1.0 SCOPE

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

2.0 REFERENCE DOCUMENTS

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

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

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

3.0 DEFINITION

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

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

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4.0 DESIGN

4.1 GENERAL

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

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

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

4.1.4 POWER SUPPLY

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

5.0 FABRICATION (TECHNICAL REQUIREMENT)

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

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

5.3 LIGHTING FIXTURES

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

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

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

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

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5.3.5 Glass shall be of approved make or as specified in Material Requisition.

5.3.6 The fixing parts of the enclosure which is to be opened for replacement of bulb shall be so fastened that they can be unfastened only with special tools. All fixtures shall carry a special warning inscription in English "Isolate supply elsewhere before opening".

5.3.7 All lighting fixtures which are not certified as flameproof construction but approved for use in Zone-2 area shall have approved enclosed break lamp holder and complete enclosure certified as having restricted breathing type construction. Lamp holder shall he screw type.

5.3.8 All lighting fixtures suitable for .discharge lamps shall be provided with one 3/4 "ET threaded entry and supplied with .approved type double compression nickel plated brass cable gland.

5.3.9 All lighting fixtures suitable for incandescent lamps shall be provided with two 3/ "ET threaded entry. Two entries shall be used 'for looping of circuit 'wherever required. The fixtures shall be supplied with approved type two double compression nickel plated brass cable glands and one threaded plug for sealing unused entry.

5.3.10 The top of all well glass lighting fixtures shall be identically drilled / threaded to facilitate the installation on pole/column or ceiling.

5.3.11 All flood lighting fixtures shall be supplied with adjustable mounting arrangement both in horizontal and vertical plane.

5.4 CONTROL GEAR BOX

5.4.1 Lighting fixtures suitable for discharge lamps shall be provided with power factor, correction capacitor, choke starter to be housed .in separate control gear box. The choke shall be copper wound. .The complete control gear shall have power factor not less than 0.9. All components shall be of approved make or as specified in Material Requisition.

5.4.2 Control gear box shall be provided with three 3/4 ET threaded entry (Incoming supply to lighting fixture and for looping to other Fixture/Control gear box). The control gear box shall be supplied with approved type three double compression nickel plated brass cable glands and one threaded plug for sealing unused entry.

5.4.3 Control gear box for flame proof fixtures shall be flameproof type and for div.2 or increased safety fixtures shall be increased safety type unless specified otherwise in the material requisition.

5.5 JUNCTION BOXES

5.5.1 The junction boxes shall be 3 way or 4 way type as specified in material requisition. All junction boxes for looping of single phase lighting circuits using cables up to 4mm shall he minimum 100mm diameter in size. Each junction box shall be complete with requisite number of ET threaded cable entries and with approved type double compression nickel plated brass cable glands and one threaded plug for sealing unused cable entry.

5.6 TERMINALS & WIRING

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5.6.1 All equipments shall he 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 4mm2 copper conductor or as specified in material requisition using crimped type tinned copper lugs. All terminals shall be of non sparking, anti-loosening design such that they do not produce any arc or spark in normal operation.

5.6.2 Flexible wires used for internal wiring shall be minimum 1.5mm2 copper conductor and connections, shall he done using crimped type tinned copper lugs.

5.6.3 Terminals shall .be of approved make or as specified in Material Requisition.

5.6.4 All equipments on single phase supply shall be provided with an independent earth terminal inside the enclosure for connecting the earth core of the cable and shall have facility for looping.

5.6.5 All the hardwares shall be cadmium plated whereas clamps and supporting brackets shall be hot dip galvanized. The galvanizing shall be 610gms/m for clamps and 900gms/m2 for supporting brackets. All gaskets shall be of neoprene.

5.6.6 External surfaces of all the equipment’s shall be treated and prepared for painting with two coats of epoxy paint to shade 632 as per IS-5.

6.0 INSPECTION, TESTING & ACCEPTANCE

6.1 During fabrication, the equipment shall be subjected to inspection by Consultant / Owner or by an agency authorized by the Owner. Manufacturer shall furnish all necessary information concerning the supply to Consultant /Owner's inspector. Tests shall be carried out at manufacturer's works under his care and expense. 4 weeks prior notice shall be given before date of commencement of test for witnessing by Consultant /Owner's authorized representative. The test certificate indicating test result shall be furnished.

6.2 CMRS test certificates along with CCE/DGFASLI/DGMS approval certificates as applicable shall be furnished for each type of fixture. All equipments shall be routine tested as per applicable Indian standards.

6.3 During inspection, facility shall be provided for impact testing of random sample. One well glass of each fixture type from each lot shall be tested for impact strength

7.0 PACKING & SHIPMENT

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

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Energising Quality

VCS Quality Services Pvt Ltd

STANDARD SPECIFICATION
FOR
DC – DC CONVERTER

VCS – SS – EL - 4016

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

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REVISION RECORD						
Rev.	Revision Date	Prepared by	Checked by	Approved by	Authorized by	Revision Description
00	05.07.2017	MG	RD	AD	SK	Issued for use as Standard
01	16.10.2019	MG	VV	AD	SK	New revision system updated
02	05.03.2022	SP	RD	AA	HK	New revision system updated

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ABBRIVATION

BIS/IS	Bureau of Indian standards
IEC	International Electro-Technical Commission
BS	British Standards
IEEE	Institute of Electrical and Electronics Engineers
NEMA	National Electrical Manufacturers Association
OISD	Oil Industries Safety Directorate
CCE	Chief Controller of Explosive
DGMS	Director General Mines Safety
IE Rules	Indian Electricity Rules
CPRI	Central Power Research Institute
AC	Alternating Current
DC	Direct Current
CP	Cathodic Protection
SCADA	Supervisory Control And Data Acquisition

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1.0 SCOPE

This specification covers the requirements of design, manufacture, testing, packing, supply, testing and commissioning of the DC to DC converters.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of latest revision of following standards, unless otherwise specified

- BIS specifications
- International Electro-technical Commission (IEC)
- American standards institution (ANSI)

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

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

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

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

3.0 DEFINITION

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

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

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4.0 MATERIALS

4.1 The converter panel shall be fabricated with 1.6/2mm thick sheet steel. Frames shall be enclosed by using 2mm thick sheet steel and doors and covers shall be made of 1.6 mm sheet steel. Wherever required suitable stiffeners shall be provided.

4.2 660V PVC insulated wires with stranded copper conductor of size 2.5 mm2 shall be used for control wiring. All fuses shall be, provided inside the panel and shall be of link type.

5.0 DESIGN

5.1 GENERAL REQUIREMENTS

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

5.1.2 Vendor shall ensure availability of spare parts and maintenance support services for' the offered equipment at least for 15 years from the date of supply.

5.1.3 Vendor shall give a notice of at least one year to the end user of equipment and Consultant before phasing out the product/spares to enable the end user for placement of order for spares and services.

5.1.4 DC to DC converters are required for installation at remote and unattended stations of pipelines for feeding power to station loads of telecommunication, SCADA, instrumentation and CP system requiring highly reliable power supply. These DC to DC converters shall be suitable for continuous and uninterrupted operation without failure and requiring minimum maintenance (maintenance interval not less than three months) and without requiring any operator or any other attention at unattended stations. The basic module of DC to DC converters shall be highly reliable, having proven performance record.

5.2 PERFORMANCE REQUIREMENTS

5.2.1 DC to DC converter shall be of solid state type and shall operate on switch mode principle. The converters shall operate on a switching frequency above 20 kHz. The voltage conversion/control from input to output shall be by control of duty cycle of conduction of the power semiconductor device.

5.2.2 The DC to DC converters shall either work in dual parallel redundant mode or single non redundant mode, as specified in the Data Sheet/MR/Tender Document.

5.2.3 The parallel redundant DC to DC converters shall have two nos. DC-DC converters which shall work in parallel redundant mode, sharing the load in normal operation, but each capable of delivering full load. In case of failure of any one of converter, the other converter shall continue to feed the load.

5.2.4 DC-DC converters shall be suitable for the incoming supply voltage as specified in the data sheet, with variation in voltage up to +25% and -15%, unless specified otherwise in the data sheet. It shall be possible to operate the DC to DC converters with its output polarities ungrounded or any of its polarity grounded, irrespective of grounding of input supply. The DC to DC converters shall have galvanic isolation (between input supply and

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output supply), requisite isolation transformer shall be provided in the converter. The electrical isolation between input and output shall be rated for min 500V DC.

5.2.5 The overall efficiency shall be minimum 75%. The output of the converter shall be filtered/smoothened to provide DC output with less than 2% ripple. The steady state output regulation for no load to full load and with input voltage variation of +25% and -15%(unless specified otherwise) over nominal voltage, shall be better than ±1% of the rated output. The output voltage shall be adjustable up to ±5% of the nominal output voltage.

5.2.6 The DC to DC converter shall be suitable for feeding power to loads having switch mode power supply regulators at the input, drawing repetitive peak surge currents.

5.2.7 The output voltage dynamic response of the converter unit shall not be more than ±10% of nominal output voltage for step loading and unloading 50% of the rated output in case of dual redundant DC to DC convertors and on 100% step loading and unloading in case of single non redundant DC to DC converters. The normal output shall be restored within 100m sec.

5.2.8 Each converter module shall be protected against output short circuit and over current. DC to DC converters shall be suitable to withstand switching surges or otherwise protective devices shall be provided.

5.2.9 The converter shall preferably be of natural cooled type.

5.2.10 The noise level measured at 1 m distance from the converter unit at any position shall not exceed 70 db (A) at any load from 0-100%.

5.2.11 The convertor shall have input filters to minimize the AC feedback to the power supply. Radio interference noise emitted by the converter shall be minimized to allow proper operation of telecom and SCADA systems in the vicinity and powered by the converter.

5.2.12 The converter shall be field proven and shall be suitable for unattended operation at remote locations. The converter design, internal component layout and component rating shall ensure high MTBF and low MTTR.

5.3 MONITORING, CONTROLS, INDICATIONS AND METERING

5.3.1 Each DC to DC converter module shall be provided with monitoring for the following:

a. Load voltage high
b. Load voltage low
c. Thermal overload protection
d. Module-fault/fail (module not feeding the load)
e. Input fuse fail
f. Input voltage- Too high/Too low

5.3.2 Following control devices, LED indications and meters for each DC to DC converter shall be provided on front of the panel.

a. Potentiometer for adjustment of output voltage

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b. Led indication for module fault/fail (module not feeding the load)

c. Other alarm indication & control devices as per manufacturer's requirement/standard.

5.4 INTERFACE WITH SCADA

5.4.1 Following digital/analog monitoring signals shall be provided in DC to DC converters for remote connection to SCADA system.

a. "DC to DC converter module feeding the load" for each DC to DC converter module (module not faulty/not failed)

b. DC output voltage.

5.4.2 Potential free contacts for remote monitoring shall be provided for digital signals and 4-20mA current signals corresponding to input parameter range(0-110% of maximum rated value of the parameter) for analog signals. The potential free contact for digital monitoring shall be open to alarm state.

5.4.3 The transducers shall have electrical isolation rated for minimum 2kV, 50Hz between input and output. The transducers shall be protected against input and output voltage surges. The accuracy class of the 4-20mA current transducers shall be 5% or better. The 4-20mA current transducers shall be suitable for driving load resistance of 600 ohms located up to 100m away and connected through 0.5 mm2 copper cable.

6.0 FABRICATION

6.1 The converter panel shall be fabricated with 1.6/2mm thick sheet steel. Frames shall be enclosed by using 2mm thick sheet steel and doors and covers shall be made of 1.6 mm sheet steel. Wherever required suitable stiffeners shall be provided. The converter panel shall be wall mounted type and shall not need rear access for maintenance. All components, connectors and terminals shall be arranged, so that maintenance requirements can be attended from front only. Overall hinged door shall be provided at the front of the panel. Alternatively the cabinet may be designed in two vertical portions with plug in modules of DC to DC converters in one portion, while other auxiliary devices, housed in another portion. In this type of construction, the front facial, of DC to DC converter module shall be flushed with the front of panel, so that LEDs and operating knobs/potentiometer can be directly accessed. The bottom vertical portion with hinged door shall accommodate MCCBs/MCBs, alarm, indication and other auxiliary devices as required for the overall unit. Suitable louvers shall be fitted for ventilation. It shall be possible to operate the MCCBs/MCBs without opening the door of the converter panel.

6.2 All instruments shall be switchboard type and back connected. 660V PVC insulated wires with stranded copper conductor of size 2.5 mm2 shall be used for control wiring. All fuses shall be, provided inside the panel and shall be of link type.

6.3 All live parts shall be properly shrouded. This shall ensure complete safety to personnel intending routine maintenance by opening the panel doors.

6.4 All non-current carrying metallic parts shall be earthed with copper wire: The. Main earth connection shall be brought out to two terminals for connection to station earthing system.

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6.5 Removable cable gland plate shall be provided for glanding of all cables, using single compression nickel plated brass cable glands. The termination provision shall be provided in the panel for terminating the power cables, using suitable cable lugs.

6.6 All components and devices shall be provided with screwed nameplates. Nameplates shall be 3 ply (white/black/white) two color laminated plastic.

6.7 PAINTING

6.7.1 The sheet steel used for fabrication shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surfaces shall be prepared by applying a coat of phosphate and a coat of zinc oxide/phosphate primer. The under surface shall be free from all imperfections before undertaking the finishing coat. It shall then be spray painted with two coats of epoxy paint. Color of final paint shall be vendor standard. The finished panel shall be dried in stoving ovens in dust free atmosphere. Panel finish shall be free from imperfections like pin holes, orange peels etc. All unpainted steel parts shall be cadmium plated or suitably treated to prevent corrosion.

6.7.2 Alternatively, powder coating as per manufacturer's standard is also acceptable.

7.0 INSPECTION AND TESTING

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

7.2 Detailed test procedures along with the facilities available at Vendor's works shall be submitted along with the bid. Owner's representative shall be given minimum four weeks advance notice for witnessing the final testing. Test certificates including test records and performance data etc. shall be furnished by the vendor.

7.3 Final acceptance tests shall be carried out at manufacturer's works under his care and expense. All the instruments and equipment required for testing shall be arranged by vendor. Acceptance tests shall include but not be limited to the following:

7.3.1 VISUAL INSPECTION

a. Completeness of the equipment in the lines with specs.
b. Dimensional checking
c. Proper mounting of components and nearness of wiring etc.
d. Model number

7.3.2 Functional testing:-All functions shall be checked up for proper operation.

7.3.3 Heat run test (full load test) shall be carried out for a minimum duration of 8 hours on all units except that in case of identical ratings for more than one unit, heat run test may be conducted only one of the identical units. During this test, measurements shall be carried out to prove that the operating temperatures of various components do not exceed their

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design ratings with sufficient margins as per good engineering practice/established guidelines.

7.3.4 Type test certificates shall be submitted for ensuring compliance to other guaranteed performance parameters.

8.0 MARKING, PACKING AND SHIPMENT

The equipment shall be properly packed for transportation by ship/rail or trailer. The panels shall be wrapped in polyethylene air bubble sheets before being placed in wooden crates /cases to prevent damage to the finish Crates/cases shall have skid bottoms for handling. Special precaution/parameters such as "Fragile", "This side up", center of gravity, weight, Owner's particulars, Purchase number etc. shall be clearly marked on the package together with other details as per Purchase Order.

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.

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VCS Quality Services Pvt Ltd

STANDARD SPECIFICATION
FOR
CORROSION SURVEY

VCS – SS – EL - 4017

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

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REVISION RECORD						
Rev.	Revision Date	Prepared by	Checked by	Approved by	Authorized by	Revision Description
00	05.07.2017	MG	RD	AD	SK	Issued for use as Standard
01	16.10.2019	MG	VV	AD	SK	New revision system updated
02	05.03.2022	SP	RD	AA	HK	New revision system updated

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ABBREVIATION

ROU	Right of Use
EHC	Extra High Voltage
HV	High Voltage

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1.0 SCOPE

1.1 The Specification covers the requirements for corrosion survey including measurement of soil resistivity, chemical analysis of soil/water and collection of other cathodic protection related data along ROU of the pipelines.

2.0 REFERENCE DOCUMENTS

2.1 Equipment and measurement techniques shall unless otherwise specified, conform to the requirement of latest revisions of following applicable Standards:

- BIS Specifications
- BS Specifications and codes of practice
- NACE publications

2.2 The work shall be carried out in compliance with all applicable local laws and regulations.

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

- Statutory regulations
- Data Sheets
- Job Specification
- This Specification
- Codes and Standards.

3.0 DEFINITION

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

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

4.0 GENERAL

4.1 This Specification defines the basic guidelines for carrying out the corrosion survey. Contractor shall be responsible for providing necessary data interpretation based on corrosion survey measurements, which is intended to form a basis for design of cathodic protection system for the pipeline.

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5.0 SOIL RESISTIVITY SURVEY

5.1 Unless otherwise specified the soil resistivity measurements shall be carried out at intervals of approximately 500 m along the ROU. Where soil resistivity is less than 100 ohm.m and two successive readings differ by more than 2:1 then additional soil resistivity readings in between the two locations shall be taken.

5.2 To carry out the soil resistivity measurement Wenner's 4 pin method or approved equal shall be used. The depth of resistivity measurement at each location shall be at around 1 m and at the burial depth of the pipeline accounting for the cuttings /fillings or 2 m approximately whichever is higher. At locations where multi-layer soil with large variation in resistivity/ corrosiveness is expected and /or locations specifically advised by Owner or his representative resistivity measurements at additional depth of up to 3 m (approx.) or more shall be taken. In general the resistivity of soil, which shall be surrounding the pipe, shall be measured. Hence the depth of measurement / electrode spacing may vary depending on topography and strata at the area.

5.3 At places where ROU has not yet been cleared, measurements shall be made right over the center line of pipeline route surveyed accounting for the cuttings /fillings also.

5.4 Observations shall be made enclosing the soils adjoining the trench wherever pipeline trenching has already been done.

5.5 The observations shall be made enclosing the soil immediately surrounding the pipeline route where ROU has been cleared but trenching has not been done.

5.6 All measurements shall be taken at right angles to the ROU unless otherwise asked by Owner or his representative at site.

5.7 At places in ROU where other pipelines are already existing care shall be taken to precisely locate such pipes line and take such precautions that observations are not adversely affected by presence of such pipelines.

5.8 Care shall also be taken that the observations are not influenced by presence of other earth currents in the area especially in the vicinity of EHV/HV lines and plants using earth return in their source of power etc.

