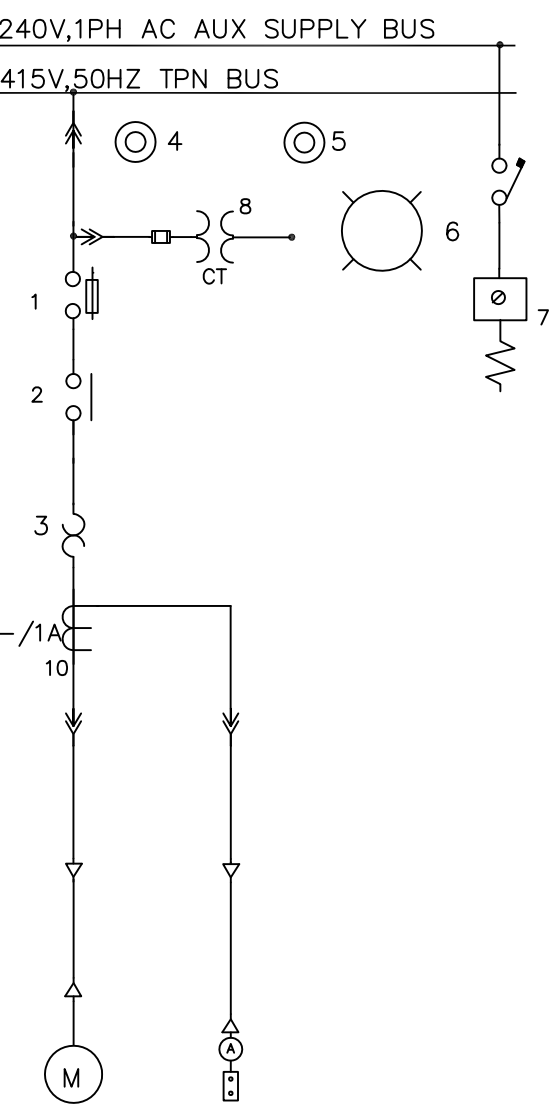
ENGINEERS INDIA LIMITED
NEW DELHI

M.V. SW. BD. DATA SHEET
GTMCC INCOMER

DATA SHEET	REV
B240-910-16-50-DS-5014 SHEET 1 OF 5	A

The drawing, design and details given on this format are the property of ENGINEERS INDIA LIMITED. They are merely loaned on the borrower's express agreement that they will not be reproduced, copied, exhibited or used except in the limited way permitted by the lender to the borrower for the intended use. EIL-1650-Mvswb_conmotfrd.dwg Rev.0. A4-210x297.

REV	DATE	PURPOSE	BY	CHKD	APPRV
A	09.04.2019	ISSUED WITH MR	DK	SH	ANPS



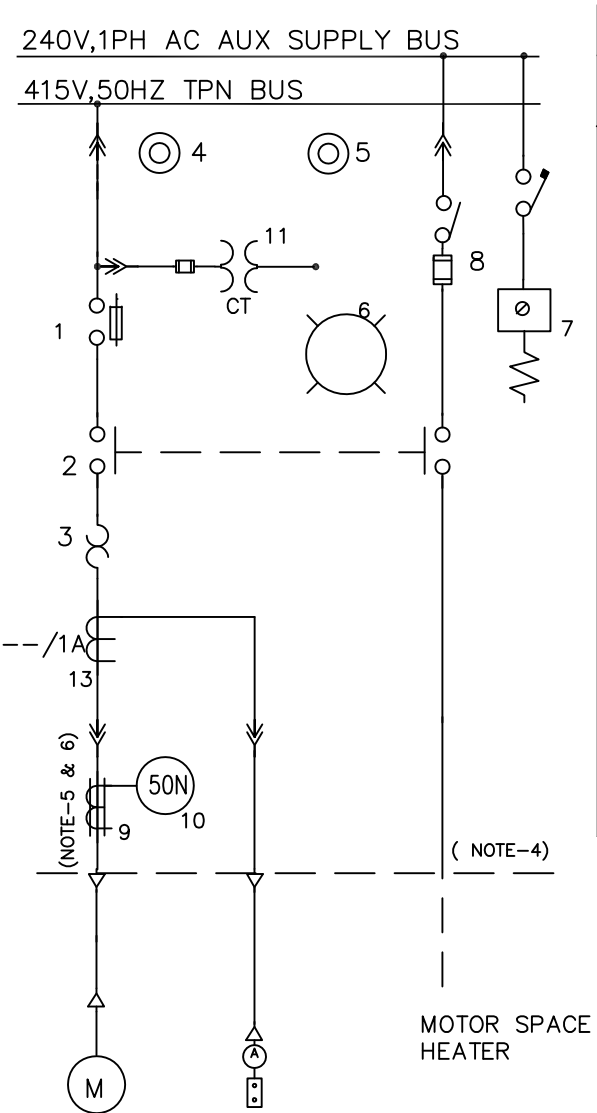
EQUIPMENT DATA			
ITEM NO.	NEMA NO.	QTY.	DESCRIPTION
1	—	1	MOTOR DUTY FUSE SWITCH (DUTY AC-23)
2	—	1	AIR BREAK CONTACTOR, DUTY-AC3 WITH 2NO+2NC AUXILIARY CONTACTS.
3	49	1SET	THERMAL O/L RELAY WITH INHERENT PROTECTION AGAINST SINGLE PHASING
4	—	1	STOP PUSH BUTTON
5	—	1	RESET PUSH BUTTON FOR BIMETAL RELAY
6	—	AS REQD	INDICATING LAMPS - LED TYPE
7	—	1	PANEL SPACE HEATER WITH MCB AND THERMOSTAT
8	—	1	415/240V, CONTROL TRANSFORMER
9	—	AS REQD	AUX.CONTACTORS WITH MIN.2NO+2NC CONTACTS
10	—	1	METERING CT CL-1.0, 15VA

NOTES:

1. THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN SPECIFICATION 6-51-0093 SHALL BE IN VENDOR'S SCOPE.
2. COMPONENT RATING SHALL BE AS PER DATA SHEET
3. NO. OF CONTROL TERMINALS PROVIDED SHALL INCLUDE 20% SPARE TERMINALS SUBJECT TO A MINIMUM 24 TERMINALS.
4. METERING CT SHALL BE PROVIDED FOR MOTORS ABOVE 5.5 KW.

The drawing, design and details given on this format are the property of ENGINEERS INDIA LIMITED. They are merely loaned on the borrower's express agreement that they will not be reproduced, copied, exhibited or used except in the limited way permitted by a written consent given by the lender to the borrower for the intended use. EIL-1650-Mvswb_conmotfr.dwg Rev.0. A4-210x297.

REV	DATE	PURPOSE	BY	CHKD	APPRV
A	09.04.2019	ISSUED WITH MR	DK	SH	ANPS



EQUIPMENT DATA			
ITEM NO.	NEMA NO.	QTY.	DESCRIPTION
1	—	1	MOTOR DUTY FUSE SWITCH DUTY AC23
2	—	1	AIR BREAK CONTACTOR, DUTY-AC3 WITH 2NO+2NC AUXILIARY CONTACTS.
3	49	1SET	THERMAL O/L RELAY WITH INHERENT PROTECTION AGAINST SINGLE PHASING
4	—	1	STOP PUSH BUTTON
5	—	1	RESET PUSH BUTTON FOR BIMETAL RELAY
6	—	AS REQD	INDICATING LAMPS - LED TYPE
7	—	1	PANEL SPACE HEATER WITH MCB AND THERMOSTAT
8	—	1	DP SWITCH & FUSE FOR MOTOR SPACE HEATER
9	—	1	CORE BALANCE CURRENT TRANSFORMER
10	50N	1	EARTH LEAKAGE RELAY 'AREVA' TYPE CTUM-15 SETTING RANGE (1-16%) WITH BUILTIN TIMER
11	—	1	415/240V, CONTROL TRANSFORMER
12	—	AS REQD	AUX.CONTACTORS WITH MIN.2NO+2NC CONTACTS
13	—	1	METERING CT CL-1.0, 15VA

NOTES:

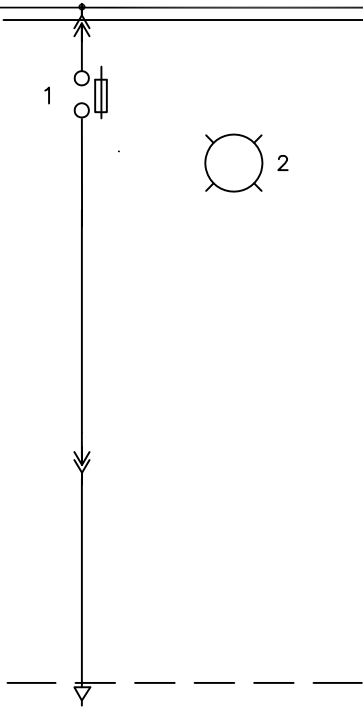
1. THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN SPECIFICATION 6-51-0018 SHALL BE IN VENDOR'S SCOPE.
2. COMPONENT RATING SHALL BE AS PER DATA SHEET
3. NO. OF CONTROL TERMINALS PROVIDED SHALL INCLUDE 20% SPARE TERMINALS SUBJECT TO A MINIMUM 24 TERMINALS.
4. MOTOR SPACE HEATER CKT. TO BE PROVIDED FOR MOTORS RATED 30kW AND ABOVE.
5. CBCT AND ELR SHALL BE PROVIDED FOR MOTORS RATED MORE THAN 30 KW.
6. AREVA RELAYS ARE INDICATED FOR TYPE REFERENCE ONLY.

The drawing, design and details given on this format are the property of ENGINEERS INDIA LIMITED. They are merely loaned on the borrower's express agreement that they will not be reproduced, copied, exhibited or used except in the limited way permitted by a written consent given by the lender to the borrower for the intended use. EIL-1650-Mv sfu_fdr.dwg Rev.0. A4-210x297.

PROJECT: PMC SERVICES FOR INSTALLATION OF GTC AT GAIL GANDHAR	REV	DATE	PURPOSE	BY	CHKD	APPRV
CLIENT: M/S GAIL GANDHAR	A	09.04.2019	ISSUED WITH MR	DK	SH	ANPS

240V,1PH AC AUX SUPPLY BUS

415V, 50Hz TPN BUS



EQUIPMENT DATA

ITEM NO.	NEMA NO.	QTY.	DESCRIPTION
1	-	1	HEAVY DUTY SWITCH FUSE UNIT (DUTY AC 22)
2	-	3	INDICATING LAMPS - LED TYPE

NOTES:

1. THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN SPECIFICATION 6-51-0018 SHALL BE IN BIDDER'S SCOPE.
2. FOR THE OTHER REQUIREMENTS OF RELAYS AND METERS INCLUDING SEPARATE METERS AND MULTIFUNCTION METER, REFER JOB SPECIFICATION.



ENGINEERS INDIA LIMITED
NEW DELHI

M.V. SW. BD. DATA SHEET
SWITCH FUSE FEEDER

DATA SHEET

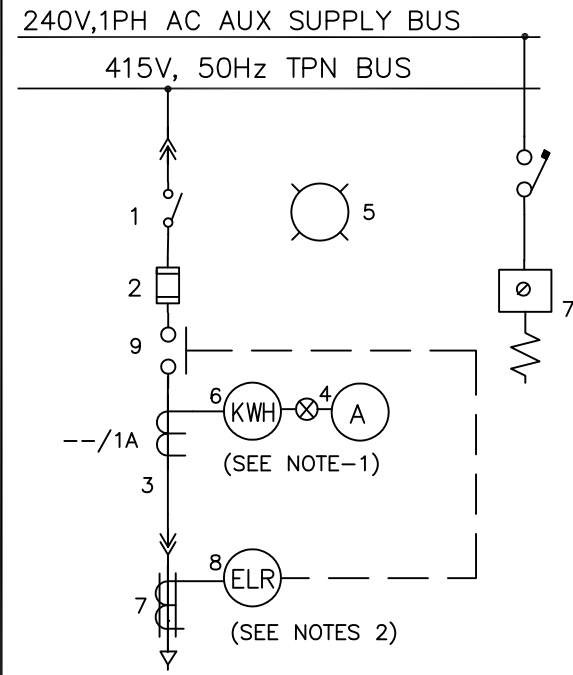
REV

B240-910-16-50-DS-5014
Sheet 4 OF 5

A

The drawing, design and details given on this format are the property of ENGINEERS INDIA LIMITED. They are merely loaned on the borrower's express agreement that they will not be reproduced, copied, exhibited or used except in the limited way permitted by a written consent given by the lender to the borrower for the intended use. EIL-1650-Mv sfu_fdr.dwg Rev.0. A4-210x297.

REV	DATE	PURPOSE	BY	CHKD	APPRV
A	09.04.2019	ISSUED WITH MR	DK	SH	ANPS



EQUIPMENT DATA			
ITEM NO.	NEMA NO.	QTY.	DESCRIPTION
1	-	1	HEAVY DUTY SWITCH WITH NEUTRAL LINK
2	-	3	HRC FUSE WITH FUSE BASE
3	-	3	METERING CT, CL-1, 10VA
4	-	1	AMMETER WITH 4WAY SELECTOR SWITCH.
5	-	3	INDICATING LAMPS - LED TYPE
6	-	1	KWH METER WITH ACCURACY CL.1.0
7	-	1	CORE BALANCE CURRENT TRANSFORMER
8	-	1	EARTH LEAKAGE RELAY 'ALSTOM' TYPE CTUM-15 SETTING RANGE (1-16%) WITH BUILT-IN TIMER
9	-	1	CONTACTOR

NOTES:

1. CT, AMMETER AND KWH METER SHALL BE PROVIDED FOR SWITCH FUSE FEEDER RATED 250A & ABOVE.
2. CBCT, ELR AND CONTACTOR SHALL BE PROVIDED FOR FEEDERS RATED 250A AND ABOVE.
3. THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN SPECIFICATION 6-51-0093 SHALL BE IN VENDOR'S SCOPE.

FEEDER TYPE	MOTOR RATING KW	APPROX. CABLE SIZE	COMPONENT RATING (A)				
			FUSE/BMR	FUSE/BMR	CT RATIO	HEAVY DUTY SWITCH	CONTACTOR (AC3)
FVNR-15 FVR - 15 FVNR - 15HD	≤ 5.5	3*16	6/0.8-1.2 10/2.5-4 16/5.5-8 32/11-16	10/2-3.3 16/4.5-7.5 20/6-10 32/9-15	—	32	15
FVNR-30 FVR - 30 FVNR - 30HD	5.5 <KW ≤ 11	3*35	32/11-16 63/30-45	32/9-15 63/14-23	30/1	63	30
FVNR-60 FVR - 60 FVNR - 60HD	11 <KW ≤ 22	3*70	63/25-40 80/30-45	63/20-33 100/30-50	60/1	125	60
FVNR-100 FVR - 100 FVNR - 100HD	22 <KW ≤ 45	3*150	125/38-63 160/50-90 200/70-110	125/45-75 150/45-75 200/66-110	100/1	250	100
FVNR-150 FVR - 150 FVNR - 150HD	45 <KW ≤ 55	3*185	200/70-110	200/66-110	150/1	400	150
FVNR-200 FVR-200 FVNR-200HD	55 <KW ≤ 90	2*3*120	MOTOR PROTECTION RELAY (46, 50, 49, 50N & 51LR)		200/1	400	200
FVNR-300 FVR-300 FVNR-300HD	90 <KW ≤ 132	2*3*185	MOTOR PROTECTION RELAY (46, 50, 49, 50N & 51LR)		300/1	400	300
FVNR-400 FVR-400 FVNR-400HD	132 <KW ≤ 160	2*3*300	MOTOR PROTECTION RELAY (46, 50, 49, 50N & 51LR)		400/1	630	400
FVNR-600 FVR-600 FVNR-600HD	160 <KW ≤ 250	2*3*300	MOTOR PROTECTION RELAY (46, 50, 49, 50N & 51LR)		600/1	630	600
SWF-32	—	3.5*50	32	32	—	32	—
SWF-63	—	3.5*50	63	63	—	63	—
SWF-100	—	3.5*120	100	100	—	100	—
SWF-125	—	2*3.5*120	125	125	—	125	—
SWFC-250	—	2*3.5*300	250	250	250/1	250	—
SWFC-63	—	3.5*50	63	63	—	63	63
MCCB-125	MCCB	2*3.5*120	MCCB WITH O/C, S/C & E/F RELEASES		—	—	125 (See note-2)
MCCB-160	MCCB	2*3.5*185	MCCB WITH O/C, S/C & E/F RELEASES		—	—	160 (See note-2)
MCCB-250	MCCB	2*3.5*300	MCCB WITH O/C, S/C & E/F RELEASES		250/1	—	250 (See note-2)
MCCB-400	MCCB	3*3.5*300	MCCB WITH O/C, S/C & E/F RELEASES		400/1	—	400 (See note-2)

A	08.04.2019	ISSUED WITH TENDER	DK	SH	ANPS
Rev.	Date	Purpose	Prepared	Checked	Approved

NOTES:

1. CT for metering shall be provided for motor rated above 5.5kW .
2. Contactor with CBCT and earth leakage relay shall be provided for MCCB feeder rated more than 100A and upto 400A .
3. Major components are shown above, all other items as specified in equipment data sheet and specification: 6-51-0018 shall also be in vendor's scope.
4. Typical fuse rating and bimetal relay ranges are specified above. Final fuse rating and bimetal range shall be selected by the manufacturer meeting type-2 co-ordination as per IS-13947.
5. Number of cores for motor feeders shall be 3.

Generated through Electrical Datasheet system (Copyrights EIL - All rights reserved)

Project PMC Services for Installation of GTC at GAIL, Gandhar					Client GAIL - NOIDA		
Unit New Comprssor area					Job No. B240		Unit No. 910
3. DC distribution board							
a. Type					Compartmentalized		
b. Feeder requirements							
	SI No.	Item no. as per MR	Feeder type	Feeder rating	No. of feeders	Max. cable size	Rating of DC contactor for lighting
	1						
4. ECS Interface							
a. Indication-Charger failure					Required		
b. Indication-Inverter failure					Required		
c. Indication-Battery discharged					Required		
d. Indication-Battery isolated					Required		
MANUFACTURER'S DATA							
A. Battery							
1.	Item no. As per MR/PR						
2.	Tag. No.						
3.	Manufacturer's name						
4.	Type & Catalogue no. of cell						
5.	Ampere hour capacity						
6.	No. of cells						
7.	Nominal cell voltage						
8.	Cell voltage at the end of full discharge at 10 hrs/ 5 hrs rate						
9.	Specific gravity of electrolyte at the end of full charging at °C						
10.	Specific gravity of electrolyte at the end of full discharge at 10 hrs/5 hrs rate at °C						
11.	Quantity of electrolyte per cell						
12.	Weight of cell with electrolyte						
13.	Quick charging current						
	Max. safe quick charging rate						
	Permissible ripple content						
14.	Suggested quick charging rate						
15.	Quick charging voltage						
	Max. quick charging voltage/cell						
	Quick charging voltage/cell for constant voltage finish charging						
16.	Float charging voltage/cell						
17.	Float charging current						
	Float charging current range						
	Permissible ripple content						
18.	AH efficiency at 10 hrs/5 hrs rate						
19.	Short ckt current of battery bank						
20.	Short circuit withstand time						
21.	Max. allowable temp.of electrolyte the cells can withstand without injurious effects						
	Continuously						
	Short period						
Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By		

Generated through Electrical Datasheet system (Copyrights EIL - All rights reserved)

Project PMC Services for Installation of GTC at GAIL, Gandhar		Client GAIL - NOIDA
Unit	New Comprssor area	Location
Job No.	B240	Unit No. 910
13.	Safety factor for component selection	
14.	Charger dimensions	
	Width	
	Depth	
	Height	
15.	Max. heat loss in watts	
16.	Degree of protection	
C.	DCDB	
1.	Item no. As per MR/PR	
2.	Tag. No.	
3.	Manufacturer's name	
4.	DCDB dimensions	
	Width	
	Depth	
	Height	
5.	Degree of protection	
D.	Cell booster	
1.	Item no. As per MR/PR	
2.	Tag. No.	
3.	Manufacturer's name	
4.	Current rating	
5.	Voltage range	
6.	Dimensions	
	Width	
	Depth	
	Height	

Eil Notes

- 1 All interconnecting cables of DC system is in scope of bidder. cable sizes/details shall be furnished by bidder for EIL review.
- 2 ECS Interface Normally Open (NO) potential free contacts shall be wired upto terminal strip for connection to ECS interface

A			KINDO DEEPAK KARTIC		
Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By

ELECTRICAL LOAD DATA

(New Compressor area at Gandhar-GPU)

A	08.04.19	ISSUED WITH MR	DK	SH	ANPS	
REV	DATE	PURPOSE	BY	CHECKED	APPROVED	
 ENGINEERS INDIA LIMITED NEW DELHI		Project: PMC Services for Installation of GTC at GAIL, Gandhar Location: Gandhar Client: M/s GAIL	Electrical Load Data	DRAWING NO	Date	REV
				B240-910-16-50-DS-5017 Sheet 1 of 2	08.4.19	A

The drawing, design and details given on this format are the property of ENGINEERS INDIA LIMITED. They are merely loaned on the borrower's express agreement that they will not be reproduced, copied, exhibited or used, except in the limited way permitted by a written consent given by the lender to the borrower for the intended use. EIL-1650-1281, Rev1 A4-210 X 297

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
S.no	Tag no.	Service	Nor- mal / Std.by	Type of eqpt.: Pump/Cent. comp./Recip.com p./blower etc.	Manufacturer of equipment	Eqpt. Statu s	Mounting	Drive arrgmt.	Rated speed r.p.m.	GD of Rot. Part kg-m	Desi- gn abs. Shaft kW	End of curve /max KW	Min Rec. kW of motor	Dri ver incl Yes /No	Mot. dir. of rot. (from nde)	Motor	
																Rated kW	Speed rpm

Legend for Equipment status: # : Based on offer @ : Based on formal data * : Estimated Sheet X of X

 ENGINEERS INDIA LIMITED NEW DELHI	Plant: PMC Services for Installation of GTC at GAIL, Gandhar Location: Gandhar Client: M/s GAIL	Electrical Load Data	DRAWING NO	Date	REV
			B240-910-15-50-DS-5017 Sheet 2 of 2	08.04.19	A

VENDOR DATA REQUIREMENTS FOR ELECTRICS OF GAS TURBINE COMPRESSOR

A	10-APR-2019	ISSUED WITH MR	DK	SH	ANPS
Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by

VENDOR DATA REQUIREMENTS

The following drawings/documents marked "✓" shall be furnished by the bidder.

BATTERY & BATTERY CHARGER

S. N O.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Vendor Drawing/ Document Submission Schedule (Format EIL-1641-1923)		✓		✓	
2.	List of deviations, if any, to MR requirements		✓			
3.	Data Sheets (Duly filled-in)		✓		✓	
4.	Dimensional/Assembly Drawings : GA Drawing for Charger Panels, Cell Boosters and DCDB		✓		✓	
5.	Dimensional/Assembly Drawings : Battery Rack Arrangement Drawing		✓		✓	
6.	Dimensional/Assembly Drawings : Sectional View Drawing			✓	✓	
7.	Dimensional/Assembly Drawings : Cubical Arrangement Drawing			✓	✓	
8.	Dimensional/Assembly Drawings : Installation Plan/ Mounting Details/ Cable Cutout Details			✓	✓	
9.	Dimensional/Assembly Drawings : Bill of Material			✓	✓	
10.	Electrical Wiring Drawings : Single Line Diagram		✓		✓	
11.	Electrical Wiring Drawings : Block and Logic Diagrams			✓	✓	
12.	Electrical Wiring Drawings : Control Schematics			✓	✓	
13.	Electrical Wiring Drawings : Wiring Diagram and Terminal Details			✓	✓	
14.	Electrical Wiring Drawings : Interconnection Diagrams			✓	✓	
15.	Calculations for : Battery Sizing			✓	✓	
16.	Calculations for : Charger Sizing			✓	✓	
17.	Calculations for : System Cables			✓	✓	
18.	QA Plan of Vendor		✓		✓	
19.	Inspection & Test Plan (ITP) -For review by Inspection Dept.		✓		✓	Refer Note- ^{*1}
20.	Site Acceptance Test Procedure			✓	✓	
21.	Test Records			✓	✓	
22.	Type Test Certificates for similar equipment		✓		✓	
23.	Performance Curves of battery			✓	✓	
24.	List of Commissioning Spares		✓		✓	
25.	List of Maintenance Spares		✓		✓	

**VENDOR DATA REQUIREMENTS
FOR
ELECTRICS OF GAS TURBINE
COMPRESSOR**

S. N. O.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
26.	List of Special Tools & Tackles		✓		✓	
27.	Data Books/ Manuals : Installation Manual		✓		✓	
28.	Data Books/ Manuals : Operating/ Maintenance Manual		✓		✓	
29.	Data Books/ Manuals : Catalogues/ Brochures		✓		✓	
30.	Equipment storage procedure at site		✓		✓	

FLAMEPROOF CONTROL STATIONS

S. N. O.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Schedule of Vendor Documents		✓		✓	
2.	Dimensional/Assembly Drawings : GA Drawings (For control station and canopy)		✓		✓	
3.	Dimensional/Assembly Drawings : Installation and mounting details			✓	✓	
4.	Wiring Diagram And Terminal Details			✓	✓	
5.	Type Test Certificate from Independent Test Lab			✓	✓	
6.	Statutory approval certificate			✓	✓	
7.	BIS Licence			✓	✓	
8.	List of Maintenance Spares			✓	✓	
9.	List of Special Tools & Tackles			✓	✓	
10.	Inspection & Test Plan (ITP) -For review by Inspection Dept.		✓		✓	Refer Note- ¹ *
11.	Test Records				✓	
12.	Data Books/ Manuals : Installation Manual				✓	
13.	Data Books/ Manuals : Operating/ Maintenance Manual				✓	
14.	Data Books/ Manuals : Catalogues/ Brochures				✓	
15.	Equipment storage procedure at site				✓	