5.9 Wherever possible / advised by Owner or his representative, depth of water table shall be determined by resistivity observations.

5.10 All measurements shall be made and recorded in metric units. While recording the data reference to the nearest intersecting point shall be made. To provide visual representation of variations in the resistivity along ROU, values shall be plotted on semi log graph sheets. The resistivity graph shall also indicate the resistivity at additional depths measured at various locations and depth of water table.

6.0 TESTS ON SOIL SAMPLES

6.1 Soil/water samples shall be collected along the ROU for analysis. Samples shall be collected on an average at one location for every 10 km along ROU with minimum at two locations. Exact locations shall be decided at site depending on the type of soil, soil

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resistivity and in consultation with Owner or his representative. At each location the soil samples shall be collected at 1 m, 2 m depth and at expected depth of pipeline if it is more than 2 in at the location.

6.2 The collected soil/water shall be analyzed to determine presence and percentage of corrosive compounds including carbonates, bicarbonates, nitrates, chlorides, oxygen activity, moisture content and pH value.

7.0 ADDITIONAL DATA COLLECTION

7.1 The following data shall be collected with a view to generate design data for evaluation of cathodic protection interaction possibilities due to presence of other services in ROU and its vicinity:

7.2 Following information regarding foreign service/pipeline in or around the ROU (for existing and those, which are likely to come up during contract execution).

7.2.1 Types of service / pipelines and year of laying.

7.2.2 Diameter and pipeline coating in case of pipeline.

7.2.3 Parallel running / crossing.

7.2.4 Year of laying / commissioning.

7.2.5 Depth of laying.

7.2.6 Type of existing cathodic protection systems (impressed-current / sacrificial).

7.2.7 Location and type (Deep well / surface) of anode ground bed.

7.2.8 Rating of impressed current type of anode ground bed.

7.2.9 Location of existing CP power supply units and their output voltage, current, pipe to soil potential readings.

7.2.10 Location of existing test stations.

7.2.11 Remedial measures existing on foreign service/pipeline to prevent interactions.

7.2.12 Graphical representation of existing structure / pipe to soil potential records.

7.2.13 Possibility of integration/isolation of CP system of the foreign service/pipeline with that of the proposed pipeline, which may involve negotiations with owners of foreign services.

7.2.14 Where, pipeline is likely to "pass close to any existing ground bed (within 100 m approx.), anode-bed potential gradient survey shall .be carried out, to verify possible interference with the CP system of the pipeline covered under this project.,

7.3 Voltage rating, phases and sheathing details of cables running parallel or crossing the ROU.

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7.4 Existing .and proposed DC/AC power sources and systems using earth return path such as HVDC substations/ earthing stations fabrication yards with electric welding etc. in the vicinity of the entire pipeline route

7.5 Crossing and parallel running of electrified and non-electrified traction (along with information regarding, operating voltage, AC/DC type etc.) as well as abandoned tracks near ROU having electrical continuity with the tracks in use.

7.6 Crossing or parallel running of any existing or proposed EHV/HV AC/DC overhead power lines along with details of voltage, AC/DC type etc.

7.7 Voltage rating, phases, sheathing details of underground power cables, along ROU or in its vicinity.

7.8 Any-other relevant information that may be needed in designing and implementing of proper cathodic protection scheme for the proposed pipeline.

8.0 REPORT

8.1 On completion of all the field and laboratory work an interim report incorporating results generated from surveys, additional data collected, results of test carried out, etc., shall be submitted for comments / approval. The report shall also highlight any adverse impact on performance of sacrificial anodes due to the percentage of corrosive compounds including carbonates, bicarbonates, nitrates, chlorides present in the soil and pH value of the soil noticed during the survey. The final report incorporating comments/missing data shall be furnished for records. The report along with various drawings, graphs etc. prepared in connection with the work shall be submitted along with six prints by the Contractor.

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Energising Quality

VCS Quality Services Pvt Ltd

STANDARD SPECIFICATION

FOR

SACRIFICIAL ANODE CATHODIC PROTECTION SYSTEM FOR PIPELINES

VCS – SS – EL - 4018

02	05.3.2022	SP	RD	AA	HK
01	16.10.2019	MG	VV	AD	SK
00	05.07.2017	MG	RD	AD	SK
Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By

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REVISION RECORD

Rev.	Revision Date	Prepared by	Checked by	Approved by	Authorized by	Revision Description
00	05.07.2017	MG	RD	AD	SK	Issued for use as Standard
01	16.10.2019	MG	VV	AD	SK	New revision system updated
02	05.3.2022	SP	RD	AA	HK	New revision system updated

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ABBREVIATION

AC	Alternating current
BS	British Standards
BIS	Bureau of Indian Standards
CP	Cathodic Protection
CP TR	Cathodic Protection Transformer Rectifier unit.
CMRI	Central Mining Research Institute.
CTE	Coal To Enamel
DC	Direct Current
EHV	Extra High Voltage
FBE	Fusion Bonded Epoxy
HDD	Horizontal Directional Drilling
HV	High Voltage
HVDC	High Voltage Direct Current
MOV	Motor Operated Valve
NACE	National Association of Corrosion Engineers
PE	Polyethylene
SV	Sectionalizing Valve
ROW	Right Of Way
HV	High Voltage
CIPS	Close Interval Potential logging
DCVG	Direct Current Voltage Gradient
Cu / CuSo4	Copper / Copper sulphate reference electrode
Ag / AgCl	Silver / Silver chloride reference electrode

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1.0 SCOPE

1.1 This Specification defines the requirements of design, engineering, installation, testing and commissioning of sacrificial anode cathodic protection system for external surface of cross country onshore underground pipelines/structures including supplementing of corrosion survey, investigation for interference/interaction problems and mitigation of the same.

1.2 This Specification defines the basic guidelines to develop a suitable sacrificial anode cathodic protection system for the pipelines/structures required to be protected. All data required in this regard shall be taken into consideration to develop an acceptable design and for proper engineering of the system.

1.3 Compliance with these Specifications and/or approval of any of the Contractor's documents shall in no case relieve the contractor of his contractual obligations.

2.0 REFRENCE DOCUMENT

2.1 The system design, performance and materials to be supplied shall conform to the requirements of the latest revision of following Standards as a minimum:

NACE Standard RP-0169	Standard Recommended Practice Control of External Corrosion on Underground or Submerged Metallic Piping Systems
NACE Publication 10A 190	Measurement technique related to criteria for CP of Underground or Submerged Steel Piping System (as defined in NACE Standard RP0169-83).
NACE Standard RP-0177	Standard Recommended Practice Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems
NACE Standard RP-0286	Standard Recommended Practice The Electrical isolation of Cathodically Protected Pipelines
NACE Publication No. 54276	Cathodic Protection Monitoring for Buried Pipelines.
NACE TM0497	Measurement technique related to criteria for Cathodic Protection on underground submerged metallic piping system
BS 7361 Part I	Code of Practice for Cathodic Protection for land and Marine applications.
IS0 15889-1	Cathodic Protection of pipeline transportation system

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

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

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

a. Statutory regulations.

b. Data Sheets.

c. Job Specification.

d. This Specification.

e. Codes and Standards.

3.0 DEFINITION

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

Owner / Company	OWNER of the particular Project (Project Specific).
Consultant	The party which is doing engineering, procurement, construction, pre-commissioning and assistance for commissioning, monitors and controls the overall project management.
Bidder / Supplier / Vendor	The party(s) which manufactures and / or supplies material, equipment, technical documents / drawings and services to perform the duties specified by Contractor.
Anaerobic	Lack of free oxygen in the electrolyte adjacent to a metallic structure
Blistering (of paint film)	Formation of swelling on the surface of an unbroken paint film by moisture, gases or the development of corrosion products between the metal and paint film.
Cathodic disbanding	Failure of adhesion between a coating and metallic surface that is directly attributed to cathodic protection conditions and that is often initiated by a defect in the coating system, such as accidental damage, imperfect application or excessive permeability of the coating.
Current Density	The current to or from a unit are of electrode surface.
Foreign structure	Any metallic structure that is not intended as a part of a system under cathodic protection
Holiday	A defect in a protection coating at which metal is exposed. This may, in some cases, be small as possible.
Instantaneous off potential	The structure-to-electrolyte potential measured immediately after the synchronous interruption of all sources of applied cathodic protection current

4.0 DESIGN

Unless otherwise specified in the Data Sheet, following parameters shall be used for design of cathodic protection system.

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4.1 SYSTEM IMPLEMENTATION

4.1.1 All work to be performed and supplies to be effected as a part of contract shall require specific review by Owner or his authorized representative. Major activities requiring review shall include but not be limited to the following:

a. Corrosion survey data interpretation report and. design basis for CP system.

b. CP system design package. (Including calculation for CP system)

c. Detailed engineering package

d. Field testing and commissioning procedure,

e. Procedures for interference testing and mitigation.

f. Close interval potential logging survey and system monitoring procedures:

g. As built documentation

4.2 CORROSION SURVEY

4.2.1 The details of corrosion survey including soil resistivity data along ROW and other data required for CP design if available with the Owner shall be included as part of project Specification/Data Sheet. However, verification of its veracity and adequacy shall be the entire responsibility of the contractor. Contractor shall also carry out soil resistivity survey at sacrificial anode ground bed locations for proper design of ground beds as specified in Data Sheet. Wenner's 4-pin method or approved equal shall be used for such measurements. Survey instruments shall have maximum AC and DC ground current rejection feature.

4.2.2 Care shall be taken to ensure that the resistivity observations are not influenced by the presence of foreign pipelines/structures, and earth currents in the vicinity of EHV/HV lines and installations using earth return in their power system etc.

4.2.3 Where specified in the project Specification/Data Sheet, the contractor shall carry out corrosion survey along the ROW of the pipeline conforming to the Specifications included in the tender document.

4.3 Additional Data to be Collected

4.3.1 The following data shall be collected to generate design data for evaluation of interaction/interference possibilities due to presence of other services in ROW/in vicinity. Owner shall provide assistance for liaison work to the extent possible.

4.3.2 Route and types of foreign service/pipeline in and around or crossing the right of way (including those existing and those which are likely-.to come up during contract execution).

4.3.3 Diameter, wall thickness, pressure, soil-cover, and coating scheme used, type of cathodic protection system provided, if any and year of laying/commissioning in case of foreign pipelines.

4.3.4 Details of the existing cathodic protection systems protecting the services i.e. type of protection, location, type, rating of anode beds, test station locations and their

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connection schemes. Present output current and voltage readings of the CP power supply units.

4.3.5 Remedial measures existing on foreign pipelines/services to prevent interaction. Graphical representation of existing structure/ pipe to soil potential records.

4.3.6 Possibility of integration/isolation of CP systems, which may involve negotiations with owners of other services.

4.3.7 Information on existing and proposed DC/AC power sources and systems using earth return path such as HVDC substations/ earthing stations, fabrication yards with electric welding etc. in the vicinity of the entire pipeline route.

4.3.8 Crossing and parallel running of electrified and non-electrified traction (along with information regarding operating voltage; AC/DC type etc.) as well as abandoned tracks near ROW having electrical continuity with the tracks in use.

4.3.9 Crossing or parallel running of any existing or proposed 11 KV and above AC/DC overhead power lines along with details of voltage, AC/DC type etc.

4.3.10 Voltage rating phases sheathing details of-underground power cables running along ROW or in its vicinity.

4.3.11 Any other relevant information that may be needed in designing and implementing proper protection.

4.3.12 Contractor shall conduct necessary potential gradient surveys for any existing anode ground beds that may interfere with the CP system of the pipelines covered under this project.

4.4 Report

4.4.1 On completion of all fieldwork, a report incorporating all the results generated from surveys and details of additional data collected shall be prepared. The report shall also contain detailed interpretation of survey results and resistivity data enclosed, probable interference prone areas etc. to form design basis for the scheme of cathodic protection. This report shall also include various drawings prepared in connection with the above work. The soil resistivity values shall be plotted on semi-log graph sheets.

4.5 CATHODIC PROTECTION DESIGN PARAMETERS

4.5.1 Unless otherwise specified in the Data Sheet, following parameters shall be used for design of cathodic protection system.

4.5.2 Where the cathodic protection system is specified for temporary protection, those parts of sacrificial anode cathodic protection system, which will be integrated, with the permanent CP system shall be designed based on permanent CP parameters.

4.6 Protection Current Density

4.6.1 Pipelines having coal tar enamel (CTE) coating with two / three layers of reinforcement

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Pipeline surrounding	Minimum protection Current Density	
	Temporary CP (μ A/m^2)	Permanent CP (μ A/m^2)
Soil resistivity more than 100 ohm/m	40	200
Soil resistivity 10 ohm m to 100	75	300
Soil resistivity less than 10 ohm/m	500	2000
Sea water	1000	5000

4.6.2 Pipelines having fusion bonded epoxy coating

Pipeline surroundings	Minimum protection Current Density	
	Temporary CP (μ A/m^2)	Permanent CP (μ A/m^2)
Soil resistivity more than 100 ohm/ m	25	90
Soil resistivity 10 ohm m to 100 ohm/	35	125
Soil resistivity less than 10 ohm/m	125	500

4.6.3 Pipelines having polyethylene (PE) coating

Pipeline surrounding	Minimum protection Current Density	
	Temporary CP (μ A/m^2)	Permanent CP (μ A/m^2)
Soil resistivity more than 100 ohm/m	10	35
Soil resistivity 10 ohm /m to 100	15	50
Soil resistivity less than 10 ohm/m	35	125

4.6.4 The above current density values for temporary CP system are applicable for CP system design life up to two years

4.6.5 Actual current density to be adopted shall be decided based upon soil and other environmental conditions, current drainage survey data (where included in Contractor's scope), proximity of foreign pipe lines/structures and other interference areas affecting the installation. Where considered necessary for satisfactory protection of pipeline the current density shall be suitably increased by contractor.

4.6.6 The pipe protection Current Density indicated as above shall be applicable where the temperature of the fluid transported by the pipeline/ the surface temperature of the buried portion of the pipeline does not exceed 30° C, the protection Current Density shall be increased suitably in consultation with the Owner/Company.

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4.6.7 At HDD (Horizontal Directional Drilling) crossing, the pipe protection current density applicable for marshy area shall be considered.

Safety factor for current density	1.3
Anode utilisation factor	0.85 for solid anodes 0.6 for ribbon anodes
Pipeline natural potential	(-) 0.45V.

4.6.8 Unless otherwise specified in Data Sheet the design life of temporary CP shall be two year and that of permanent CP shall be 30-years

4.6.9 Along the ROW Where soil resistivity is higher than 100 ohm/ m temporary CP for the pipeline may not be provided after obtaining specific approval from the Owner.

4.7 CATHODIC PROTECTION DESIGNCRITERIA

4.7.1 Cathodic protection system shall be designed to meet the following criteria:

4.7.2 The pipe to soil potential measurements shall be between (-) 0.95 V (ON) and (-) 1.5 V (ON) for polyethylene coated pipe lines between (-) 0.95 (ON) and (-) 1 7 V (ON) for fusion bonded epoxy/coal tar coated pipe lines with respect to a copper/copper sulphate reference electrode.

4.7.3 A positive potential swing of 100 milli volts or more shall be considered sufficient to indicate the presence of an interaction/interference situation requiring investigation and incorporation of mitigation measures by the Contractor.

5.0 MATERIAL

The system shall include the following major equipment/sub-systems unless otherwise specified in project Specifications.

a. Sacrificial anodes and anode ground beds
b. CP system at cased crossings
c. Test stations
d. Surge diverter and polarisation cell
e. Permanent reference cells
f. Electrical resistance probes
g. Interconnecting cables
h. Cables to pipe connections

All equipment shall be new and procured from approved manufacturers. Equipment offered shall be field proven. Equipment requiring specialised maintenance or operation shall be avoided as far as possible. Prototype equipment shall not be accepted.

Equipment shall conform to the relevant Specifications enclosed with the tender document. All equipment including test stations, anode lead junction boxes etc. shall be located in safe non-hazardous areas.

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Where it is essential to install the equipment in hazardous area, such equipment shall be flame proof type and shall meet the requirement of IS: 2148 or equivalent international Standard and shall be suitable for gas group IIB, temperature class T3 (200°C). Indigenous equipment shall be certified by CMRI or any other recognised testing body and shall be approved by the concerned statutory authority. All flameproof equipment shall carry the BIS license marking as per the requirement of statutory authorities.

All Imported equipment for hazardous area may be tested and certified by an independent certifying agency of country of equipment origin and shall be approved by the concerned statutory authority in India.

5.1 Anode Ground Beds

5.1.1 Along row where soil resistivity predominantly remains low, ranges from 0-10 ohm/ m and pH value is within 9, zinc anodes may be provided.

5.1.2 Anodes of type I as per ASTM-B 418 Standard shall be used for seawater, brackish water or saline electrolyte application and anode of type II as per ASTM-B 418 Standard shall be used for fresh water, back fill and soil applications.

5.1.3 Along ROW where soil resistivity is predominantly in the range of 10 ohm/m to 30 ohm/ m, low potential (1.55V) magnesium anodes may be provided.

5.1.4 Along ROW where soil resistivity is predominantly in the range of 30 ohm/m to 50 ohm/m high potential (1.75V) magnesium anodes may be provided.

5.1.5 At high resistivity area where resistivity is of the order of 50 ohm/m and above magnesium ribbon anodes may be provided.

5.1.6 Where magnesium anode is used for protection of polyethylene coated pipelines, the anodes shall preferably of low potential (1.55V) type.

5.1.7 Anodes shall be installed along the pipeline at suitable intervals as per pipeline protection voltage attenuation calculations and ground bed resistance/current output of anode installations. At high resistivity area the magnesium ribbon anodes shall be installed all along the pipeline by the side of the pipeline in the pipeline trench.

5.1.8 Suitability of the selected sacrificial anodes for the soil conditions with particular attention to carbonates, bicarbonates, phosphates and nitrates, shall be checked for proper operation by the Contractor. The anodes shall be laid in proper type of back fill, such that the effect of soil is minimum on the anode effectiveness and life. Suitable safe guards against anode passivation in prevailing soil shall be taken by the Contractor.

5.1.9 At the temporary CP anode ground-bed, the leads of all the anodes shall be joined together in a junction box filled with epoxy and buried. A single cable shall be routed from the junction box to test station.