MEDIUM VOLTAGE SWITCHBOARD

S. N. O.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Schedule of Vendor Documents		✓			

**VENDOR DATA REQUIREMENTS
FOR
ELECTRICS OF GAS TURBINE
COMPRESSOR**

S. N. O.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
2.	Confirmation of Technical Compliance					
3.	Data Sheets (Duly filled-in)		✓		✓	
4.	Dimensional/Assembly Drawings : GA Drawings		✓			
5.	Dimensional/Assembly Drawings : Installation Plan/Mounting Details			✓	✓	
6.	Dimensional/Assembly Drawings : Cross Sectional View			✓	✓	
7.	Dimensional/Assembly Drawings : Bus Duct GA Drawing		✓		✓	
8.	Dimensional/Assembly Drawings : Bus Duct Termination Drawing			✓	✓	
9.	Dimensional/Assembly Drawings : Cubicle Arrangement Drawing			✓	✓	
10.	Dimensional/Assembly Drawings : Name Plate Drawing			✓	✓	
11.	Dimensional/Assembly Drawings : GA drawing of Data Concentrator, HMI			✓		
12.	Electrical Wiring Drawings : Single Line Diagram		✓		✓	
13.	Electrical Wiring Drawings : Block and Logic Diagrams		✓			
14.	Electrical Wiring Drawings : Control Schematics			✓		
15.	Electrical Wiring Drawings : Wiring Diagram and Terminal Details			✓	✓	
16.	Electrical Wiring Drawings : Interpanel Wiring Diagram			✓	✓	
17.	Electrical Wiring Drawings : System Architecture		✓			
18.	Bill Of Material			✓	✓	
19.	Relay Characteristic Curve			✓	✓	
20.	Auxiliary Power Requirement Data (AC & DC)		✓		✓	
21.	Test Records				✓	
22.	Inspection & Test Plan (ITP) -For review by Inspection Dept.		✓		✓	Refer Note- ¹ & ²
23.	Type Test Certificate for Panel, Breakers & Bus ducts				✓	
24.	List of Commissioning Spares				✓	
25.	List of Maintenance Spares				✓	
26.	List of Mandatory Spares		✓			
27.	List of Special Tools & Tackles				✓	
28.	Data Books/ Manuals : Installation Manual				✓	
29.	Data Books/ Manuals : Operating/ Maintenance Manual				✓	
30.	Data Books/ Manuals : Catalogues/ Brochures				✓	
31.	Relay Parameterisation			✓		

**VENDOR DATA REQUIREMENTS
FOR
ELECTRICS OF GAS TURBINE
COMPRESSOR**

S. N O.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
32.	Data Mapping Details			✓		
33.	ECS I/O List			✓		

MV MOTOR

S. N O.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Schedule of Vendor Documents		✓		✓	
2.	Confirmation of Technical Compliance					
3.	Data Sheets (Duly filled-in)		✓		✓	
4.	Dimensional/Assembly Drawings : GA Drawing For motors < 75kW			✓		
5.	Dimensional/Assembly Drawings : GA Drawing For motors >= 75kW		✓			
6.	Dimensional/Assembly Drawings : Installation Plan/Mounting Details			✓	✓	
7.	Dimensional/Assembly Drawings : Terminal Box Arrangement			✓	✓	
8.	Dimensional/Assembly Drawings : Name Plate Drawing			✓	✓	
9.	Performance Curves : Speed Torque Curves			✓	✓	
10.	Performance Curves : Speed-Current/Time Curves			✓	✓	
11.	Performance Curves : Thermal Withstand Curves (Hot & Cold)			✓	✓	
12.	Performance Curves : P.f. & Efficiency Curves			✓	✓	
13.	Inspection & Test Plan (ITP) -For review by Inspection Dept.		✓		✓	Refer Note- ¹ *
14.	Test Records				✓	
15.	Type Test Certificates for similar equipment			✓	✓	
16.	List of Commissioning Spares					
17.	List of Maintenance Spares					
18.	List of Mandatory Spares		✓			
19.	List of Special Tools & Tackles					
20.	Data Books/ Manuals : Installation Manual				✓	
21.	Data Books/ Manuals : Operating/ Maintenance Manual				✓	
22.	Data Books/ Manuals : Catalogues/ Brochures				✓	
23.	Equipment storage procedure at site				✓	

**VENDOR DATA REQUIREMENTS
FOR
ELECTRICS OF GAS TURBINE
COMPRESSOR**

MV VFD

S. N. O.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Schedule of Vendor Documents		✓		✓	
2.	Confirmation of Technical Compliance					
3.	Dimensional/Assembly Drawings : GA Drawings		✓		✓	
4.	Dimensional/Assembly Drawings : Installation Plan/Mounting Details			✓	✓	
5.	Dimensional/Assembly Drawings : Terminal Box Arrangement			✓	✓	
6.	Dimensional/Assembly Drawings : Name Plate Drawing			✓	✓	
7.	Performance Curves : Speed Torque Curves			✓	✓	
8.	Performance Curves : Speed-Current/Time Curves			✓	✓	
9.	Performance Curves : Thermal Withstand Curves (Hot & Cold)			✓	✓	
10.	Performance Curves : P.f. & Efficiency Curves			✓	✓	
11.	Schemactic and Logic Diagram			✓	✓	
12.	Block Diagram/ Interconnection Diagram			✓	✓	
13.	Wiring Diagram			✓	✓	
14.	Inspection & Test Plan (ITP) -For review by Inspection Dept.		✓		✓	Refer Note- ^{1*}
15.	Test Records				✓	
16.	Combined Test Certificate (For similar Motor & VFD)			✓	✓	
17.	List of Commissioning Spares			✓	✓	
18.	List of Maintenance Spares			✓	✓	
19.	List of Mandatory Spares		✓			
20.	List of Special Tools & Tackles			✓		
21.	Data Books/ Manuals : Installation Manual				✓	
22.	Data Books/ Manuals : Operating/ Maintenance Manual				✓	
23.	Data Books/ Manuals : Catalogues/ Brochures			✓	✓	
24.	Equipment storage procedure at site				✓	
25.	Filled up PTR format wherever applicable		✓			

PACKAGED EQUIPMENT

**VENDOR DATA REQUIREMENTS
FOR
ELECTRICS OF GAS TURBINE
COMPRESSOR**

S. N. O.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Schedule of Vendor Documents		✓			
2.	Confirmation of Technical Compliance					
3.	Guaranteed max. Power Consumption			✓	✓	
4.	Single line diagram			✓	✓	
5.	Electrical load data			✓	✓	
6.	Area classification		✓		✓	
7.	Block Diagram- FA & PA		✓		✓	
8.	Equipment layout		✓		✓	
9.	Cable layout			✓	✓	
10.	Sizing calculation			✓	✓	
11.	Cable schedule			✓	✓	
12.	Interconnection diagram			✓	✓	
13.	Electrical interface with owner		✓		✓	
14.	Technical details/Data sheets for major equipment			✓	✓	
15.	Motor data sheet		✓		✓	
16.	GA and internal arrangement drawing for panels			✓	✓	
17.	Schematic/Logic diagrams			✓	✓	
18.	Interconnection/Wiring diagrams			✓	✓	
19.	Bill Of Material			✓	✓	
20.	List of Mandatory Spares		✓		✓	
21.	List of recommended maintenance spares			✓	✓	
22.	Type Test certificates			✓	✓	
23.	Inspection & Test Plan (ITP) -For review by Inspection Dept.		✓		✓	Refer Note-1*
24.	Test certificates			✓	✓	
25.	Catalogues and brochures				✓	
26.	Installation manual				✓	
27.	Operation/maintenance manual				✓	
28.	Equipment storage procedure at site				✓	

Notes :

1. "TICK" denotes applicability.
2. Post order, drawing / document review shall commence only after approval of Document Control Index (DCI).
3. All post order documents shall be submitted / approved through EIL eDMS portal.
4. Final documentation shall be submitted in hard copy (Six prints) and soft (two CDs/DVDs) in addition to

submission through EIL eDMS.

5. Refer - 6-78-0001: Specification for quality management system from Bidders.
6. Refer - 6-78-0002: Specification for documentation requirements from Contractors.
7. Refer - 6-78-0003: Specification for documentation requirement from Suppliers.
8. All drawings & documents shall be submitted in A4 or A3 paper sizes. Documents in higher paper size shall be submitted in exceptional circumstances or as indicated in the MR/Tender.
9. Post order- The schedule of drawing / data submission shall be mutually agreed between EIL & the bidder / contractor / supplier during finalization of Document Control Index (DCI).
10. "@" indicates submission of documents to Inspection Agency.
11. Bill of Material shall form part of the respective drawing.
12. Also refer other department's VDR :-
13. Instrumentation
14. Packaged Equipment
15. Rotating Equipment
16. '*' indicates the following:
 - a. Equipments whose ITP is attached with Contract -ITP for respective equipment shall be followed. Therefore, no ITP is to be furnished for review for those equipments.
 - b. Equipments whose ITP is not attached with Contract-Manufacturer's ITP shall be submitted by Packager/ Vendor/Contractor to respective Regional Procurement Office (RPO) near to manufacturer's works for approval by EIL Inspection.
17. All technical details and documents furnished with bids shall be treated as data for engineering. These shall however be subject to Purchasers review after order placement and bidder shall comply to MR/Tender requirements without any cost & time implication to EIL/Owner.
18. '*' indicates the following:
 - a. Equipments whose ITP is attached with Contract -ITP for respective equipment shall be followed. Therefore, no ITP is to be furnished for review for those equipments.
 - b. Equipments whose ITP is not attached with Contract-Manufacturer's ITP shall be submitted by Packager/ Vendor/Contractor to respective Regional Procurement Office (RPO) near to manufacturer's works for approval by EIL Inspection.
19. All technical details and documents furnished with bids shall be treated as data for engineering. These shall however be subject to Purchasers review after order placement and bidder shall comply to MR/Tender requirements without any cost & time implication to EIL/Owner.
20. '*' indicates the following:
 - a. Equipments whose ITP is attached with Contract -ITP for respective equipment shall be followed. Therefore, no ITP is to be furnished for review for those equipments.
 - b. Equipments whose ITP is not attached with Contract-Manufacturer's ITP shall be submitted by Packager/ Vendor/Contractor to respective Regional Procurement Office (RPO) near to manufacturer's works for approval by EIL Inspection.
21. All technical details and documents furnished with bids shall be treated as data for engineering. These shall however be subject to Purchasers review after order placement and bidder shall comply to MR/Tender requirements without any cost & time implication to EIL/Owner.
22. '*' indicates the following:
 - a. Equipments whose ITP is attached with Contract -ITP for respective equipment shall be followed. Therefore, no ITP is to be furnished for review for those equipments.

**VENDOR DATA REQUIREMENTS
FOR
ELECTRICS OF GAS TURBINE
COMPRESSOR**

b. Equipments whose ITP is not attached with Contract-Manufacturer's ITP shall be submitted by Packager/ Vendor/Contractor to respective Regional Procurement Office (RPO) near to manufacturer's works for approval by EIL Inspection.

23. All technical details and documents furnished with bids shall be treated as data for engineering. These shall however be subject to Purchasers review after order placement and bidder shall comply to MR/Tender requirements without any cost & time implication to EIL/Owner.

24. '*' indicates the following:

a. Equipments whose ITP is attached with Contract -ITP for respective equipment shall be followed. Therefore, no ITP is to be furnished for review for those equipments.

b. Equipments whose ITP is not attached with Contract-Manufacturer's ITP shall be submitted by Packager/ Vendor/Contractor to respective Regional Procurement Office (RPO) near to manufacturer's works for approval by EIL Inspection.

25. All technical details and documents furnished with bids shall be treated as data for engineering. These shall however be subject to Purchasers review after order placement and bidder shall comply to MR/Tender requirements without any cost & time implication to EIL/Owner.

26. '*' indicates the following:

a. Equipments whose ITP is attached with Contract -ITP for respective equipment shall be followed. Therefore, no ITP is to be furnished for review for those equipments.

b. Equipments whose ITP is not attached with Contract-Manufacturer's ITP shall be submitted by Packager/ Vendor/Contractor to respective Regional Procurement Office (RPO) near to manufacturer's works for approval by EIL Inspection.

27. All technical details and documents furnished with bids shall be treated as data for engineering. These shall however be subject to Purchasers review after order placement and bidder shall comply to MR/Tender requirements without any cost & time implication to EIL/Owner.

अग्निरोधक नियंत्रण स्टेशन के लिए विनिर्देश

SPECIFICATION FOR FLAMEPROOF CONTROL STATIONS

5	24.02.16	REVISED AND ISSUED AS STANDARD SPECIFICATION	NNB/AK	ANPS	BRB	SC
4	11.04.11	REVISED AND ISSUED AS STANDARD SPECIFICATION	PS	ANPS	UAP	DM
3	24.08.07	REVISED AND ISSUED AS STANDARD SPECIFICATION	ANPS	UAP	JMS	VC
2	30.01.02	REVISED AND ISSUED AS STANDARD SPECIFICATION	UAP	AAN	VPS	GRR
1	19.08.96	REVISED AND ISSUED AS STANDARD SPECIFICATION	AP	VPS	SG	AS
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

Abbreviations:

AC	Alternating Current
BIS	Bureau of Indian Standards
BS	British Standards
CEA	Central Electricity Authority
CIMFR	Central Institute of Mines and Fuel Research (formerly CMRI)
CT	Current Transformer
DGMS	Directorate General of Mines Safety
ERTL	Electronics Regional Test Laboratory
FM	Factory Mutual Research Corporation
GI	Galvanised Iron
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronics Engineers
IP	Ingress Protection
IS	Indian Standards
LCIE	Laboratoire Central des Industries Electriques
LED	Light Emitting Diodes
NEMA	National Electrical Manufacturers Association
PESO	Petroleum and Explosives Safety Organisation
PVC	Poly Vinyl Chloride
SWG	Standard Wire Gauge
VDE	Verband Der Electrotechnik, Elektronik und Information Technik
UL	Underwriters Laboratory

Electrical Standards Committee

Convenor: Mr. B. R. Bhogal

Members: Ms. Sumita Anand
Mr. Parag Gupta
Mr. M. K. Sahu
Ms. N. S. Bhattacharya
Mr. Saeed Akhtar (Inspection)
Ms. N. P. Guha (Projects)

CONTENTS

1.0	SCOPE.....	4
2.0	CODES AND STANDARDS.....	4
3.0	GENERAL REQUIREMENTS.....	4
4.0	SITE CONDITIONS	4
5.0	CERTIFICATION	5
6.0	TECHNICAL REQUIREMENTS.....	5
7.0	INSPECTION, TESTING AND ACCEPTANCE.....	6
8.0	PACKING AND DESPATCH	6

1.0 SCOPE

This specification covers the requirements of design, manufacture, testing, packing and supply of flameproof control stations and accessories suitable for installation in locations handling flammable liquids and gases / vapours.

2.0 CODES AND STANDARDS

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

IS-5	: Colours for ready mixed paints and enamels.
IS-1248	: Direct acting indicating analogue measuring instruments and their accessories.
IS / IEC 60079-0	: Electrical apparatus for explosive gas atmospheres (General Requirements).
IS / IEC 60079-1	: Electrical apparatus for explosive gas atmospheres (Equipment Protection by Flameproof Enclosures "d").
IS / IEC 60079-7	: Electrical apparatus for explosive gas atmospheres (Equipment Protection by Increased Safety "e").
IS / IEC 60529	: Degree of protection provided by enclosures (IP Code).
IS / IEC 60947	: LV switchgear and control gear.

2.2 In case of imported equipment, standards followed in the country of origin shall be applicable, if these standards are equivalent or more 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 conflict between requirements specified in various applicable documents for the project, the most stringent requirement shall govern. However, 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 having 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 for at least 10 years from the date of supply.

4.0 SITE CONDITIONS

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 and fertilizer plants. Unless otherwise specified, a design ambient temperature of 40° C and an altitude not exceeding 1000 m above mean sea level shall be considered.

5.0 CERTIFICATION

The equipment shall have test certificates issued by recognised independent test house (CIMFR/ ERTL/ Baseefa/ LCIE/ UL/ FM or equivalent). 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 marking as required by statutory authorities.

6.0 TECHNICAL REQUIREMENTS

6.1 Construction

- 6.1.1 The enclosures of the control stations shall be made of cast light metal alloy.
- 6.1.2 The control stations shall be suitable for use in outdoor open locations and shall have IP-55 degree 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. The canopy shall be suitable for providing protection against rain from top and two sides.
- 6.1.3 The control stations shall be provided with gaskets made of non-inflammable and self-extinguishing material.
- 6.1.4 All metal surfaces shall undergo manufacturer's standard cleaning/ painting cycle. After preparation of under surface, the equipment shall be painted with two coats of epoxy based final paint with colour shade as below:
 - Flame proof (Gas group IIA/ IIB) : Dark admiralty grey shade 632 of IS-5/ RAL 7031
 - Flame proof (Gas group IIC) : Light yellow shade 355 of IS-5/ RAL-1012

All unpainted steel parts shall be suitably treated to prevent rust formation. If these parts are moving elements then these shall be greased.

- 6.1.5 A warning inscription "DO NOT OPEN WHEN ENERGIZED" 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 plate shall be of nickel plated brass or stainless steel.
- 6.1.6 All accessories like nuts, bolts, washers etc. and operating shaft of pushbuttons, switches etc. shall be made of stainless steel SS-304.
- 6.1.7 The control stations shall be provided with two earthing studs with lugs on the external surface of the enclosures suitable for termination of 8 SWG GI wire.
- 6.1.8 The control station shall be provided with bottom cable entries. Required number of flameproof double compression nickel plated brass cable glands and flameproof nickel plated brass sealing plugs shall be provided.
- 6.1.9 The control stations shall have external fixing lugs for mounting on wall or column. The holes provided on these lugs shall be of oblong type.
- 6.1.10 A nameplate indicating Tag Number shall be provided on each control station. Separate nameplate shall also be provided to indicate the details of testing agency (CIMFR or equivalent), test certificate reference, statutory approval agency (PESO / DGMS) and reference, BIS license number, applicable gas group etc. The nameplates shall be engraved type and permanently fixed on the equipment. In case the standard details given above are embossed on the enclosures, the same need not be repeated on the name plate.
- 6.1.11 All flameproof control station shall be suitable for 240V AC as well as 110V/220V DC control supply.

6.2 Component Specification

- 6.2.1 Push buttons for START and STOP shall be of GREEN and RED colour respectively. Each push button shall have two NO and two NC contacts. The STOP push button shall be mushroom type with stay put feature and lockable in pressed position.
- 6.2.2 All control switches shall be provided with a pistol grip handle. Circuit breaker control switch, wherever specified, shall have three positions (START - NEUTRAL - STOP) with spring return to neutral from START position and stay put in STOP position. All control/ selector switches shall have minimum two poles for each position. Each position of switch shall be indelibly marked on the control station. Exact configuration of selector switch (LOCAL-OFF-REMOTE or AUTO-OFF-MANUAL) shall be as per datasheet / MR requirement.
- 6.2.3 All ammeters shall be of moving iron type having an accuracy class of 3 and suitable for 1 Ampere CT secondary. Minimum size of ammeter shall be either 72mm x 72 mm or 65 mm diameter. 80% of the scale length shall cover 100% of the CT primary current uniformly and the balance 20% of the scale shall cover 100-800% of the CT primary. A red mark corresponding to the full load current of the motor shall be provided on the ammeter dial. The ammeter front glass shall be toughened.
- 6.2.4 Indicating lamp(s) wherever provided shall be clustered LED type (with minimum 3 numbers LEDs, preferably connected in parallel), mounted inside an enclosure of minimum diameter of 15mm.

6.3 Terminals & Wiring

- 6.3.1 The control stations 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 2.5 mm² solid copper conductor. Tinned copper lugs shall be provided for cable termination wherever applicable.
- 6.3.2 All internal wiring shall employ 1.5 mm², 660V grade, FR type, PVC insulated copper conductor wires.
- 6.3.3 For flameproof equipments, terminal box can be provided in 'Exe' or 'Exd' execution.

7.0 INSPECTION, TESTING AND ACCEPTANCE

- 7.1 During fabrication, the equipment shall be subjected to inspection by EIL/ 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 EIL/ Owner's inspector. All routine/acceptance tests shall be carried out at manufacturer's works under his care & expense.
- 7.2 Type test certificates from CIMFR or equivalent test house, applicable PESO/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 despatch.
- 7.3 Test certificates of bought out components shall be shown to the inspection agency on demand during inspection.
- 7.4 All equipments shall be subjected to various routine / acceptance tests as per Inspection & Test plan no. 6-81-1006.

8.0 PACKING AND DESPATCH

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 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.

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 agreed. A set of instruction manuals for installation, testing and commissioning, a set of operation & maintenance manuals and a set of final drawing shall be enclosed in a waterproof cover along with the shipment.

मध्यम वोल्टेज स्वीचबोर्ड के लिए विनिर्देश

SPECIFICATION FOR MEDIUM VOLTAGE SWITCHBOARD

5	21.12.2016	REVISED AND SPECIFICATION	ISSUED AS STANDARD	CA/RKS	SA	BRB	RN
4	23.03.2011	REVISED AND SPECIFICATION	ISSUED AS STANDARD	DA	SG	UAP	DM
3	01.03.2005	REVISED AND SPECIFICATION	ISSUED AS STANDARD	SSM	RR	AAN	SKG
2	19.11.2001	REVISED AND SPECIFICATION	ISSUED AS STANDARD	SSM	AAN	VPS	GRR
1	26.12.1996	REVISED AND ISSUED AS STANDARD SPECIFICATION	AAN	VPS	SG	AS	
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman	Approved by

Abbreviations:

A	: Ampere	kVA	: kilo Volt Ampere
AC	: Alternating Current	kW	: kilo Watt
ACB	: Air Circuit Breaker	LV	: Low Voltage
ASB	: Auxiliary Service Board	LED	: Light Emitting Diode
BIS	: Bureau of Indian Standard	LDB	: Lighting Distribution board
BS	: British Standard	LOTO	: Lock-Out Tag-Out
CEA	: Central Electricity Authority	mA	: milli Ampere
CFL	: Compact Fluorescent Lamp	MCC	: Motor Control Center
CT	: Current Transformer	MCB	: Miniature Circuit Breaker
CPRI	: Central Power Research Institute	MCCB	: Moulded Case Circuit Breaker
CRCA	: Cold Rolled Cold Annealed	NO	: Normally Open
DC	: Direct Current	NC	: Normally Closed
EIL	: Engineers India Limited	NEMA	: National Electrical Manufacturer Association
EPDM	: Ethylene Propylene Diene Monomer	PCC	: Power Control Center
FRLS	: Flame Retardant Low Smoke	PMCC	: Power cum Motor Control Center
HDPE	: High-density polyethylene	PT	: Potential Transformer
HRC	: High Rupture Capacity	PVC	: Poly Vinyl Chloride
IEC	: International Electrotechnical Commission	R-C	: Resistor-Capacitor
IEEE	: The Institute of Electrical and Electronics Engineers	SWG	: Standard Wire Gauge
IP	: Ingress Protection	V	: Volt
IS	: Indian Standard	VA	: Volt Ampere
kA	: kilo Amperes	VDE	: Verband Deutscher Elektrotechniker
		XLPE	: Cross-Linked Polyethylene

Electrical Standards Committee

Convenor: Mr. B.R. Bhogal

Members: Ms. S. Anand
Mr. Parag Gupta
Mr. M.K. Sahu
Ms. N.S. Bhattacharya
Mr. Saeed Akhtar (Inspection)
Ms. N.P. Guha (Projects)

CONTENTS

1.0	SCOPE.....	4
2.0	CODES AND STANDARDS	4
3.0	GENERAL REQUIREMENTS	4
4.0	SITE CONDITIONS	5
5.0	DESIGN AND FABRICATION REQUIREMENTS	5
6.0	SPECIFIC REQUIREMENTS OF AIR CIRCUIT BREAKER PANELS.....	9
7.0	SPECIFIC REQUIREMENTS OF FEEDERS OTHER THAN ACB FEEDERS.....	10
8.0	SWITCHGEAR MODULES	11
9.0	SWITCHBOARD COMPONENTS	12
10.0	INSPECTION, TESTING AND ACCEPTANCE	16
11.0	PACKING AND DESPATCH.....	16

1.0 SCOPE

- 1.1 This specification covers the requirements of design, manufacture, testing, packing and supply of fixed and draw out type medium voltage switchboards.

2.0 CODES AND STANDARDS

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

IS : 1248	:	Direct Acting Indicating Analogue Electrical Measuring Instruments and their Accessories
IS : 2705	:	Current transformers
IS : 2824	:	Method for determining the proof and the comparative tracking indices of solid insulating materials.
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	:	Wrought aluminum and aluminum alloy bars, rods, tubes and sections for electrical purposes.
IS : 5578	:	Guide for marking of insulated conductor.
IS: 8623	:	Low voltage switchgear and control gear assemblies. Particular requirement for bus bar trunking system.
IS : 11353	:	Guide for uniform system marking and identification of conductors and apparatus terminals.
IS : 13703	:	Low voltage fuses for voltages not exceeding 1000V AC or 1500V DC.
IS/ IEC: 60529	:	Degree of protection provided by enclosures (IP Code).
IS/ IEC: 60947	:	LV Switchgear and control gear.
IEC-61439	:	Low voltage switchgear and controlgear assemblies
IEC-61641	:	Enclosed low-voltage switchgear and controlgear assemblies - Guide for testing under conditions of arcing due to internal fault.

- 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 sheet and statutory regulations, the most stringent requirement shall govern and decision of owner/EIL in this regard shall be final & 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.

4.0 SITE CONDITIONS

- 4.1** The switchboards shall be suitable for installation and satisfactory operation in an air-conditioned/pressurised substation or in a covered shed/enclosed electrical room (e-room) or in a substation with restricted natural air ventilation in a tropical, humid and corrosive atmosphere.
- 4.2** The switchboards shall be designed to operate under specified site conditions. If not specifically mentioned, a design ambient temperature of 40° C and altitude not exceeding 1000 metres above mean sea level shall be considered.
- 4.3** All the equipment described in this specification shall be suitable for continuous duty with the specified ratings under the mentioned ambient conditions unless indicated otherwise.

5.0 DESIGN AND FABRICATION REQUIREMENTS

- 5.1** Medium voltage switchboard shall be metal enclosed fully draw out or fixed, as specified in datasheet/ job specification, free standing, floor mounting, compartmentalised, modular type suitable for indoor installation with form of internal separation "Form-4b" as per IEC-61439 (except for fixed type switchboards), unless otherwise specified elsewhere. The switchboard shall be a type tested assembly (TTA) as per IEC-61439.
- 5.2** The switchboard enclosure shall be dust and vermin proof and shall provide a degree of protection not less than IP-41.
- 5.3** The switchboard shall be assembled out of vertical panels of uniform height, not exceeding 2450mm in a single line up.
- 5.4** It shall be possible to extend the switchboard, in either direction at a later date. End of bus bars shall be suitably drilled for this purpose. Panels at extreme end shall have openings, which shall be covered with plates screwed to the panel.
- 5.5** 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 energised and without taking any special precautions.
- 5.6** 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/modules/feeders.
- 5.7** All identical equipments and corresponding parts shall be fully interchangeable.
- 5.8** 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 the doors and covers that may be made of 1.6mm (16SWG) CRCA. Wherever required, stiffeners shall be provided to increase mechanical strength of large size doors and covers.
- As an alternative to CRCA, Aluzinc/pre-galvanised sheet steel can also be provided for internal inter-panel partitions only as per vendor's standard manufacturing practices. However, all external surfaces shall be of CRCA with specified paint shade.
- 5.9** The switchboard shall be provided with integral base frame for each vertical panel. The switchboard integral base frame shall be suitable for tack welding.
- 5.10** All openings, covers and doors shall be provided with gaskets of Neoprene/HDPE/EPDM or equivalent around the perimeter to make the switchboard dust and vermin proof.
- 5.11** All hardware shall be corrosion resistant. All joints and connections of the panel members shall be made of galvanized or zinc passivated or cadmium plated high quality steel bolts, nuts and washers, secured against loosening.
- 5.12** Suitable removable type eyebolts/ lifting hooks shall be provided for lifting of the panel/shipping section. These eyebolts/ lifting hooks, when removed shall not leave any opening in the panels.