5.1.10 For sacrificial anode ground bed which as intended for permanent CP system and/or which is to be integrated with permanent CP system, the leads of all the anodes shall be brought up to the test station and shall be terminated individually.

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5.1.11 The number of anodes at each ground bed shall be sufficient for providing the specified pipe protection current density taking into consideration the ground bed resistance, cable resistance, etc. For permanent cathodic protection system, Contractor shall prepare a table for number of anodes required at different soil resistivities to produce the specified protection current for the specified designed life. For Temporary Cathodic Protection system, an indicative design data for sacrificial anodes ground bed in tabular form is given in Data Sheet. The number of anodes for ground bed, spacing of ground beds based on the applicable soil resistivity, size of pipeline, type of coating for the pipeline shall be chosen from the table after necessary verification by the CP contractor. Any deficiency in the protection system if noticed during commissioning or during monitoring shall be corrected by the CP contractor by suitably augmenting the system with additional anodes without any cost / schedule implications.

5.1.12 For the portion of the pipeline for which the CP system has been specified based on the permanent CP system parameters the contractor shall ascertain the requirement of the cathodic protection current density indicated above. Where specified in the project Specification/Data Sheet the requisite current density test/survey shall be conducted by the contractor to establish the adequacy of CP current requirement and number of anode ground beds.

5.2 Test Stations

5.2.1 Test stations shall be provided along the pipeline ROW for monitoring the performance of the cathodic protection system at the following locations. Test stations shall be provided at additional locations, if required, so that distance between any two adjacent test stations does not exceed 1000 meters in inhabited areas and 2000 meters in uninhabited areas like forest/deserts.

a. Al the locations of anode ground beds.

b. At vulnerable locations with drastic, changes in soil resistivity

c. At both sides of metaled road crossings

d. At locations of surge diverters, pipeline grounding through polarisation cells, zinc and magnesium anodes.

e. At EHV/HV AC/DC overhead line crossings and selected locations where EHV/HV overhead line is in the vicinity of the pipeline.

f. At railway line crossings and at selected locations along lines running parallel to the pipeline.

g. At both sides of major river crossings.

h. At EHV/HV cable crossings or along routes where EH/HV cables are running in parallel.

i. In the vicinity of DC networks or grounding systems and HVDC grounding systems where interference problems are suspected.

j. At crossings of other pipelines/structures.

k. At the locations of reference cell and Electrical Resistance probe installation m) at both sides of cased crossings.

l. Locations, where interference is expected.

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m. At locations of Sectionalizing Valve (SV) stations.

n. At any other locations considered necessary by Owner /Owner's representative.

5.2.2 Test stations used for sacrificial anodes shall have shunt for measurement of anode current, provision for resistance insertion to limit the anode current output and anode disconnecting link.

5.2.3 Test stations for bonding shall be provided with shunt and resistor as a means to monitor and control current flow between the pipeline and foreign pipelines or structures that may exist in common ROW.

5.2.4 Test station with current measuring facility shall be provided at interference prone areas, on both sides of major river crossings, near marshy areas and minimum one for every 10 km max. along the pipeline.

5.2.5 The test stations shall be installed with the face of the test station facing the pipeline. The nameplate of test stations shall carry the following minimum information

a. Chainage in km.

b. Test station connection scheme

c. Distance from pipeline in meters.

d. Direction of product flow.

5.2.6 Terminals and different schemes of wiring shall be provided as per the test station connection scheme. Minimum twenty percent spare terminals shall be provided in each test

5.2.7 Minimum two cables shall be provided from the pipeline at any test station

5.2.8 The location of all the test stations shall be marked with their connection schemes and other relevant information on alignment sheets. A detailed test station schedule shall be prepared.

5.3 Permanent Reference Cells

5.3.1 High purity copper-copper sulphate reference cells with proven high reliability shall be provided for stable coupon to soil potential measurement at the locations of polarisation coupons.

5.3.2 The reference cells shall be of silver/silver chloride type in place of copper/copper sulphate cells, at marshy area locations, where water table is high and chloride ion concentration is more than 300 ppm for marshy area in saline soils high purity zinc may be considered as an alternative to silver/silver chloride.

5.3.3 The life of reference cells shall be minimum 10 years under burial-conditions.

5.3.4 The test station connection scheme inside the test station shall clearly indicate the type of reference cell (Cu CuSO4 /Ag AgCI).

5.4 Electrical Resistance Probe

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5.4.1 Where specified in Data Sheet electrical resistance probes (E/R probes) utilising the electrical resistance technique shall be provided along the pipeline at marshy areas and at vulnerable locations to monitor the external corrosion activity on the pipeline. The lead wires of the probe shall be connected to pipeline through test station and terminated inside test station enabling periodic resistance measurement of the probe using a portable measuring instrument.

5.4.2 The E/R probes shall be provided preferably at the bottom portion of pipeline. The number of ER probes, the location of their installation and the number of portable ER probe reading instruments shall be as specified in the project Specification/Data Sheet.

5.5 SURGE DIVERTER AND POLARISATION CELL

5.5.1 SURGE DIVERTER

Explosion proof type spark gap surge diverter shall be connected across each insulating joint to protect it from high voltage surges.

5.5.2 POLARISATION CELL

Where ever the pipeline is either crossing or running in parallel, with overhead EHV/HV transmission lines of voltage grade 66kV and above, it is mandatory that the pipeline shall be grounded to discharge any accumulated potential /singe that may appear in case of transmission line faults, as per below

The pipeline shall be grounded through polarization cell with zinc galvanic anodes of minimum 20kg net weight each at location where pipeline crosses EHV/HV transmission lines.

The pipeline shall be grounded at regular intervals of maximum 1 km where EHV/HV transmission lines run parallel within 25 m of the pipeline

Locations along pipeline where continuous induced over-voltage due to other overhead transmission lines/underground cables of voltage grade below 66kV is expected or observed during commissioning, the pipeline shall be grounded through polarization cell to the earth system of the EHV /HV tower causing the voltage induction or to a separate earthing system of zinc anodes through polarization cell.

The polarization cell shall be installed inside test station of suitable size. Type of polarization cell shall be as specified in Data Sheet.

The total system including cable, cable termination, surge diverters/polarization cells/anodes shall be suitable for the anticipated fault current at the location of its installation

The surge diverter, polarization cell and anode system shall be suitable for the design life of permanent CP system. The grounding system shall have minimum resistance to earth to restrict the pipeline voltage as per NACE/VDE criteria but shall not exceed 5 ohms. The anodes shall be pre packed with special backfill adequately so that the performance of the anode is not affected by the carbonates, bicarbonates, nitrates, etc., present in the soil. In any case, the thickness of back fill shall not be less than 50mm on all the sides of the anode.

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Motor operated valves where located on the cathodically protected portion of the pipeline shall be grounded by a zinc or magnesium anode of 20 kg net where the type of anode provided for the CP system of the pipeline is zinc or magnesium respectively. The MOV power supply cable armour shall be insulated (by cutting and taping with insulation tape) at MOV end to avoid armour carrying CP current.

The above ground cathodically unprotected pipeline at intermediate SV stations, pigging stations etc. and terminals shall be earthed with GI earth electrodes, The resistance to earth of grounding shall be limited to 5 ohms max.

5.6 CP at cased crossing

5.6.1 At cased crossings where casing is coated, the casing shall be protected by sacrificial anode installations, provided at both ends of casing. The anode installation shall be sized based on the permanent CP design parameters and design life of permanent CP system. At cased crossings where casing is painted or uncoated, additional protection for casing pipes may not be provided.

5.6.2 The carrier pipe inside the painted or coated casing shall be protected by zinc ribbon anodes weld connected to the outer surface of bottom of carrier pipe extending up to hour hand positions of 4 and 8 O'clock. The anodes shall be placed at close intervals as per design

5.6.3 Calculations with minimum one number of anodes installed between every two supports provided between carrier and casing. The anodes shall be sized based on the permanent CP design parameters for marshy area and design life of permanent CP system.

5.6.4 Where casing is bare (i.e. uncoated or unpainted), additional protection for carrier pipe may not be provided.

5.7 Reference Cell Access Points

5.7.1 Reference cell access points shall be provided near insulating joint locations and at SV stations, where the ground is paved, for measurement of pipe to soil potentials. A perforated PVC pipe filled with native soil and buried at the location shall be provided for the purpose. The length of the PVC pipe shall be adequate to reach the native soil below the paving.

5.8 Cables

5.8.1 Cables shall be with annealed high conductivity stranded copper conductor, PVC insulated, 650/1100V grade, armoured, PVC sheathed conforming to IS: 1554 Part -I except for the cables for reference cells and pipeline for potential measurement. The size of the copper conductor shall be 6 sq.mm for anode tail cable from anode to buried junction box or test station (in case of permanent CP anode ground bed), 10sq.mm from buried junction box to test station and a 10 sq.mm. from test station to pipe line. The size of cable for bonding, polarisation cell, grounding anodes and surge diverter connections shall be suitable for the maximum fault current subject to Minimum 25 sq.mm. The length of anode tale cable shall be sufficient for routing from anode to buried junction box or test station for anodes for temporary CP or permanent CP respectively.

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5.8.2 The cables for reference cells and pipeline potential measurements shall be of 4 sq.mm copper conductor, PVC insulated, Aluminum backed by Mylar / polyester tape shielded, PVC sheathed, armoured PVC overall sheathed type.

6.0 INSTALLATION

6.1 Cable laying

6.1.1 Cables shall be laid in accordance with the layout drawings to be prepared by the Contractor. No straight through joint shall be permitted. Cable route shall be carefully measured and cables cut to required length. Minimum half meter cable slack shall be provided near anodes, pipeline and test stations to account for any settling

6.1.2 All cables inside station/plant area shall be laid at a depth of 0.75 M Cables outside station/plant area shall be laid at a depth of minimum 1.5 m Cables shall be laid in sand under brick cover and back filled with normal soil. For cables laid outsider the station/plant area, polyethylene warning mats shall place at a depth of 0.9 m. from the finished grade to mark the route

6.1.3 In case of above ground cable, all armoured CP cables shall be laid in GI conduits of sufficiently large size up to accessible height for protecting against the mechanical damage.

6.1.4 All underground armoured cables including anode tail cables shall run through PE sleeves. The cables routed along the pipeline shall be carried at the top of the carrier pipe by securely strapping it at intervals with adhesive tape or equivalent as required.

6.1.5 PVC pipes of proper size shall be provided for all underground cables for road crossings

6.1.6 Cables shall be neatly arranged in trenches in such a manner that crisscrossing is avoided and final take off to equipment is facilitated.

6.1.7 The cables for reference cells and pipeline potential measurement shall be routed in a separate trench other than the trench provided for the rest of the CP system cables, AC cables for CPTR units, etc.

6.1.8 The armour of all the cables from pipeline to test station (potential measurement, reference cell cables, cathode cables, etc.) and test station to ground bed (anode cable) shall be earthed only at test station end of the cable to avoid armour carrying CP current. The cable armour shall be insulated by cutting and taping with insulation tape.

6.2 Permanent Reference Cells

6.2.1 The permanent reference cells shall be installed in natural soil conditions as per the recommendations of the cell manufacturer. Installations in highly acidic/alkaline soil and soil contaminated by hydrocarbons shall be avoided.

6.3 Cable to pipe connections

6.3.1 All cable connections to the new pipeline shall be made by an approved exothermic process or by pin brazing. However, cable connection to charged pipelines shall be made by pin brazing. Exothermic welding shall be adopted for water pipelines. The resistance

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of the cable to pipe at the connection point shall not exceed 0.1 ohm. Coating shall be repaired after connection of cable conductor to pipeline. The coating repair material shall be compatible with the original coating and shall prevent ingress of water along the cable, surface and at the interface of coating repair with the original pipe coating

6.4 Ground bed Fencing

6.4.1 Where specified in project Specifications/Data Sheet a chain link fencing shall be provided around the location of each ground bed, designed based on the permanent CP design

7.0 INSPECTION, TESTING AND COMMISSIONING

7.1 System testing at site

7.1.1 Field tests as per the reviewed field testing and commissioning procedures prepared by the Contractor shall be carried out on the equipment/systems before these are put into service. Acceptance of the complete installation shall be contingent upon inspection and test results

7.1.2 Before the CP system facilities are put into operation, necessary tests shall be carried out to establish that all equipment, devices, wiring and connection have been correctly installed, connected and are in good working condition as required for the intended operation. Owner/Owner's representative may witness all tests. Intimation shall be given at least one week before commencing the tests.

7.1.3 All tools, equipment and instruments required for testing shall be provided by Contractor. Generally, the following minimum tests must be carried out and recorded.

a. Cables

I. Cable No.

II. Voltage grade.

III. Conductor cross section.

IV. Continuity check.

V. Voltage test.

VI. Insulation resistance values between each core & earth, between cores. All cables shall be tested by 500 V megger.

b. Insulating joint

I. Location.

II. Pipe to soil potential of both protected and nonprotected sides of the insulating joint before and after energisation of CP system

c. Surge diverter

I. Location/Identification number rating

II. Type

III. Explosion proof enclosure check for healthiness.

IV. Check for proper connection.

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d. Polarisation Cell

I. Location/Identification number.

II. Ratings.

III. Check for wiring

IV. Check standby current drain after CP system energisation. (Current drain with respect to voltage across the cell shall be recorded).

V. Details of grounding provided for the polarisation cell

e. Anode Ground Bed

I. Location/Station

II. Vertical/horizontal

III. Check for actual layout and compliance with drawings.

IV. Current output of ground bed.

V. Current output of each anode (in case of permanent, CP anode ground beds)

f. Reference Cell

I. Location

II. Type of cell

III. Potential reading

IV. Installed on top/bottom level of pipeline

g. E/R Probe

I. Location/Identification number

II. Checking of wiring as per schematics

III. Resistance reading of probe

IV. Installed on top/bottom/side of the pipeline

7.2 Commissioning

7.2.1 Natural potential of pipe to soil for the complete pipeline and casing pipeline at the locations of cased crossings shall be measured at all the test station locations, recorded prior to connecting anodes to pipe line and casing pipeline respectively.

7.2.2 The anode shall be connected to pipeline in the test station and the pipe to soil potential observation shall be made after allowing sufficient time for polarisation. The current output of each anode at permanent CP anode ground bed or the total current output of anode bed at temporary CP anode ground bed shall also be measured to ensure that it does not exceed the output current capacity of the anodes. In case the anode output current exceeds the rated capacity, it shall be controlled by insertion of resistance element in the anode circuit inside test station and the pipe to soil potential shall be rechecked for adequacy of protection. At locations of polarisation coupons the coupon 'OFF' potential shall be measured by switching off the reed switch. Additional anodes shall be provided where required to achieve desired level of protection and to keep the anode output current within the rated value. In case pipe to soil potential exceeds the specified value, suitable resistance shall be inserted in the anode circuit to limit the potential.

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7.2.3 Anode installation shall become individually operational as above.

7.2.4 At the locations of cased crossings where anode installations are provided for the protection of the casing pipe, these anode installations shall be commissioned as per the procedure detailed in clause 7.2.2. above.

7.2.5 After connecting all the anode ground beds to pipe line, measurement of pipe to soil potentials shall be taken at each test station to ensure conformity to protection criteria.

7.2.6 In case of insufficient protection as per the CP design criteria on any portion of the pipeline/ casing pipeline (at cased crossings where casing is cathodically protected) Contractor shall carry out necessary additions/modifications to the provided protection in consultation with the Owner/Owner's representative.

7.2.7 Resistance readings of the probe shall be taken at all the locations of electrical resistance probes.

8.0 INTERFERENCE MITIGATION

8.1 Investigations shall be made for stray current electrolysis of the pipeline, mutual interference between the pipeline and foreign pipelines/structures, interference on foreign pipelines/structures due to the CP of the pipeline and ground bed, AC induction on pipeline due to 11 KV and above overhead HV/EHV line, interference due to high voltage DC line, HVDC groundings, electric traction etc.

8.2 Where transmission lines cross the pipeline or run in parallel within or more than 25m from the pipeline, AC voltage measurements shall also be made on the pipeline to find out continuous induction of voltage. In case of induced voltage being beyond safe limits, the pipeline shall be grounded in line with clause no.5.5.2 above.

8.3 Measurements including pipe/structure to soil potential and pipeline/structure current etc. on the pipeline/structure being CP protected and on foreign pipelines/structures shall be made to investigate the current discharge and pickup locations. In case of fluctuating stray current, investigations shall be made continuously over a period of time and if required simultaneously at different locations to find out the stray current source(s). For measurements over longer durations, recorders shall preferably be used.

8.4 Where foreign pipelines (unprotected or protected by independent CP system) run in parallel to the pipeline in same trench or very near to the pipeline, and are not bonded to the pipeline then investigation shall be made for current discharge points on both the pipelines.

8.5 Mitigation measures shall be provided depending on type of stray current electrolysis/ interference. These shall include installation of bond with variable resistor, diodes, installation of galvanic anodes for auxiliary drainage of current, adjustment relocation (if possible) of offending interference source, provision electrical shield.etc. depending on the type of interference.

8.6 Bonding with foreign pipeline/structure, as a mitigation measure shall be provided where the Owner of the foreign pipeline/structure has no objection, otherwise alternative mitigation measure shall be provided. Where bonding is provided for mitigation, the

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bonding resistor shall be adjusted for optimum value for minimum/no interference. Galvanic anodes installed as a mitigation measure shall be sized for the design life specified for permanent CP.

9.0 SYSTEM MONITORING

9.1 Where the CP provided is temporary, the CP system shall be monitored at all test stations once in a month for healthiness/adequacy of protection hit commissioning of permanent CP or for design life of temporary CP specified, whichever is less, during this period if any deficiency/interference in protection system is noticed, the same shall be rectified/augmented by providing additional anodes as required. The monitoring report shall be submitted regularly to Owner for his review/information.

10.0 CLOSE INTERVAL POTENTIALLOGGING SURVEY (CIPS)

10.1 Where specified in project Specification/Data Sheet, contractor shall carry out a close interval potential survey over the entire length of pipeline by computerized potential logging method and identify the under protected/over protected area, any major coating damage on the pipeline, after the back-filling has been consolidated sufficiently and CP system has stabilized. Contactor shall provide required mitigation measures and rectify the under/overprotected zones, identify if any, the major pipeline coating defects required to be repaired. During the survey the reference cell shall be calibrated minimum once in 24 hours.

10.2 Where specified in the project Specification/Data Sheet, additional tests for detailed identification of coating defects shall be conducted by the contractor.