- 5.13 Non-magnetic cable gland plates (min. 3mm thick) shall be provided for termination of single core cables.
- 5.14 The switchboard shall be formed using distinct vertical panels each comprising of the following compartments.
- 5.14.1 A metal enclosed horizontal bus bar compartment running at the top or rear, unless otherwise specified.
- 5.14.2 Individual feeder modules in multitier mode.
- 5.14.3 Vertical bus bars serving all feeder modules in the vertical panel.
- 5.14.4 Cable termination compartment.
- 5.14.5 Perforated sheet steel / insulating material enclosed, horizontal auxiliary bus bars for control, interlock, indication and metering running horizontally.
- 5.15 Metal sheets shall be provided between two adjacent vertical panels running upto the full useful height of the switchboard.
- 5.16 MCC/MCC part of PMCC 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.
- 5.17 Motor starter and MCCB/switch fuse modules shall not be accommodated at front and rear of ACB Incomer and bus coupler panels.
- 5.18 The MCC/ASB/LDB switchboards shall be provided with castle-key interlock between incomers and bus-coupler for manual changeover of supplies unless otherwise specified elsewhere.
- 5.19 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.
- 5.20 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.
- 5.21 Unless otherwise specified elsewhere, the switchboard assembly and components shall be suitable for use in pollution degree 3 environment as per IS/IEC.
- 5.22 In open doors condition of compartment, all live parts or terminals of all door-mounted, internal components and bus contact openings shall be IP-2X protected.
- 5.23 LOTO arrangement**
- 5.23.1 Pad locking arrangement shall be provided for rack in operation of breaker as well as for the panel door meeting LOTO requirements.
- 5.23.2 LOTO arrangement shall be provided for each module of draw-out switchboard PCC/PMCC/MCC etc and shall include provision for the following:
- Provision for hooking lockout devices by multiple lock arrangement to prevent opening of panel door and racking-in of circuit breaker.
 - Provision for attaching tag-out device for warning against energisation and to provide information regarding date of isolation, agency working on the equipment, etc.
 - Provision for Hasp such that the same shall be put-in and closed in the locking arrangement of the breaker/switch and panel door.
- 5.24 Unless otherwise specified elsewhere, the switchboard shall be designed and tested to meet the requirements of IEC-61641 for arcing due to an internal fault of full short circuit current for

duration of 0.1 sec such that the arc is confined in the section where it occurs and adjacent sections are not affected.

5.25 Space Heaters & Panel Illumination

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 buses for space heater. The space heater shall be provided with a switch, fuse or double pole MCB and thermostat having adjustable setting range of 30-70° C. Further, one number 240V AC, 6/ 16A, 5 Pin socket for owner's use shall be provided inside panels. The panels shall be provided with suitable illuminating lamp/CFL or LED with switch and fuse or MCB.

5.26 Auxiliary Bus Bars

5.26.1 Auxiliary bus bars (solid – rectangular or circular), each of minimum size 18-mm² copper, shall be provided for the following applications.

- a) Panel space heater supply and motor space heater supply.
- b) AC Control supply.
- c) DC Control supply.
- d) AC PT supply for energy meters, voltage operated relays etc.

5.26.2 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.

5.26.3 Provision for hook up of external AC space heater/ DC control supply to be provided either in bus PT panel or bus coupler panel.

5.27 Bus Bar

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

5.27.2 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.

5.27.3 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.

5.27.4 Only zinc passivated or cadmium plated high tensile strength steel bolts, nuts and washers shall be used for all bus bar joints and supports.

5.27.5 The hot spot temperature of bus bars, including joints, at design ambient temperature shall not exceed 95° C under normal operating conditions. However, for silver plated joints, the allowable maximum temperature shall be 115°C.

5.27.6 The current rating as defined for switchboard and components in data sheet/enquiry document 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.

5.27.7 All bus bars shall be insulated with heat shrunk PVC sleeves of 1100 V grade. Red, yellow and blue colour shall be used for phase bus bars and black colour shall be used for neutral bus bars. Alternatively, colour bands at suitable intervals along PVC sleeved bus bars may be provided. Removable type shrouds shall be provided for joints & tap off points.

5.27.8 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 respective components.

- 5.27.9 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.

5.28 Wiring and Terminals

- 5.28.1 Inside the switchboards, the wiring for power, control, signalling protection and instrument circuits shall be done with BIS approved FRLS, PVC/XLPE insulated copper conductor wires having 660/1100 V grade insulation. The wiring shall preferably be enclosed in flame retardant plastic channels or neatly bunched together.
- 5.28.2 PVC insulated copper conductor of cross section 1.5 mm^2 may normally be used provided the control fuse rating is 10 A or less. For higher fuse ratings minimum 2.5 mm^2 copper conductor shall be used. Each wire shall be terminated at a separate terminal. CT circuit wiring shall be done with 2.5 mm^2 copper conductor.
- 5.28.3 Shorting links/suitable arrangement for shorting CT secondary shall be provided.
- 5.28.4 Each wire shall be identified at both ends by PVC ferrules.
- 5.28.5 Inter panel 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 jumpering wires. Inter-panel wiring shall be taken thorough PVC sleeves or rubber grommets.
- 5.28.6 A minimum of 10% spare terminals shall be provided on each terminal block.
- 5.28.7 Required number of single compression nickel plated brass cable glands and tinned copper compression type lugs (for bolted terminals) for all power and control cables shall be included in the vendor's scope of supply, if specified in the datasheet. Sufficient terminals shall be provided on each terminal block to ensure that not more than one outgoing wire is connected per terminal.
- 5.28.8 Terminal strips shall preferably be separated from power circuits by metal barriers or enclosures. All spare input and output contacts of numerical relays, auxiliary relays, contactors, timers, etc shall be wired up to the terminal strips/block (ensuring that two terminals are provided for each contact).

5.29 Earthing

- 5.29.1 All panels shall be connected to a tinned copper earth bus bar running throughout the length of the switchboard at the bottom of the panels.
- 5.29.2 The minimum earth bus size shall be $30 \times 6 \text{ mm}^2$ copper for fault level up to 31.5kA and $50 \times 6 \text{ mm}^2$ copper for fault level above 31.5kA.
- 5.29.3 All doors and movable parts shall be earthed, using flexible copper connections, to the fixed frame of the switchboard. Provision shall be made at the end panels of each switchboard to connect the earthing bus bar to the plant-earthing grid at two ends.
- 5.29.4 All non-current carrying metallic parts of the mounted equipment shall be earthed. Minimum 4 nos, 10 mm diameter bolts with nuts shall be provided on the earth bus for termination of fourth core of cable per vertical panel.

5.30 Nameplate

- 5.30.1 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. Danger nameplate shall be provided at the front and rear of each panel.
- 5.30.2 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.
- 5.30.3 Blank nameplates shall be provided for all spare and vacant modules.

- 5.30.4 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.
- 5.30.5 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.
- 5.30.6 Engraved nameplates shall preferably be of 3- ply (Black-White- Black) lamicoid sheets or anodised aluminium. However back engraved perspex sheet nameplates may also be acceptable. Nameplates shall be fastened by screws and not by adhesives.

5.31 Painting

- 5.31.1 After preparation of the under surface, the panel shall be spray painted with two coats of epoxy based final paint or shall be powder coated. The colour shade of final paint shall be as RAL-7032, unless specified otherwise. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint, etc.
- 5.31.2 All unpainted steel parts shall be zinc passivated, cadmium plated or suitably treated to prevent rust and corrosion. If these parts are moving elements, then these shall be greased.

6.0 SPECIFIC REQUIREMENTS OF AIR CIRCUIT BREAKER PANELS

- 6.1 The breaker panels shall have distinct bus bar, breaker and cable compartments.
- 6.2 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.
- 6.3 In order to minimise accidental access and avoid accidents due to falling tools, all the outgoing links shall be shrouded.
- 6.4 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.

6.5 Cable Compartment

- 6.5.1 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 cover.
- 6.5.2 The incoming / outgoing cable termination shall be staggered for each circuit and barriers of sheet steel or insulating material shall be provided between terminations 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.
- 6.5.3 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.
- 6.5.4 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 panel, an extension panel of full height shall be added to the cabling compartment for accommodating extra cables. Alternatively, in view of extra cables, provision for back to back connections of cables may be offered.

6.6 Circuit Breaker Compartment

- 6.7.1 The circuit breaker compartment shall be fully draw-out. Suitable guides shall be provided to facilitate easy withdrawal of the circuit breaker.

- 6.7.2 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.
- 6.7.3 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.
- 6.7.4 There shall be three positions for the draw out trolley viz:
- "Service" position - In this position both power and control circuits shall be connected. This shall be the normal operating position of the circuit breaker.
 - "Test" position - The power contacts shall be disconnected in this position but the control connections shall not be disturbed, testing provision for the entire control circuitry shall be available in test mode including close and trip of breakers.
 - "Drawout" Position - both power and control circuits shall be disconnected in this position and breaker removed from the cubicle.
- 6.7.5 The circuit breaker shall be lockable in "service" and "test" positions. Safety shutters shall be provided when the breaker is in withdrawn/drawout position.
- 6.7.6 The earth connection must remain connected in "Test" position; Earthing of the unit shall be done with a "pin" or with scrapping earth connections.
- 6.7.7 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

6.7 Interlocks

Following interlocks shall be provided:

- 6.7.1 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.
- 6.7.2 It shall not be possible to push "in " a drawn out circuit breaker in closed condition or withdraw a circuit breaker in closed condition.
- 6.7.3 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.
- 6.8 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.

7.0 SPECIFIC REQUIREMENTS OF FEEDERS OTHER THAN ACB FEEDERS

- 7.1 The design of drawout feeder modules shall not change for single front or double front execution. Separate vertical bus bars shall be provided for each front side modules.
- 7.2 All identical feeder modules shall be interchangeable.
- 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.
- 7.4 Sheet steel barrier 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.
- 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.

- 7.6 The outgoing feeder trolleys for drawout type switchboard shall be fully drawout and shall have the following features.
- 7.6.1 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.
- 7.6.2 Both power and control connections shall be drawout type. All line and bus PTs shall be in drawout execution only. However, outgoing modules having size more than half of the useful vertical height of the panel may be in mixed combination of drawout /fixed type.
- 7.6.3 Control supply transformer modules may be provided in fixed execution.
- 7.6.4 The trolley withdrawal shall be by means of crank and screw arrangement. Alternatively movement on guided rollers or swivelling guide levers for self guided movement may also be acceptable. Plug in operation shall be independent of manual force. An insulating handle for racking in/ out modules shall be provided, as required.
- 7.6.5 For drawout 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 drawout contacts once the trolley is plugged in. Alternatively, fixed execution may be acceptable for feeder with higher rating, equal to or greater than 400A.
- 7.6.6 Power drawout 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. In test position, testing provision for the entire control circuitry shall be available.
- 7.7 The incomer and bus tie feeders with load break switches rated 800A and above may be in fixed execution
- 7.8 Various compartment sizes in a vertical panel shall be multiples of a basic dimension. However the minimum module size for switch fuse/MCCB feeder and motor starter/contactors 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.
- 7.9 All switch drives other than rotary control switches, shall be lockable in 'OFF' position.
- 7.10 The switches/Moulded case circuit breakers /MCB shall be interlocked with the compartment door to prevent opening of the door when the switch/ moulded 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.
- 7.11 The maximum height of the operating handle and switches shall not exceed 1900 mm and the minimum height shall not be below 300 mm.
- 7.12 Unused modules in the panel shall be fully equipped with hinged door & vertical busbars and shall be suitable for mounting power and control terminals for starter modules and cradle for future use.
- 7.13 For all the contactor controlled starter/feeder modules of MCC/PMCC, R-C circuit across the power contactor shall be provided. Further, low burden auxiliary contactors shall be provided in each contactor controlled motor starter modules for receiving start and stop command from remote.

8.0 SWITCHGEAR MODULES

- 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 MCCB or switch fuse.
- 8.2 Starter modules required for motor control shall be of the following types and internal control wiring of all starter modules of each type shall be identical for all ratings.

8.2.1 FVNR Full Voltage Non -Reversing starter with minimum 18 control terminals.

- 8.2.2 FVR Full Voltage Reversing starter with minimum 24 control terminals.
- 8.2.3 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.
- 8.3 Switch fuse/MCCB /contactor feeder modules shall be of following types and internal control wiring of all modules of each type shall be identical for all ratings.
- 8.3.1 SFU/MCCB Switch Fuse Unit or MCCB modules with no control terminals.
- 8.3.2 SFC/MCCB+C Switch Fuse Contactor or MCCB with contactor modules with 18 control terminals.
- 8.4 Control transformer shall be provided for each FVR/FVNR/SFC starter/MCCB+C starter/feeder modules or bus section of the PMCC/MCC switchboard having contactor control feeders as specified in the datasheet/job specification or elsewhere. Each control transformer of starter/feeder module shall be sized for taking control supply load of all components of starter module. In case control transformer is provided in bus section, same shall be sized for control supply load of entire switchboard. Switchboard having two bus sections and coupled by bus tie shall have manual changeover switch for the control transformers. The control transformer shall have at least 10% spare capacity. The control transformer secondary shall be earthed at one end.
- 8.5 To facilitate site modification due to changes in motor KW ratings and to minimise spares inventory, overload relays and power fuse links shall meet the following requirements.
- 8.5.1 All bimetal overload relays shall be separately mounted type with connecting links rated for the maximum rating of the contactor in a starter module.
- 8.5.2 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.
- 8.6 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.
- 8.7 All contactor controlled starter feeders shall meet the requirements of type-2 co-ordination as per IS/IEC: 60947. However, contactor controlled motor feeders shall meet the requirements of type-2 co-ordination as per IS/IEC: 60947 considering energy efficient motors of IE-2 type, unless otherwise specified elsewhere.
- 9.0 SWITCHBOARD COMPONENTS**
- 9.1 Circuit Breakers**
- 9.1.1 Circuit breakers shall be air break, draw-out type and 3/4 poles as specified in the datasheet/job specifications. However, all ACBs of PCC/PMCC incomers and bus-coupler(s) shall be with 4 poles unless specified elsewhere.
- 9.1.2 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.
- 9.1.3 The circuit breakers shall be provided with minimum 4 NO + 4 NC contacts, wired and available for owner's use. In case contacts are directly not available in breaker, auxiliary latching type relays shall be used to multiply the auxiliary contacts of the breakers.
- 9.1.4 Circuit breaker's Open and closed positions; Service and test locations and spring charged condition shall also be indicated mechanically in addition to electrical indications.
- 9.1.5 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.

9.1.6 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 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 mechanisms shall be equipped with the 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 the 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.

9.1.7 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.

9.1.8 Circuit breakers shall be provided with anti-pumping and trip free feature.

9.1.9 Circuit breakers shall be provided with operation counters.

9.1.10 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.

9.2 Switches

9.2.1 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.

9.2.2 Rating of switches for starter module shall meet the requirements of AC-23 duty as per IS/IEC 60947 and minimum rating shall be as specified in job specification/data sheets.

9.3 Fuses

9.3.1 Fuses shall be non-deteriorating HRC cartridge link type.

9.3.2 Power fuses shall be pressure fitted type and shall preferably have ribs on the contact blades to ensure good line contact.

9.3.3 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.

9.4 Contactors

- 9.4.1 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 AC4 ratings, as specified in data sheet
- 9.4.2 Unless specified otherwise, the coil of the contactor shall be suitable for operation on 240 V, 1 Phase, AC supply.

9.5 Thermal Overload Relay

- 9.5.1 Bimetal relays shall be provided for protecting the motor from thermal overload.
- 9.5.2 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.
- 9.5.3 Bimetal relays shall be positive acting ambient temperature compensated type with adjustable setting range.
- 9.5.4 Bimetal relays shall have built-in single phasing prevention feature, which operates even with 50% rated current at the time of single phasing.

9.6 Moulded Case Circuit Breakers

- 9.6.1 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.
- 9.6.2 MCCBs shall be provided with a 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.
- 9.6.3 '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.
- 9.6.4 Each MCCB shall be provided with minimum 1 NO + 1 NC auxiliary contact and 1NO contact for tripping indication/alarm for owner's use.
- 9.6.5 MCCBs shall be provided with solenoid/ motorised closing mechanism to make them suitable for remote closing operation if specified. The closing solenoid/motor shall be suitable for specified control supply voltage.
- 9.6.6 MCCB's as part of motor starter module shall be current limiting type and type tested for type-2 co-ordination as per IS/ IEC-60947 considering energy efficient motors of IE-2 type unless otherwise specified elsewhere.

9.7 Relays

- 9.7.1 Type of relay shall be numerical, static or electro-mechanical type as specified in the data sheet /job specification.
- 9.7.2 All electro-mechanical protective relays shall be back connected, of drawout type, suitable for flush mounting, and fitted with dust-tight covers. Alternatively, "plug-in" type relays will also be acceptable. Auxiliary relays and lock out relays are acceptable in fixed execution.
- 9.7.3 The protective (static or electro-mechanical type) relay cases shall have a provision for insertion of a test plug at the front for testing and calibration purpose using an external power supply. 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 permits extension of external power supply to the relay.
- 9.7.4 Each protective relay shall be provided with minimum 2 numbers potential free contacts of required configuration.
- 9.7.5 Each tripping relay shall be of lockout type with hand reset coil cut-off contact.

9.7.6 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.

9.8 Instrument Transformers (CTs/PTs)

9.8.1 Current transformers shall generally conform to IS: 2705 and any special requirement with respect to numerical relay shall be taken care by the vendor.

9.8.2 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"/"PX". Vendor shall co-ordinate the knee point voltage, magnetising current for PS class CTs to avoid saturation and mismatching of CTs provided at other end by other vendor.

9.8.3 Current transformers for instruments shall have an accuracy class 1.0 and accuracy limit factor less than 5.0.

9.8.4 The current transformers in breaker feeders shall be capable of withstanding the applicable peak momentary short circuit and the symmetrical short circuit current.

9.8.5 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.

9.9 Measuring Instruments

9.9.1 All measuring instruments shall be of 96 x 96 mm square pattern, flush mounting type for incomer and outgoing feeders in the switchboard. The accuracy class for all instruments shall be 1.0 as per IS: 1248.

9.9.2 All auxiliary equipment such as shunts, transducers, CT, PT, etc. as required shall be included in the supply of the switchboard.

9.9.3 All AC ammeters and voltmeters shall be of moving iron type. 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.

9.9.3 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.

9.9.4 Digital meters shall be provided, if specified in job specification/data sheets. All digital meters shall be highly 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 have RS232/485 port in case specified in the job specification/data sheet.

9.10 Control Switches

9.10.1 All control switches shall be rotary type, having a cam operated contact mechanism. Switch shall have pistol grip handle for circuit breaker control and knob type handle for other applications.

9.10.2 Ammeter selector switches shall have make before break feature on its contacts. The selector switch shall generally have 4 positions, three for reading 3 phase currents and the 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.

9.11 Push Buttons

Push button colours shall be as follows:

Stop /open/emergency stop	:	Red
Start/close	:	Green
Reset/test		Yellow / Black /white

The stop push button shall be stay put type.

9.12 Indication

9.12.1 Clustered LED type indicating light with minimum 8mm diameter size shall be provided for indications.

9.12.2 Breaker positions (Close, Open, spring-charged, test position, service position) electrical indications, with colors as given below, shall also be provided:

Breaker 'Closed'/ ON	:	Red lamp
Breaker 'Open'/ OFF	:	Green lamp
Breaker auto-trip	:	Amber lamp
Trip circuit healthy	:	White lamp
Spring charging	:	Blue lamp

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

'Closed'	:	Red lamp
'Open'	:	Green lamp
'Trip'	:	Amber lamp

9.13 Auxiliary Relays/Contactors

Auxiliary relays/contactors shall generally be used for interlocking and multiplying contacts. However, in the case of numerical relays, the interlocking logic shall be built in the relay itself.

9.14 Timers

For re-acceleration duty, timers shall be electronic type or static type. The time settings, where specified, shall be accurately set before despatch of the switchboard. Timer provided for control of capacitor feeder and re-acceleration feeders shall have minimum setting of 0-5 minutes.

9.15 Miniature Circuit Breaker

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.

10.0 INSPECTION, TESTING AND ACCEPTANCE

10.1 During fabrication, the switchboard shall be subject to inspection by EIL / Owner, or by an agency authorised by the Owner, to assess the progress of work, as well as to ascertain that only quality raw material is used. The manufacturer shall furnish all necessary information concerning the supply to EIL / Owner's inspectors.

10.2 For testing requirements refer Inspection & Test Plan No. 6-81-1018. Prior notice of minimum 4 weeks shall be given to EIL/owner for witnessing the final testing of the complete assembly to ensure satisfactory operation of all components. Tests shall be carried out at manufacturer's works under his care and expense.

10.3 Vendor shall provide certificates to prove that the design of switchgear/switchboard has been successfully type tested as per IEC-61439 and IEC-61641(for arcing due to internal faults).

11.0 PACKING AND DESPATCH

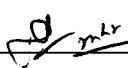
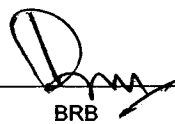
All the equipment shall be divided into several shipping sections for protection and ease of handling during transportation. The equipment shall be properly packed for selected mode of transportation i.e. by ship/rail or trailer. The panels shall be wrapped in polyethylene sheets before being placed in wooden crates /cases to prevent damage to the finish. Crates /cases shall have skid bottoms for handling. Special precaution notations such as 'Fragile', 'This side

up', 'Centre of gravity', 'weight', Owner's particulars, Purchase order number 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 should be suitable for outdoor storage in areas with heavy rains and high ambient temperature unless otherwise agreed. A set of instruction manuals for installation, testing and commissioning, a set of operation & maintenance manuals and a set of final drawing shall be supplied duly enclosed in a waterproof cover along with the shipment.

बैटरी चार्जर के लिए विनिर्देश

SPECIFICATION FOR BATTERY CHARGER

5	17/11/16	REVISED AND REISSUED AS STANDARD SPECIFICATION	 PB/MHR	 RS	 BRB	 RN
4	11/04/11	REVISED AND REISSUED AS STANDARD SPECIFICATION	RS	PG	UAP	DM
3	10/09/08	REVISED AND REISSUED AS STANDARD SPECIFICATION	RS	NS	JMS	VC
2	25/03/02	REVISED AND REISSUED AS STANDARD SPECIFICATION	VCB	JMS	VPS	GRR
1	30/08/96	REVISED AND REISSUED AS STANDARD SPECIFICATION	RKM	VPS	SG	AS
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

Abbreviations:

AC	:	Alternating Current
Ah	:	Ampere-hour
BIS	:	Bureau of Indian Standards
BS	:	British Standard
CEA	:	Central Electricity Authority
CFL	:	Compact Fluorescent Lamp
CRCA	:	Cold Rolled Cold Annealed
DC	:	Direct Current
DCDB	:	Direct Current Distribution Board
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical and Electronics Engineers
IP	:	Ingress Protection
IS	:	Indian Standard
LED	:	Light Emitting Diode
MCB	:	Miniature Circuit Breaker
MCCB	:	Moulded Case Circuit Breaker
MR	:	Material Requisition
MSL	:	Mean Sea Level
NEMA	:	National Electrical Manufacturers Association
Ni-Cd	:	Nickel Cadmium
PO	:	Purchase Order
PVC	:	Poly Vinyl Chloride
RFI	:	Radio Frequency Interference
RMS	:	Root Mean Square
UPS	:	Uninterrupted Power Supply
V	:	Volt
VDE	:	Verband Der Elektrotechniker, Elektronik und Information stechnik
VRLA	:	Valve Regulated Lead Acid

Electrical Standards Committee

Convenor: Mr. B.R. Bhogal

Members: Ms. Sumita Anand
Mr. Parag Gupta
Mr. M.K. Sahu
Ms. N.S. Bhattacharya
Mr. Saeed Akhtar (Inspection)
Ms. N.P. Guha (Projects)

CONTENTS

1.0	SCOPE	4
2.0	CODES AND STANDARDS	4
3.0	GENERAL REQUIREMENTS.....	4
4.0	SITE CONDITIONS	4
5.0	TECHNICAL REQUIREMENTS.....	5
6.0	INSPECTION, TESTING AND ACCEPTANCE	12
7.0	PACKING & DESPATCH	12

1.0 SCOPE

This specification covers the design, manufacture, testing at manufacturer's works, packing and supply to site of Battery Chargers and Distribution Boards.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of latest revision of the following standards issued by BIS/ IEC:

IS 5	Colours for ready mixed paints and enamels.
IS 1248	Direct acting indicating analogue electrical measuring instruments and accessories.
IS 3700	Essential rating and characteristics of semi-conductor devices.
IS 3715	Letter symbols for semi-conductor devices.
IS 4411	Code of designation of semi-conductor devices.
IS 5001	Guide for preparation of drawings for semi-conductor devices and integrated circuits.
IS 5469	Code of practice for the use of semi-conductor junction devices.
IS 6619	Safety code for semiconductor rectifier equipment.
IS 7204	Stabilised power supplies DC output.
IS 12021	Control transformers for switchgear and controlgear for voltages not exceeding 1000VAC.
IS 13703	Low voltage fuses for voltages not exceeding 1000VAC or 1500VDC.
IS/ IEC 60947	Low voltage switchgear and control gear.
IEC 60146	Semiconductor converters.

2.2 In case of imported equipment, the standards of the country of origin shall be applicable, if these standards are equivalent or more 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 conflict between various referred standards/ specifications/ datasheets and statutory regulations, the most stringent requirement shall prevail and Owner's/ EIL's decision in this regard shall be final and binding.

3.0 GENERAL REQUIREMENTS

3.1 The offered equipment shall be brand new with state of the art technology and a 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 for at least 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 to place order for spares and services.

4.0 SITE CONDITIONS

The Battery Chargers shall be suitable for installation and satisfactory operation in a pressurised or non-pressurised substation with restricted natural air ventilation in a tropical, humid and corrosive atmosphere. The Battery Chargers 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 1000 m above MSL shall be considered for all equipment.

5.0 TECHNICAL REQUIREMENTS

5.1 Input Power Supply

- 5.1.1 The Battery Chargers shall be suitable for input power supply as defined in the data sheet. If not specified therein, these shall be suitable for the following input power supply:

Voltage : 415V $\pm$ 10%
Frequency : 50 Hz $\pm$ 3%

In addition to the above variations, the input voltage may be subject to transient variations comprising of voltage dips up to 20% of normal voltage during motor start-up, voltage interruptions during short circuits as well as frequency variations due to large motor start-up. The Battery Chargers shall operate satisfactorily with a total harmonic distortion of up to 5% in the input power supply.

The Battery Chargers shall also be designed to operate satisfactorily while drawing input power from an emergency diesel generator set.

- 5.1.2 The incoming power supply to the Battery Charger system shall be provided by 2 independent feeders. One feeder shall supply power to each rectifier.

5.2 Battery Charger

5.2.1 Design Basis

- 5.2.1.1 The Battery Charger system shall have two chargers (Charger-1 & Charger-2). Both chargers shall be of identical design and rating. The battery to be connected to the chargers shall be of Nickel Cadmium/ flooded electrolyte Lead Acid/ VRLA type as indicated in the data sheet. Battery Chargers for flooded Lead Acid and Nickel Cadmium batteries shall be sized to provide quick charging of the battery within a duration of 10 hours. Battery Chargers for VRLA battery shall be sized to provide quick charging of the battery up to 90% of rated Amperehours within a duration of 24 hours and to 100% within 4 days. Each charger shall be sized for the most stringent of the following duty conditions, whichever is higher:

- a. Offline quick charging of the battery assembly. The charger shall be sized as under:

Charger rating in Amps. = 0.14 Ah(C₁₀) of battery (for Lead Acid battery)
= 0.2 Ah(C₁₀) of battery (for VRLA battery)
= 0.2 Ah(C₅) of battery (for Nickel Cadmium battery).

- b. Online float charging of the battery assembly while feeding the complete DC load. The charger shall be sized as under:

Charger rating in Amps. = 1.15 x Average DC load + float charging current
(Average DC load = Area under the battery duty cycle/ battery duty cycle duration).

- 5.2.1.2 Each charger shall have a 3 phase full wave, controlled rectifier bridge with protective devices.

- 5.2.1.3 Independent current limits shall be provided for charger load current and battery charging current. Subsequent to a discharge cycle and completion of quick charging, when battery is connected to charger under float mode, the battery current shall be monitored, controlled and limited to set value automatically irrespective of the value of load current. Fast acting semi-conductor fuses shall be provided for protection against internal short circuits. In case of external short circuits, the chargers shall be protected by rapid shutdown of the semi-conducting power devices. The high speed semi-conductor fuses used for rectifier protection shall be complete with trip indication.

- 5.2.1.4 Filter circuits consisting of smoothing choke and condenser, complete with protection to limit the ripple content at the output, shall be provided.
- 5.2.1.5 Silicon blocking diodes shall be provided in the charger output circuit to prevent back-feed from battery into the charger and filters.
- 5.2.1.6 Protection against reverse battery connection and DC earth fault relay for earth leakage detection shall be provided.
- 5.2.1.7 Silicon blocking diodes (min. 4 nos.) connected to 80% tap of the battery bank shall be provided to maintain continuity in the DC supply to the load.
- 5.2.1.8 Internal cooling of the charger unit shall preferably be by natural ventilation. If forced air cooling is necessary, a redundant air cooling fan shall be provided. The charger components shall be capable of delivering their rated output with one forced air cooling fan out of service. Under this condition, maximum continuous temperature of components shall not exceed the permissible limits. In case of chargers with forced cooling, loss of ventilation alarm/ trip with override facilities shall be provided.
- 5.2.1.9 Selection, sizing and suitability of all components used for various applications shall be vendor's responsibility and the rating of components shall be increased, if required, to suit associated components during execution of the order without any claim for extra price or time.
- 5.2.1.10 The DC system shall be unearthed. However, a high impedance earth fault relay shall be provided for the protection of the battery.
- 5.2.1.11 Each charger shall be galvanically isolated from the input power supply by providing a double wound transformer at its input. The transformer shall be natural air cooled, dry type suitable for location inside a panel.
- 5.2.1.12 An RFI filter shall be provided to suppress the radio frequency interference to permissible limits. The production of radio frequency interference voltages shall not exceed the value of suppression grade N as defined in VDE-0875.
- 5.2.1.13 Transient/ surge protection devices shall be provided in the input circuit of chargers to protect them against surges & voltage spikes.
- 5.2.1.14 The Chargers shall be designed to draw power from mains supply at a minimum power factor of 0.85 lag while sharing the rated load in normal operating configuration.
- 5.2.1.15 The chargers shall be designed to ensure that the harmonic component in the input currents are limited so as not to cause undue harmful effects on other sensitive equipment operating on the same supply bus. Suitable filters/ harmonic traps shall be provided, as required, for this purpose.
- 5.2.1.16 All breakers shall be adequately rated for the required continuous rating and breaking capacity as applicable. Paralleling of breaker/ switch/ contactor poles to achieve the required current rating is not acceptable. All output isolating devices shall be double pole type. The DC contactors shall be operated with a DC control supply using ON/ OFF selector switches and not push buttons.
- 5.2.1.17 All the thyristors, diodes and other power electronic devices shall be protected with high speed semiconductor fuses. I²t co-ordination between fuse and semi-conducting power devices shall be ensured.
- 5.2.1.18 The Battery Chargers shall be specifically designed to limit float and quick charging voltages to the battery to limits recommended by the battery manufacturer. Output voltage shall be limited to maximum +10% of nominal system voltage when the battery is float charged while feeding the load. Vendor shall specifically ensure that the charger output voltage does not exceed the recommended limits of operation under any conditions of internal/ external fault or operation, including:
 - Filter capacitor fuse failure of either charger

- DC output switch OFF of either charger
- DC output fuse blown of either charger.

Other specific current/ voltage limits during normal charging/ operation of the chargers shall also be incorporated in the design of the chargers.

5.2.2 Operation and Performance

5.2.2.1 Operation (Option – I)

The DC system shall comprise of 2 Nos. Float cum quick Chargers (each rated for 100% capacity) with 1 set of battery (Refer typical scheme block diagram option – I).

- a. Normal operation requires that the battery assembly shall be float charged simultaneously by both Chargers-1 & 2 while feeding the DC load, the chargers thus operating in parallel and equally sharing the total load.
- b. However in case of failure of either of the chargers, the other charger shall float charge the battery while feeding the complete DC load. Faulty charger shall automatically get disconnected from the healthy system.
- c. In case of AC mains failure, the battery shall continue to supply the load.
- d. The process of changeover from float to quick charging and reverting from quick to float charging shall be selectable in Automatic or Manual mode by means of an Auto/ Manual selector switch. In Automatic mode, the changeover from float to quick charging shall be initiated through a current sensor, set at a preset value. Similarly, the changeover from quick to float charging shall also be automatic based on current sensing. In Manual mode, both change over from float to quick charging and from quick to float charging shall be performed manually using push buttons. When quick charging mode is selected, the battery charger shall initially charge the battery under constant current mode followed by constant voltage (finishing charging) mode or as per the battery manufacturer's recommendation. Changeover from constant current to constant voltage (finishing charging) mode shall be fully automatic. A backup synchronous or digital timer shall also be provided for initiating the changeover to float mode by default after a preset time period. The timer range shall be 0 to 24 hours or the nearest available as per manufacturer's standard range.
- e. In the event of failure of the charger feeding the load, when battery is being quick charged by the other charger, continuity in DC supply shall be maintained from the battery to the load through 80% tap of the battery bank followed by full battery supplying the load through contactor C-2 (refer block diagram Option – I).
- f. Interlock shall be provided to ensure that when either of the chargers is selected in quick charging mode, it will be disconnected from both the DC load and the other charger operating under float charging mode.
- g. The chargers shall have facility for manual mode of operation in the event of failure of controller under closed loop control. The selection shall be done through Auto/ Manual selector switch.
- h. Energisation of contactor for DC critical lighting shall be initiated by means of an AC mains failure relay complete with Auto/ Manual selector switch, On/ Off push buttons etc.

5.2.2.2 Operation (Option – II)

- a) The DC system shall comprise of 2 nos. Float cum quick Chargers (each rated for 100% capacity) and 2 sets of Batteries (each of the battery sets rated for 50% AH capacity unless specified otherwise in datasheet/ job specification). (For typical scheme, refer block diagram Option - II).

- b) Normal operation requires that Battery-1 shall be float charged by Charger-1 while Battery-2 shall be float charged by Charger-2. In this case both the chargers 1 and 2 shall feed the DC load by operating in parallel and equally sharing the total load.
- c) Selection of Float / quick mode shall be Automatic or Manual based on the position of selector switch for Auto / Manual selection.
- d) In case of failure of either of chargers, the other charger shall float charge both the batteries while feeding the complete DC load. Faulty charger shall automatically get disconnected from the healthy system.
- e) In case of AC mains failure, both the batteries shall continue to supply the load.
- f) After restoration of power supply, one of the Charger (say Charger-1) shall float charge Battery-1 and also feed the complete DC load while the other Charger-2 shall quick charge Battery-2. Upon completion of quick charge of Battery-2, Charger-2 shall switchover to float mode and shall float charge Battery-2 and also feed the complete DC load while the other Charger-1 shall switchover to quick mode and shall quick charge Battery-1.
- g) The process of changeover from float to quick charging and reverting from quick to float charging mode shall be selectable in Automatic or Manual mode by means of Auto / Manual selector switch.
- h) In automatic mode, the changeover from float to quick charging shall be initiated through a current sensor set at a preset value. Similarly, the changeover from quick to float charging shall also be automatic based upon current sensing and through timer.
- i) In manual mode, both the changeovers i.e. from float to quick charging and from quick to float charging shall be performed using push buttons. When quick charging mode is selected, one of the battery charger (say Charger-1) shall initially charge the battery under constant current mode followed by constant voltage (finishing charging) mode or as per the battery manufacturer's recommendation. Changeover from constant current to constant voltage (finishing charging) mode shall be fully automatic. A back-up synchronous or digital timer shall also be provided for initiating the changeover to float mode by default after a preset time period. The timer range shall be 0 to 24 hours or the nearest available as per manufacturer's standard range.
- j) In the event of failure of charger feeding the load (say Charger-1), when Battery-2 is being quick charged by the other Charger-2, Charger-2 shall changeover to float mode and continuity of 100% DC supply to the load shall be maintained from the Charger-2 while float charging both Battery-1 as well as Battery-2 after providing suitable time delay.
- k) In an event of AC mains failure, when one of the Charger (say Charger-1) is float charging the Battery-1 and supplying the 100% DC load while the other Charger-2 was quick charging Battery-2, continuity of 100% DC supply to the load shall be maintained from Battery-1 (through 100% tap). Further, Battery-2 (which was being quick charged) shall also be made available, after providing suitable time delay, to feed the DC load by operating in parallel with Battery-1 and sharing the total load.
- l) Interlock shall be provided to ensure that when either of the chargers (say Charger-1) is selected in quick charging mode, it will be disconnected from both the DC load as well as the other Charger-2 operating under float charging mode.
- m) The chargers shall have facility for manual mode of operation in the event of failure of controller under closed loop control. The selection shall be done through Auto/Manual selector switch.
- n) Energisation of contactor for DC critical lighting shall be initiated by means of an AC mains failure relay complete with Auto/Manual selector switch, On/Off push buttons etc.

5.2.2.3 Performance

- a. Both chargers shall be of solid state design, constant voltage and current limit type. The output voltage shall be stabilised to within $\pm 1\%$ of set value in float charging mode for mains steady state voltage and frequency variation of $\pm 10\%$ and $\pm 3\%$ respectively, and load variation of 10 to 100% at any temperature up to the design ambient temperature specified in the data sheet. However, the variation in output voltage can be up to $\pm 2\%$ for chargers with rated output voltage up to 24V.
- b. Under constant current quick charging condition, the DC output current shall be maintained within $\pm 2\%$ of set value.

The output voltage dynamic response of the charger unit with battery disconnected shall not vary more than $\pm 10\%$ of nominal output voltage in the event of step load of up to 50% of the rated output. The output voltage shall be restored to a value within the steady state limits within 250 msec.

- c. The maximum allowable RMS ripple voltage, with battery disconnected, shall be equal to or less than 2% of the nominal output voltage.
- d. The maximum noise level from the chargers measured at 1 metre distance in any position, at any load between 0- 100% with all normal cooling fans running shall not exceed 75 dB(A).

5.2.2.4 Controls

The minimum controls shall include but not be limited to those shown in the block diagrams (OPTION-I or OPTION-II as applicable):

5.2.2.5 Panel Metering and Indication

These shall include but are not limited to those shown in the block diagrams (OPTION-I or OPTION-II as applicable):

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

5.2.2.6 Annunciation

Static type audio-visual annunciator with annunciation windows, acknowledge, test and reset push buttons and hooter shall be provided on each charger for the following annunciations. Any additional relays/ components, including DC undervoltage relay and current sensors, required for this purpose shall be provided in the chargers. Facility for bypassing the audio alarm on each charger shall also be provided.

- DC under voltage
- DC overvoltage
- DC earth leakage
- AC incoming power supply failure
- AC input fuse blown-off
- Thyristor/ diode failure or Thyristor/ diode protection fuse failure
- DC output fuse blown-off
- DC battery fuse blown-off
- Filter Capacitor fuse blown-off
- Load on Battery (using current direction sensing with time delay)
- Battery undervoltage/ Disconnected during discharge (using zero current sensing)
- Cubicle fan failure/ cubicle temperature high (for chargers with forced cooling).

One summary alarm potential-free contact each for Battery, Charger-1 and Charger-2 shall be wired to terminal block for remote annunciation.

5.2.2.7 Printed Circuit Boards (PCBs)

PCBs used in the chargers shall be made of glass epoxy material. The PCBs shall be firmly clamped in position so that vibration or continued usage do not result in loose contacts. All PCBs shall be fitted in a manner to avoid replacement of a PCB by a wrong spare card. The PCBs shall be provided with visual light emitting diode (LED) status indications, monitoring points/ test connections and setting potentiometers in a readily accessible location which is visible without removing the PCBs.

5.2.2.8 Vendor shall provide adequate protection to the system.

5.3 Construction of Chargers/ Distribution Board

5.3.1 Each Battery Charger and DC distribution board shall be housed in a separate free standing cubicle with minimum IP-31 degree of protection. All panels shall be of the same height so as to form a panel line up which shall have good aesthetic appearance. Chargers-1 & 2 shall be installed side by side whereas DCDB may be located separately and interconnected to the charger through cables. The DCDB shall accommodate outgoing feeders as desired. Each panel shall be provided with an 11W CFL light or LED lamp of required wattage with a door operated switch and a thermostatically controlled MCB protected space heater.

The DCDB shall be compartmentalised with each outgoing feeder housed in a separate compartment. Cable alley of minimum 200mm width with suitable supports shall be provided for the termination of cables for each vertical arrangement of outgoing feeders in DCDB.

5.3.2 The Chargers, DCDB and Cell Booster enclosures shall be fabricated from structural/ CRCA sheet steel. The frames shall be fabricated by using minimum 2 mm thick CRCA sheet steel while the doors and covers shall be made from minimum 1.6 mm thick CRCA sheet steel. Wherever required, suitable stiffeners shall be provided. The panels shall be provided with suitable louvers for ventilation backed by wire mesh. They must be suitable for use in a tropical climate. Hinged doors shall be provided at the front and back as required. Inter panel sheet steel barriers shall be provided.

5.3.3 Bus bars shall be colour 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 nameplates and device tag numbers as per the schematic diagram. All wires shall be ferruled and terminals shall be numbered.

5.3.4 The DCDB incomer and main bus bars shall be rated based on the maximum load current considering an additional 10% design margin for contingencies. The rating shall be selected from standard available ratings and shall be adequate for the expected short circuit current. The bus bar voltage shall be higher than the recommended quick charging voltage for the system. The insulation for all equipment where provided shall be heat resistant, moisture proof and tropicalised.

5.3.5 All power and control switches shall be rotary/ cam operated type. All power switches shall be air insulated load break type. Vendor shall ensure that all equipment/ components such as incomer switches, outgoing DC switches, MCCBs, push buttons, indicating lamps, charger mode selector switches, voltage control switches, annunciator windows etc. are suitably located on the charger and distribution board door such that they can be operated without opening the front door. Power switches shall be provided with a door interlock. In case of difficulty in installation on the charger front panel door, the AC incoming power switches, DC outgoing switches and MCCBs may be installed within the panel provided that they are operable after opening the front panel door. However, all other selector/ control switches, push buttons, indicating lamps, annunciators, meters etc. shall necessarily be installed on the front panel door as specified above.

5.3.6 All instruments shall be switchboard type, back connected and maximum 96 x 96 mm square size. Accuracy class of all meters shall be 1%. Digital meters capable of displaying different parameters can be considered subject to Owner's/ EIL's approval. Analogue instrument scales shall have a red mark indicating maximum permissible operating rating.

- 5.3.7 All fuses shall be link type and shall be located inside the panel. Diazed fuses shall not be accepted.
- 5.3.8 All power and control wiring connections within the panels shall be carried out with 660V grade, PVC insulated, Flame Retardant Low Smoke (FRLS), BIS marked wires having stranded copper conductors. However, copper strip connections shall preferably be used for currents exceeding 100A. Control wiring for electronic circuits/ components shall be through flat ribbon cable or copper wire of minimum 0.5mm diameter. Ferruling of wires shall be as per relevant IS.
- 5.3.9 For all cabling external to panels, power cables shall be with aluminium/ copper conductors and control cables shall be with copper conductors. All cable connections shall be from the bottom of the panel. Removable bolted undrilled gland plates shall be provided along with single compression type nickel plated brass cable glands for all external cable connections. Separate test terminals shall be provided for measuring and testing the equipment to check performance.
- 5.3.10 A suitably sized earth bus shall be provided at the bottom of the panels running through the panel line up with provision for earth connections at both ends to owner's main earth grid. All potential free metallic parts of equipment shall be suitably earthed to ensure safety.
- 5.3.11 The maximum height of the operating handles/ switches shall not exceed 1800 mm and the minimum height shall not be below 300 mm.
- 5.3.12 All components/ devices/ feeders shall be provided with screwed nameplates and lettering shall be of minimum 6 mm height.
- 5.3.13 Panels shall undergo manufacturer's standard cleaning and painting cycle. After preparation of the under surface, the panel shall be painted with two coats of epoxy based final paint. Colour shade of final paint shall be 631 of IS 5/ RAL 7032. All unpainted steel parts shall be suitably treated to prevent rust formation. If these parts are moving elements, then they shall be greased.

5.4 Cell Booster

Cell booster shall be suitable for charging one to six cells within the time duration specified at Cl.5.2.1.1. It shall be suitable for charging not only new cells before being introduced to the battery bank but also for any treatment to be given to individual weak cells. Cell booster shall be suitable for $240\text{ V} \pm 10\%$, $50\text{ Hz} \pm 3\%$ SPN input power supply. Cell booster output voltage shall be in the range of 0-18V and 0-12V for Lead Acid and Nickel Cadmium batteries respectively. Cell booster shall be sized as under:

For Lead Acid battery	=	$0.14 \times \text{Ah}(C_{10})$ of cell
For VRLA battery	=	$0.2 \times \text{Ah}(C_{10})$ of cell
For NiCd battery	=	$0.2 \times \text{Ah}(C_5)$ of cell.

Cell booster shall have a heavy duty switch fuse or MCCB on both AC incomer and DC output sides, along with AC voltmeter, DC ammeter, DC voltmeter and indicating lamps for AC/ DC power ON. The output voltage and current of cell booster shall be manually controlled using a suitably rated variac or a full wave controlled rectifier bridge. Suitable interlock shall be provided so as 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 braided cables for both AC incoming power supply and DC output connection to the battery. An industrial type 3 pin 15A plug shall be provided on AC incoming cable end and lugs shall be provided on DC outgoing cable end.

5.5 Reliability

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

- 5.5.1 There shall be no common device between the two units, the failure of which could cause shutdown of more than one charger.
- 5.5.2 It shall be possible to attend to any individual power circuit for maintenance without affecting the total DC supply.
- 5.5.3 Series-parallel combination of smaller devices to achieve specified rating shall not be acceptable.

6.0 INSPECTION, TESTING AND ACCEPTANCE

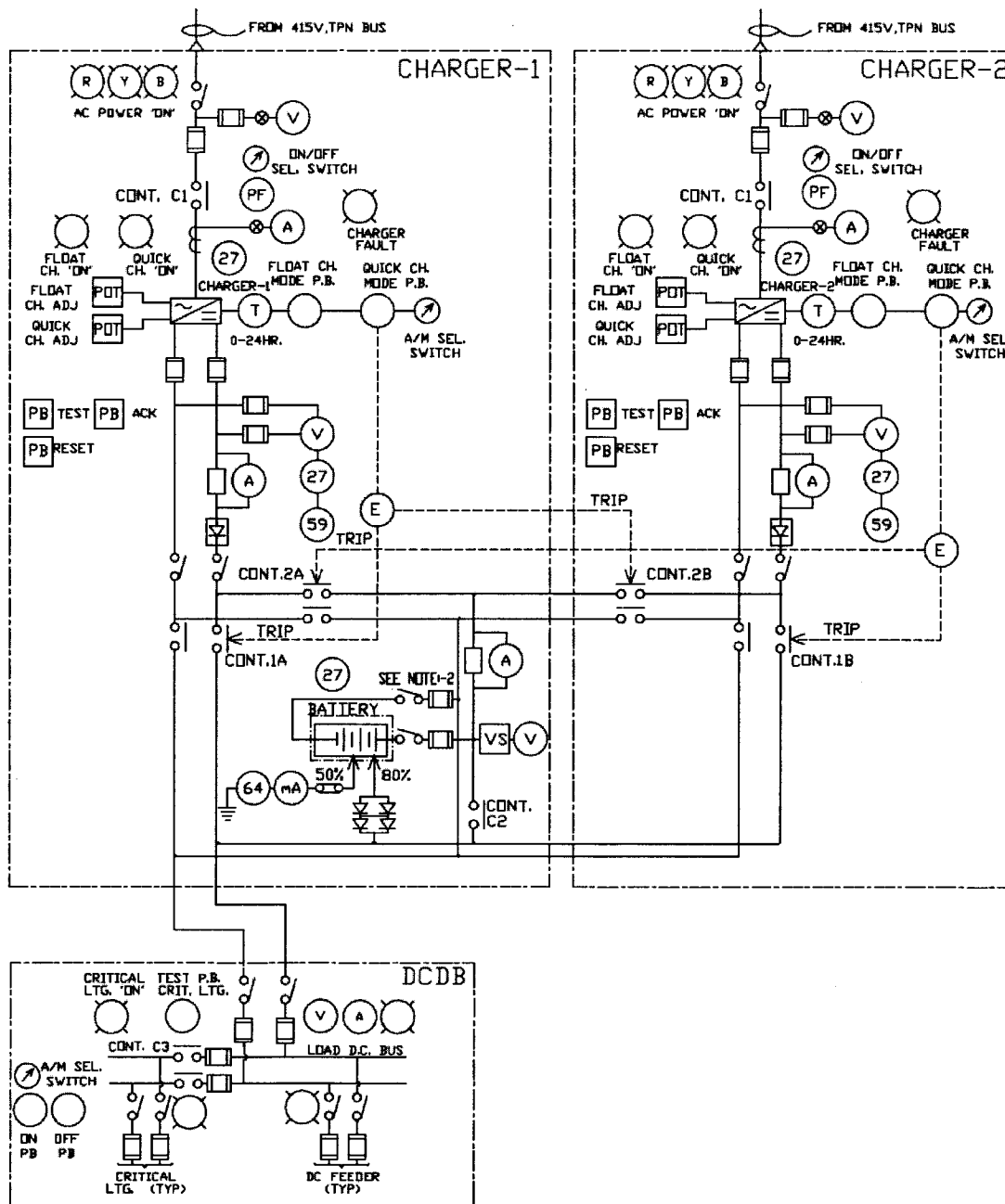
- 6.1 During fabrication, the equipment shall be subjected to inspection by EIL / Owner or by an agency authorised by the Owner. Manufacturer shall furnish all necessary information concerning the supply to EIL's/ Owner's inspector. Tests shall be carried out at manufacturer's works under his care and expense.
- 6.2 For testing requirement, Inspection & test plan for battery chargers (Standard no. 6-81-1019) shall be followed.

7.0 PACKING & DESPATCH

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. It shall be wrapped in polythene sheets before being placed in crates/ cases to prevent damage to finish. The 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 and indelibly marked on the packages 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. A set of instruction manuals for installation, testing and commissioning, a set of operation & maintenance manuals and a set of final drawing shall be supplied along with the shipment duly enclosed in a waterproof cover.

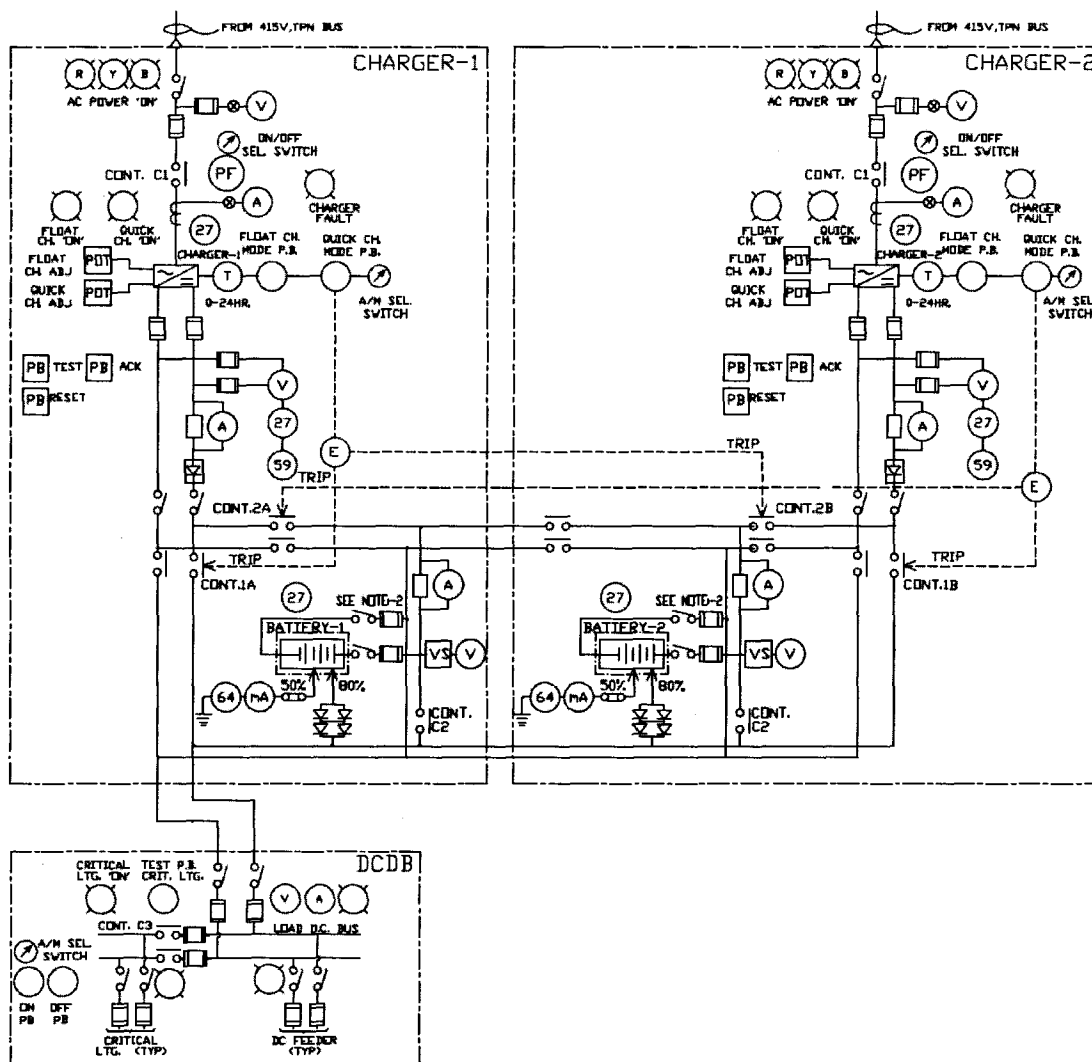
OPTION-I



NOTES: -

1. a) THE DC CONTACTORS SHALL HAVE A TESTED/ PUBLISHED DC RATING EQUAL TO OR EXCEEDING THE MOST STRINGENT CURRENT CARRYING AND BREAKING REQUIREMENTS CONSIDERING ADEQUATE DESIGN MARGINS.
b) PUSH BUTTONS ARE NOT ACCEPTABLE IN PLACE OF SELECTOR SWITCHES FOR THE ON/OFF SWITCHING OPERATIONS OF THE CONTACTORS.
c) THE DC CONTACTORS SHALL BE OPERATED WITH A DC CONTROL SUPPLY.
2. SUITABLY RATED DC MCCB CAN BE ACCEPTED IN PLACE OF SWITCH FUSE UNIT AT BATTERY OUTPUT.