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Energising Quality

VCS Quality Services Pvt Ltd

STANDARD SPECIFICATION
FOR
ELECTRICAL EQUIPMENT INSTALLATION

VCS – SS – EL - 4023

02	09.03.2022	SP	RD	AA	HK
01	16.10.2019	MG	VV	AD	SK
00	05.07.2017	MG	RD	AD	SK
Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By

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REVISION RECORD

Rev.	Revision Date	Prepared by	Checked by	Approved by	Authorized by	Revision Description
00	05.07.2017	MG	RD	AD	SK	Issued for use as Standard
01	16.10.2019	MG	VV	AD	SK	New revision system updated
02	09.03.2022	SP	RD	AA	HK	New revision system updated

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ABBREVIATION

BIS/IS	Bureau of Indian standards
IEC	International Electro-Technical Commission
BS	British Standards
IEEE	Institute of Electrical and Electronics Engineers
NEMA	National Electrical Manufacturers Association
OISD	Oil Industries Safety Directorate
CCE	Chief Controller of Explosive
DGMS	Director General Mines Safety
IE Rules	Indian Electricity Rules
CPRI	Central Power Research Institute
AC	Alternating Current
DC	Direct Current
CP	Cathodic Protection
SCADA	Supervisory Control and Data Acquisition
HV	High Voltage
MV	Medium Voltage
LV	Low Voltage
ACDB	Alternating Current Distribution Board
DCDB	Direct Current Distribution Board
CT	Current Transformer
PT	Potential Transformer
IR	Insulation Resistance
CTC	Carbon Tetra Chloride
MMI	Man Machine Interface

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1.0 SCOPE

1.1 Specification defines the requirements for the installation, field inspection, testing and commissioning of electrical equipment, forming part of electrical power distribution and utilization system, including communication and fire alarm system.

2.0 REFERENCE DOCUMENTS

2.1 The work shall be carried out in the best workmanlike manner in conformity with this specification, Consultant Installation Standards, layout drawings and to the following specifications/ codes of practice of Bureau of Indian Standards and OISD standards.

SP-30(BIS)	National Electrical Code.
IS-7816	Guide for testing Insulation resistance of rotating machines.
IS 10028(Part-2)	Code of practice for selection, Installation and maintenance of transformers; Part 2: Installation.
IS 10118(Part-3)	Code of practice for selection, installation and maintenance of switchgear and control gear Part 3 Installation.
OISD 137	Inspection of Electrical Equipment.
OISD 147	Inspection and safe practices during electrical installations

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

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

3.0 INSTALLATION

3.1 Prior to start of installation of the electrical equipment contractor shall verify that equipment and complete materials have been received. Handling, shifting to required site location, installation, testing and commissioning of all electrical equipment shall be done by contractor with utmost care. Manufacturer's instructions and the requirements given in their technical manuals shall be strictly adhered. The substation/switchgear room wherein the equipment shall be installed shall be kept clean, dry and-free from all debris. Panel floor cutouts not in immediate use shall be suitably covered to avoid any mishap. When handling the switchboard panels, care shall be taken to observe the correct lifting arrangements and to make sure that slings are attached to the manufacturer's designated lifting points. No parts shall be subjected to undue strains or sudden stresses which could cause damage to the equipment.

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3.2 The lifting position mark indicated on packing casing shall be adhered to strictly, for keeping it in required vertical position.

3.3 Contractor shall check and report to the Engineer-in-charge about any damaged item and / or missing component for getting the same replaced as per Specifications. During installation, all accessories and loose items shall also be inspected by the contractor before their assembly/mounting.

3.4 Switchboards and Bus Ducts

3.4.1 The term switchboard here includes all HV / MV/ LV switchboard panels, motor control centers, power and lighting distribution boards, UPS panels, ACDB, charger panels, DCDB etc. The switchboard panels shall be handled with care, avoiding any impact to the equipment. Dragging of the panels directly on floor shall be avoided. Roller bars may be used for shifting of panels. Use of a crane and trailer shall be made for handling of equipment. The switchboard panels shall be properly supported on the truck or trailer by means of ropes to avoid any chance of tilting. The switchboards shall be lifted after ensuring that panel supports, nuts and bolts are all intact and tightened. While lifting the panels in packed conditions utmost care shall be taken to avoid any damage to insulators, bushings, metering and protective equipment. The panels shall be preferably kept inside the packing cases till foundations are ready.

3.4.2 The switchboard panels shall be installed on prepared foundations or floor cutouts. Steel base channels shall be welded to inserts provided in floor slab. Cross members shall be provided at the junctions of each shipping section and other places as required. Alternatively, when the floor is being laid, base channel frame of panels supplied by the Vendor shall be grouted and leveled in cement concrete. It shall be ensured that the base plate level of HV switchboard shall match with the finished floor level. The foundation pockets and the grouted bolts shall be cured fora minimum period of 48 hours.

3.4.3 The switchboard panels shall be taken out from the packed cases and shifted one by one to its proper place. All the panels shall be assembled, aligned and leveled. Alignment of panels shall be checked in both longitudinal and lateral directions. It shall be ensured that panel to panel coupling bolts, bus bar links etc. fit properly without any strain on any part. No new holes for jointing of the panels other than those recommended by the Vendor shall be drilled. No gaps shall be left between the panels. The lifting, racking in and out operation of the breaker and all other motions shall be free from any obstruction.

3.4.4 The panels shall be checked for correct vertical position using pendulum weight and spirit levels. The switchboard panels shall be tack welded at suitable intervals at base channel.

3.4.5 After erection of switchboard panels, all uncovered portions of floor cutouts shall be covered with 6 mm thick removable chequerred plates finished with floor level. The design of the chequerred plates shall be such that the maximum allowable deflection is L/200 (where L is the span of the chequerred plates in meters) for alive load of 500 kg/sq. meters. Suitable lifting arrangements shall be provided for chequerred plates. The chequerred plates shall be painted with a coat of red oxide zinc chromate primer after proper surface preparation as per specifications. Where specified, panel's cutouts provided for future use shall be filled with lean concrete.

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3.4.6 After completion of erection of switchboards, all the cubicles, switchboard components such as switches, starters, C.T. and P.T. chambers, busbar chamber shall be cleaned and checked for tightness of all the components. Vacuum circuit breakers shall be checked for integrity of bottle seals. All loosely supplied items shall be fitted up. Bus bar sections or links shall be inserted and where specified, of high voltage equipment shall be insulated. Interconnection wiring between shipping sections shall be made by contractor. All the wiring connections shall also be checked. Phase sequence and polarity of PTs and CTs shall be checked. Contact resistance of all busbar joints and contactors shall be checked. Insulator shall be checked for any damage. All the starters, switches, contacts shall be cleaned with C.T.C. where required. All the moving parts shall be checked for easy and free movement. Hinges of panel doors shall be lubricated to give free and noise free movement. All -openings shall be kept completely closed to avoid ingress of any foreign particles inside the panel.

3.4.7 Functional scheme verification of individual feeder shall be carried out and minor wiring modifications in the panel wiring, if required shall be done as per the directions of Engineer-in-charge. Special attention shall be paid to CT circuits polarity, wiring continuity and correctness in the protection as well as measurement circuits. Auto transfer scheme shall be simulated and verified. During the course of scheme verification tests, defective components if any shall be taken out, after bringing to the notice of Engineer-in-charge. The same shall be replaced by component supplied by Owner.

3.4.8 Where switchboard is damp or having a low IR value due to damaged insulators/ bushings/any other insulated parts, or any other reason, the entire-switchboard shall be dried up according to the instruction of the Engineer-in-charge for the IR value-to improve to a safe level for commissioning. Care shall be taken to protect the surrounding insulation from direct local heating during the drying up process.

3.4.9 All the metering instruments, protective relays and other relays and contactors shall be tested as per manufacturer's recommendations and according to the instructions of the Engineer-in-charge. Protection relays shall be inserted and connected and settings adjusted as required by the Engineer- in- charge.

3.4.10 All moving parts, of closing/tripping mechanism racking in and racking out mechanism, spouts and shutter closing mechanism shall be checked for proper operation. All the auxiliary contacts of breaker shall be checked-up cleaned and contact pressure measured.

3.4.11 All the control wiring, PTs, bushings, bus bars other live parts of switchgear, incoming and outgoing cables shall be meggered.

3.4.12 Electrical simulation tests shall be named out for all the protective alarm and annunciation relays and external interfaces to ascertain proper functioning.

3.4.13 Safety insulation mats of approved make and of required voltage grade shall be provided in the sub-station.

3.4.14 Pre-Commissioning Checklist

Before commissioning any switchboard, following points shall be checked and ensured for safe energizing of the switchboard:

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a. That the installation of equipment to be commissioned is complete in all respects with its auxiliaries and all other mounting including earthing. Openings in floor within and outside panels have been sealed off. All cover and door gaskets are intact to-make the enclosure vermin proof.

b. That all the metering instruments have been checked and found in working order. Indicating lamps are healthy and are in correct position. All power and control fuses are of proper rating.

c. That the polarity test and ratio test of all the PT s and CT s is complete and phase sequence of CTs conforms to the correct vector group connections. Wiring continuity and correctness are ensured in the protection and measurement circuits. Polarity of D.C. supply for all the circuits-is correct.

d. That the high voltage tests of incoming and outgoing cables have been conducted and results are satisfactory.

e. That all the protective relays including both conventional and microprocessor based numerical relays and thermal overload relays have been tested for secondary injection tests. (Primary injection tests shall be carried out for differential protection, Restricted Earth fault protection at full / reduced current to ensure correctness of complete wiring). Relay settings, status indications, fault annunciations, data logging, and display of switchboard SLDs shall be verified from MMI in case the same is provided.

f. That I.R. Value have been recorded for bus bars, circuit breaker, incoming and outgoing cables, control wiring and potential transformers. Where required joint resistance of bus bars have been recorded and found to be satisfactory. All the surroundings and panels have been cleaned and temporary earth leads have been removed.

3.4.15 Bus Ducts:

The bus ducts as per issued drawings will be supplied in parts and all the parts shall be assembled and the bus bar connections shall be made at site. The insulators in bus ducts shall be inspected for any possible damage during transit and the defective ones shall be replaced. The insulators shall be cleaned. Contact surface of bus bars, bus bar bolts and nuts shall be thoroughly cleaned. Petroleum jelly shall then be applied and bolted connection made. The bus duct enclosure shall be checked for earth continuity and then earthed at two places. The bus duct shall be properly supported between switchgear and transformer. The opening in the wall where the bus duct enters the switchgear room. shall be completely sealed to avoid rain water entry. Expansion joints, flexible connections etc. supplied by the manufacturer of the bus duct shall be properly connected. The bus duct leveling shall be checked with spirit level and pendulum weight.

3.5 Transformers

3.5.1 Transformers on receipt at site shall be unloaded by means of crane or lifting devices of adequate capacity. All lifting lugs shall be used to avoid unbalanced lifting and undue stresses on lugs. Lifting lugs if any provided for partial lifting (e.g., for. active part, conservator) etc. shall not be used for lifting complete transformer. Parts other than those identified for lifting of the transformer shall not be used for lifting. While slinging,

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care shall be taken to avoid slings touching other parts.

3.5.2 Before lifting transformer, it shall be ensured that all cover bolts are tightened fully. In case when it is necessary to use jacks for lifting, projections provided for the purposes of jacking shall be used. Lifting jacks shall not be used under the valves or radiator tubes. For transporting transformers from stores to site, the transformers shall be loaded on a suitable capacity truck or trailer. The transformers shall be properly supported by steel ropes and stoppers on the trailer to avoid tilting of the transformers in transit due to jerks and vibrations. At no instance the transformer shall be kept on bare ground. Where it is not possible to unload the transformer directly on a foundation, it shall be unloaded on a properly built wooden sleeper platform. A transformer shall never be left without putting stoppers to the wheels.

3.5.3 Transformers shall be examined, for any sign of damage in transit Particular attention shall be given to the following in this regard.

a. Dents on tank wall or cooling tubes.
b. Damage to protruding parts like valves, sight glass etc.
c. Loosening of bolts due to vibration in transit.
d. Cracked or broken bushings.
e. Oil leakage particularly along welds.

Anything adverse is noted the same shall be brought to the notice of Engineer- in- charge.

3.5.4 Contractor shall examine the transformer base, oil pit, fire walls and foundations laid by the civil contractor. It shall be surged that oil spills cannot propagate along cable trenches. Any discrepancy noted will be brought to the notice of Engineer- in- charge. Transformers shall be placed on channels or rails over concrete foundation. The transformers shall be leveled, aligned and checked for free movement on the channels or rails. Stoppers shall be provided to the transformer immediately to prevent any movement. Normally transformers up to 1000 kVA rating shall be received duly fitted- with radiator tubes, conservator tanks, valves, wheels and other accessories. While the transformers of above 1000 kVA rating may be supplied with loose accessories. All the accessories like radiators, cooling fans, valves, conservator tanks, explosion vent pipe, bushings and other devices which are supplied indifferent packages shall be checked for any transit damage and cleaned thoroughly before fixing on the transformer. All loosely supplied parts shall be assembled as per manufacturer's instruction manuals/ drawings and documents. All the connections for C.T.s bushings and other wiring shall be checked for tightness and correctness before replacing the lid or tightening all the bolts.

3.5.5 TOPPING OF TRANSFORMER WITH OIL

Before topping up with oil, transformer shall fit with all accessories such as valves, gauges, thermometers etc. Oil samples shall be taken from each drum and tested for determination of dielectric strength. Any sign of leakage of the barrel or of its having been opened shall be recorded and reported. It is necessary to filter the oil before the transformers are filled. It shall be ensured in oil filling operation that no air pockets are left in the tank and that no dust or moisture enters the oil. All air vents shall be opened. Oil shall be filled through a Streamline oil filter using metal hose. To prevent aeration of the oil, the transformer tank shall be filled through the bottom drain valve. In a transformer

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with conservator tank, the rate of oil flow shall be reduced when the level is almost up to the bottom of the main cover to prevent internal pressure from rupturing the pressure relief-pipe diaphragm. Sufficient time shall be allowed for the oil to permeate the transformers and also for the locked -up air bubbles to escape. Any air accumulation in the Buchholz relay shall be released.

3.5.6 TRANSFORMER OIL

a. Sample of oil from the transformer shall be taken from the bottom of the tank.
b. Testing of oil: -

For dielectric test, the oil shall be tested as described in IS: 335. The oil shall also be tested for acidity in accordance with methods prescribed.

3.5.7 Drying out of the transformer's if required shall be carried out and record maintained in accordance with IS: 10028. Normally a streamline filter shall be used for drying-up. I.R. value versus time of both windings shall be recorded during the drying up process.

Precaution when drying:

a. The maximum sustained temperature to which transformer oil may be subjected shall be limited to 80° C.
b. The transformer shall be carefully monitored throughout the drying out process and all observations shall be carefully recorded
c. Drying out shall be continued so that the insulation resistance as prescribed in the standard code of practice is attained and the value remains constant for more than 12 hours. However, a minimum number of cycles shall be done for each transformer as found necessary by the engineer-in-charge. Generally, a megger reading of 2 mega ohms / KV at 60° C temp. with a 5 KV megger may be a rough indication for stopping the dehydration.

3.5.8 The following work on transformers shall be performed by the contractor if specifically called for:

Before finally commissioning the transformer, it may sometimes be desired to run it for a few hours on short-circuit, applying a low voltage, approximately equal to the impedance voltage of the transformer. During this process, regular readings of the insulation resistance of the winding to earth and winding to winding and temperature against time shall be recorded.

Testing of radiator tubes for any leakage and rectifying these by welding / brazing.

3.5.9 PRE-COMMISSIONING CHECK LIST:

Before commissioning of any transformer, the following points shall be checked for safe energization of the transformer:

a. That all the accessories have been fixed properly and transformer body and neutral are properly earthed. The transformer dehydration is over and results are satisfactory and approved by the Engineer-in-charge. In case transformers are idle for more than one month after dehydration, transformer oil has been given at least two circulations.

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b. That the oil level, in the transformer conservator tank and all the bushings is up to the marked point and the oil have been tested for dielectric strength and acidity.
c. That the silica gel is in reactivated condition. The breather pipe is clear from any blocking and contains oil up to the proper level.
d. The explosion vent diaphragm does not have any dents. Accumulation of any oil and air had been released.
e. That the operation of off-load and. on-load tap changers on all the tap positions is satisfactory. The mechanical parts of the on-load tap changer are lubricated. Motor IR value has taken and found satisfactory. Tap position mechanical indicator on the transformer and tap position indication meter on the control panel are reading the same tap positions. Tap changer limit switches are operating satisfactorily on the maximum and minimum tap positions. On-load tap changer contact pressure and resistance is as per manufacturers recommendations. Oil level of tap changer tank is up to the required level and oil has been tested for dielectric strength. The tap setting on which the off-load tap switch is locked shall be recorded. Generally, the off-load tap switch shall be kept on nominal tap.
f. That the Buchholz relay has been tested and checked up for any friction in the movement, and floats are free. All the other protective relays, alarm and annunciation relays have been tested.
g. That all the metering equipment’s have been tested and polarity test of PT's and transformer winding is satisfactory. Phase sequence and connections have been checked for proper vector group.
h. That the ratio test and winding resistance on all the tap positions is satisfactory.
i. That gaps of arcing horns for the bushings where provided are in order and earth connections for the surge diverters have been checked.
j. That the winding and oil temperature thermometer -pockets contain oil and the winding and oil temperature settings on dial gauges are in order.
k. That the transformers fitted with fans for forced air cooling have been checked up for automatic starting and stopping of the fans and air-displacement has been verified.
l. That the simulation tests for all external interface connection alarm, annunciation and trip circuits have been checked and are order.
m. That the insulation resistance of all the control circuits and IR value of the transformer windings and all the incoming and outgoing cables have been checked.
n. That all the valves in the codling system and valve between the Buchholz relay and the conservator tank is in open position.
o. That the setting of all the protective relays is at the desired value and D.C. Trip supply is healthy.

3.5.10 Observations after Commissioning:

After switching on-the transformer the following points shall be observed and recorded.

a. The inrush magnetizing current and no-load current.
b. Alarm if any, or if any relay flag has operated.
c. Voltage and current on all the three phases
d. Transformer hums or abnormal noise.