OPTION-II



- THE DC CONTACTORS SHALL HAVE A TESTED/ PUBLISHED DC RATING EQUAL TO OR EXCEEDING THE MOST STRINGENT CURRENT CARRYING AND BREAKING REQUIREMENTS CONSIDERING ADEQUATE DESIGN MARGINS.
 - PUSH BUTTONS ARE NOT ACCEPTABLE IN PLACE OF SELECTOR SWITCHES FOR THE ON/OFF SWITCHING OPERATIONS OF THE CONTACTORS.
 - THE DC CONTACTORS SHALL BE OPERATED WITH A DC CONTROL SUPPLY.
- SUITABLY RATED DC MCCB CAN BE ACCEPTED IN PLACE OF SWITCH FUSE UNIT AT BATTERY OUTPUT.
- BATTERY CONFIGURATION SHALL BE 2X50% AH CAPACITY UNLESS SPECIFIED OTHERWISE IN DATASHEET/ JOB SPECIFICATION.

एम.वी. वैरीएबल फ्रीक्वेन्सी ड्राइव सिस्टम के लिए विनिर्देश

SPECIFICATION FOR MV VARIABLE FREQUENCY DRIVE SYSTEM

2	20.08.14	REVISED AND ISSUED AS STANDARD SPECIFICATION	MK/SA	HK	BRB	SC
1	24.04.09	REVISED AND ISSUED AS STANDARD SPECIFICATION	AM	SG	JMS	ND
0	24.09.02	ISSUED AS STANDARD SPECIFICATION	RM	AAN	VPS	GRR
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

Abbreviations:

AC	:	Alternating Current
BIS	:	Bureau of Indian Standards
BS	:	British Standard
CBCT	:	Core Balance Current Transformer
CEA	:	Central Electricity Authority
CFL	:	Compact Fluorescent Lamp
CRCA	:	Cold Rolled Cold Annealed
DC	:	Direct Current
DCS	:	Distributed Control System
DOL	:	Direct On Line
ELR	:	Earth Leakage Relay
EM	:	Electromagnetic
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical and Electronics Engineers
IGBT	:	Insulated Gate Bipolar Transistor
IO	:	Input/Output
IP	:	Ingress Protection
IS	:	Indian Standard
LED	:	Light Emitting Diode
MCB	:	Miniature Circuit Breaker
MCCB	:	Moulded Case Circuit Breaker
MTBF	:	Mean Time Between Failure
NEMA	:	National Electrical Manufacturer's Association
PCC	:	Point of Common Coupling
PLC	:	Programmable Logic Controller
PO	:	Purchase Order
PVC	:	Poly Vinyl Chloride
r.m.s	:	Root Mean Square
THD	:	Total Harmonic Distortion
VDE	:	Verband Deutscher Elektrotechniker
VFD	:	Variable Frequency Drive

Electrical Standards Committee

Convener : Mr. B.R.Bhogal

Members : Ms. Sumita Anand
Mr. Parag Gupta
Mr. M.K.Sahu
Mr. A.K. Chaudhary (Inspection)
Ms. N.P. Guha (Projects)

CONTENTS

1.0	SCOPE	4
2.0	CODES AND STANDARDS	4
3.0	SITE CONDITIONS	5
4.0	GENERAL REQUIREMENTS	5
5.0	TECHNICAL REQUIREMENTS	5
6.0	INSPECTION, TESTING AND ACCEPTANCE	14
7.0	PACKING AND DESPATCH.....	15

1.0 SCOPE

The scope of this specification is to define the minimum technical requirements for the design, manufacture, testing and supply of Medium Voltage, AC Variable Frequency Drive (VFD) System. The VFD system shall be complete with Squirrel Cage Induction motor as specified in data sheet, Converter, Converter input transformer(if required), DC link/AC line reactor with associated auxiliaries, filters(if required) and field mounted local motor control panel. Separate dedicated panel(s) shall be provided for each VFD system.

The Vendor shall be responsible for engineering and functioning of the complete system, meeting the intent and requirement of this specification and data sheets.

This specification applies to drives connected to line voltage up to 1000 V, AC.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the latest editions of the following standards unless specified otherwise:

IS:325	Three-phase Induction Motors
IS:3700	Essential Ratings and Characteristics of Semiconductor Devices
IS:3715	Letter symbols for semi-conducting devices
IS:4411	Code of designation of semi-conducting devices
IS:5001	Guide for preparation of drawings of semiconductor devices and Integrated Circuits
IS:5469	Code of practice for the use of semiconductor Junction Devices
IS:8789	Values of Performance characteristics for Three Phase induction motor
IS: 12615	Energy Efficient Induction Motors- Three Phase Squirrel Cage
IS:14901	Semi-conductor devices- Discrete devices & Integrated Circuits
IS:15880	Three Phase Cage Induction motors when fed from IGBT Converters- Application Guide
IS/IEC:60947	Low Voltage Switchgear and Controlgear
IEC:60146-1-3	Semiconductor Convertors general requirements and line commutated convertors-Transformer & reactors
IEC:61800	Adjustable speed electrical power drive systems
IEEE:519	Recommended Practices and requirements for Harmonics Control in Electrical Power Systems

2.2 In case of imported equipment, the 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 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 conflict between requirements specified in various applicable documents, the most stringent one shall prevail. However, owner's decision in this regard shall be final and binding.

3.0 SITE CONDITIONS

- 3.1** The AC drive system shall be designed to operate under specified site conditions as specified in the data sheets. If not specifically mentioned therein, a design ambient temperature of 40°C and an altitude not exceeding 1000 metres above mean sea level shall be considered.
- 3.2** The AC drive shall be installed indoors in a non-hazardous, air-conditioned or pressurised room, as specified in data sheet.
- 3.3** All the equipment shall be designed for continuous duty as per nameplate rating under the specified ambient conditions.

4.0 GENERAL REQUIREMENTS

- 4.1** The offered equipment shall be brand new with state of the art technology and a proven field track record. No prototype equipment shall be offered.
- 4.2** Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 10 years from the date of supply.
- 4.3** 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 to place order for spares and services.
- 4.4** The vendor shall be responsible for design, engineering and manufacturing of the complete VFD system to fully meet the intent and requirements of this specification and attached data sheets.

5.0 TECHNICAL REQUIREMENTS

5.1 Performance Requirement

- 5.1.1** The system shall be energy efficient, and shall provide very high reliability, high power factor, low harmonic distortion and low vibration / wear / noise. It shall be easy to install in minimum time and expense and no special tools shall be required for routine maintenance.
- 5.1.2** The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the load, with input supply variation of $\pm 10\%$ and frequency variation of $\pm 3\%$. The system shall be suitable for the load characteristics and the operational duty of the driven equipment. It shall be capable of withstanding the thermal and dynamic stresses and the transient mechanical torque, resulting from short-circuit.
- 5.1.3** The drive system shall be designed to operate in one or more of the following operating modes as specified in the data sheet:
- a) Variable torque changing as a function of speed i.e. Speed squared
 - b) Constant torque over a specific speed range
 - c) Constant power over a specific speed range where the torque decreases when speed increases
 - d) Any other as specified in data sheet

- 5.1.4 The drive controller shall be equipped with microprocessor based digital regulator with programmable functions. The power control regulator logic shall provide for an acceleration/deceleration current limit curve and shall be capable of field adjustments without shutting the system down. Linear acceleration and deceleration shall be separately programmable from 0.1 to 20 seconds.
- 5.1.5 The System shall be suitable for single quadrant operation and the speed variation shall be with range 1:100 unless otherwise specified with speed set accuracy of $\pm 1\%$ of rated maximum speed and steady state regulation of $\pm 0.5\%$ of rated speed.
- 5.1.6 The total harmonic distortion (THD) of the voltage and current at inverter output shall be as per IEC 61800 and same shall be considered in the design of the motor. The dv/dt limits & V_{peak} shall also be as per IEC-61800-2.
- 5.1.7 Harmonic at the supply side of the drive system at PCC (point of common coupling) shall be restricted within the maximum allowable levels of current and voltage distortion as per recommendations of the latest edition of IEEE-519.
- 5.1.8 The controller output overload capacity shall be 150% of rated current of motor for one minute for constant torque applications, and 110% of rated current for one minute for variable torque applications at rated voltage. If the motor load exceeds the limit, the drive shall automatically reduce the frequency and voltage to the motor to guard against overload. If load demand exceeds the current limit for more than 1 minute, the drive shall shut down to prevent over heating of the motor and damage to the drive.
- 5.1.9 During operation, the system shall be capable of developing sufficient torque under all load conditions to respond to a 20% alteration in set point within a time limit up to 60 seconds.
- 5.1.10 The integrator action of the set point alteration shall be independently adjustable for both an upward and a downward alteration. The minimum time interval between set point adjustment by the distributed control system shall be considered as 10 seconds.
- 5.1.11 Drive shall trip in case the speed exceeds 105% of the maximum operational speed and / or reduces to 95% of the minimum operational speed for more than 10 seconds.
- 5.1.12 Maximum noise level from the drive at 1 meter distance, under rated load with all normal cooling fans operating shall not exceed 75 dB(A).
- 5.1.13 Variable frequency drive shall be arranged so that it can be operated in an open circuit mode, disconnected from the motor for start-up adjustments and troubleshooting.

5.2 Control Requirement

- 5.2.1 The system shall operate on constant V/f supply with required voltage boost capability in low frequency mode of operation.
- 5.2.2 Short time voltage dips upto 20% of nominal (e.g. in case of a large motor start up connected to the same bus as VFD), shall not cause the control system to stop functioning and shall not trip the drive system.
- 5.2.3 The system shall also be equipped with a momentary powerloss ride through feature which will restart the system in case of voltage dip over 20% or power interruptions for less than 2 seconds, with recovery of the voltage to its nominal value. The drive shall have the facility to block this feature, if required by the operator. Upon restart, the converter shall be capable of re-synchronizing onto running motor and develop full acceleration torque within 10 seconds.

- 5.2.4 The system shall be suitable for number of starts as per attached standard specification for Medium Voltage Induction Motors.
- 5.2.5 The power controller shall be regulated to always start the motor in the forward direction. Logic shall be provided to prevent the motor from being started in the reverse direction.
- 5.2.6 The drive motor shall be speed regulated corresponding to 4-20 mA or 0-10 V reference input signal. Upon complete loss of the user's speed reference signal, the drive shall automatically run at constant speed as determined by the last speed reference available prior to the loss of signal.
- 5.2.7 It shall be possible to vary the speed of the drive in either manual or auto mode. Auto/Manual selection shall be from VFD panel unless otherwise specified.
- a) With the selector switch in "manual" mode, the operator shall be able to set the speed through key pad (mounted on front of the drive panel) or from speed increase/decrease push buttons (from the field). Motor operated potentiometer shall be provided as a speed set point device.
 - b) With the selector switch in "auto" mode, speed of the motor shall be controlled from a 4-20 mA signal, from owner's PLC/DCS (Process Control) system. Necessary equipment required for interfacing with PLC/DCS shall also be provided in the VFD panel.
 - c) Local/Remote selector switch shall be provided in local control station (in Field). With the selector switch in "Local" mode, the operator shall be able to start and set the speed through local control station (in Field). With the selector switch in "Remote" mode, speed of the motor shall be controlled either from VFD panel or from Owner's PLC/DCS as explained in a) and b) above. (For local control station, also refer Cl. 5.5.7 below).
- 5.2.8 The required provision for the interface with PLC/DCS (located at remote control room) including the details of communication module and data transfer facility, I/O details shall be furnished. The communication interface shall be via serial communication link with industry standard open protocol i.e. MODBUS/Data Highway Plus/IEC-61850/ RS-485 etc. and same shall be coordinated with the interfacing equipment. In case the vendor is using their proprietary software, the interface software for use with owner's system (software) shall be provided.

5.3 Panel Construction

- 5.3.1 The panel shall include suitable isolating device (i.e. Circuit breaker/MCCB/ Switch fuse) for main supply, contactors, semi conducting power devices (Diodes / IGBT) modules with protective devices, reactors, filters, output isolating device, control circuit, control accessories, indication and annunciation etc.
- 5.3.2 Main isolating device shall function as a manual disconnect and shall be an AC thermal-magnetic circuit breaker or a fused switch with dual element fuse to trip automatically on fault currents, as specified in data sheet. Devices shall be lockable in the open position and shall have a minimum interrupting capacity as specified in data sheet. Interlock shall be provided between the door, so that door cannot be opened unless the breaker/switch is open.
- 5.3.3 The drive shall be suitably housed in sheet steel panels and shall be fabricated using cold rolled sheet steel. The sheet steel used for the panel shall be of minimum 2 mm CRCA except the doors & covers that may be made of 1.6mm CRCA. The panel shall be suitable for indoor installation, if not otherwise specified. The panel shall be free standing with degree of

protection as min. IP-41. The maximum and minimum operating height shall be 1900 mm and 300 mm respectively.

- 5.3.4 Bolted undrilled gland plate shall be provided at bottom with single compression type cable gland. Clamp type terminals shall be used for connection of all wires up to 10 mm² and terminal for higher sizes shall be bolted type suitable for cable lugs. Minimum space for power cable termination shall be 300mm clear.
- 5.3.5 Bus bars shall be of electrolytic copper/aluminium, colour coded. All the live parts shall be sleeved / shrouded to ensure complete safety to personnel intending to carry out routine inspection by opening the panel doors. All the equipment inside the panel and on the doors shall be provided with suitable nameplate. All wires shall be ferruled and terminals shall be properly numbered, minimum 20% spare terminals shall be provided.
- 5.3.6 All the power and control switches shall preferably be mounted on the door and shall be operable externally. All the analogue instruments, wherever provided, shall be switch board type, back connected, 96x96mm size. Scale shall have red mark indicating maximum permissible operating rating.
- 5.3.7 Each panel shall be provided with illuminating lamp/11 W CFL with switch and fuse. 5/15A, 240V power socket with switch and fuse shall be provided. Each panel shall have space heater with switch fuse and variable setting thermostat.
- 5.3.8 Copper earth bus of min. 30X6 mm size shall be provided at the bottom of the panel extending outside the panel on both sides. All the non-metallic components/parts shall be connected to the main earth bus bar. In case a separate earth bus for electronic control system is required, the same shall be indicated in the drawings.
- 5.3.9 All panels shall be of same height so as to form a uniform line-up, to give good aesthetic appearance.
- 5.3.10 All the control wiring shall be enclosed in plastic channel. Each wire shall be identified at both ends by self-sticking wire marker tapes or PVC ferrules. Power and control wiring inside the panel shall be done with BIS approved, PVC insulated, flame retardant, low smoke, copper conductor wire. 1.5 mm² size wire shall normally be used provided the control fuse rating is 10 Amps or less and 2.5 mm² size for control fuse rating above 16 A for electrical circuits and 0.5 mm² for electronic circuits.
- 5.3.11 All electronic modules and components shall be accessible from front of panel only. Modular plug-in/draw-out assemblies for both the system control electronic equipment and power electronic equipments shall be used.
- 5.3.12 Suitable removable type hooks shall be provided for lifting the panel.

5.4 Cooling

Cooling system shall include well-dimensioned panel, adequate cooling airflow path, module cooling fan and if necessary, panel cooling fan. Vendor shall ensure that the panel dimensions and flow paths have been designed for continuous running at the specified ambient without overheating. For fan cooled drives, redundant ventilating fans (N+1) shall be provided. Necessary starters shall be provided within the VFD panels for these fans. In case redundant cooling fan is not possible to be mounted, same shall be supplied loose.

5.5 Equipment/ Component Specification

5.5.1 Motor

The motor shall be designed, constructed and tested in accordance with the attached standard specification for Medium Voltage Induction Motor, in addition to the following requirements:

- a) The motor shall be inverter grade motor suitable for operation with a solid state power supply consisting of an adjustable frequency inverter for speed control.
- b) The motor shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.
- c) The motor shall be designed to operate continuously at any speed over the range (1-100%) of rated speed or as specified in data sheet.
- d) Motor shall be provided with thermistor type temperature detector.
- e) The motors shall be provided with Class 'F' insulation with temperature rise limited to Class 'B'.
- f) The permitted voltage variation should take into account the steady state voltage drop across the AC drive.
- g) Motors required to be transferred to DOL by-pass mode shall be rated for specified variations in line voltage, frequency and starting current limitations as specified in data sheet.
- h) The motor shall be constructed to withstand torque pulsations resulting from harmonics generated by the solid state power supply.
- i) The motor insulation shall be designed to accept the applied voltage wave form, within the V_{peak} and dv/dt limits as per IEC-61800-2.
- j) The drive manufacturer shall be solely responsible for proper selection of the motor for the given load application and the output characteristics of the drive.
- k) Induced voltage at the shaft end of the motor at no load shall not exceed 250 mV rms for roller and ball bearings and 400 mV for sleeve bearings. The non driving end bearing shall be insulated from the motor frame to avoid circulating current. The insulated bearing end shield or pedestal shall bear a prominent warning.

5.5.2 Converter Transformer

The converter transformer shall be suitable for use with the variable frequency drive system. The impedances of transformers with two secondary windings for 12 pulse systems shall be selected to ensure equal load/current sharing between the two secondary windings, the converters and the motor windings under all operational conditions including starting and restarting. The transformer shall be provided with $\pm 5\%$ off circuit taps in steps of $\pm 2.5\%$.

5.5.3 Power Converter

- a) The static power converter shall consist of a line side power converter for operation as a rectifier and a load side power converter for operation as a fully controlled inverter.

- b) Normally, for all output short circuits, the inverter shall interrupt the current before any semi-conductor fuse blows. For internal short circuits, semi-conductor fuse protection shall be provided, and for faults upstream of semi-conductor fuses, the converter shall be able to withstand a three-phase short circuit current until interrupted by normal breaker operation. In case of fuseless design, the failure shall be limited to the particular device, without causing any damage to other parts of the power module. There must be clear annunciation of the failure of the device.
- c) All power converter devices shall include co-ordination by peak voltage protecting snubber networks and di/dt and dv/dt networks.
- d) The current rating of the converter's semi-conductor components shall not be less than 120% of the nominal current flowing through the elements at full load of the VFD through the whole speed range.
- e) All power diodes shall be of silicon type with minimum V_{BO} rating as 2.5 times the rated operating voltage.
- f) The power converter circuit shall be designed so that motor can be powered at its full name plate rating continuously without exceeding its rated temperature rise due to harmonic currents generated by the inverter operation.
- g) The conversion devices and associated heat sinks shall be assembled such that individual devices can be replaced without requiring the use of any special precautions/tools.
- h) The cooling system of the electronic components, if provided, shall be monitored and necessary alarms shall be provided to prevent any consequential damage to the power control devices.
- i) All the power transistors, thyristors and diodes shall be protected with high-speed semiconductor grade fuse. Particulars of the power controller devices and the fuses shall be properly co-ordinated for the selection of fuses.

5.5.4 DC Link / AC line Reactor

- a) Smoothing reactors for the DC link shall be designed to sufficiently decouple the rectifier and inverter portion of the converter and to limit fault currents in this circuit. AC line reactors, if provided as per standard vendor design, shall be suitable for harmonic suppression and fault current limitation.
- b) The reactor shall be dry type, air cooled or fan cooled type located within the panel. In case of fan cooled type, operation of fans shall be monitored.
- c) Reactor shall be suitable for operation with the non-sinusoidal current wave shapes and DC components under all operational conditions of the system without exceeding its temperature limits.

5.5.5 Output filter

VFD output current waveform shall be inherently sinusoidal at all speeds, with harmonic limits as per Cl.5.1.6. Output filter capacitors shall be provided with discharge circuits to ensure that all residual stored charge is reduced to less than 50 V DC within 60 seconds after a loss of AC voltage.

The VFD system shall inherently protect motor from high voltage dv/dt stress, independent of cable length to motor. Output filter shall be an integral part of the VFD system and included within the VFD enclosure.

5.5.6 Bypass Feature

5.5.6.1 Output contactor/Load Break Switch shall be provided for isolation between the output of the controller and the motor for VFD systems with Bypass feature.

5.5.6.2 Bypass feature shall be provided, if specified in the data sheet. Accordingly Bypass feature with Bypass starter shall meet the following requirements, unless otherwise specified in the data sheet:-

- Bypass starter shall comprise of switch-fuse, contactor, bimetal relay meeting the requirements of Type-2 coordination as per IS/IEC-60947. CBCT and ELR shall be provided for motors rated above 22kW & upto 55kW unless otherwise specified in the data sheet. Heavy duty starters shall be provided with saturable type current transformer operated overload relay only, which shall be suitable for motor starting time of 15-60 seconds. For motors rated above 55kW, ACB/MCCB and motor protection relay along with necessary metering shall be provided.
- Bypass starter shall be in separate compartment and it shall be possible to isolate and maintain the VFD while drive motor runs in Bypass mode. Three contactors/ breakers shall be used for this purpose, one contactor in the bypass and two contactors across the drive, such that in case of drive mal-operation, the motor could be taken on bypass control, while the drive could be attended by opening its contactors. Suitable interlock shall be provided such that bypass mode and VFD mode shall not operate simultaneously.

5.5.7 Local Control Station

The local control station shall conform to the attached standard specification(s).

Meters in the local control station for motors rated above 5.5kW shall be suitable for 4-20mA transducer outputs and shall be calibrated for the actual motor current unless specified otherwise. Further, for drives with bypass facility, the meters shall be capable of reading bypass full load and starting currents, as well as the drive current. Local-off-Remote selector switch shall be provided in the LCS for selection of control from Local (i.e. LCS in Field) and Remote (i.e. from VFD panel / DCS / PLC).

5.6 Protection, Control, Metering and Indication / Annunciation

5.6.1 The manufacturer shall provide all the necessary system control, protection, alarm equipment and metering for the entire drive system and its auxiliary equipment.

5.6.2 Automatic sequence control shall include start-up of cooling system, interlock checking, automatic start and run-up of drive, planned and emergency shutdown. The same shall be processed through microprocessor based system.

5.6.3 Operator Control Panel

Each drive shall be equipped with a front mounted operator control panel consisting of a backlit alphanumeric display and a keypad with keys for Run/Stop, Local/Remote, Increase/Decrease, menu navigation and parameter select/save. All parameter names, fault messages, warnings and other information shall be displayed in Complete English words or standard English abbreviations to allow the user to understand what is being displayed without the use of a manual or cross-reference table. This shall also be used for the modification of all

5.6.4 Protective Features

The system offered shall incorporate adequate protective features, properly coordinated for the drive control and for motor but not limited to the following:

- i) Incoming line surge protection
- ii) Under / Over voltage protection
- iii) Phase loss, phase reversal protection
- iv) Programmable Over current protection
- v) Inverter Fault protection
- vi) Over frequency /Over speed protection of motor
- vii) Ventilation loss (In case same is not provided, drive shall generate an over temperature fault alarm. Suitable sensors as required for same shall be provided)
- viii) Over temperature protection of equipment
- ix) Complete motor protection
- x) System Earth fault Protection

5.6.5 Alarms

The system shall incorporate protection alarms, required for various fault conditions, for the Drive motor, Supply cables, Converter Transformer, DC Reactor and the Converter. Alarms shall also be included for the failure of various auxiliaries together with identification of the failing unit, loss of cooling system, various protection devices provided for converter transformer etc.

5.6.6 Controls

The following controls shall be provided as a part of the Operator Control Panel or through separate switches.

- i) Start/Stop
- ii) Speed control (Raise/lower)
- iii) Forward/Reverse
- iv) Auto/Manual mode
- v) Emergency stop
- vi) Start/stop for by pass starter
- vii) Trip-Remote upstream feeder

5.6.7 Indications

The following indications shall be provided as a part of the Operator Control panel.

- i) Motor running
- ii) Motor stopped
- iii) VFD System Fault
- iv) System ready to start
- v) AC mains ON
- vi) Motor over speed
- vii) Drive 'ON'
- viii) Motor zero speed
- ix) Remote breaker trip

Potential free contacts of items i) - iv) shall be wired separately for indications in DCS system.

5.6.8 Metering

Digital display of the following parameters shall be as a part of the Operator Control Panel, selectable by the operator.

- i) Input AC voltage
- ii) Input AC frequency
- iii) Input AC Current
- iv) Output voltage
- v) Output current VFD / Bypass
- vi) Output frequency
- vii) Drive thermal state
- viii) Motor speed
- ix) Motor energy meter
- x) Run hour meter

Necessary transducer shall be provided with 4-20mA output for indicating motor speed and motor current in DCS.

5.6.9 Annunciations

Potential free contacts shall be provided for following annunciations and shall be wired up to terminal block for owner's use for remote monitoring:

- i) Rectifier fuse failure/Drive fault
- ii) Main AC failure
- iii) Inverter fuse failure/Drive fault
- iv) Inverter overload
- v) Inverter high temperature/Drive fault
- vi) Failure of panel cooling system
- vii) Motor failed to start/Drive fault

All drive internal faults will be annunciated as drive fault.

5.7 Fault Diagnostic

Fault diagnostic shall be built into the system to supervise the operation and failure of the system. The information regarding failure of any of the system including shut down of the system shall be available for a period of minimum 4 days (96 hours) after a shut down even though no supply would be available to the system. The system may be totally de-energized for maintenance or otherwise. It shall be possible to retrieve the record of events prior to tripping of the system or de-energisation. Auxiliary supply to the system components or to the electronics (firmware) for the diagnostics / display shall be taken care by the manufacturer for this purpose.

5.8 External Control Circuit

Control supply for devices external to VFD module i.e contactors control, space heater supply for Motor / VFD, indicating lamps digital meters (Ammeter, Speedometer) etc. shall operate on 240 V control supply derived from single-phase control supply transformer, with switch-fuse provided in primary and MCB in secondary, located inside the drive controller.

5.9 Reliability Features

- i) The expected life time of the VFD shall be minimum 20 years. The VFD including all individual components forming part of the system shall have an availability of minimum 0.997 and a minimum MTBF of 4 years.

ii) The controller design shall incorporate the following reliability features:

- Pre-tested components with power components to be 100% tested under dynamic conditions.
- Printed circuit boards shall be computer tested and adjusted.
- Printed circuit boards shall be temperature cycled for a minimum of 40 hours.
- Printed circuit boards shall be treated for tropical, humid and corrosive environment.

5.10 Maintenance Features

The controller design shall incorporate the following maintenance features:

- Modular construction
- Printed circuit boards shall be plug connected.
- All components shall be easily accessible from the front of the enclosure.
- Standard diagnostics to aid maintenance personnel. These shall include LED or alphanumeric displays, test or measurement points.

5.11 Painting

- 5.11.1 All metal surfaces shall be thoroughly cleaned and de-greased 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 a coat of yellow zinc chromate primer. The under-surface shall be made free from all imperfections before undertaking the finishing coat.
- 5.11.2 After preparation of the under surface, the panel shall be provided with epoxy based powder coating. The color shade of the final paint shall be RAL-7032, unless otherwise specified. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint, etc.
- 5.11.3 All unpainted steel parts shall be zinc passivated, cadmium plated or suitably treated to prevent rust and corrosion. If these parts are moving elements, then these shall be greased.

6.0 INSPECTION, TESTING AND ACCEPTANCE

- 6.1 During fabrication, the VFD shall be subject to inspection by EIL / Owner, or by an agency authorized by the Owner, to assess the progress of work, as well as to ascertain that only quality raw material is used. The manufacturer shall furnish all necessary information concerning the supply to EIL / Owner's inspectors.
- 6.2 All tests shall be carried out at the manufacturer's works under his care and expense. The tests shall be witnessed by an inspector of EIL/ 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.
- 6.3 All Routine & Type Tests shall be conducted as per the ITP for MV variable frequency drive 6-81-1038 on the complete VFD system (as defined in Cl.1.1.0 above) as per IEC 61800-2.
- 6.4. **String Test with Driven Equipment**

If a string test with driven equipment is required, this will be mentioned in the data sheet of the driven equipment.

7.0 PACKING AND DESPATCH

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. ship/rail or trailer. The panels 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', 'Weight', 'Owner's particulars', 'PO nos.' etc., shall be clearly marked on the package together with other details as per purchaser for scrutiny.

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.

स्टेशनरी निकल केडमियम बैटरीज के लिए विनिर्देश

SPECIFICATION FOR STATIONARY NICKEL CADMIUM BATTERIES

3	14.07.2016	REVISED AND ISSUED AS STANDARD SPECIFICATION	 PB/MHR	 RS	 BRB	 RN
2	11.04.2011	REVISED AND ISSUED AS STANDARD SPECIFICATION	CS	PG	UAP	DM
1	27.08.2007	REVISED AND ISSUED AS STANDARD SPECIFICATION	AP	NS	JMS	VC
0	28.03.2002	ISSUED AS STANDARD SPECIFICATION	SSM	AAN	VPS	
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

Abbreviations:

AC	Alternating current
Ah	Amperehour
BIS	Bureau of Indian Standards
BS	British Standard
CEA	Central Electricity Authority
DC	Direct current
EIL	Engineers India Limited
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical & Electronics Engineers
IS	Indian Standard
MSL	Mean Sea Level
NEMA	National Electrical Manufacturers Association
PO	Purchase Order
PVC	Polyvinyl Chloride
UPS	Uninterrupted Power Supply
VDE	Verband der Elektrotechnik, Elektronik und Information stechnik
V	Volt

Electrical Standards Committee

Convenor: Mr. B.R. Bhogal

Members: Ms. Sumita Anand
Mr. Parag Gupta
Mr. M.K. Sahu
Ms. N.S. Bhattacharya
Mr. Saeed Akhtar (Inspection)
Ms. N.P. Guha (Projects)

CONTENTS

1.0	SCOPE	4
2.0	CODES AND STANDARDS	4
3.0	GENERAL REQUIREMENTS	4
4.0	SITE CONDITIONS	4
5.0	TECHNICAL REQUIREMENTS	4
6.0	PERFORMANCE	6
7.0	INSPECTION, TESTING AND ACCEPTANCE	6
8.0	PACKING AND DESPATCH.....	6

1.0 SCOPE

This specification covers the design, Manufacture, testing and supply requirements of stationary vented type Nickel Cadmium cell/batteries for DC power system /AC UPS system application.

2.0 CODES AND STANDARDS

- 2.1 The equipment shall comply with the requirements of the latest revision of the following standards issued by BIS:

IS-10918 Specification for Vented type Nickel Cadmium batteries

- 2.2 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.

- 2.3 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 conflict between various referred standards/ specifications/ datasheets and statutory regulations, the most stringent requirement shall prevail and Owner's/ EIL's decision in this regard shall be final and binding.

3.0 GENERAL REQUIREMENTS

- 3.1 The offered equipment shall be brand new with state of the 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 for at least 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 to place order for spares and services.

4.0 SITE CONDITIONS

Stationary Nickel Cadmium cell/battery shall be suitable for operating satisfactorily in humid and corrosive atmosphere found in refineries, 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 40°C and an altitude not exceeding 1000m above MSL shall be considered, with a minimum temperature of 10°C for battery sizing.

5.0 TECHNICAL REQUIREMENTS

- 5.1 The Nickel Cadmium 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 The standard rated ampere hour capacity of the cell/ battery shall be at a reference temperature of 27°C, constant current discharge at 5 hours rate (C5) and an end cell voltage of 1.0 V/cell.

- 5.3 Ampere hour of the battery shall be selected based on the following criteria:
- Minimum site ambient temperature of 10°C
 - Discharge duty cycle
 - End cell voltage
 - Ageing factor of 0.8
 - Capacity rating factor
- 5.4 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 minimum number of cells and end cell voltage shall be as per the data sheet.
- 5.5 The battery shall be suitable for being quick charged to fully charged condition from fully discharged condition within 10 hours.
- 5.6 Battery assembly shall be supplied empty, dry and uncharged. Packed unused liquid electrolyte with 10% extra shall be delivered with the battery in suitable non returnable sealed containers.
- 5.7 Each cell/battery shall have a separate container of 1.2V (nominal voltage). 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.
- 5.8 The terminal posts shall be of nickel plated steel. The terminals shall be suitable for short circuit current and specified discharge current without damage to the cell as a result of terminal heating.
- 5.9 Stationary Nickel Cadmium cells/battery shall be designed to withstand the mechanical stresses encountered during normal transportation and handling.
- 5.10 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.
- 5.11 The following information shall be permanently marked on the cell.
- Nominal voltage
 - Name of manufacturer/model reference
 - Rated capacity in ampere hours (Ah) with End Cell Voltage
 - Voltage for float operation at 27°C with tolerance of ±1%
 - Month and year of manufacture
 - Polarity Marking
- 5.12 Each set of battery shall be supplied with all the accessories, including, but not limited to the following:
- Battery stand in formation as per data sheet. Mild steel stand pretreated and epoxy painted epoxy powder coated / PVC coated.
 - Inter cell, inter row and inter bank connectors and end take offs. These shall be of nickel plated copper/flexible insulated copper cable/completely insulated solid copper connectors.
 - Cell insulator as applicable.
 - Stand insulator.
 - Cell number plates/permanent stickers, Lugs for cable termination, as required.
 - Other accessories and their quantity as per data sheet.

6.0 PERFORMANCE

Nickel Cadmium batteries shall have been type tested to meet the performance requirements for each design and Ah rating of cells as per Indian Standard referred in clause 2.1 above.

7.0 INSPECTION, TESTING AND ACCEPTANCE

Batteries shall be subject to inspection by EIL/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 EIL/owner's representative. EIL/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.

The routine, acceptance & type testing shall be carried out as per Inspection & test plan for stationary nickel - cadmium battery (Standard no. 6-81-1047). Routine tests shall be conducted on each cell/battery. Acceptance tests & Type tests shall be conducted on few cells/battery as per relevant Indian standard.

Battery load test shall also be performed at site after installation as part of commissioning.

8.0 PACKING AND DESPATCH

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. A set of instruction manuals for installation, testing and commissioning, a set of operation & maintenance manuals and a set of final drawing shall be enclosed in a waterproof cover along with the shipment.

ऊर्जा दक्ष मध्यम वोल्टेज इंडक्शन मोटरों के लिए विनिर्देश

SPECIFICATION FOR ENERGY EFFICIENT MEDIUM VOLTAGE INDUCTION MOTORS

1	12.08.14	REVISED & ISSUED AS STANDARD SPECIFICATION	SS/SHIRALI	VKJ	BRB	SC
0	20.04.09	ISSUED AS STANDARD SPECIFICATION	SD	BRB	JMS	ND
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

Abbreviations:

AL	:	Aluminium
BASEEFA	:	British Approvals Service for Electrical Equipment in Flammable Atmospheres
BIS	:	Bureau of Indian Standards
BS	:	British Standards
CEA	:	Central Electricity Authority
CIMFR	:	Central Institute of Mines and Fuel Research
CPRI	:	Central power research institute
CT	:	Current Transformer
CU	:	Copper
DGMS	:	Directorate General of Mines Safety
DOL	:	Direct On Line
EIL	:	Engineers India Limited
ERTL	:	Electronics Regional test laboratory
FM	:	Factory Mutual
FRP	:	Fiber Reinforced Plastic
IEC	:	International Electro-technical Commission
IEEE	:	Institute of Electrical & Electronics Engineers
IP	:	Ingress Protection
IS	:	Indian Standard
JEC	:	Japanese Electro-technical Committee
KLPL	:	Karandikar laboratories Pvt. Ltd.
LCIE	:	Laboratoire Central des Industries Electriques
NEMA	:	National Electrical Manufacturers Association
PESO	:	Petroleum and Explosive Safety Organisation
PO	:	Purchase Order
PVC	:	Poly Vinyl Chloride
RPM	:	Revolutions per Minute
UL	:	Underwriter's Laboratories
VFD	:	Variable Frequency Drive
VDE	:	Verband Deutscher Elektrotechniker

Electrical Standards Committee

Convenor: Mr. B.R. Bhogal

Members: Ms. S. Anand
Mr. Parag Gupta
Mr. M.K. Sahu
Mr. A.K. Chaudhary (Inspection)
Ms. N.P. Guha (Project)

CONTENTS

1.0	SCOPE.....	4
2.0	CODES AND STANDARDS.....	4
3.0	GENERAL REQUIREMENTS.....	5
4.0	OPERATING CONDITIONS.....	5
5.0	PERFORMANCE.....	6
6.0	CONSTRUCTION DETAILS.....	7
7.0	MISCELLANEOUS ACCESSORIES.....	10
8.0	CRITICAL SPEEDS.....	10
9.0	PAINTING.....	10
10.0	INSPECTION AND TESTING.....	11
11.0	CERTIFICATION.....	11
12.0	PACKING AND DESPATCH.....	11

1.0 SCOPE

This specification covers the design, manufacture, testing, packing and supply of energy efficient-High efficiency (IE2) three phase medium voltage squirrel cage induction motors.

2.0 CODES AND STANDARDS

2.1 The squirrel cage induction motors and their components shall comply with the latest editions of following standards issued by BIS (Bureau of Indian Standards) unless otherwise specified:

IS - 5	:	Colours for ready mixed paints and enamels.
IS - 325	:	Three phase induction motors.
IS - 1076	:	Preferred numbers.
IS - 1231	:	Dimensions of three phase foot mounted induction motors.
IS - 1271	:	Electrical insulation- Thermal evaluation and designation.
IS - 2223	:	Dimensions of flange mounted AC Induction motors.
IS - 2253	:	Designation for types of construction and mounting arrangement of rotating electrical machines.
IS - 2254	:	Dimensions of vertical shaft motors for pumps.
IS - 2968	:	Dimensions of slide rails electric motors.
IS - 4029	:	Guide for testing three phase induction motors.
IS - 4889	:	Method of determination of efficiency of rotating electrical machines.
IS - 6362	:	Designation of methods of cooling of rotating electrical machines.
IS - 7816	:	Guide for testing insulation resistance of rotating machines.
IS - 8223	:	Dimensions and output series for rotating electrical machines.
IS - 8789	:	Values of performance characteristics for three phase induction motors.
IS - 9283	:	Motors for submersible pump sets.
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 - measurement, evaluation and limits of vibration severity.
IS - 12615	:	Energy Efficient induction motors - Three phase squirrel cage.
IS - 12824	:	Type of duty and classes of rating assigned to rotating electrical machines.
IS - 13529	:	Guide on effects of unbalanced voltages on the performance of three phase cage induction motors.
IS - 13555	:	Guide for selection and application of three phase induction motors for different types of driven equipment.
IS - 14568	:	Dimensions and output series for rotating electrical machines, frame numbers 355 to 1000 and flange numbers 1180 to 2360.
IS / IEC60079-0:	:	Electrical apparatus for explosive gas atmospheres (General requirements)
IS/IEC-60079-1:	:	Explosive atmospheres-Equipment protection by flame proof enclosures "d".
IS/IEC60079-2 :	:	Explosive protection by pressurized enclosure "p".
IS/IEC60079-7 :	:	Explosive atmospheres-Equipment protection by increased safety – "e".
IS/IEC-60079-15:	:	Construction, test & marking of type of protection "n" electrical apparatus.
IS/ IEC: 60529 :	:	Degree of protection provided by enclosures (IP Code)
IS/IEC 60034-1 :	:	Rotating electrical machines:-Rating & Performance
IS/IEC-60034-5:	:	Degrees of protection provided by the internal design of rotating electrical machines.

IS/IEC 60034-8: Rotating electrical machines-Terminal marking and direction of rotation
IS/IEC 61241: Electrical apparatus for use in the presence of combustible dust

- 2.2 In case of imported motors, standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian Standards.
- 2.3 The motors shall also conform to the provisions of CEA regulations and other statutory regulations currently in force in the country.
- 2.4 In case Indian Standards are not available, standards issued by IEC/ BS/ VDE/ IEEE/ JEC/NEMA or equivalent agency shall be applicable.
- 2.5 In case of any conflict between requirements specified in various applicable documents, the most stringent one shall prevail. However, owner's decision in this regard shall be final and binding.

3.0 GENERAL REQUIREMENTS

- 3.1 The offered equipment shall be brand new with state of the 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 ensure the end user for placement of order for spares and services.

4.0 OPERATING CONDITIONS

4.1 Ambient Conditions

Motors shall be suitable for operating satisfactorily in humid and corrosive atmosphere found in refineries, petrochemical, fertilizer and metallurgical plants. Service conditions shall be as specified in the motor data sheet. If not specifically mentioned therein, a design ambient temperature of 40 ° C and an altitude not exceeding 1000 meters above mean sea level shall be taken into consideration.

4.2 Frequency and Voltage Variations

Unless otherwise agreed, motors shall be designed for continuous operation at rated output under the following conditions:

- a) The terminal voltage differing from its rated value by not more than $\pm 6\%$ or
- b) The frequency differing from its rated value by not more than $\pm 3\%$ or
- c) Any combination of (a) and (b)

4.3 Starting

- a) Motors shall be designed for direct-on-line starting or other method of starting as specified in datasheet.
- b) Motors shall be designed for re-acceleration under full load after a momentary loss of voltage with the residual voltage being 100% and is in phase opposition to the applied voltage.
- c) Minimum locked rotor thermal withstand time at rated voltage shall be 10 seconds under cold conditions and 8 seconds under hot conditions. In addition, Locked Rotor

withstand time under hot conditions at 75% & 100% voltages, shall be minimum 1.4 times the starting time at the corresponding voltage.

- d) Unless otherwise specified, all motors shall be suitable for starting under specified load conditions with 75 % of the rated voltage at the motor terminals.
- e) Motors shall be designed to allow the minimum number of consecutive starts indicated in Table below:

Starts	Min. no. of consecutive starts
No. of consecutive start-ups with initial temp. of the motor at ambient level (cold)	3
No. of consecutive start-ups with initial temp. of the motor at full load operating level (hot).	2

4.4 Direction of Rotation

Motors shall be suitable for either direction of rotation. In case unidirectional fan is provided for motors, direction of rotation for which the motor is designed shall be permanently indicated by means of an arrow. Directional arrow should be manufactured from corrosion resistant material. When a motor is provided with bi-directional fans, a double-headed arrow should be provided.

Normally, clockwise rotation is desired as observed from the driving (coupling) end, when the terminals UVW are connected to a power supply giving a terminal phase sequence in the order UVW. Counter-clockwise rotation of the motor shall be obtained by connecting the power supply to terminals so that the phase sequence corresponds to the reversed alphabetical sequence of the terminal letters. Ample space shall be provided at the terminal box for interchanging any two external leads for obtaining the reverse phase sequence.

5.0 PERFORMANCE

- 5.1 Motors shall be rated for continuous duty (S_1), unless otherwise specified.
- 5.2 Unless specified, the starting current (as % rated current) shall be limited to maximum 600-700% (based on number of poles and KW rating) as per IS 12615:2011, subject to IS tolerance
- 5.3 In particular cases, when the starting current is to be limited, care shall be taken such that the design values of torque meets the load requirement while at the same time complying to clause 4.3 above of this specification. Unless otherwise specified the minimum pull-up torque of motors, at rated voltage & frequency shall be minimum 50% of the rated full load torque.
- 5.4 In particular cases, when the starting with reduced voltage is specified, care shall be taken such that the design values of torque meets the load requirement while at the same time complying to clause 4.3 above of this specification.
- 5.5 Starting torque and minimum torque of the motor shall be compatible with the speed torque curve of the driven equipment under specified starting and operating conditions.

In case where characteristics of driven equipment are not available while selecting the motor, minimum starting torque shall be 110% of rated value for motors up to 75 kW and shall be 90% of rated value for motors above 75 kW.
- 5.6 The breakdown torque at the rated voltage shall be not less than 175% of the rated load torque with no negative tolerance. Unless otherwise agreed, the breakdown torque shall not exceed 300% of the rated load torque.

In case of motors driving equipment with pulsating loads (e.g. reciprocating compressors, crushers, ball mills) the minimum value of pull out torque at 75% of the rated voltage shall be more than the peak value of pulsating torque and the current pulsation shall be limited to 40%.

- 5.7** Motors fed by variable frequency drive shall additionally meet the following requirements.
- 5.7.1** The motors shall be suitable for the current wave forms produced by the power supply including harmonics generated by the drive. The necessary coordination by motor manufacturers with drive manufacturers regarding harmonics generated by VFD shall be taken care and incorporated in motor design suitably.
- 5.7.2** The motors shall be designed to operate continuously at any speed over the range as per process requirement with minimum range as 10–100% of rated speed or as specified in data sheet. The characteristics shall be based on the application – in terms of constant torque / variable torque as per the driven equipment. Additional cooling fan shall be provided if required to limit the temperature rise to specified limits, alternatively option of applying suitable de-rating may be considered.
- 5.7.3** The motors shall withstand torque pulsation resulting from harmonics generated by the solid state power supply.
- 5.7.4** The motors required to be transferred to DOL bypass mode shall be rated for specified variations in line voltage and frequency.
- 5.8** The minimum values for performance characteristics of these motors shall be as given in the tables 1, 2 & 3 of IS 12615-2011 for IE2 motors, subjected to tolerance as per IS/IEC. Motor meant for application with VFD, the efficiency value can be one class lower as per IS.

6.0 CONSTRUCTIONAL DETAILS

6.1 Windings

- 6.1.1** Unless otherwise specified, motors shall be provided with class 'B' insulation as a minimum. In case of motors with class 'F' insulation, the permissible temperature rise above the specified ambient temperature shall be limited to those specified in the applicable Indian standards for class 'B' insulation.
- 6.1.2** The winding shall be tropicalised. The windings shall preferably be vacuum impregnated. Alternately the windings shall be suitably varnished, baked and treated with epoxy gel for operating satisfactorily in humid and corrosive atmospheres.
- 6.1.3** Windings shall be adequately braced to prevent any relative movement during operation. In this respect, particular care shall be taken for the stator windings for direct-on-line starting squirrel cage motors. Insulation shall be provided between coils of different phases that lie together. Core laminations must be capable of withstanding burnout for rewind at 350 °C without damage or loosening.
- 6.1.4** In case of motors driving equipment with pulsating loads, special care shall be taken for the joints of rotor bars and end rings to avoid premature failures due to induced fatigue stresses.
- 6.1.5** The windings shall be connected in delta. However, for motors rated 2.2 kW and below, star connection may be accepted. In case of motors with star-delta starting, the motor windings shall be fully insulated for delta connection.

- 6.1.6 The ends of the windings shall be brought out into a terminal box. These shall be terminated by means of terminals mounted on an insulating base made of non-hygroscopic and non-flammable material.
- 6.1.7 All motors shall be provided with six terminals and suitable links to connect them in star or in delta except for motors rated up to and including 2.2 kW which may be accepted with three terminals.

6.2 Terminal Box and Cable Entries

- 6.2.1 Unless otherwise agreed, the terminal box shall be located on the right hand side as viewed from the driving (coupling) end. The terminal box shall have side cable entry from non-driving end. However, as a special case, terminal box located on top may also be accepted, particularly for hazardous area motors, in case manufacturer has only top mounted terminal box design which is duly tested/certified by CIMFR and approved by PESO for installation in hazardous area. The terminal box design shall allow rotation in steps of 90 ° C to facilitate cable entry from any direction at site.
- 6.2.2 Terminal box cover shall be provided with handles to facilitate easy removal. However, for terminal box covers weighing less than 5 kg., terminal box covers without handles can be accepted.
- 6.2.3 The terminal box shall be provided entries for suitable cable glands corresponding to the size of the specified cable. Crimp type tinned Copper lugs and nickel-plated brass (or aluminum if specifically required), double compression type cable glands shall be supplied along with the motors for the specified cable sizes for power and space heater cables.
- 6.2.4 For flameproof motors, terminal box can be provided in increased safety 'Exe' execution.
- 6.2.5 The terminals, cable lugs, terminal box, cable entries and cable glands shall be suitable for the maximum cables sizes as specified below for 2 pole, 4 pole or 6 pole motors:

Motor rating up to and including	Size of phase conductor (mm ²)
2.2 kW and below	2.5 cu
3.7 kW	6 cu
5.5 kW	10 cu
7.5 kW	16 cu
9.3 kW	16 cu
11.0 kW	16 cu
15.0 kW	50 Al.
18.5 kW	70 Al
22.0 kW	70 Al
30.0 kW	95 Al
37.0 kW	120 Al
45.0 kW	150 Al
55.0 kW	240 Al
75.0 kW	2x95 Al
90.0 kW	2x120 Al
110.0 kW	2x240 Al
125.0 kW/132 kW	2x240 Al
160.0 kW	2x240 Al

- 6.2.6 Cable sizes for motors having synchronous speeds 750 RPM and below shall be as agreed between the purchaser and manufacturer.

6.3 Motor Casing and Type of Enclosure

- 6.3.1 The minimum degree of motor enclosures including terminal boxes and bearing housing shall be IP-55 as per IS.
- 6.3.2 Motors for outdoor use shall be suitable for installation and satisfactory operation without any protective shelter or canopy. Motor casing shall be provided with a suitable drain for removal of condensed moisture except in case of flameproof motors (Type Ex d/Exde).
- 6.3.3 All internal and external metallic parts, which may come into contact with cooling air, shall be of corrosion resistant material or appropriately treated to resist the corrosive agents, which may be present in the atmosphere. Screws and bolts shall be of rust proof material or protected against corrosion.
- 6.3.4 Unless otherwise agreed, motors shall have standard frame sizes (min.) for various output ratings as stipulated in IS.

6.4 Bearing and Lubrication

- 6.4.1 Motors shall have grease lubricated ball or roller bearings. In all cases, the bearings shall be chosen to provide a minimum L-10 rating life of 5 years, (40, 000 hours) at rated operating conditions
(The L-10 rating life is the number of hours at constant speed that 90% of a group of identical bearings will complete or exceed before the first evidence of failure).
- 6.4.2 The bearings shall be adequate to absorb axial thrust produced by the motor itself or due to shaft expansion. Motors designed to handle external thrust from the driven equipment shall be supplied with a thrust bearing at the non-driving end.
- 6.4.3 In cases such as pumps for hot liquids where the driven equipment operates at high temperatures, bearings shall be cooled by a shaft-mounted fan. This shall ensure efficient ventilation of the bearing and disperse the heat transmitted from the driven equipment by conduction or convection.
- 6.4.4 Bearings shall be capable of grease injection from outside without removal of covers with motors in the running conditions. The bearing boxes shall be provided with necessary features to prevent loss of grease or entry of dust / moisture e.g. labyrinth seal/ oil seal/ V seal. Where grease nipples are provided, these shall be associated, where necessary, with appropriately located relief devices, which ensure passage of grease through the bearings.
- 6.4.5 Pre-lubricated sealed bearings may be considered provided a full guarantee is given for 4 to 5 years of trouble-free service without the necessity of re-lubrication.

6.5 Cooling System

All motors shall be self ventilated, fan cooled. Fans shall be corrosion resistant or appropriately protected. They shall be suitable for motor rotation in either direction without affecting the performance of the motor. If this is not possible for large outputs, it shall be possible to reverse the fan without affecting the balancing of the motor.

For motors operating in hazardous area, the fans shall be of an anti-static non-sparking material.

6.6 Rotor

The rotor shall be of squirrel cage type, dynamically balanced to provide a low vibration level and long service life for the bearings. Die cast aluminum rotors for motors in hazardous areas may be accepted provided the same are type tested and approved by competent authorities.

6.7 Shaft Extension

Motors shall be provided with a single shaft extension with key-way and full key. Motor shaft shall be sized to withstand 10 times the rated design torque.

6.8 Lifting Hooks

All motors weighing more than 30 kg. shall be provided with lifting hooks of adequate capacity.