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e. Circulation of oil and leakages.

f. Record current, voltage, cooling air temperature, winding temperature and oil temperature readings, hourlyfor24hours.

g. Cable end boxes for any overheating.

3.6 H.V. and M.V. motors

3.6.1 All the motors generally would be erected by the mechanical contractor.

3.6.2 Electrical contractor shall keep the, motor space heater energized, asper the directions of Engineer-in-charge. Electrical contractor shall measure the insulation resistance of motor windings. Insulation resistance of the motors shall be measured between the winding the machine and its frame by means of a 500/1000 V megger in case of 415 V motors. A minimum value of 1 mega ohm for415Vmotors shall be considered a safe value. In case of lower I.R. Value, the insulation value shall be improved by any of the following methods as directed by the Engineer-in-charge.

a. Blowing hot air from external source.

b. Putting the motor in oven.

c. Placing heaters or lamps around and inside after making suitable guarding and covering arrangements so as to conserve the heat.

3.6.3 In case the insulation is low, the following method of drying has to be adopted, after consultation with Engineer-in-charge. During drying the temperature rise of winding shall not exceed the permissible value for the class of insulation used.

a. By locking the motor so that it cannot rotate and then applying such a low voltage to the stator terminals so .as to pass full load current in the stator keeping the stator winding temperature below 90° C. In this case a close watch shall be kept for any possible overheating and I.R. Values vs. temperature shall be plotted and heating continued till I.R. value becomes steady.

b. By blasting hot air from external source, Maximum temperature of winding while drying shall be 70° C to 80° C (thermometer) or 90° C to 95° C by resistance method. Heating shall be done slowly first till steady temperature of winding is reached after 4 to 5 hours, and for large machines after 10 hours. A record has to be kept for drying process, with half an hour reading and, till steady temperature is reached. In case it is essential, the drying process can be supplemented by blower.

3.6.4 It shall be ensured that the motor leads are correctly connected in the terminal box, as indicated in the `Name Plate'. The covers of all terminal boxes shall be properly fixed, the gaskets intact. The control circuit shall be tested for proper functioning as per circuit diagram.

3.6.5 In case of synchronous machines, slip rings and brush gear shall be polished and brushes shall be fixed in their holders with clearance and pressure as recommended by the manufacturers.

3.6.6 Before commissioning, the ventilation and cooling system of the motor must be inspected. In case of motor with forced ventilation the air inlet shall be examined to ensure that it is free from moisture and any foreign material. It shall also be ensured

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that recommended flow and pressure of air is available to produce the required cooling effect.

3.6.7 The motor control gear shall also be carefully examined, the over-load settings may be reduced or time lags bypassed from protective gear to ensure rapid tripping of switchgear in event of faults. The direction of rotation of a new motor especially of large capacity, and phase sequence of supply shall be kept in view while joining and connecting to the motor terminals.

3.6.8 Finally, the motor shall be started on no-load after decoupling, and shall be allowed to run for a minimum period of 4 hours, or for a time as instructed by Engineer-in-charge. Attention shall be given to the proper running of the bearings, vibration or unusual noises if any. Voltage, starting current, no-load current, stator winding and bearing temperature shall be recorded after every 1 hour during this test. Direction of rotation shall be checked and recorded. Normally the motors run in clockwise direction as viewed with reference to the phase sequence R, Y, B.

3.6.9 After switching off the motor, the insulation resistance of the motor shall be recorded under hot and cold conditions.

3.6.10 If the no load test run is found satisfactory, the motor shall be allowed to run for 8 hours and all readings shall be recorded.

3.6.11 The following work on motors may be performed by the contractor if specifically called for.

a. The proper level of bearing oil has to be checked. The condition of grease in bearings shall be checked and in case it is necessary, complete replacement of bearing with specified grade of grease after proper cleaning of the bearing shall have to be done. Wherever external greasing facility exists, the condition of grease may be checked by pumping some new grease of specified grade at start. If the grease coming out is deteriorated grease shall be replaced.

b. All the motors, -motor exciter set and induction generators directly coupled or coupled through reduction gears shall be checked for abnormal vibration, if any Large rated HV motors with journal type bearings are liable to get damaged from shock, rough handling during transit. Any minor defect in a race or roller may give rise to considerable amount of vibration and noise. Contractor shall check and bring to the attention of Engineer-in-charge any defect noticed in this regard.

c. Due care shall be taken to avoid any damage to bearing insulation wherever provided.

3.7 Batteries

3.7.1 Battery (Lead acid, Nickel Cadmium or VRLA type as specified) shall be erected on stands and insulators supplied by the manufacturer of the batteries. The installation shall be done as per the layout drawings and manufacturer's instructions. Electrolyte if required / as applicable shall be filled as per manufactures instructions. Interrow connections shall be made with the leads supplied by the manufacturer.

3.8 Neutral Earthing Resistor

3.8.1 The neutral earthing resistor shall be inspected for any damage to the resistor grid and

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other components. The resistor shall be leveled and installed. All covers etc. shall be checked for lightness to ensure that the enclosure of the resistor is dust, vermin acid weatherproof. Earthing conductors shall be taken from the out-end terminal of the resistor for connection to earth electrodes and to the main grid.

3.9 welding Receptacles

3.9.1 The welding receptacles shall be erected on steel/concrete structures as per the drawings, in isolated places a separate support shall be fabricated and installed.

3.10 Push Button/Control Stations

3.10.1 The push buttons / control stations shall be installed near to the motors to be controlled. Individual channel support shall be installed as per standard installation drawings. If control stations for hazardous areas are to be supplied by contractor. These shall be of Ex(d) type tested by CMRI and approved by CCOE or other applicable certifying authorities. All outdoor push buttons / control stations shall preferably have integral canopies for additional weather protection. The canopy shall be made of 2 mm thick galvanized sheet steel or FRP where these are not integral with the equipment.

3.11 Gang operated Isolators/outdoor Disconnectors

3.11.1 The isolators shall be transported to site in the dismantled condition. All the insulators may be also supplied loose. The contractor shall inspect, clean assemble and install the isolator on the base structure previously fabricated erected and leveled by him. The operating mechanism shall be installed on the structure and connected to the isolator poles. The operating mechanism shall be tested by slowly bringing the isolator to the closed position and carrying out the necessary adjustment as per the manufacturer's instructions. The earthing switches, frames and operating handle etc. shall be earthed.

3.11.2 Contractor shall provide the following items in substation as per Indian Electricity Rules:

a. Fire buckets filled with clean dry sand and ready for immediate use for extinguishing fires and fire extinguisher (carbon dioxide, dry chemical extinguisher etc.) suitable for dealing with electric fires shall be conspicuously marked and kept.
b. First aid boxes containing ointments and medicines for immediate treatment of injuries (As prescribed by Indian Red Cross Society or equivalent).
c. Instructions of restoration of persons suffering from electric shock in English, Hindi and local language of the district shall be affixed in a conspicuous place.
d. Danger boards (H.V, M.V.) shall be provided on transformer gate, switchboards, entrance to switchgear room and at other places as required by Engineer-in-charge.
e. The Communication system and Fire alarm system panels and equipment shall be installed complying to manufacturer's instructions. The location of field station (call back station unit, break glass unit, telephone set etc.) shown on, the drawing is indicative. The exact location shall be decided at site by contractor in consultation with Engineer-in-charge. Correct type of equipment with regard to hazardous protection as specified on drawing shall be adhered to by contractor, for installation.

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4.0 INSPECTION, TESTING ANDCOMMISSIONING

4.1.1 Field inspection, testing and commissioning of the complete electrical installation shall be carried out as per consultants Specification.

4.1.2 After the equipment is installed properly in accordance with drawings and Specifications, Contractor shall carry out all pre-commissioning checks and tests as per company format in the presence of Engineer-in-charge and test readings shall be recorded and furnished to Consultant/Owner in triplicate.

4.1.3 All equipment layout drawings shall be marked by the Contractor for "AS BUILT STATUS" and two sets of copies shall be submitted to Consultant/Owner.

5.0 SPARES AND ACCESSORIES

5.1.1 The Contractor shall have all necessary construction equipment, tools and tackles and testing instruments to carry out the erection works and to commission the system as specified. These shall include but not be limited to the following, and these shall be brought to site by Contractor before the start of work.

Equipment:

a. Portable grinder.
b. Portable welding machine.
c. Portable gas cutting / welding set.
d. Pipe threading machine.
e. Pipe bending machine (hydraulic).
f. Portable drill machine suitable to take up drilling for different sizes as per requirement.
g. Dewatering pump sets (diesel driven).
h. Power Hacksaw.
i. Conduit dye set.
j. Hydraulic crimping machine.
k. Hand crimping tool.
l. Portable electric blowers, vacuum cleaners.
m. Miscellaneous items such as slings, pulleys, tarpaulins, wooden sleepers, ladders. etc. as required.
n. Safety belts, safety goggles, and gloves.
o. Separate tool kit for each Electrician.
p. Insulation tester 1000 V hand driven.
q. Insulation tester 2500 V motor/hand driven.
r. Insulation tester 5000 V motor/hand driven
s. Phase sequence indicator.
t. Earth Resistance tester.
u. Single phase variac
v. 3 phase variac of adequate capacity.
w. Secondary injection testing kit.

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x. Multimeter both analogue and digital
y. Portable Ammeters, Wattmeter, P.F. meters.
z. Portable Voltmeters.
aa. Clip on meters of different ranges.
bb. Tacho-meter.
cc. Kelvin's double bridge for measurement of very low resistance.
dd. D.C. high pot test kit.
ee. D.C. high pot test kit.
ff. Oil filtration machine of adequate capacity.

5.2 Lux meter to measure illumination levels.

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Energising Quality

VCS Quality Services Pvt Ltd

STANDARD SPECIFICATION
FOR
CABLE INSTALLATION

VCS – SS – EL - 4024

02	09.03.2022	SP	RD	AA	HK
01	16.10.2019	MG	VV	AD	SK
00	05.07.2017	MG	RD	AD	SK
Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By

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REVISION RECORD

Rev.	Revision Date	Prepared by	Checked by	Approved by	Authorized by	Revision Description
00	05.07.2017	MG	RD	AD	SK	Issued for use as Standard
01	16.10.2019	MG	VV	AD	SK	New revision system updated
02	09.03.2022	SP	RD	AA	HK	New revision system updated

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ABBREVIATION

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

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1.0 SCOPE

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

2.0 REFERENCE DOCUMENTS

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

SP: 30 (BIS)	Special Publication - National Electrical Code.
IS:1255	Code of practice for installation and maintenance-of power cables up to and including 33 KV rating.
IS:10810	Method of Test for cables; Part 43 Insulation resistance. (Part 43)
IS:10810	Method of Test for cables; Part 45 High voltage test. (Part45)
OISD 147	Inspection and safe practice during electrical installation
OISD I 73	Fire prevention and protection system for electrical installation

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

a. Indian Electricity Act and Rules.

b. Regulations laid down by CEA/Electrical Inspectorate.

c. Regulations laid down by CCE/DGMS/DGFASLI (as applicable).

d. The Petroleum rules (Ministry of Industry Government of India).

e. Any other regulations- laid down by central/state/local authorities and insurance agencies

3.0 DEFINITION

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

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

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4.0 DESIGN

4.1 MATERIAL SPECIFICATIONS

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

4.2 CABLE TRAYS

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

4.3 PRE-FABRICATED HOT DIPPED GALVANISED TRAYS

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

4.4 SITE FABRICATED ANGLE IRON TRAYS

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

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

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

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

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

4.5 CABLE GLANDS

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

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

4.6 CONNECTORS

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

4.7 FERRULES

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

5.0 INSTALLATION

5.1 CABLE LAYING (GENERAL)

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

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

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

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

5.1.5 The Telephone, Communication and Fire alarm cables shall run on instrument trays/ducts/ trenches in the units. Wherever these are not available, cables shall be taken in, a separate trench/tray with a min spacing of 600mmfrom power, and control cables but in any case, such separation shall not be less than300mm.

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

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5.1.7 The lengths indicated in the cables schedule are only approximate. The contractor shall ascertain the exact length of cable for a particular feeder by measuring at site. All cable routes shall be carefully measured. Before the start of cable laying, the contractor shall prepare cable drum schedule and get that approved by Engineer-in-charge to minimize/avoid straight through joints and then the cables cut to the required lengths, leaving sufficient lengths for the terminations of the cable at both ends. The various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. Extra loop length shall begiven for feeder cables where required as per the directions of Engineer-in-charge to meet contingencies.

5.1.8 Cables shall be laid in directly buried trench or in RCC trench (underground trench) or in cable tray along pipe sleepers or in overhead trays as shown on cable layout drawings.

5.1.9 Overhead trays shall be installed 2700-mm (minimum) above grade level. At road crossings overhead trays shall be installed at 7000mm(minimum) above grade level or cables shall be routed cable tray culvert/ Electrical Road crossings as per layout drawings. Sufficient care shall be taken while laying cables to avoid formation of twist, sharp bend etc. in order to avoid mechanical injuries to cables. Rollers shall be used for pulling of cables.

5.1.10 Cable installation shall provide minimum cable bending radii as recommended by cable manufacturer.

5.1.11 Cables shall be neatly arranged in the trenches / trays in such a manner that crisscrossing is avoided and final take off to the motor / switchgear is facilitated. Arrangement of cables within the trenches / trays shall be in line with cable layout drawings. Cable routing between cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. Pipe sleeves shall be laid at an angle of maximum 45 to the trench wall. Bending radii of pipes shall not be less than 8D. It is to be ensured that both the ends of GI, pipe sleeves shall be sealed with approved weather proof sealing plastic compound after cabling. In places where it is not possible, cables shall be laid in smaller branch trenches.

5.1.12 All cables shall be identified close to their termination point by cable tag numbers as per cable schedule. Cable tag numbers shall be punched on aluminum straps (2mm thick, 20 mm wide and of enough length) securely fastened to the cable-and wrapped around it.

5.1.13 Each underground cable shall be provided with cable tags of lead securely fastened every 30 m of its underground length with at least one tag at each end before the cable enters/leaves the ground. In unpaved areas, cable trenches shall be identified by means of cable markers as per installation drawing. These cable markers shall be placed at location of changes in the direction of cables and at intervals of not more than 30 m and also at cable straight through, joint locations.

5.1.14 All temporary ends of cables must be protected against dirt and moisture to prevent, damage to the insulation. For this purpose, ends of cables shall be taped with an approved PVC end cap or rubber insulating tape.

5.1.15 Each row of cables shall be laid in place and before covering with sand. All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/lined trench. Every cable shall be given an insulation

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

5.1.16 Where cables pass through, foundation walls, the necessary openings shall be provided in advance for the same by another agency. However, should it become necessary to cut holes in existing structures for example floor slab etc., the electrical contractor shall determine their location and obtain approval of the Engineer-in-charge before carrying out the same.

5.1.17 Cables for road crossings shall be taken through ERC (Electrical Road Crossing) as shown in the cable layout drawings.

5.1.18 At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends.

5.1.19 Wherever cable trench crosses storm water, waste water channel/drain, cables shall be taken through PVC/RCC pipes. Where cables are required to cross drains of depth more than 1200 mm, cables shall be taken over the drain on cable trays supported suitably using ISMC 150/200 sections.

5.1.20 Ends of cables leaving trench shall be coiled & capped and provided with protective cover till such time the final termination to the equipment is completed.

5.2 CABLES LAID DIRECT IN GROUND

5.2.1 Cables shall be laid underground in excavated cable trenches where specified in cable layout drawings. Trenches shall be of sufficient depth and width for accommodation of all cables. Cables shall be properly spaced and arranged with a view of heat dissipation and economy of design. Maximum number of cable layers in trench shall be preferably limited to 5 layers.

5.2.2 Minimum depth of cable trench shall be 750 mm for medium voltage and 900 mm for H.V. Cables. The depth and the width of the trench shall vary depending upon the number of layers of cables as per Installation Standard.

5.2.3 Cables shall be laid in buried trenches depth as shown in the cable layout drawings. It is to be insured by the contractor that the bottom of buried trenches shall be cleared of all rocks, stones and sharp objects before cables are placed. The trench bottom shall be filled with a layer of sand. This sand shall be leveled and cables laid over it. These cables shall be covered with 150 mm of sand on top of the largest diameter cable and sand shall be lightly compacted. A flat protective covering of75 mm thick second-class red bricks shall then be laid and the remainder of the trench shall then be back filled with soil, rammed and leveled.

5.3 CABLES LAID IN CONCRETE TRENCH

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

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5.3.2 All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water.

5.4 Above ground cables

5.4.1 Cables installed above grade shall run in cable trays, clamped on walls, ceiling or structures and shall be run parallel or at right angles to beams, walls or column. Cable routing shall be planned to be away from heat sources such as hot piping, gas, water, oil drainage piping, air conditioning duct etc. Each cable shall contain only one layer of cables as far as possible for power cables. However control may be laid in double layer in the cable trays.

5.4.2 Individual cable or small group of cables (up to 3 to 4 cables) which run along structures / walls etc. shall be clamped by means of 16 SWG GI saddles on 25 x 6 mm saddle bars. Alternatively small group of cables can be taken through 100/150 mm slotted channel tray / ISMC 100. Cables shall be supported so as to prevent sagging. In general, distance between supports shall be approximately 300mm for cables upto25 mm diameter and maximum 450 mm for cables largerthan25mm dia. To prevent the sagging of cables.

5.4.3 Cable laid on supporting angle in cable trenches structures, columns and vertical run of cable trays shall be suitably clamped by means G.I. saddles /clamps, whereas cables in horizontal run of cable trays shall be tied by means of nylon cords. Distance between supporting angles shall not exceed 600 mm.

5.4.4 All cable trays (other than galvanized trays) and supporting steel structures. shall be painted before laying of cables. The under surfaces shall be properly degreased, dedusted, descaled and cleaned. The painting shall be done with one coat of red oxide zinc chromate primer. Final painting shall be done with two coats of approved bituminous aluminum paint unless otherwise specified.

5.4.5 Where cables rise from trench to motor, lighting panel, control station, junction box etc., they shall be taken in GI pipe for mechanical protection up to a minimum of 300 mm above grade. Cable ends shall be carefully pulled through conduit to prevent damage to cable.

5.4.6 All G.I. Pipes shall be laid as per layout drawings and site conditions. Before fabrication of various profiles of pipes by hydraulically operated bending machine (which is to be arranged by the contractor) all the burrs from the pipes shall be removed. GI Pipes having bends shall be buried in soil / concrete in such a way that the bend shall be totally concealed. For G.I. pipes buried in soil, bitumen coating shall be applied on the buried lengths, Installation of G.I. pipes shall be undertaken well before paving is completed and necessary coordination with paving agency shall be the responsibility of Electrical Contractor.

5.4.7 Following guide shall be used for sizing of G.I. pipe.

a) 1 cable in a pipe -53% of pipe cross-sectional area occupied by cables.

b) 2 cables in a pipe -31% of pipe cross-sectional area occupied by cables.

c) 3 cables in a pipe - 43% of pipe cross-sectional area occupied by cables

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

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

5.5 TERMINATIONS

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

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

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

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

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

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

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

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

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5.5.9 The contractor shall bring to the notice of Engineer-in-charge any mismatch in cable glands, lugs provided with the equipment vis-a-vis to the cable size indicated in cable schedule for taking corrective action.

5.5.10 The cable joints in-power and control tables shall be avoided as far as possible. In case a joint is unavoidable, the following shall be insured:

a. The number of joints shall be restricted to minimum as far as possible,
b. The location of joints shall be identified with permanent markers.
c. No joints shall be allowed in hazardous areas without the approval of Engineer-in charge

5.5.11 The jointing and termination of medium voltage power cables shall be carried out by trained personnel only. Jointing wand termination of high voltage cables shall be done by skilled and experienced jointer duly approved by Engineer-in-charge. Only type tested termination kits of approved make shall be used.

5.5.12 No unauthorized repairs modifications shall be carried-out on the hazardous area equipment terminal boxes and junction boxes. Damaged enclosures of hazardous area equipment shall bring to the notice of Engineer-in-charge by Contractor. After termination is complete all the bolts, nuts, hardware of terminal box shall be properly placed in its position and tightened.

5.5.13 Where required, cable sealing boxes intended to be used with the apparatus shall be filled with solid setting type bituminous compound unless otherwise specified.

6.0 TESTING AND COMMISSIONING

6.1 Field testing and commissioning of electrical installation shall be carried out as per Standard Specification.

6.2 Before energizing the insulation resistance of every-circuit-shall-be measured from phase to phase, phase to neutral and from phase/neutral to earth.

6.3 Where splices or terminations are required in circuits rated above 650 volts, insulation resistance of each length of cable shall be measured before splicing and or /terminating. After completion of splices and /or terminations measurements shall be repeated.

6.4 The insulation resistance of directly buried cables shall be measured before cable trenches are backfilled. Measurements shall be repeated after back filling.

6.5 For cables up to 1.1 kV grade 1000VMegger and for H.V. Cables 2.5 kV / 5 kV Megger shall be used.

6.6 D.C. High Voltage test shall be conducted on cables given below after installation. .

6.7 All 1100 volts grade cables in which straight through joints have been made.

6.8 All cables above 1100 V grade.

6.9 The D.C. High Voltage test shall be performed as detailed below in the presence of the Engineer in charge or his authorized representative only,

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6.10 Cables shall be installed in final position with all the straight through joints complete. During the high voltage test, all other electrical equipment related to the cable installation, such as switches, instrument transformers, bus bars, etc., must be earthed and adequate clearance shall be maintained from the other equipment and framework to prevent flash over.

6.11 In each test, the metallic sheath/screen/armor shall be connected to earth.

6.12 All checks and tests shall be made as per Consultant standard test Performa available with site engineer.

6.13 All test readings shall be recorded and submitted to Consultant / Owner in triplicate sets.

6.14 Cable schedule, cable layout drawings, Interconnection drawings shall be marked by contractor for `AS BUILT STATUS' and two sets of copies shall be submitted to Consultant / Owner.

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Energising Quality

VCS Quality Services Pvt Ltd

STANDARD SPECIFICATION
FOR
EARTHING INSTALLATION

VCS – SS – EL - 4025

02	09.03.2022	SP	RD	AA	HK
01	16.10.2019	MG	VV	AD	SK
00	05.07.2017	MG	RD	AD	SK
Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By

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REVISION RECORD						
Rev.	Revision Date	Prepared by	Checked by	Approved by	Authorized by	Revision Description
00	05.07.2017	MG	RD	AD	SK	Issued for use as Standard
01	16.10.2019	MG	VV	AD	SK	New revision system updated
02	09.03.2022	SP	RD	AA	HK	New revision system updated

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ABBREVIATION

BIS/IS	Bureau of Indian standards
IEC	International Electro-Technical Commission
BS	British Standards
IEEE	Institute of Electrical and Electronics Engineers
NEMA	National Electrical Manufacturers Association
OISD	Oil Industries Safety Directorate
CCE	Chief Controller of Explosive
DGMS	Director General Mines Safety
IE Rules	Indian Electricity Rules
CPRI	Central Power Research Institute
GI	Galvanized Iron
MS	Mild Steel

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1.0 SCOPE

1.1 This specification defines the requirements for the supply of earthing and lightning protection materials and installation of the earthing and lightning protection systems.

2.0 REFERENCE DOCUMENTS

2.1 The work shall be carried out in the best workman like manner in conformity with this specification, consultant installation standards, layout drawings, the latest edition of relevant specifications, codes of practice of Bureau of Indian standards and OISD standards listed below:

SP: 30 (BIS):	Special Publication-National Electrical Code
IS: 2309:	Protection of buildings and allied structures against lightning.
IS: 3043:	Code of practice for earthing.
IS: 7689:	Guide for control of undesirable static electricity.
OISD 110:	Recommended practices on static electricity
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. Indian Electricity Act and Rules.
b. Regulations laid down by CEA/Electrical Inspectorate.
c. Regulations laid down by OISD/PESO (as applicable).
d. The petroleum rules (Ministry of Industry Government of India).
e. Any other regulations laid down by central/state/local authorities and Insurance agencies.

3.0 DEFINITIONS

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

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

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4.0 MATERIALS

4.1 MATERIAL SPECIFICATIONS

4.1.1 All materials and hardware's to be supplied by the contractor shall be new, unused and of best quality and shall conform to the specifications given here under and to latest Specifications of Bureau of Indian Standards. Contractor shall bring material samples to site and get it approved by engineer-in-charge before installation.

4.1.2 The main earth grid conductor shall be hot dip galvanized M.S. flat unless otherwise specified. Sizes for main conductors shall be as indicated on the earthing layout drawing. Amount of galvanizing shall be 610gm per sq. meter. Earth electrodes and Earth plate shall be as per job specification.

5.0 DESIGN

5.1 EARTHING NETWORK

5.1.1 This consists of main earth conductor (grid conductor) forming a closed ring network with required number of earth electrodes connected to it to provide a common earth for electrical devices and metallic structures. From each earth electrode two distinct connections shall be made to the main earth conductor. The earth plates shall be used for taking multiple earth connections to two or more equipment.

5.1.2 The earth conductor shall be laid along cable trays/cable trench/pipe racks as indicated on the earthing layout drawing. Where lined cable trenches are available, the earth conductor shall be laid in the trenches and shall be firmly cleated to the sidewall of concrete trenches using GI clamps at interval of 400 mm to 500 mm and near to the termination end. The earthing conductor shall run along one of the cable trays along a cable route. The earthing conductor shall be suitably cleated and electrically bonded to all the other cable trays on the same cable route at a regular interval of 25 to 30 meter. The earthing for equipment shall be tapped from the main earth conductor and not from cable tray support structure. Earth conductor when laid underground shall be at a depth of 500mm below finished grade level.

5.1.3 Joints and tapping's in the main earth loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below grade shall be welded and shall be suitably protected by giving two coats of bitumen and covering with hessian tape. Earth strip laid above ground shall be welded across straight through joints and joints shall be suitably protected by giving two coats of bitumen to avoid oxidation and insulation film formation of the strip surface. When two earth strips are to be joined by means of welding, lap welding with an overlapping of strip equivalent to double the width of the strip and all four sides shall be continuously welded. All joints at tapping's above ground shall be by means of connector/lugs. A minimum of two bolts of adequate size shall be used for this purpose. Earthing strip joints at earth plate and equipment shall be through GI bolts, nut etc.

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6.0 INSTALLATION

6.1 INSTALLATION OF EARTH ELECTRODE

6.1.1 Earth Electrode shall be installed as shown on installation standard and layout drawings. The location shown on the layout drawings are indicative.

6.1.2 The exact location of earth electrodes in the field shall be determined by contractor in consultation with the Engineer-in-charge, depending on the soil strata and resistivity. Earth electrodes shall be located avoiding interferences with road, building foundation, column, pipelines etc. The civil area drawings shall be referred for this. The distance between two electrodes shall not be less than twice the depth of electrode.

6.1.3 Electrodes shall preferably be located in a moist soil which has a fine texture, grain size and distribution. Wherever practicable the soil shall be dug up, all lumps broken and stones removed from the immediate vicinity of the electrodes and soil packed by watering and ramming as tight as possible.

6.1.4 The electrodes shall have a clean surface, not covered by paint, enamel, grease or other materials of poor conductivity.

6.1.5 All earth electrodes shall be tested for earth resistance by means of standard earth test meter. The tests shall take place in dry months, preferably after a protracted dry spell.

6.1.6 The disconnect facility shall be provided for the individual earth electrode to check its earth resistance periodically.

6.1.7 Location of earth electrodes shall be marked by permanent markers for easy identification. All earth Electrodes shall be serial numbered and also marked on `As Built' drawing for future reference.

6.1.8 Individual earth electrodes shall be provided for each lightning arrestor and flood light mast.

6.1.9 Earthing system provided for concrete paved area by other agency where applicable; shall be connected to the plant earthing system below ground by minimum two earth connections.

6.2 CONNECTION

6.2.1 The earth system connections shall generally cover the following:

a. Equipment earthing for personnel safety
b. System neutral earthing
c. Static and lightning protection
d. System neutral
e. Current and potential transformer secondary neutral
f. Metallic non-current carrying parts of all electrical apparatus such as transformers, switchboards, bus ducts, motors, neutral earthing resistors, capacitors, UPS, battery charger panels, welding receptacles, power sockets, lighting/power panels, control stations, lighting fixtures etc.

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g. Steel structures/columns, rail loading platforms etc.
h. Cable trays and racks, lighting mast and poles
i. Storage tanks, spheres, vessels, columns and all other process equipment.
j. Fence and Gate for electrical equipment (e.g., transformer, yard etc.)
k. Cable shields and armor.
l. Flexible earth provision for Wagon, Truck
m. Shield wire

6.2.2 Conductor size for branch connection to various equipment shall be as per consultant Installation Standards unless otherwise stated on earthing layout drawings.

6.2.3 All process pipelines shall be bonded and earthed at the entry and exist points of battery limit of hazardous area. Earth continuity conductors across pipe line flanges shall not be provided as per OISD 110.

6.2.4 Steel pipe racks in the process units and offsite area shall be earthed at every 24 meters.

6.2.5 Equipment / street light pole etc. located remote from main earth network may be earthed by means of individual earth electrode and earth conductor unless otherwise stated in Job Specifications.

6.2.6 Lightning protection shall be provided for the equipment, structures and buildings as shown on layout drawing. Self-conducting structures shall not require separate aerial rod and down conductors. These shall however be connected to the earthing system at two or more points as shown on layout drawing. An independent earthing network shall be provided for lightning protection and this shall be bonded at least at two points with the main earthing network below ground. Lightning down conductor shall be brought to earth electrode in shortest straight path as feasible to minimize surge impedance.

6.2.7 The main earthing network shall be used for earthing of equipment to protect against static electricity.

6.2.8 All medium and high voltage equipment (above 250V) shall be earthed by two separate and distinct connections with earth.

6.2.9 Plant instrument system clean earthing, UPS system clean/safety earth shall be separate from the electrical earthing system.

6.2.10 All paint, scale and enamel shall be removed from the contact surface before the earthing connections are made.

6.2.11 All earthing connections for equipment earthing shall be preferably from the earth plate mounted above ground wherever provided.

6.2.12 Equipment foundation bolts shall not be used for earthing connection.

6.2.13 Earth connections shall be made through compression type cable lugs/by welded lugs.

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6.2.14 All hardware used for earthing installation shall be hot dip galvanized or zinc passivated. Spring washers shall be used for all earthing connections and all connections adequately locked against loosening.

6.2.15 Lighting fixtures and receptacles shall be earthed through the extra core provided in the lighting circuit/cable for this purpose.

6.2.16 The reinforcements of sub-station building and the sub-station floor shall be connected to main earth grid.

7.0 INPSPECTION AND TESTING

7.1.1 Field inspection, testing and commissioning of electrical installation shall be done as per specification no.00004-PL-EL-SP-21-R0.Earthing systems/connections shall be tested as follows:

7.1.2 Resistance of individual earth electrodes shall be measured after disconnecting it from the grid by using standard earth test meggar.

7.1.3 Earthing resistance of the grid shall be measured after connecting all the earth electrodes to the grid. The resistance value of an earth grid to the general mass of earth shall be as follows:

a. For the electrical system and equipment, a value that ensures the operation of the protection device in the electrical circuit but not in excess of 4 ohm. However, for generating stations and large sub-systems the value shall not be more than 1 ohm.
b. For lightning protection, the value of 5ohms as earth resistance shall be desirable, but in no case, it shall be more than 10 ohms.

7.1.4 The resistance to earth shall be measured typically at the following points.

a. At each electrical system earth or system neutral earth.
b. At each earth provided for structure lightning protections.
c. At each point on earthing system used to earth electrical equipment enclosures.
d. At one point on earthing system used to earth wiring system, enclosures, such as metal conduits and cable sheaths or armor.
e. At one point on fence enclosing electrical equipment.

7.1.5 All earthing layout drawing shall be marked by contractor for 'AS BUILT STATUS' and two sets of copies shall be submitted to consultant.

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Energising Quality

VCS Quality Services Pvt Ltd

STANDARD SPECIFICATION
FOR
LIGHTING INSTALLATION

VCS – SS – EL - 4026

02	09.03.2022	SP	RD	AA	HK
01	16.10.2019	MG	VV	AD	SK
00	05.07.2017	MG	RD	AD	SK
Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By

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

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REVISION RECORD						
Rev.	Revision Date	Prepared by	Checked by	Approved by	Authorized by	Revision Description
00	05.07.2017	MG	RD	AD	SK	Issued for use as Standard
01	16.10.2019	MG	VV	AD	SK	New revision system updated
02	09.03.2022	SP	RD	AA	HK	New revision system updated

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ABBREVIATION

BIS/IS	Bureau of Indian standards
IEC	International Electro-Technical Commission
BS	British Standards
IEEE	Institute of Electrical and Electronics Engineers
NEMA	National Electrical Manufacturers Association
OISD	Oil Industries Safety Directorate
CCE	Chief Controller of Explosive
DGMS	Director General Mines Safety
IE Rules	Indian Electricity Rules
CPRI	Central Power Research Institute
AC	Alternating Current
DC	Direct Current
CP	Cathodic Protection
SCADA	Supervisory Control And Data Acquisition
FRP	Fiber Reinforced Plastic
TPN	Triple Pole Neutral
MCB	Miniature Circuit Breaker
ELCB	Earth Leakage Circuit Breaker
MDB	Main Distribution Board
HPMV	High Pressure Mercury Vapor
HPSV	High Pressure Sodium Vapor
PVC	Poly Vinyl Chloride
GI	Galvanized Iron
HRC	High Rupturing Capacity
MS	Mild Steel
CFM	Cubic Flow Meter

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1.0 SCOPE

1.1 This specification defines the requirements for the supply of equipment; materials, installation, testing and commissioning of the lighting system (lighting fixtures, lighting power distribution, telephone wiring etc.).

2.0 REFERENCE DOCUMENTS

2.1 The work shall be carried out in the best workmanlike manner, in conformity with this specification, and the relevant specifications/codes of practice of the bureau of Indian standards.

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

a. Indian Electricity Act and Rules.
b. Regulations laid down by CEA/Electrical Inspectorate.
c. Regulations laid down by OISD/PESO (as applicable).
d. The petroleum rules (Ministry of Industry Government of India).
e. Any other regulations laid down by central/state/local authorities and Insurance agencies.

3.0 DEFINITION

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

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

4.0 FABRICATION (EQUIPMENT SPECIFICATION)

All materials, fittings and appliances to be supplied by the contractor shall be new, unused and of the best quality and shall conform to the specifications given hereunder. These shall be manufactured in accordance with the latest revision of the specifications of Bureau of Indian 'Standards/International Standards. In the absence of any specifications for a particular item contractor shall bring material samples along with proven track record to site and get the same, approved by Engineer-in-Charge/Owner before installation.

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4.1 Lighting and Power Panels

4.1.1 Lighting and power panels (general purpose panels for safe area) shall be made of 1.6mm thick sheet steel and shall be dust and vermin proof. All metal surfaces shall be cleaned free of rust, given a coat of red-oxide primer and finished with two coats of epoxy-based paint of shade 632 of IS 5. Panels shall be indoor/outdoor type as specified. Indoor type panels shall have IP42 degree of protection and shall be suitable for surface or flush mounting on wall surface as specified. Lighting and power panels located outdoor shall be IP55 weather protected and shall also preferably have integral canopy for additional weather protection. The canopy shall be made of 2mm thick galvanized sheet steel or FRP where these are separate from the equipment.

4.1.2 Lighting and Power panels shall have TPN incoming feeder and single phase outgoing feeders. Lighting circuit feeders shall be rated for 10 amps and power circuit feeders shall have current rating of 16Amps.In power panels for window Air conditioning units, power circuit feeder shall be rated for 20 amps. Panels shall be equipped with phase and neutral bus bars of required current carrying capacity. The outgoing feeders shall be provided with single pole miniature circuit breakers (MCBs) for safe areas and double pole MCBs for hazardous areas. The incomer shall be with MCB and ELCB unit unless otherwise specified. Miniature circuit breakers shall be mounted in such a way that the operating levers project outside the front Bakelite covers plates for ease of operation. A hinged door to cover the operating knobs shall be provided. In addition, a circuit diagrams indicating incomer details and outgoing details viz. Circuit number, circuit rating, and load connected and details of the load shall be pasted inside the panel. Also a laminated copy of the diagram shall be provided inside the panel in a suitably designed pocket. Two external earthing studs for connection to the plant earthing grid shall be provided on the panel. Further, the panel shall be provided with an earth bus bar with terminal studs for connection to the third core of each outgoing circuit. Each circuit phase and neutral shall be given ferrule numbers. Complete wiring inside the panel, shall be neatly bunched with PVC tape and button. Sufficient terminals shall be provided in the terminal block so as to ensure that not more than one wire (core) is connected to a terminal. The panel shall have knock out holes or removable gland plate for the entry of incoming and outgoing conduits or cables. The panels shall be complete with requisite number of cable glands as specified.