6.9 Earth Terminals

Two earth terminals located preferably on diametrically opposite sides shall be provided for each motor. Necessary nuts and spring washers shall be provided for earth connection.

7.0 MISCELLANEOUS ACCESSORIES

7.1 Anti-Condensation Heaters

All motors rated 30 kW and above shall be provided with 240 V anti-condensation heaters, sized and located so as to prevent condensation of moisture during shutdown periods.

For motors with heaters installed in hazardous atmospheres (Zone - 1 or Zone - 2), such heaters shall conform to the provisions of applicable Indian Standards and temperature classification specified in the motor data sheet.

The heater leads shall be brought out, preferably, to a separate terminal box which shall be of the same specification and grade of protection as the main terminal box.

A warning label with indelible red inscription shall be provided on the motor to indicate that the heater supply shall be isolated before carrying out any work on the motor.

7.2 Name Plates

In addition to the motor rating plate, a separate number plate for motor tag number shall be fixed in a readily visible position. This number shall be as per the motor data sheets.

8.0 CRITICAL SPEEDS

The first actual critical speed of stiff rotors shall not be lower than 120 % of the synchronous speed. For flexible rotors this shall be between 60 % and 80 % of the synchronous speed; the second actual critical speed shall be above 120 % of the synchronous speed.

9.0 PAINTING

All metal surfaces shall undergo manufacturer's standard cleaning /painting cycle. After preparation of the under surface, the equipment shall be painted with two coats of epoxy based final paint. Color shade of final paint shall be 632 of IS: 5/ RAL-7035. All unpainted steel parts shall be suitably treated to prevent rust formation. If these parts are moving elements, then these shall be greased.

10.0 INSPECTION AND TESTING

10.1 All tests shall be carried out at manufacturer's shop under his care and expense.

10.2 The manufacturer shall submit all internal test records of the tests carried out by him on the bought-out items, motor sub-assembly and complete motor assembly.

10.3 The manufacturer shall carry out the following routine and acceptance tests as per applicable Standards/ITP on all the motors.

- a) Visual check (Nameplate, terminal box location, terminal type, clearance, size, entries, space adequacy & gland size, direction of rotation etc.)
- b) Dimension check (shaft height etc.)
- c) Cable glands, cable lugs size and no. of entries in terminal box.
- d) Winding resistance
- e) No load test & measurement of voltage, speed, current, power input
- f) Measurement of starting torque, starting current, full load torque, breakdown torque
- g) Reduced voltage starting & running
- h) Insulation resistance before and after high voltage test
- i) High voltage
- j) Vibration

10.4 The manufacturer shall submit the following type test certificates (one sample from each type/rating):

- a) Full load test & measurement of voltage, current, power slip, power factor, bearing, noise
- b) Efficiency & pf at 100%, 75% and 50% load
- c) Temperature rise test
- d) Momentary overload test
- e) Vibration
- f) Noise level
- g) Over speed
- h) Measurement of starting torque, starting current, full load torque.

10.5 For VFD fed motors, all tests as specified in the VFD specification shall be followed in addition to the above.

11.0 CERTIFICATION

The motors and associated equipment shall have test certificates issued by recognised independent test house (CIMFR/ CPRI/ ERTL/ BASEEFA/ LCIE/ UL/ FM/ KLPL or equivalent). All indigenous motors shall conform to Indian standards and shall be certified by recognised testing agencies. All motors (indigenous & imported) shall also have valid statutory approvals (e.g. PESO, DGMS etc). as applicable for the specified location. All indigenous flameproof motors shall have valid BIS license and marking as required by statutory authorities.

12.0 PACKING AND DESPATCH

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 the finish. Crates/cases shall have skid bottom 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/high ambient temperature, unless otherwise agreed.

विद्युत संस्थापनों के साइट निरीक्षण, परीक्षण व कमीशनिंग के लिए विनिर्देश

SPECIFICATION FOR FIELD INSPECTION, TESTING AND COMMISSIONING OF ELECTRICAL INSTALLATIONS

3	10.6.14	REAFFIRMED & ISSUED AS STANDARD SPECIFICATION	AKG	SA	BRB	SC
2	03.03.09	REVISED & ISSUED AS STANDARD SPECIFICATION	RKS	NS	JMS	ND
1	14.07.03	REVISED & ISSUED AS STANDARD SPECIFICATION	HKM	RSG	VPS	SKG
0	02.08.01	ISSUED AS STANDARD SPECIFICATION	UAP	RR	VPS	MI
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

Abbreviations:

AC	:	Alternating Current
AFC	:	Approved for Construction
BIS	:	Bureau of Indian Standards
CCOE	:	Chief Controller of Explosives
CEA	:	Central Electricity Authority
DC	:	Direct Current
DCS	:	Distributed Control System
DGMS	:	Director General for Mines and Safety
ECS	:	Electrical Control Station
GI	:	Galvanized Iron
HV	:	High Voltage
IS	:	Indian Standard
MV	:	Medium Voltage
OISD	:	Oil Industry Safety Directorate

Electrical Standards Committee

Convenor: Mr. BR Bhogal

Members: Ms. S. Anand
Mr. Parag Gupta
Mr. M.K. Sahu
Mr. A.K. Chaudhary (Inspection)
Ms. N.P. Guha (Projects)

CONTENTS

1.0	SCOPE.....	4
2.0	CODES AND STANDARDS	4
3.0	FIELD INSPECTION, TESTING AND COMMISSIONING.....	4
4.0	RECORDS.....	8

1.0 SCOPE

This specification covers the requirements for the field inspection, testing and commissioning of Electrical Equipment and Installation, forming part of electrical power distribution and utilisation system.

2.0 CODES AND STANDARDS

2.1 The field inspection, testing and commissioning of electrical equipment shall be carried out in line with this specification and the latest edition of following Indian Standards and OISD standards.

SP-30(BIS)	National Electrical Code.
IS 1255	Code of practice for installation and maintenance of power cables up to & including 33 kV rating.
IS-7816	Guide for testing Insulation resistance of rotating machines.
IS 10810(Part 43)	Method of Test for cables; Part 43 Insulation resistance.
IS 10810(Part 45)	Method of Test for cables; Part 45 High voltage test.
IS 12729	HV Switchgears
OISD 137	Inspection of Electrical Equipment.
OISD 147	Inspection and safe practice during 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. CEA Regulations
- b. Regulations laid down by CEA / Electrical Inspectorate.
- c. Regulations laid down by Tariff Advisory Committee/Loss prevention council.
- d. Regulations laid down by CCoE/DGMS (as applicable).
- e. The petroleum rules (Ministry of Industry, Government of India).
- f. Any other regulations laid down by central / state / local authorities / insurance agencies

3.0 FIELD INSPECTION, TESTING AND COMMISSIONING

3.1 Contractor shall carry out complete field inspection, testing and commissioning of electrical equipment as per Inspection & Test plans.

3.2 Before the completed installation or an addition to the existing installation is put into service, inspection / pre-commissioning checks and tests shall be carried out by contractor. In the event of defects being found out, the same shall be rectified and the installation retested as applicable.

3.3 The pre-commissioning inspection among other requirements shall include visual inspection, checking the workmanship of the installation, the rating of equipment, safety clearances, sizes of cables installed, conformance to the AFC document, soundness of switchgear bus connections, wiring properly dressed and labeled, sealing of unused cable entries, checking of all safety interlocks, control/interface functions as per requirement etc.

3.4 Visual inspection for soundness of bus bar connections of busducts, terminal connections of equipment/motor shall be carried out. It shall be ensured that no foreign materials are present inside busduct and equipment terminal boxes. After the visual inspection, all the covers of terminal boxes, inspection chambers shall be refitted with gaskets, bolts & nuts as per equipment manufacturer's instructions.

3.5 Pre-commissioning tests shall include but not be limited to the following:

- Continuity test for each winding and power and control circuits.
- Insulation test for each winding and power and control circuit
- High voltage test for cables
- Dielectric strength test on transformer oil.
- Checking the correctness of wiring schemes, control circuit interlocks for intended functioning.
- Verification of phase sequence.
- Testing of all types of relays/releases for required operation.
- Testing of measuring instruments for proper functioning.
- Earth continuity test for all circuits.
- Checking of safety features for correctness of operation, etc.
- Checking of all wired interface contacts (analogue, digital input/output contacts) for DCS and ECS interface, at panel and equipment terminal chambers as applicable.

(Electrical contractor shall co-ordinate with other agencies involved for the above and provide support services for checking interfaces of electrical equipment and the intended functioning)

- Earth resistance measurement for each earth electrode, and the earthing system as a whole.
 - Lighting installation shall be tested for correct illumination levels, with fittings installed. Fittings shall be operated only with specified type of a lamp or tube.
- 3.6** After the above tests and inspection are completed, control circuits shall be tested for correct operation under all operating combinations and proved correct before applying power to main circuit.
- 3.7** Plant Communication, Fire alarm detection and telephone system shall be checked for correct operation and intended function.
- 3.8** A close visual inspection of electrical equipment in hazardous areas shall be made to ensure that equipment is suitable for the classified zone and gas group and correctly installed, with all covers, bolts, nuts and hardwares intact and there is no physical damage mark seen on the enclosure
- 3.9** Site Acceptance Test procedure for specific equipment shall be furnished by the respective equipment vendor. The contractor shall provide necessary assistance to the equipment vendor to perform Site acceptance testing to enable the equipment vendor to perform the same.
- 3.10** All pre-commissioning checks and tests shall be carried out as per the directions of Engineer-in-charge. In addition to the equipment manufacturer's instructions, pre-commissioning check requirements shall also be complied. All tests shall be carried out by contractor in the presence of EIL/Owner's representatives
- 3.11** The contractor shall bring to site all required tools, tackles, and testing instruments for carrying out field testing. Contractor shall use only calibrated measuring and test instruments and shall maintain valid calibration records.

3.12 The **Insulation Resistance** test values for various electrical equipment shall be as below:

3.12.1 **Cables**

The insulation resistance test values for cables shall be as per following table:

Rated voltage of the Cable	DC Test Voltage in Volts	Minimum Insulation resistance in Mega ohms
Lighting and power circuit wiring	250	1
650/1100V grade cables	1,000	10
1,900/3,300V grade cables	1,000	200
3,800/6,600V grade cables	1,000	200
6,350/11,000V grade cables	5,000	200
8,700/15,000V grade cables	5,000	200
12,700/22,000V grade cables	5,000	200
19,000/33000V grade cables	5,000	200

3.12.2 **HV, MV and Miscellaneous Switchboards**

The insulation resistance test values for the switchboards shall be as per following table:

Rated voltage of the Switchboard	DC Test Voltage in Volts	Minimum Insulation resistance in Mega ohms
33,000V	5,000	200
11,000V	5,000	200
6,600V	1,000	200
3,300V	1,000	200
415V	1,000	100
240V	500	10
110V	500	10

3.12.3 **Generators and Motors**

3.12.4 The insulation resistance test values for the Generators and Motors shall be as per following table:

Rated voltage of the Generators and Motors	DC Test Voltage in Volts	Minimum Insulation resistance in Mega ohms at 40 °C
11,000V	5,000	120
6,600V	1,000	80
3,300V	1,000	50
415V	1,000	15
240V	500	12

3.12.5 Transformers

3.12.6 The insulation resistance test values for the Transformers shall be as per following table:

Rated voltage of the Transformers	DC Test Voltage in Volts	Minimum Insulation resistance in Mega ohms at 40 °C
Up to 600V	1,000	100
601 to 5000V	2,500	1,000
5001 to 15,000V	5,000	5,000
15001 to 35,000V	5,000	10,000

3.12.7 It shall be ensured that during insulation tests, electronic devices and components that are liable to get damaged on applied test voltage shall be disconnected from circuit. The instructions of equipment/panel manufacturer shall be followed strictly in this regard.

3.13 High-voltage Testing

3.13.1 DC high voltage test shall be conducted as per following table on all HV feeder cables and also on 1100 V grade cables where straight through joints have been made.

Rated Voltage of Cable (kV)	TEST VOLTAGE (kV) BETWEEN		Duration (Minutes)
U_0 / U^*	Any Conductor and Metallic Sheath/ Screen/Armour	Conductor to Conductor (For Unscreened Cables)	
0.65/1.1	3	3	5
1.9/3.3	5	9	5
3.3/3.3	9	9	5
3.8/6.6	10.5	18	5
6.6/6.6	18	18	5
6.35/11	18	30	5
11/11	30	30	5
12.7/22	37.5	-	5
19/33	60	-	5

* U_0 : Phase Voltage

U : Line Voltage

The cable cores must be discharged on completion of DC high voltage test and cable shall be kept earthed until it is put into service.

DC test voltage for old cables shall be 1.5 times rated voltage or less depending on the age of cables, repair work or nature of jointing work carried out, etc. In any case, the test voltage shall not be less than the rated voltage.

3.13.2 AC high voltage test shall be conducted as per following table on all HV Switchboards.

Rated Voltage (rms Value in kV)	Rated 1 Min. Power Frequency Withstand Voltage (rms Value in kV)		Duration in Minutes
	To Earth, Between Poles and Across Open Switching Device	Across the Isolating Distance	
U			
3.6	10	12	1
7.2	20	23	1
12	28	32	1
24	50	60	1
36	70	80	1
72.5	140	160	1

The withstand voltage values across the isolating distances are valid only for switching devices, where the clearance between open contacts is designed to meet the safety requirements specified for disconnectors.

- 3.14 All protective relays including thermal overload relays shall be tested by secondary injection current. Primary injection tests shall be carried out for differential protection, restricted earth fault protection at full/reduced current to ensure correctness of complete wiring.
- 3.15 Before energizing any equipment, 'COMMISSIONING CLEARANCE FORM' as per standard format shall be duly filled in by contractor and submitted to EIL/owner.
- 3.16 It shall be ensured that the electrical inspectorate approval is available before energizing the equipment

4.0 RECORDS

Contractor shall keep up-to-date records of all activities carried out and test results. Field inspection / test reports shall be submitted to EIL / Owner by the contractor in bound volumes (triplicate copies).

अग्निरोधक नियंत्रण स्टेशनों के लिए निरीक्षण एवं परीक्षण योजना

INSPECTION AND TEST PLAN FOR FLAMEPROOF CONTROL STATIONS

2.	21.11.2013	Revised and Reissued	MJ	RS	SCG	SC
2	29.06.2012	Revised and Reissued	AB	HVJ	AKC	DM
1	28.09.2007	Revised and Re-issued	AKG	PPM	MVKK	VC
0	30.04.2002	Issued for implementation	RG	AKC	AKB	GRR
Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
						Approved by

INSPECTION AND TEST PLAN FOR FLAMEPROOF CONTROL STATIONS

STANDARD SPECIFICATION NO.

6-81-1006 Rev. 3

Page 2 of 5

Abbreviations

AS	:	Alloy Steel	MPT/MT	:	Magnetic Particle Testing
BASEEFA	:	British Approval Service for Electrical Equipment in Flammable Atmospheres	MRT	:	Mechanical Run Test
BIS	:	Bureau of Indian Standard	MTC	:	Material Test Certificate
CCE or CCOE	:	Chief Controller of Explosives	MOC	:	Material of Construction
CEIL	:	Certification Engineers International Limited	NPSH	:	Net Positive Suction Head
CIMFR	:	Central Institute of Mining & Fuel Research	NDT	:	Non Destructive Testing
CE	:	Carbon Equivalent	NEMA	:	National Electrical Manufacturers Association
DFT	:	Dry Film Thickness	PO	:	Purchase Order
DT	:	Destructive Testing	PESO	:	Petroleum Explosive Safety Organization
DPT	:	Dye Penetrate Testing	PQR	:	Procedure Qualification Record
ERTL	:	Electronics Regional Test Laboratory	PR	:	Purchase Requisition
FCRI	:	Fluid Control Research Institute	PMI	:	Positive Material Identification
FM	:	Factory Mutual	PVC	:	Poly Vinyl Chloride
FLP	:	Flame Proof	QC	:	Quality Control
HT	:	Heat Treatment	RT	:	Radiography Testing
HIC	:	Hydrogen Induced Cracking	TC	:	Test Certificate
ITP	:	Inspection and Test Plan	TPI or TPIA	:	Third Party Inspection Agency
IP	:	Ingress Protection	UT	:	Ultrasonic Testing
IC	:	Inspection Certification	UL	:	Under writer Laboratories
IGC	:	Inter Granular Corrosion	VDR	:	Vendor Data Requirement
IEC	:	International Electro technical Commission	WPS	:	Welding Procedure Specification
JEC	:	Japanese Electro technical Committee	WPQ	:	Welders Performance Qualification
			XLPE	:	Cross Linked Poly Ethylene

Inspection Standards Committee

Convenor : Mr. S.C. Gupta

Members:

Mr. R.K. Singh	Mr. Rajeev Kumar	Mr. Himangshu Pal
Mr. Neeraj Mathur	Mr. T Kamalakannan	Mr. Deepak Gupta (Project)
Mr. Mayank Jain		

INSPECTION AND TEST PLAN FOR FLAMEPROOF CONTROL STATIONS

STANDARD SPECIFICATION NO.

6-81-1006 Rev. 3

Page 3 of 5

1.0 SCOPE

This Inspection and Test Plan covers the minimum testing requirements of Flameproof Control Stations.

2.0 REFERENCE DOCUMENTS

PO/PR/ Standards referred there in/Job specifications/Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	Procedures	--	--	--	--	--	--
2.0	Material Inspection						
2.1	Incoming material like castings, glass, meters, Fasteners etc	Visual, Dimensional, Operational checks, Review of Manufacturer's Certificates etc. as applicable	100%	TC's/ Inspection & Test records / Lab Test Records	H	H	R
3.0	In process Inspection						
3.1	Flameproof enclosure without components	Routine Pressure test	100% by Supplier	Supplier's Test Records	-	H	R

INSPECTION AND TEST PLAN FOR FLAMEPROOF CONTROL STATIONS

STANDARD SPECIFICATION NO.

6-81-1006 Rev. 3

Page 4 of 5

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.0	Final Inspection						
4.1	Flameproof Control Station (Acceptance tests)	- Visual/Dimensional/BOM Checks - Plan Gap/Path/Clearances - Electrical/Functional Checks - High voltage test - IR test before and after High voltage	100% by Supplier 10% by EIL/TPIA	Test Records / Inspection Witness Record	-	H	H
4.2	Submission of Certificates & Documents	- Certificate of Statutory testing agency for suitability of area classification - Certificate of Statutory approval authority like CCoE/ PESO as applicable. - Valid BIS License as applicable - Degree of protection certificate as applicable	Samples	Certificates from test agencies	-	H	R
5.0	Painting						
5.1	Painting and Packing	- Visual - Suitable protection to prevent entry of foreign material. - Proper packing to prevent any damage during transportation and storage.	100%	Packing list / Supplier's Records	-	H	-
6.0	Documentation and IC						

**INSPECTION AND TEST PLAN
FOR
FLAMEPROOF CONTROL STATIONS**

STANDARD SPECIFICATION NO.

6-81-1006 Rev. 3

Page 5 of 5

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
6.1	Documentation and IC	- Review of Internal Test Reports & MTC - IC Issuance	100%	Supplier's Test Records / Inspection Certificate	-	H	H

Legends: H- Hold (Do not proceed without approval), Random 10% , R-Review, RW-Random witness, W- Witness (Give due notice, work may proceed after scheduled date).

NOTES :-

- This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable. (Unless otherwise agreed upon).
- Acceptance Norms for all the activities shall be as per PO/PR/ Standards referred there in/ Job specifications /Approved documents

एम वी स्विचबोर्डों के लिए निरीक्षण एवं परीक्षण योजना

INSPECTION AND TEST PLAN FOR M.V.SWITCHBOARDS

3	21.11.13	Revised and Reissued	MJ	RS	SCG	SC
2	15.07.11	Revised and Reissued	GS	SA	AKC	DM
1	28.09.07	Revised and Reissued	AKG	PPM	MVKK	VC
0	30.04.02	Issued for implementation	RG	AKC	AKB	GRR
Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

**INSPECTION AND TEST PLAN
FOR
M.V.SWITCHBOARDS**

STANDARD SPECIFICATION No.

6-81-1018 Rev. 3

Page 2 of 7

Abbreviations

CCE or CCOE	:	Chief Controller of Explosives	MPT	:	Magnetic Particle Testing
CEIL	:	Certification Engineers International Limited	MRT	:	Mechanical Run Test
CIMFR	:	Central Institute of Mining & Fuel Research	NPSH	:	Net Positive Suction Head
DFT	:	Dry Film Thickness	NDT	:	Non Destructive Testing
DT	:	Destructive Testing	PO	:	Purchase Order
ERTL	:	Electronics Regional Test Laboratory	PESO	:	Petroleum Explosive Safety Organization
FCRI	:	Fluid Control Research Institute	PQR	:	Procedure Qualification Record
FR	:	Fire Retardant	PR	:	Purchase Requisition
FAT	:	Factory Acceptance Test	PMI	:	Positive Material Identification
HMI	:	Human Machine Interface	RT	:	Radiography Testing
HT	:	Heat Treatment	TC	:	Test Certificate
HIC	:	Hydrogen Induced Cracking	TPI or TPIA	:	Third Party Inspection Agency
ITP	:	Inspection and Test Plan	VDR	:	Vendor Data Requirements
IP	:	Ingress Protection	WPS	:	Welding Procedure Specification
IC	:	Inspection Certificate	WPQ	:	Welders Performance Qualification
LPT	:	Liquid Penetrate Testing			

Inspection Standards Committee

Convenor : Mr. S.C. Gupta

Members:

Mr. R.K. Singh	Mr. Rajeev Kumar	Mr. Himangshu Pal
Mr. Neeraj Mathur	Mr. T Kamalakannan	Mr. Deepak Gupta (Project)
Mr. Mayank Jain		

INSPECTION AND TEST PLAN FOR M.V.SWITCHBOARDS

STANDARD SPECIFICATION No.

6-81-1018 Rev. 3

Page 3 of 7

1.0 SCOPE

This Inspection and Test Plan covers the minimum testing requirements of fixed / draw out type MV Switchboards.

2.0 REFERENCE DOCUMENTS

PO/PR/ Standards referred there in/ Job specifications /Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	Procedures	--	--	--	--	--	--
2.0	Material Inspection						
2.1	Incoming Material like Insulators, Bus Bars, Fabricated items, Bus bar sleeves and supports, Instrument Transformers, Relays, Indicating Instruments, Switches, Breakers, Contactors etc.	Visual, Dimensional, operational checks, Manufacturer's test certificates etc. as applicable	100%	Material Test Certificates / Test Records	H	H	R

**INSPECTION AND TEST PLAN
FOR
M.V.SWITCHBOARDS**

STANDARD SPECIFICATION No.

6-81-1018 Rev. 3

Page 4 of 7

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
3.0	Inprocess Inspection						
3.1	Wiring checks	Size, termination, ferruling, continuity	100%	Test Records	--	H	R
4.0	Final Inspection						
4.1	Switchgear Assembly	- Visual check including layout, Tag plates. Paint shade, Bus marking and sleeving, joint shrouding, Identification and location of components etc. - Dimension check including operational height, Bus size, Clearances, Creepage distances, paint thickness, gland size etc. - Verification of Bus bar support arrangement with respect to type tested panel drawings, provision for external cable termination and Bus Duct flange Dimensions (if applicable). - Bill of material / Make of Components check. - Interchangeability of identical modules / feeders (if applicable).*	100%	Supplier's Test Records / Inspection Witness Record	-	H	H

**INSPECTION AND TEST PLAN
FOR
M.V.SWITCHBOARDS**

STANDARD SPECIFICATION No.

6-81-1018 Rev. 3

Page 5 of 7

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
	Switchgear Assembly (contd.)	• Operation check for control and auxiliary equipment circuits and auxiliary contacts. • Manual and electrical operation check of Breakers, Relays etc. under normal and worst voltage conditions.* • Operation checks for all control functions and interlocks as per schematic diagrams in Test and service position including mechanical interlock as applicable. • Relay operation check through primary/secondary injection.* • Communication check between relays and Data concentrator / HMI (if applicable).* • HMI operation and functional checks as per separate agreed ITP/FAT(if applicable). • Insulation resistance of main, auxiliary and control circuits before and after High Voltage tests.	100%	Test Records / Inspection Witness Record	-	H	H

**INSPECTION AND TEST PLAN
FOR
M.V.SWITCHBOARDS**

STANDARD SPECIFICATION No.

6-81-1018 Rev. 3

Page 6 of 7

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
		Power Frequency voltage withstand test on main, auxiliary and control circuits.					
4.2	Switchgear Assembly	TYPE TESTS: - Short Circuit making and breaking tests. - Short time current withstand test. - Temperature Rise test. - Degree of protection for panels.	Sample Basis	Test Agency Reports	-	R/H**	R/W**
5.0	Painting						
5.1	Painting and Packing	- Visual - Suitable protection to prevent entry of foreign material. - Proper packing to prevent any damage during transportation and storage.	100%	Packing list / Supplier's Records	-	H	-
6.0	Documentation and IC						
6.1	Documentation and IC	- Review of Internal Test Reports - Certification from supplier for Complete relay parameterization of numeral relays at works - IC issuance	100%	Supplier's Test Records / Inspection Certificate	-	H	H

* Quantum of check is 100% by Supplier & random basis by EIL/TPIA

* * Witness if called for in job specifications. In such cases specified Type test will be considered as part of Acceptance Tests.

**INSPECTION AND TEST PLAN
FOR
M.V.SWITCHBOARDS**

STANDARD SPECIFICATION No.

6-81-1018 Rev. 3

Page 7 of 7

Legends: H- Hold (Do not proceed without approval), Random -10%, R-Review, RW-Random witness, W- Witness (Give due notice, work may proceed after scheduled date).

NOTES :-

1. This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable. (Unless otherwise agreed upon).
2. Acceptance Norms for all the activities shall be as per PO/PR/ Standards referred there in/ Job specifications /Approved documents

बैटरी चार्जर
के लिए
निरीक्षण व परीक्षण योजना

INSPECTION AND TEST PLAN
FOR
BATTERY CHARGERS

3	21.11.13	Revised and Reissued	MJ	RS	SCG	SC
2	29.06.12	Revised and Reissued	RKP	RJD	AKC	DM
1	28.09.07	Revised and Re-issued	AKG	PPM	MVKK	VC
0	30.04.02	Issued for implementation	RG	AKC	AKB	GRR
Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

INSPECTION AND TEST PLAN FOR BATTERY CHARGERS

STANDARD SPECIFICATION NO.