4.1.3 The Main distribution board (MDB) where used, shall be made of 2mm thick sheet steel panel, dust and vermin proof similar-in construction to Lighting and Power panels but with TPN MCB incoming and TPN outgoings (MCB with ELCB units and MCB without ELCB unit as applicable) of required numbers as specified.

4.1.4 All MCBs shall be of M9 category as per IS 8828 and sensitivity of ELCBs shall be 100 mA unless otherwise specified.

4.1.5 Wherever the size of incoming cable to lighting, power panels/MDB is more than 35 sq.mm a suitable cable adapter box shall be provided and attached .to the panel. The incoming cable leads shall be connected to terminal block (bolted type terminals) of required size. This terminal block shall be connected to TPN incomer unit through separate PVC insulated copper conductor wires/bus bars. Sufficient space shall be provided (200 to 250mm) between gland plate and the bottom of terminal block for easy termination.

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4.2 Lighting fixtures

The types, Makes and catalogue numbers of various types of lighting fixtures shall be as given in Fixture schedule job Data Sheet. HPMV/HPSV lighting fixtures shall be complete with ballast, starters and capacitor, as required. Control gears shall be integral or non-integral as specified in lighting layout drawings. Unless-otherwise specified all fixtures shall be supplied complete with lamps. Ballast for fixture shall be copper wound or electronic type. The fixtures shall be of high power factor type i.e. at least 0.9 or more.

4.3 Switches

Switches, manufactured in accordance with IS: 13947 shall be used for non-hazardous areas. Switches in areas where concealed wiring has been adopted, shall he flush mounting piano type unless otherwise specified. For surface conduit wiring, piano type switches in surface mounted box shall be provided. Industrial Type switches (Weather protected) shall be used for outdoor areas.

4.4 Receptacles

Three pin type 5A/15A receptacles manufactured in accordance with IS:1293 shall be used for non-hazardous areas. The receptacles and the controlling ON/OFF switch shall be mounted in the same enclosure box but these shall be in separate units to facilitate replacement by parts. Flush mounting type receptacles shall be used in areas where concealed wiring has been adopted and surface type shall be used in other areas. For exhaust fans and wall mounted air circulators, socket and switch enclosures shall be separate. In buildings such as sub-station, D.G. shed, Workshop, maintenance shop etc. industrial type metal clad socket outlets and plugs shall be provided. These sockets shall be supplied complete with plugs.

4.5 Outlet Boxes

The outlet boxes used as point outlets shall be prefabricated type 65mm deep junction boxes. Outlet boxes custom fabricated for sockets, switches, fixtures and fan regulators etc. shall be made of M.S. Sheet having minimum thickness of 1.6mm. Outlet boxes shall be galvanized after fabrication. These shall be complete with terminal block suitable for connection of wires up to 4 sq. mm Front cover plate shall be of 3mm thick backelite/PE sheet. The color shall suit the shade of the walls or shall be white if the shade of the walls is not finalized. The sheet shall extend at least 2 cm on all sides of outlet box. Cover plate shall be fixed by cadmium plated brass screws and cup washers. Outlet boxes shall be provided with adequate number of knock outs on all the sides for ease of wiring either with conduits or without conduits.

4.6 Conduit and Accessories

Conduits for Electrical installations shall conform to IS:9537. The type of conduit (steel/GI/PVC) shall be as specified on drawing. Black enameled-steel or GI conduit shall be of 1.6mm thick and the minimum wall thickness of PVC conduit shall be 1.6mm. Generally, PVC conduits shall be used in concealed wiring and for surface wiring GI conduit (in plant buildings) and black enameled steel conduit (in-non plant buildings) shall be used.

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4.7 Lighting Poles

Lighting poles shall be fabricated from ERW steel tubular pipes of specified section, with joints, swaged together when hot and beveled on outside edges. Poles shall be coated with bituminous preservative solution on the ground portion of the outside surface. Remainder of the outside surface shall be given one coat of red oxide primer and finished with two coats of aluminum paint. The pole shall have, a marshalling, box near the bottom to contain HRC fuses, a neutral link earth stud and terminal block.

4.8 Lighting HIGH Mast

Lighting HIGH masts (Lattice tower) where used. They shall be complete with 2 nos. MS flats provided at the base plate for connection to the plant earthing grid. A ladder, platform, handrail, a weather protected TPN switch (at 1500mm from ground-level) and ;a weather protected distribution board fabricated out of sheet steel shall be provided at the top of mast. The TPN Switch and the distribution board shall also have a canopy for additional weather protection. The TPN switch shall be suitable for looping one more lighting high mast from the same incoming, power supply. The distribution board shall have TP & N bus bars of 30 Amps. rating and 12 Nos. outgoing circuits each with a 6A single pole MCB. The distribution board shall have cable entries from bottom. Necessary space provision and suitable mounting arrangement shall be made on top of the tower for mounting of ballast (choke) and condensers for all the circuits and the lighting fixtures. The high masts shall GI coated or painted one coat of red oxide primer and two coats of aluminum paint. Distribution board shall he fabricated out of 2mm thick sheet steel and shall be painted with two coats of enamel over a basecoat of red oxide.

Unless otherwise specified the flood lighting high masts shall be telescopic type.

4.9 Wires

Wires shall be PVC insulated and shall be of 660 Volts grade as per IS694. Conductor shall be of stranded copper and size shall be minimum1.5 Sq. mm for lighting, 2.5 Sq. mm for 15A power socket circuits and 4 sq. mm for split A/C power socket circuits. Red/Yellow/blue wires for phases, black wire for neutral and green wire for earth shall be used (size of earth wire shall be same as for phase and neutral size). Wire size for air conditioning circuit feeders shall be as indicated in the panel schedule.

4.10 Ceiling Fan/Exhaust Fan

Ceiling fans shall be of 1200mm sweep unless otherwise specified with double ball bearing and regulator. The suspension down rod shall be sturdy mild steel rod of adequate diameter and of minimum length of 300mm with shakles suspension arrangement as per IS. For exhaust fans, the sweep dia. and air CFM shall be as specified in job specification. Exhaust fans for battery room shall be with anticorrosive blades suitable for use in acidic fumes.

4.11 Decorative switches and sockets

Decorative lighting switches and sockets where specified, shall be modular in design. All these items shall fit into the same frame with overall standard dimensions. Frames shall be suitable for surface and flush mounting in brick / concrete wall. The frames shall be

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suitable for conduit entry from all the sides. Switches and sockets shall match colors of the frame and cover plates to obtain a combination which shall match decor of the interiors of Control Room, Administrative buildings, offices rooms etc.

5.0 INSTALLATION

Lighting system installation shall be as per follows.

5.1 General

5.1.1 The lighting fixtures in the plant shall be fed from lighting panel. All outdoor lighting shall be group controlled manually or through synchronous timer or photocell. Lighting wiring between panel and lighting fixtures shall be done with PVC insulated 3core (phase, neutral and earth) copper conductor armored cable for hazardous areas. Wiring in the building shall be done by means of 3core copper, conductor. PVC insulated, un-armored cables, or PVC insulated copper conductor wires in conduit/Metsec channel as specified. All joints of conductors in Switch boards/JBs Fittings shall be made only by means of approved mechanical connectors (nylon/PVC connectors). Bare twisted joints shall not be permitted anywhere in the wiring system.

5.1.2 The lighting layouts furnished by Owner will indicate approximate locations of lighting fixtures. The electrical contractor shall determine, with approval of Engineer-in-Charge, The exact location of each fixture in order to avoid interference with the piping or other mechanical equipment and also with a view to obtain as much uniform illumination as practicable, and to avoid objectionable shadows. Conduits shall be laid out by the contractor to suit field conditions and as per directions of the Engineer-in-Charge.

5.1.3 On walkways, platforms and other outdoor area, lighting fixtures shall be located nearer to landing of stairs or ladders, gauges, flow meters, panel boards and other equipment to provide proper illumination.

5.1.4 The minimum height of any lighting fixture shall be preferably not less than 2.5 meters above the floor level.

5.1.5 All outdoor cable terminations to outdoor junction boxes, panels, socket outlets etc. shall be through bottom or from side. Top entries for cables shall be avoided to avoid water entry. All cable glands for outdoor terminations shall be double compression type and the gland shall be covered with PVC or rubber boot shroud. All unused cable entries shall be plugged with suitable blanking plugs.

5.1.6 Mounting height of equipment shall be as under: -

a.	Top of Switch Box	1200 mm from FFL(Finished floor level)
b.	Top of Lighting/Power Panel	1800mm from FFL
c.	5/15 Amp. Receptacle	300mm from FFL unless otherwise specified (1200 mm for process areas and industrial sheds)
d.	Lighting fixture	As indicated in layout drawing
e.	Exhaust fan	in the cutout provided / as indicated in Layout drawings.

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5.1.7 Fixtures shall be firmly supported from the structures. Support (clamps etc. may be bolted or welded to the existing steel work or metal inserts. In case of concrete, structures, where metal inserts are not available, fixtures shall be suspended from concrete surfaces with the help of anchor fasteners. In such cases special care shall be taken to see that anchoring is firm. In places where ceiling fans are provided, lighting fixtures shall be suspended below the level of fan to avoid shadow effect.

5.1.8 Circuit cables in a group shall be cleated to structure by using galvanized strip clamps or cable run in cable trays wherever trays are available. Spacers and cleats shall be of required size to accommodate the cables. All hardware shall be galvanized or zinc passivated. Underground lighting cables (in paved areas), shall be taken in suitable G I sleeves buried at a minimum depth of 300 mm from FFL. GI pipe sleeves shall be extended to 300mm above. FFL Exact termination/layout of pipes (for protection of cables) shall be decided at site as per site convenience in consultation with Engineer-in charge.

5.1.9 Wiring for all outlet sockets shall be done with 3 cores of equal sizes for, phase, neutral and earth. The terminals of switch sockets shall be suitable to receive the size of wire specified.

5.1.10 All lighting fixtures shall be provided with terminal block with required terminals suitable for connection of wire up to 2.5 sq mm copper conductor.

5.1.11 The cable shall be straightened after unwinding it from the drum. All cables be clamped/laid in straight run without any sag and link.

5.1.12 For location where fan points are shown, fan hooks with junction box during concreting.

5.1.13 Where fan hooks and JB's are provided separately JB shall be located within a distance of 300mm from hook for mounting of ceiling rose.

5.1.14 Industrial type plug sockets with 20A MCB or rating as per job specification shall be provided at a height of 500mm from FFL for window AC units.

5.1.15 Socket outlets and plugs for installation in Substation building, DG shed, workshop, and maintenance shop etc. shall be of industrial metal clad type.

5.1.16 Wiring for exhaust fans shall be terminated in receptacles as specified in layout drawing and the connection from receptacle to the exhaust fan shall be by means of a flexible cord equivalent in size to the main run of wires. Switch for exhaust fan shall be located in a separate switch board along with other switches.

5.2 Conduit System

5.2.1 Surface or concealed conduit system of wiring shall be adopted, as specified in the drawings. Required number of pull boxes shall be used at intervals to facilitate easy drawing of wires. Separate conduit shall be run for lighting and power circuits. Further, conduits for Normal lighting/Emergency lighting/DC critical lighting shall be separate. Conduit layout shall be decided at site as per site conditions. Drop conduits for switch boards shall be decided by contractor as per wall locations shown in Architectural drawings. All exposed run of conduits on surface, shall be vertical or horizontal.

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5.2.2 Only threaded type conduit fittings shall be used for metallic conduit system. Pin grip type or clamp type fittings are not acceptable. Conduit ends shall be free from sharp edges or burrs. The ends of all conduits shall be reamed and neatly bushed.

5.2.3 Conduit shall be of minimum 25mm dia. Maximum number of wires permissible in a conduit shall be seven/nine for wire size of 2.5 sq mm/1.5 sq mm. respectively.

5.2.4 The exposed outer surface of the conduit pipes, including all accessories forming part of the conduit system, shall be adequately protected against rusting. In all cases, bare threaded portion of conduit pipe shall not be exposed unless such bare threaded portion is treated with anti-corrosive preservative or covered with approved plastic compound.

5.2.5 Conduit connection to outlet boxes shall be by means of screwed hubs or check nuts on either side. Where concealed wiring is done, junction boxes (65mm deep) shall be used so as to rest on shuttering properly. Conduits shall be laid above reinforcement. All conduit connections shall be properly screwed and Junction box covers shall be properly fitted so as to avoid entry of concrete slurry.

5.2.6 Conduit pipes shall be fixed by I.6mm thick G.I. saddles on 3mm thick G.I. saddle bars of required width in an approved manner at intervals of not more than 50cms for straight run. At places near junction boxes, bends, or similar fittings, saddle and bars shall be provided on either side.

5.2.7 Where concealed wiring is to be adopted, conduits shall be laid in time before concreting of the slab. Pull wire (GI or steel) shall be provided inside conduit .for the ease of wire pulling. The contractor shall coordinate his work with other agencies involved in the civil works in, such a way, that the work of the other agencies is not hampered or delayed. Vertical conduit runs shall be made in wall before plate ring is done so as to avoid chasing. Where chases are made for conduit run contractor shall fill these chases or any other openings made by them after completing the work and patch the surface. During installation, care shall be taken to see that proper covers are provided to prevent rusting of conduits. Locations of all point outlets, junction boxes shall be marked with brick powder or sand so that these are easily identified after shuttering removal. As built conduit layout drawing shall be submitted by contractor after completion of the work.

5.2.8 All junction boxes, bends and other accessories shall be of the same material as that of conduit and shall have the same protective coatings.

5.2.9 After erection, the entire conduit system shall be tested, for mechanical and electrical continuity and shall be permanently connected to earth by means of approved type of earthing clamps.

5.3 Hazardous Area Installation

5.3.1 Wiring in hazardous area shall be done by using minimum 2.5mm copper conductor armored cable. Circuit wiring feeding hazardous areas shall be controlled by two pole switches/MCBs (for phase as well as neutral isolation).

5.3.2 Correct type of lighting equipment (fixtures and JBs) with regard to hazardous protection as specified in the drawing shall be installed for the areas classified as Zone 1, Zone 2 etc.

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5.3.3 The terminations in the junction boxes and the lighting fittings shall be done avoiding possibility of loose connections due to vibrations. After the terminations are made the cover of the junction boxes and the lighting fittings shall be closed properly with all bolts and hard wares in correct position, retaining its explosion and weather protections. In fixtures having double cable entries, both the entries shall be used for looping in and looping out connection, thus minimizing the use of separate junction box wherever separate control gear boxes (C.G. box) are provided looping in and looping out, connections shall be through CG-box, thus avoiding the use of an additional junction box. All unused cable entries shall be sealed with suitable plugs.

5.3.4 Circuit cables shall be firmly cleated in a group along, columns/ beam/ladders/side channels/platform using 1.6 mm thick GI saddles on, 25x3 mm GI saddle bar at intervals of 400mm to 500mm for straight run and on either side close to bending and at both termination ends as per the direction of Engineer-in-charge. Where required 3 or more of cables may be taken in slotted channel tray after getting the approval of Engineer-in-charge. Cables shall not be routed along hand rails.

5.3.5 Where fire proofing column/structures are encountered, all cabling shall be taken in GI pipes of required size and both ends shall be sealed, well before fire proofing is done. Similarly, equipment such as lighting fixture, control gear box, lighting/ power panels, field call stations, junction-boxes etc. shall be installed on suitable steel mounting frame/distance bracket, thereby direct contact with the concrete used for fire proofing.

5.3.6 Cable glands for terminating cable on flameproof equipment shall be of double compression FLP type. Any material/equipment specified to be supplied by contractor for installation in hazardous areas, shall be tested by CMRI and duly approved by C.C.E. Nagpur or DGMS Dhanbad or any other applicable statutory authority. All indigenous FLP equipment shall also have valid BIS license as required by statutory authorities.

5.4 Building Lighting

5.4.1 The type of wiring system shall comprise surface/concealed conduit system or cable wiring as specified on layout drawings.

5.4.2 Mounting details of fixtures shall be indicated on the drawings. If specified on the drawings, a group of fluorescent lighting fixtures which are to be mounted end to end shall be fixed to mild steel cold Tolled sections of 50mm x 50mm and of 1.2mm thick (Metsec channel). The entire assembly shall be fixed to the ceiling with necessary number of supports which may be by means of steel conduit or chromium plated chain link as required. The 'Metsec' Channel shall run continuous in suitable sections from one end to other end of wall. The complete channel shall be spray painted, with approved color as per the directions of Engineer-in-Charge. All wires inside channel shall be neatly bunched by nylon tape & buttons.

5.4.3 Wiring in areas above false ceiling shall be done in Surface Conduit (25mm die GI conduit) suitably clamped to the true ceiling. Vertical drops from true ceiling for panels, switches, receptacles etc. shall be taken in 25mm die PVC conduit concealed in walls up to switchboards/panels. Lighting fixtures shall be supported from true ceiling. Exact location of fixtures shall be finalized in co-ordination with air-conditioning duct-diffuser layout, panels layout and false ceiling grid layout. To facilitate easy maintenance Looping

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back system' of wiring shall be followed throughout. Accordingly supply tapping's and other interconnections including for earthing are made only at fixture connector blocks or at switch boards. Required number of junction boxes shall be used at intervals for wire pulling and inspection.

5.4.4 All wires in conduit shall be color coded as specified. Each circuit shall have independent phase neutral and earth wire. However when group of circuits are run in a single conduit the earth wire can be common.

5.4.5 Building conduit lighting system of wiring where measurement is done on point wiring basis generally consists of two parts. The first part is the circuit wiring which includes the work necessary from lighting panel up to switch box and from switch box to another switch box. The second part is the point wiring which shall include the work necessary from tapping point in the switch box up to various fixtures or fan outlets/ceiling roses.

5.4.6 In no case, two different sources or two different phases of supply shall be combined in one switchboard.

5.4.7 Switches for light fixtures/exhaust fans in battery room shall be provided outside the Battery room.

5.4.8 Lighting layouts for non-plant buildings (such house, cement go down, gate house, workshop, service building, rest room, etc.) shall be prepared by installation contractor.