6-81-1019 Rev. 3

Page 2 of 7

Abbreviations

AS	:	Alloy Steel	MPT/MT	:	Magnetic Particle Testing
BASEEFA	:	British Approval Service for Electrical Equipment in Flammable Atmospheres	MRT	:	Mechanical Run Test
BIS	:	Bureau of Indian Standard	MTC	:	Material Test Certificate
CCE or CCOE	:	Chief Controller of Explosives	MOC	:	Material of Construction
CEIL	:	Certification Engineers International Limited	NPSH	:	Net Positive Suction Head
CIMFR	:	Central Institute of Mining & Fuel Research	NDT	:	Non Destructive Testing
CE	:	Carbon Equivalent	NEMA	:	National Electrical Manufacturers Association
DFT	:	Dry Film Thickness	PO	:	Purchase Order
DT	:	Destructive Testing	PESO	:	Petroleum Explosive Safety Organization
DPT	:	Dye Penetrate Testing	PQR	:	Procedure Qualification Record
ERTL	:	Electronics Regional Test Laboratory	PR	:	Purchase Requisition
FCRI	:	Fluid Control Research Institute	PMI	:	Positive Material Identification
FM	:	Factory Mutual	PVC	:	Poly Vinyl Chloride
FLP	:	Flame Proof	QC	:	Quality Control
HT	:	Heat Treatment	RT	:	Radiography Testing
HIC	:	Hydrogen Induced Cracking	TC	:	Test Certificate
ITP	:	Inspection and Test Plan	TPI or TPIA	:	Third Party Inspection Agency
IP	:	Ingress Protection	UT	:	Ultrasonic Testing
IC	:	Inspection Certification	UL	:	Under writer Laboratories
IGC	:	Inter Granular Corrosion	VDR	:	Vendor Data Requirement
IEC	:	International Electro technical Commission	WPS	:	Welding Procedure Specification
JEC	:	Japanese Electro technical Committee	WPQ	:	Welders Performance Qualification
LPT	:	Liquid Penetrate Testing	XLPE	:	Cross Linked Poly Ethylene

Inspection Standards Committee

Convenor : Mr. S.C. Gupta

Members:

Mr. R.K. Singh	Mr. Rajeev Kumar	Mr. Himangshu Pal
Mr. Neeraj Mathur	Mr. T Kamalakannan	Mr. Deepak Gupta (Project)
Mr. Mayank Jain		

INSPECTION AND TEST PLAN FOR BATTERY CHARGERS

STANDARD SPECIFICATION NO.

6-81-1019 Rev. 3

Page 3 of 7

1.0 SCOPE

This Inspection and Test Plan covers the minimum testing requirements of Battery Chargers (DC System consisting of Battery Charger, Cell Booster, DCDB and Battery).

2.0 REFERENCE DOCUMENTS

PO/PR/ Standards referred there in/Job specifications/Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	Procedures	--	--	--	--	--	--
2.0	Material Inspection						
2.1	Incoming Material like Fabricated items, Electronic components, PCBs, Relays, Indicating Instruments, Power Supply Unit, IGBT/SCRs, etc.	Visual, Dimensional, operational checks, etc. as applicable	100%	TC's/ Inspection & Test records / Lab Test Records	H	H	R
3.0	In process Inspection						
3.1	PCBs & Electronic components, Sub-assemblies	Burn-in Test for 96 hours at 50deg C	100%	Supplier's Test Records	H	H	R

INSPECTION AND TEST PLAN FOR BATTERY CHARGERS

STANDARD SPECIFICATION NO.

6-81-1019 Rev. 3

Page 4 of 7

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.0	Final Inspection						
4.1	Battery Charger Assembly (Acceptance Tests)	- Visual check including layout, Tag plates, Paint shade, Bus marking, Identification and location of components, etc. - Check calibration status of all testing equipment. - Dimension check including operational height, Bus size, Clearances, paint thickness, etc. - Bill of material/ Make of Components. - Full Load test for 16 hours with minimum 8hrs for each Charger*. Temperature rise for critical components would be recorded during this test. - Charger testing at constant output voltage in float and boost charge mode, including measurement of AC phase voltage, frequency, current, power, DC output voltage, current and output voltage ripple at nominal AC input voltage at zero, 50% and 100% of rated output current. Measurement shall be repeated at 100% full load current at 90% and 110% of nominal AC supply - Charger testing under constant output current limiting condition in float and boost mode, including measurement of DC	100% by Supplier and on Random Basis by EIL/TPIA	Test Records / Inspection Witness Record	-	H	H

INSPECTION AND TEST PLAN FOR BATTERY CHARGERS

STANDARD SPECIFICATION NO.

6-81-1019 Rev. 3

Page 5 of 7

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
	Battery Charger Assembly (Acceptance Tests Contd.)	output voltage and current with DC output voltage varying between zero and set value corresponding to constant voltage operation. • Proper functioning of all measuring instruments, alarms, indications, protection and controls as per requirement. • Parallel operation of both chargers including load sharing and automatic isolation of faulty charger. • Charger Efficiency and Voltage regulation test. • Harmonic Measurement. • Dynamic Response test for step load as per PR/spec. • Audible noise test. • Insulation resistance before and after HV test for power, control and auxiliary circuits. • High voltage withstand test for power, control and main circuits. • Check for protection against reverse battery connection.	100% BY Supplier and on Random Basis by EIL/TPIA	Test Records / Inspection Witness Record	-	H	H
4.2	D.C Distribution Board	Visual, Dimensions, Feeder Tag plates, Functional checks, IR and HV test.	100% by Supplier and on Random Basis ny EIL/TPIA	Supplier's Test Records / Inspection Witness Record	-	H	H

**INSPECTION AND TEST PLAN
FOR
BATTERY CHARGERS**

STANDARD SPECIFICATION NO.

6-81-1019 Rev. 3

Page 6 of 7

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.3	Cell Booster	- Visual and Functional checks - Full load capability test at 90% , 100% and 110% of nominal AC supply - IR and HV test	100% by Supplier and on Random Basis ny EIL/TPIA	Supplier's Test Records / Inspection Witness Record	-	H	H
4.4	Battery	All test as per respective ITP, as a minimum	Sample	Supplier Test Record	-	H	H
4.5	Submission of Certificates/ Documents	Type test report on radio frequency interference voltages on RFI filter.	100%	Supplier's Test Records/ Statutory Body Certificates	-	H	R
5.0	Painting						
5.1	Painting and Packing	- Visual - Suitable protection to prevent entry of foreign material. - Proper packing to prevent any damage during transportation and storage.	100%	Packing list / Supplier's Records	-	H	-
6.0	Documentation and IC						
6.1	Documentation and IC	- Review of Internal Test Reports - IC issuance.	100%	Supplier's Test Records / Inspection Certificate	-	H	H

**INSPECTION AND TEST PLAN
FOR
BATTERY CHARGERS**

STANDARD SPECIFICATION NO.

6-81-1019 Rev. 3

Page 7 of 7

- * Tests shall be conducted on one charger of each rating (In case of dual Chargers, both chargers will be put on load separately)

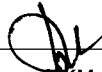
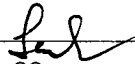
Legends: H- Hold (Do not proceed without approval), Random 10% , R-Review, RW-Random witness, W- Witness (Give due notice, work may proceed after scheduled date).

NOTES :-

1. This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable. (Unless otherwise agreed upon).
2. Acceptance Norms for all the activities shall be as per PO/PR/ Standards referred there in/ Job specifications /Approved documents

मध्यम वोल्टेज मोटरों के लिए निरीक्षण व परीक्षण योजना

INSPECTION AND TEST PLAN FOR MEDIUM VOLTAGE MOTORS

5	31.07.2015	Revised and Re-issued	 MJ	 SA	 RKM	 SC
4	04.09.2014	Revised and Re-issued	MJ	RS	SCG	SC
3	21.11.2013	Revised and Re-issued	MJ	RS	SCG	SC
2	15.07.2011	Revised and Re-issued	GS	SA	AKC	DM
1	24.12.2007	Revised and Re-issued	SA	CRM	MVKK	VC
Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	

INSPECTION AND TEST PLAN FOR MEDIUM VOLTAGE MOTORS

STANDARD SPECIFICATION NO.

6-81-1032 Rev. 5

Page 2 of 6

Abbreviations:

AS	:	Alloy Steel	MPT/ MT	:	Magnetic Particle Testing
BASEEFA	:	British Approval Service for Electrical Equipment in Flammable Atmospheres	MRT	:	Mechanical Run Test
BIS	:	Bureau of Indian Standards	MTC	:	Material Test Certificate
CCE or CCOE	:	Chief Controller of Explosives	MOC	:	Material of Construction
CEIL	:	Certification Engineers International Limited	NPSH	:	Net Positive Suction Head
CIMFR	:	Central Institute of Mining & Fuel Research	NDT	:	Non Destructive Testing
CE	:	Carbon Equivalent	NEMA	:	National Electrical Manufacturers Association
DFT	:	Dry Film Thickness	PO	:	Purchase Order
DT	:	Destructive Testing	PESO	:	Petroleum Explosive Safety Organization
DPT	:	Dye Penetrate Testing	PQR	:	Procedure Qualification Record
ERTL	:	Electronics Regional Test Laboratory	PR	:	Purchase Requisition
FCRI	:	Fluid Control Research Institute	PMI	:	Positive Material Identification
FM	:	Factory Mutual	PVC	:	Poly Vinyl Chloride
FLP	:	Flame Proof	QC	:	Quality Control
HIC	:	Hydrogen Induced Cracking	RT	:	Radiography Testing
ITP	:	Inspection and Test Plan	TC	:	Test Certificate
IP	:	Ingress Protection	TPI or TPIA	:	Third Party Inspection Agency
IC	:	Inspection Certification	UT	:	Ultrasonic Testing
IGC	:	Inter Granular Corrosion	UL	:	Underwriters Laboratories
IEC	:	International Electro technical Commission	VDR	:	Vendor Data Requirement
JEC	:	Japanese Electro technical Committee	WPS	:	Welding Procedure Specification
LPT	:	Liquid Penetrate Testing	WPQ	:	Welders Performance Qualification
			XLPE	:	Cross Linked Poly Ethylene

Inspection Standards Committee

Convenor : Mr. R.K. Medhavi

Members : Mr. R.K. Singh Mr. Rajeev Kumar Mr. Himangshu Pal
 Mr. Neeraj Mathur Mr. T. Kamalakannan Mr. Deepak Gupta (Project)
 Mr. Mahendra Mittal

INSPECTION AND TEST PLAN
FOR
MEDIUM VOLTAGE MOTORS

STANDARD SPECIFICATION NO.

6-81-1032 Rev. 5

Page 3 of 6

1.0 SCOPE

This Inspection and Test Plan covers the minimum testing & inspection requirements of three phase medium voltage squirrel cage induction motors.

2.0 REFERENCE DOCUMENTS

PO/PR & Standards referred therein/ Job specifications/ Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	Procedures	--	--	--	--	--	--
2.0	Material Inspection						
2.1	Raw Material: Body (casting or fabrication), Rotor shaft, Core laminations, Copper, Insulation material, Bearings, Terminals, Cable boxes, Cable glands, etc.	Chemical, Physical properties , finish as per relevant standard	100%	Material Test Certificates / Test records	H	H	-
3.0	In Process Inspection						
3.1	Motor Assembly	Vacuum impregnation and bracing of winding, core assembly, Rotor bars and end rings assembly, Rotor balancing, Terminal box mounting and clearances in between, Bearing setting, etc. as per supplier's internal standards	100%	Test Records	-	H	-

INSPECTION AND TEST PLAN
FOR
MEDIUM VOLTAGE MOTORS

STANDARD SPECIFICATION NO.

6-81-1032 Rev. 5

Page 4 of 6

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.0	Final Inspection						
4.1	Motor (Routine Tests)	- Visual check (Nameplate, Terminal box location, terminal type, clearances, size, entries, space adequacy & gland size, Direction of rotation etc.) - Dimensions check (shaft height etc.) - Cable Glands, cable lugs size and no. of entries in Terminal Box - Winding Resistance - No load test and measurement of Voltage, Speed, Current, Power Input - Locked Rotor Test - Reduced voltage Starting and running - Insulation resistance Before & after High Voltage test - High Voltage - Vibration	100%	Inspection test records	-	H	See Note 3 & 4
4.2	Motor (Type Tests)	- Full load test and measurement of Voltage, Current, Power, Slip, Power factor, Bearing Noise. - Efficiency and Pf at 100%, 75% and 50% load - Temp Rise test - Momentary overload test - Vibration - Noise Level	One sample from each type/ rating	Inspection test records	-	H	See Note 3 & 4

INSPECTION AND TEST PLAN
FOR
MEDIUM VOLTAGE MOTORS

STANDARD SPECIFICATION NO.

6-81-1032 Rev. 5

Page 5 of 6

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
		- Over speed - Measurement of Starting Torque, Starting current , full Load Torque, Pull out torque by JEC *					
5.0	Painting						
5.1	Painting and Packing	- Visual - Suitable protection to prevent entry of foreign material. - Proper packing to prevent any damage during transportation and storage.	100%	Packing list/ Supplier's Records	-	H	-
6.0	Documentation and IC						
6.1	Documentation and IC	- Review of Internal Test Reports - Test certificate from recognized testing laboratory for area classification. - BIS certificate for FLP motors and accessories as applicable. - PESO approved certificates for motors and accessories as applicable. - Degree of protection of enclosure - IC issuance	100%	Supplier's Test Records/ Certificates from statutory bodies/ Inspection Certificate (IC)	-	H	H
6.2	Final Document submission	Compilation of Inspection reports, drawings, etc. as per VDR / PR	100%	Final data folder/ Completeness certificate	-	H	H

* Measurements will be made in accordance with standard JEC (Logarithmic proportion method II & I as per rotor design).

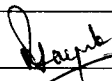
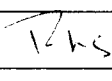
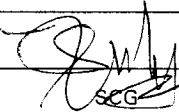
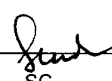
Legends: H - Hold (Do not proceed without approval), R - Review, RW - Random witness (As specified or 10 % - Samples must include min. 1 No of each type),
W - Witness (Give due notice, work may proceed after scheduled date).

NOTES :-

1. This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable. (Unless otherwise agreed upon).
2. Acceptance Norms for all the activities shall be as per PO/ PR/ Standards referred therein/ Job specifications/Approved documents
3. Motors up to 55 KW would be accepted based on Manufacturer's test certificates. Higher rating will have witness by TPIA appointed by Main Supplier.
4. Motors ordered with integration test (VFD fed motors) requirement as per PR shall be witnessed by EIL/ TPIA and main supplier for integration test (irrespective of rating) at motor manufacturer's works.

एम.वी. वैरीएबल फ्रीक्वेन्सी ड्राइव सिस्टम के लिए निरीक्षण एवं परीक्षण योजना

INSPECTION AND TEST PLAN FOR MV VARIABLE FREQUENCY DRIVE SYSTEM

2	30.01.14	Revised and Re-issued	 MJ	 RS	 AKC	 DM
1	29.06.12	Revised and Re-issued	AB	HVJ	AKC	DM
0	08.12.2008	Issued for implementation	RB	SKD	SKP	VC
Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

INSPECTION AND TEST PLAN FOR MV VARIABLE FREQUENCY DRIVE SYSTEM

STANDARD SPECIFICATION NO.

6-81-1038 Rev. 2

Page 2 of 7

Abbreviations

AS	:	Alloy Steel	MPT/MT	:	Magnetic Particle Testing
BASEEFA	:	British Approval Service for Electrical Equipment in Flammable Atmospheres	MRT	:	Mechanical Run Test
BIS	:	Bureau of Indian Standards	MTC	:	Material Test Certificate
CCE or CCOE	:	Chief Controller of Explosives	MOC	:	Material of Construction
CEIL	:	Certification Engineers International Limited	NPSH	:	Net Positive Suction Head
CIMFR	:	Central Institute of Mining & Fuel Research	NDT	:	Non Destructive Testing
CE	:	Carbon Equivalent	NEMA	:	National Electrical Manufacturers Association
DFT	:	Dry Film Thickness	PO	:	Purchase Order
DT	:	Destructive Testing	PESO	:	Petroleum Explosive Safety Organization
DPT	:	Dye Penetrate Testing	PQR	:	Procedure Qualification Record
ERTL	:	Electronics Regional Test Laboratory	PR	:	Purchase Requisition
FCRI	:	Fluid Control Research Institute	PMI	:	Positive Material Identification
FM	:	Factory Mutual	PVC	:	Poly Vinyl Chloride
FLP	:	Flame Proof	QC	:	Quality Control
HIC	:	Hydrogen Induced Cracking	RT	:	Radiography Testing
ITP	:	Inspection and Test Plan	TC	:	Test Certificate
IP	:	Ingress Protection	TPI or TPIA	:	Third Party Inspection Agency
IC	:	Inspection Certification	UT	:	Ultrasonic Testing
IGC	:	Inter Granular Corrosion	UL	:	Under writer Laboratories
IEC	:	International Electro technical Commission	VDR	:	Vendor Data Requirement
JEC	:	Japanese Electro technical Committee	WPS	:	Welding Procedure Specification
LPT	:	Liquid Penetrate Testing	WPQ	:	Welders Performance Qualification
			XLPE	:	Cross Linked Poly Ethylene

Inspection Standards Committee

Convenor : Mr. S C Gupta

Members:

Mr. R.K. Singh	Mr. Rajeev Kumar	Mr. Himangshu Pal
Mr. Neeraj Mathur	Mr. T Kamalakannan	Mr. Deepak Gupta (Project)
Mr. Mayank Jain		

INSPECTION AND TEST PLAN FOR MV VARIABLE FREQUENCY DRIVE SYSTEM

1.0 SCOPE

This Inspection and Test Plan covers the minimum testing & inspection requirements of MV Variable Frequency Drive System(VFD).

2.0 REFERENCE DOCUMENTS

PO/PR & Standards referred there in /Job specifications / Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	Procedures	--	--	--	--	--	--
2.0	Material Inspection						
2.1	Incoming Material like fabricated panels, IGBT/SCRs, relays, Meters, CT/PT, transducers, transformer unit, rectifier unit, filter etc.	Material Identification Operational checks.	100%	Material Test Certificates / Test records	H	H	-
3.0	In process Inspection						

INSPECTION AND TEST PLAN
FOR
MV VARIABLE FREQUENCY DRIVE SYSTEM

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
3.1	VFD Assembly	Visual ,Dimensional, Bill of material	100%	Test Records	-	H	-
4.0	Final Inspection						
4.1	VFD (Acceptance Tests)**	• Visual • Dimensional • Bill of Material check • Simulation check of control signals • Check of Speed/rpm at different frequency at various mode as applicable • Memory function check of fault diagnostics • Insulation Test • Light Load and Functional test • Load characteristics • Load duty test • Check Auxiliary Devices • Check the properties of the control equipment • Check the Protective Devices • Check control and functional requirements • High voltage test • Leakage and pressure test for cooling system where provided • Automatic restart/re-acceleration • Noise Level Measurement	100% By Supplier and on Random Basis by TPIA/EIL	Inspection test records	-	H	H

INSPECTION AND TEST PLAN **FOR** **MV VARIABLE FREQUENCY DRIVE SYSTEM**

STANDARD SPECIFICATION NO.

6-81-1038 Rev. 2

Page 5 of 7

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.2	VFD (Type Tests)	- Load current versus speed at different frequency at constant torque/ Voltage/Power Mode as applicable. - Efficiency - Temperature rise - Voltage division - Line side current distortion content - Power factor - Dynamic performance test - Current limit and current loop test - Speed loop test capability to ride through voltage dips upto 20% - Noise Level Measurement - Capability to restart the system and resynchronize converter onto running motor after a voltage interruption. - Harmonic measurement at output of VFD for Voltage and Current Integral Test is to be carried out along with job motor, as per PR/ EIL Standard Specification.	One sample from each type/rating	Inspection test records	-	H	H

**INSPECTION AND TEST PLAN
FOR
MV VARIABLE FREQUENCY DRIVE SYSTEM**

STANDARD SPECIFICATION NO.

6-81-1038 Rev. 2

Page 6 of 7

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.3	Submission of certificates /documents	- Degree of protection certificate as per latest IS/IEC. - Type test certificates from recognized independent test house such as ERTL, CIMFR, BASEEFA, FM/UL, PTB, ATEX etc for rated current test, power loss determination, temperature rise, EM Immunity and EM Emission	Sample/Proto type	Statutory Approval Certificates / Type Test Certificates	-	H	R
5.0	Painting						
5.1	Painting of VFD Panels	Pre treatment, primer and final paint, shade, thickness	100%	Test records	-	H	R
6.0	Documentation and IC						
6.1	Documentation and IC	- Review of Internal Test Reports and MTCs. - IC issuance	100%	Supplier's Test Records / Inspection Certificate (IC)	-	H	H
6.2	Final Document submission	Compilation of Inspection reports ,drawings, etc as per VDR / PR	100%	Final data folder /Completeness certificate	-	H	H

** All the load tests/ Functional Checks are to be carried out either with the job motor or with Shop Motor

Legends: H- Hold (Do not proceed without approval, R-Review, RW-Random witness (As specified or 10 % - Samples must include min 1 No of each type), W- Witness (Give due notice, work may proceed after scheduled date).

**INSPECTION AND TEST PLAN
FOR
MV VARIABLE FREQUENCY DRIVE SYSTEM**

STANDARD SPECIFICATION NO.

6-81-1038 Rev. 2

Page 7 of 7

NOTES :-

1. This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable. (Unless otherwise agreed upon).
2. Acceptance Norms for all the activities shall be as per PO/PR/ Standards referred there in/ Job specifications /Approved documents

स्टेशनरी निकल केडमियम बैटरी के लिए निरीक्षण एवं परीक्षण योजना

INSPECTION AND TEST PLAN FOR STATIONARY NICKEL-CADMIUM BATTERY

2.	21.11.13	Revised and Reissued	MJ	RS	SCG	SC
1	29.06.12	Revised and Re-issued	AB	HVJ	AKC	DM
0	01.12.08	Issued for implementation	SA	SKD	SKP	VC
Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

INSPECTION AND TEST PLAN FOR STATIONARY NICKEL CADMIUM BATTERY

STANDARD SPECIFICATION NO.

6-81-1047 Rev. 2

Page 2 of 5

Abbreviations

AS	:	Alloy Steel	MPT/MT	:	Magnetic Particle Testing
BASEEFA	:	British Approval Service for Electrical Equipment in Flammable Atmospheres	MRT	:	Mechanical Run Test
BIS	:	Bureau of Indian Standards	MTC	:	Material Test Certificate
CCE or CCOE	:	Chief Controller of Explosives	MOC	:	Material of Construction
CEIL	:	Certification Engineers International Limited	NPSH	:	Net Positive Suction Head
CIMFR	:	Central Institute of Mining & Fuel Research	NDT	:	Non Destructive Testing
CE	:	Carbon Equivalent	NEMA	:	National Electrical Manufacturers Association
DFT	:	Dry Film Thickness	PO	:	Purchase Order
DT	:	Destructive Testing	PESO	:	Petroleum Explosive Safety Organization
DPT	:	Dye Penetrate Testing	PQR	:	Procedure Qualification Record
ERTL	:	Electronics Regional Test Laboratory	PR	:	Purchase Requisition
FCRI	:	Fluid Control Research Institute	PMI	:	Positive Material Identification
FM	:	Factory Mutual	PVC	:	Poly Vinyl Chloride
FLP	:	Flame Proof	QC	:	Quality Control
HIC	:	Hydrogen Induced Cracking	RT	:	Radiography Testing
ITP	:	Inspection and Test Plan	TC	:	Test Certificate
IP	:	Ingress Protection	TPI or TPIA	:	Third Party Inspection Agency
IC	:	Inspection Certification	UT	:	Ultrasonic Testing
IGC	:	Inter Granular Corrosion	UL	:	Under writer Laboratories
IEC	:	International Electro technical Commission	VDR	:	Vendor Data Requirement
JEC	:	Japanese Electro technical Committee	WPS	:	Welding Procedure Specification
LPT	:	Liquid Penetrate Testing	WPQ	:	Welders Performance Qualification
			XLPE	:	Cross Linked Poly Ethylene

Inspection Standards Committee

Convenor : Mr. S.C. Gupta

Members:

Mr. R.K. Singh	Mr. Rajeev Kumar	Mr. Himangshu Pal
Mr. Neeraj Mathur	Mr. T Kamalakannan	Mr. Deepak Gupta (Project)
Mr. Mayank Jain		

INSPECTION AND TEST PLAN FOR STATIONARY NICKEL CADMIUM BATTERY

1.0 SCOPE

This Inspection and Test Plan covers the minimum testing & inspection requirements of Stationary Nickel Cadmium Battery.

2.0 REFERENCE DOCUMENTS

PO/PR & Standards referred there in /Job specifications / Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	Procedures	--	--	--	--	--	--
2.0	Material Inspection						
2.1	Incoming Material like Flame arrester, Electrodes used, Electrolyte , containers, Insulators, Battery stand and other accessories	Physical and Dimensional checks(as applicable), Mechanical properties, Chemical properties of the electrolyte and containers	100%	Sub-Supplier's TC / Supplier Test Records/ Third party lab	H	H	-

INSPECTION AND TEST PLAN FOR STATIONARY NICKEL CADMIUM BATTERY

STANDARD SPECIFICATION NO.

6-81-1047 Rev. 2

Page 4 of 5

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
3.0	Inprocess Inspection						
3.1	Battery assembly	Visual, Dimensions, Bill of Material	100%	Supplier's Test Records	-	H	R
4.0	Final Inspection						
4.1	Battery(Acceptance Tests)	• Visual • Polarity and absence of short circuit • Dimension, mass and layout check. • Test For Ah capacity • Test For voltage during discharge. • Internal resistance test • Dimension, Paint Shade and Paint Thickness of Battery Stands	100%	Inspection test records	-	H	R
4.2	Battery Stand	• Dimension, Paint Shade/thickness	100%	Inspection test records	-	H	R
4.3	Battery (Type Tests)	• Air Pressure Test • Test for charge retention/ loss of capacity. • Ampere hour and Watt-hour efficiency test.	One Sample/ Rating	Type Test Report	-	H	R
5.0	Painting and Packing						
5.1	Painting and Packing	• Visual, Packing list. • Proper packing to avoid any damage during transportation.	100%	Supplier's records	-	H	-
6.0	Documentation and IC						
6.1	Documentation and IC	• Review of Internal Test Reports.	100%	Supplier's Test	-	H	H

INSPECTION AND TEST PLAN
FOR
STATIONARY NICKEL CADMIUM BATTERY

STANDARD SPECIFICATION NO.

6-81-1047 Rev. 2

Page 5 of 5

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
		IC issuance		Records / Inspection Certificate (IC)			
6.2	Final Document submission	Compilation of Inspection reports ,drawings, etc as per VDR / PR	100%	Final data folder /Completeness certificate	-	H	H

Legends: H- Hold (Do not proceed without approval, R-Review, RW-Random witness (As specified or 10 % - Samples must include min 1 No of each type), W- Witness (Give due notice, work may proceed after scheduled date).

NOTES :-

1. This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable. (Unless otherwise agreed upon).
2. Acceptance Norms for all the activities shall be as per PO/PR/ Standards referred there in/ Job specifications /Approved documents