5.4.9 The following basic data/document for layouts will be provided to the contractor.

f. Architectural drawings
g. Illumination level required
h. Type of lighting fixture
i. Type of wiring (concealed/surface conduit/cable wiring etc.)

5.4.10 Based on the above input, contractor shall prepare and submit lighting layout drawings, panel schedules, conduit layout drawings for concealed wiring, design calculations wherever required, for review by purchaser before erection work is started. The lighting layout drawing shall show the location, type and mounting details of lighting fixtures, receptacles, junction boxes, layout of circuit indicating number of wires etc. The number of points in a circuit shall not exceed ten and the load in each circuit shall be less than 1000 Watts.

5.4.11 The panel schedule shall include rating of incoming and outgoing feeders, number of outlets, load for each outgoing circuit, etc.

5.4.12 All drawings shall be prepared preferably in AO and Al size. Panel schedules shall be in A4 size drawings (Final submission of drawings shall be in soft copies and in bound volumes together with one transparency of each document).

5.5 Street Lighting

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5.5.1 Street lighting poles to be located on road side shall be installed at a minimum distance of 300mm from the edge of the walkway of the road (road berm). Size of wires from marshalling box up to fixture shall be 1.5mm2/2.5mm2, copper conductor PVC insulated.

5.5.2 Each pole shall be earthed at two points by connecting to the plant earth grid as shown on Installation standards.

5.5.3 Street lighting fixture shall be mounted on steel tubular poles as per standard drawings. The foundation for the street lighting poles will be made by electrical contractor Street lighting poles shall be supplied with a base plate.

5.5.4 The poles shall be numbered as per the drawings/ directions of Engineer-in-charge.

5.6 HIGH Mast Lighting

5.6.1 The lattice structure high masts shall be installed on concrete foundations with the base plate bolted on to the anchor bolts. The lattice structure shall be GI coated or painted with a coat of primer and two coats of aluminum paint, the second coat to be given just before handing over to the owner. The high masts shall be numbered as per drawings. The high masts shall be connected to the plant earth grid at two points.

5.6.2 The main feeder up to the distribution board of lighting high Mast shall be through PVC insulated armored cable of size as specified in the respective drawing. Wiring from Distribution Board to each flood-light fixture shall be by means of a 3core 2.5sqmm, copper conductor PVC insulated armored cable. All the cables shall be neatly clamped to the structure at intervals not exceeding 25 cms.

5.6.3 Exact orientation of flood lighting fixtures shall be decided at site to achieve optimum utility of these fixtures.

5.7 Telephone Wiring

5.7.1 Conduits for telephone wiring in buildings shall be of 1.6mm thickness. 25mm dia black enameled steel conduit/PVC as per IS 9537, installed on wall surface or concealed or as specified in job specification.

5.7.2 Conduit installation system shall comply to the requirements given in conduit system. Required number of pull boxes shall be provided at interval for easy drawing of wires. The telephone wiring shall be done with 0.63mmdiaannealed copper conductor PVC insulated 660V grade, twin flat wire, unless otherwise specified in Job Specification. One telephone socket outlet shall be provided for connection to telephone instrument.

6.0 INSPECTION &TESTING

6.1 Lighting installation shall be tested and commissioned by installation contractor as per Specifications. Pre commissioning checks and tests shall include but not be limited to the following:

6.1.1 The insulation resistance of each circuit without the lamps (load) being in place shall be measured and it should not be less than 500,000 ohms. (Between phases, phases to neutral, phase/neutral to earth).

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6.1.2 Current and voltage of all the phases shall be measured at the lighting panel bus bars with all the circuits switched on with lamps. If require load shall be balanced on the three phases.

6.1.3 The earth continuity for all socket outlets shall be checked. A fixed relative position of the phase and neutral connections inside the socket shall be established for all sockets.

6.1.4 After inserting all the lamps and switching on all the circuits, minimum and maximum illumination level shall be measured in the area and recorded.

6.1.5 It shall be ensured that switch provided for ON/OFF control of point (light/fan/socket) is only on LIVE side.

6.1.6 Operation of ELCB's shall be checked

6.2 Contractor shall duly fill in all the above test results and submit the test reports to Engineer-in-Charge in triplicate.

6.3 All lighting layout drawings shall be marked by contractor for `AS BUILT STATUS' and two sets of copies shall be submitted to the consultant.

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STANDARD SPECIFICATION

FOR

FIELD INSPECTION, TESTING AND COMMISSIONING OF ELECTRICAL INSTALLATION

VCS – SS – EL - 4027

02	09.03.2022	SP	RD	AA	HK
01	16.10.2019	MG	VV	AD	SK
00	05.07.2017	MG	RD	AD	SK
Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By

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REVISION RECORD

Rev.	Revision Date	Prepared by	Checked by	Approved by	Authorized by	Revision Description
00	05.07.2017	MG	RD	AD	SK	Issued for use as Standard
01	16.10.2019	MG	VV	AD	SK	New revision system updated
02	09.03.2022	SP	RD	AA	HK	New revision system updated

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ABBREVIATION

CEA	Central Electricity Authority
CCE	Chief Controller of Explosive
DC	Direct Current
DGMS	Director General Mines & Safe
GI	Galvanised Iron
OISD	Oil Industries Safety Directorate
AFC	Approved For Construction
DCS	Distributed Control System
ECS	Emergency Control System
HV	High Voltage
MV	Medium Voltage

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1.0 SCOPE

1.1 This Specification covers the requirements for the field inspection, testing and commissioning of electrical equipment and installation, forming part of electrical power distribution and utilization system.

2.0 REFERENCE DOCUMENTS

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-7816	Guide for testing Insulation resistance of rotating machines.
IS 1255	Code of practice for installation and maintenance of power cables up to & including 33 kV rating.
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.
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. Indian Electricity Act and Rules.

b. Regulations laid down by CEA / Electrical Inspectorate.

c. Regulations laid down by Tariff Advisory Committee/Loss prevention council.

d. Regulations laid down by OISD/PESO (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 DEFINITIONS

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

OWNER / COMPANY	OWNER of the particular Project (Project Specific).
CONSULTANT	The party which is doing engineering, procurement, construction, pre-commissioning and assistance for commissioning, monitors and controls the overall project management.

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BIDDER / SUPPLIER / VENDOR	The party(s) which manufactures and / or supplies material, equipment, technical documents / drawings and services to perform the duties specified by Contractor.

4.0 FIELD INSPECTION, TESTING AND COMMISSIONING

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

4.2 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.

4.3 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.

4.4 Visual inspection for soundness of bus bar connections of bus ducts, terminal connections of equipment/motor shall be carried out. It shall be ensured that no foreign materials are present inside bus duct 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.

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

a. Continuity test for each winding and power and control circuits.

b. Insulation test for each winding and power and control circuit

c. High voltage test for cables

d. Dielectric strength test on transformer oil.

e. Checking the correctness of wiring schemes, control circuit interlocks for intended functioning.

f. Verification of phase sequence.

g. Testing of all types of relays/releases for required operation. Testing of measuring instruments for proper functioning Earth continuity test for all circuits.

h. Checking of safety features for correctness of operation etc.

i. Checking of all wired interface contacts (analog, digital input/output contacts) for, DCS and ECS interface, at panel and equipment terminal chambers as applicable.

j. (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)

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k. Earth resistance measurement for each earth electrode, and the earthing system as a whole.

l. Lighting installation shall be tested for correct illumination levels, with the fittings installed. Fittings shall be operated only with specified type of a lamp or tube.

4.6 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 circuits.

4.7 Plant Communication, Fire alarm, telephone and security system shall be checked for correct operation and intended function.

4.8 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.

4.9 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.

4.10 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 Consultant /Owner's representatives

4.11 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 calibration records.

4.12 The Insulation Resistance test values for various electrical equipment shall be as below.

4.12.1 Cables

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

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Rated voltage of the Cable	DC Test Voltage in Volts	Minimum Insulation resistance in Mega ohms
Lighting and power circuit Wiring	250	1
650/1100 V grade cables	1000	1
1,900/3, 300V grade cables	1000	200
3,800/6,600V grade cables	1000	200
6,350/11,000V grade cables	5000	200
8,700/115,000V grade cables	5000	200
12,700/22 000V grade cables	5000	200
19,000/33000V grade cables	5000	200

4.12.2 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
3,300	1,000	200
415V	1,000	100
240V	500	10
110V	500	10

4.12.3 Generators and motors

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	Minimum Insulation resistance in Mega 40 °C
11,000V	5,000	120
6,600V	1,000	80
3,300V	1,000	50
415V	1,000	15
240V	500	12

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4.12.4 Transformers

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

Rated Voltage of the Transformer	DC Test Volt 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

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.

4.12.5 High-voltage testing

D.C. high voltage test shall be conducted asper following table on all H. V. 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)
Uo / U*	Conductor and Metallic eath/ 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

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* Uo: 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.

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.

Before energizing any equipment, 'COMMISSIONING CLEARANCE FORM' as per standard format shall be, duly filed in by contractor and submitted to Consultant / Owner.

It shall be ensured that the electrical inspectorate approval is available before energizing the equipment.

5.0 RECORDS

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

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STANDARD SPECIFICATION
FOR
MOTOR CONTROL CENTRES (MCC)

VCS – SS – EL - 4029

02	09.03.2022	SP	RD	AA	HK
01	16.10.2019	MG	VV	AD	SK
00	05.07.2017	MG	RD	AD	SK
Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By

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REVISION RECORD

Rev.	Revision Date	Prepared by	Checked by	Approved by	Authorized by	Revision Description
00	05.07.2017	MG	RD	AD	SK	Issued for use as Standard
01	16.10.2019	MG	VV	AD	SK	New revision system updated
02	09.03.2022	SP	RD	AA	HK	New revision system updated

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ABBREVIATION

BIS/IS	Bureau of Indian standards
IEC	International Electro-Technical Commission
BS	British Standards
IEEE	Institute of Electrical and Electronics Engineers
PVC	Poly Vinyl Chloride
AC	Alternating Current
DC	Direct Current
MCC	Motor Control Centre
ATS	Auto Transfer Scheme
CPRI	Central Power Research Institute
MCCB	Moulded Case Circuit Breaker
MPCB	Motor Protection Circuit Breaker
HRC	High Rupturing Capacity
TPN	Three pole neutral
CT	Current Transformer
LED	Light Emitting Diode
BMR	Bi Metallic Relay
DCS	Distributed Control System

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1.0 SCOPE

1.1 These Specifications cover design, manufacture, testing and supply of Motor Control Centers for voltages up to 1000 volts.

2.0 REFERENCE DOCUMENTS

2.1 All materials, equipment's and accessories used in the manufacture shall conform to the latest editions of relevant Indian Standards including amendments and addenda, some of which are listed below:

IS 694	PVC insulated cables for working voltages up to and including 1100 V.
IS 722	A. C. Electric Meters
IS 1248	Direct Acting Indicating analogue Electrical measuring Instruments &their accessories.
IS 2147	Degree of Protection provided by enclosures for low voltage switchgear and control gear.
IS 2705	Current Transformers.
IS 3156	Voltage Transformers.
IS 3231	Electrical Relays for Power System Protection
IS 5578	Guide for marking of insulated conductors
IS 8623	Low Voltage Switchgear and control gear assemblies
IS 10118	Code of Practice for selection, installation & maintenance of switchgear & control gear.
IS 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals
IS 13703	Low voltage fuses for voltages not exceeding 1000V AC or 1500 VDC
IS 13947 (Part – 1):	Low Voltage Switchgear and control gear - General Rules
IS 13947 (Part – 2)	Low Voltage Switchgear and control gear - Circuit breaker
IS 13947 (Part – 3):	Low Voltage Switchgear and control gear - Switches, disconnectors, switch disconnectors and fuse combination units
IS 13947 (Part – 4)	Low Voltage Switchgear and control gear – Contactors & Motor starters
BS 60947 (Part 1 to 4):	Specification for low voltage switchgear

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2.2 In absence of specific Indian Standard Specifications, International Electro technical Committee Specification shall be followed.

2.3 The electrical arrangement of the motor control center, number of feeders, protection, metering, control, interlocking, inter tripping etc. shall be in accordance with the Single Line Diagram(s) and / or the Data Sheets.

3.0 DEFINITIONS

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

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

4.0 DESIGN

4.1 CLIMATIC CONDITIONS

Climatic conditions and other environmental conditions will be as specified in the Datasheets. It should be, however, noted in general that the switchgear shall be suitable for use in tropical climate with high humidity, heavy rainfall and / or climate conducive to fungus growth and corrosion. Design ambient temperature shall be assumed as 40 °C unless stated otherwise in the Data Sheets. All equipment's / components rating specified are for site conditions. Vendor shall apply suitable derating factor for the given site conditions to the rating of the equipment's /components offered. If dating is not required, Vendor shall declare so.

4.2 SYSTEM

4.2.1 The electrical system voltage, frequency, fault level and circuit current ratings shall be as stated in the Data Sheets.

4.2.2 Motor Control Centers shall be capable of operating continuously and without adverse effects or injurious overheating under all specified conditions of operation.

4.2.3 4.3 Motor Control Centers shall be capable of withstanding without damage or danger to operating personnel, fault currents equal to the system fault level.

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5.0 FABRICATION

5.1 Motor Control Centre (MCC) shall be sheet steel enclosed, dead front, fully compartmentalized as mentioned in the Data Sheets.

5.2 MCC shall be floor mounting, free standing, totally enclosed and dust, damp and vermin proof. Non-deteriorating gaskets to be used between all adjacent units and beneath all covers and doors for dust proofing.

5.3 For indoor location, MCC enclosure shall have minimum degree of protection - IP 52 (as per IS 2147) and for outdoor location; the MCC enclosure shall have minimum degree of protection - IP 55 (as per IS 2147).

5.4 All MCC panels shall be of same height. Panels shall be bolted together to form a continuous flush front switchboard suitable for front of board operation. All switch operating handles, meters shall be between 300mm to 1800mm from the bottom of base frame of MCC panel.

5.5 MCC shall be suitable for extension at both ends. Ends of busbars shall be drilled for extension.

5.6 MCC shall be fixed type or draw out type, as specified in the Data Sheets.

5.7 All circuit breaker feeders of the MCC shall be draw out type irrespective of whether MCC is fixed type or draw out type.

5.8 In case of draw out type MCC, all feeders, circuit breakers as well as switch fuse feeders shall be draw out type.

5.9 MCC shall be single or double front as specified in the Data Sheets.

5.10 Sheet steel used for fabrication shall be cold rolled, cold annealed. Minimum thickness of various members shall be as follows: -

Base frame / Channel / Gland plate: 3 mm

Load Bearing Members / Doors: 2 mm

Internal Partitions: 1.6 mm

Construction shall be rigid and robust. All steel work shall be flawless and have smooth finish. Stiffener shall be provided where required for sufficient rigidity.

5.11 Hinges provided for doors shall not be visible from front.

5.12 Instruments / relays, indicating lamps, etc. of MCC incomer shall be mounted in a separate compartment adjacent to the incomer compartment.

5.13 Motor Control Centre shall be self-ventilated. Ventilation louvers (without cooling fans) in busbar chamber may be accepted in specific cases and if provided shall be backed up with fine wire mesh of brass for vermin proofing.

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5.14 Clearance between phases and between phase and earthing as well as the insulation levels shall be in accordance with relevant standard. Sufficient Clearance shall be maintained between the door mounted devices and the top of components mounted inside the compartment.

5.15 MCC construction, mounting of various equipment viz. circuit breakers, instruments, relays, busbars& secondary wiring and number of feeders per vertical panel shall be done with due consideration to the following: -

a. Facility for ease of operation, inspection, maintenance and repairs.
b. Minimum vibration and noise.
c. Risk of accidental short circuits and open circuits.
d. Interchangeability of components.
e. Risk of accidental contact and danger to personnel due to live parts.
f. Secure and vibration-proof connections for power and control circuits.
g. When rear door is opened, only cable connections shall be accessible.
h. Rating of vertical busbars.
i. Conformity to latest Indian Electricity Rules and other statutory regulation (in the state in which the installation is located) as regards safety, earthing and other essential provisions specified therein for insulation and operation of electrical plants.

5.16 Hooks shall be provided for lifting the MCC. Hooks shall not leave any openings in the MCC, when the same are removed.

All equipment and materials used in construction of MCC shall be new and of best quality and of approved make

5.17 TYPE OF COMPARTMENT

5.17.1 COMPARTMENTAL TYPE

All feeders to be housed in separate compartments. All compartments to be fully segregated from one another, as well as from busbar chambers, with sheet steel barriers. Terminal chambers for incoming feeders to be segregated from those for outgoing feeders. This type of construction may be Single Front or Double Front as

Specified in Data Sheet. Each feeder compartment shall have a separate door. Separate compartments shall be provided specifically for circuit breakers, horizontal and vertical busbar / cable chambers, which will be fully and effectively segregated from one another. This is to confine internal faults to faulted compartment and to prevent damage to equipment in any other compartments. It shall be possible to maintain equipment in individual compartments / terminals whilst the remainder of MCC is energized.

5.17.2 NON-COMPARTMENTAL TYPE

One compartment can house a number of feeders. However, incoming feeders to be housed in separate compartments / panels, fully segregated from all other feeders. All equipment for each feeder, such as switches, fuses, contactors, etc. to be mounted on feeder plate. Insulating barriers to be provided between adjacent feeders. Each panel may

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have a common door, depending on size and rigidity of the door. This type of construction may be Single or Double Front as required.

5.18 TYPE OF FEEDER

5.18.1 FULLY DRAW OUT TYPE

a. The circuit breaker including its operating mechanism, starter / switch fuse feeders orca with equipment shall be mounted on wheeled trolley / carriage moving on guides designed to align correctly and allow smooth movement.
b. Incoming and outgoing power connections for each draw out cubicle between fixed portion of the panel and trolley shall be by means of self-aligning plug-in contacts. Both male and female contacts shall be of silver plated copper. Contact design shall ensure adequate pressure normally and increase in contact pressure during short circuits.
c. Control wiring connections between trolley and fixed part of panel shall be made by sliding type terminals, which will make and / or break in test and service positions, depending on control scheme.
d. The draw out design shall have three positions - 'SERVICE', 'TEST' and 'ISOLATE' for circuit breaker and motor starter feeders. For switch fuse feeders, only 'SERVICE' and 'ISOLATE' positions shall be provided. The selection of position shall be possible with the door of the circuit breaker / starter feeder closed for safety purpose.
e. Position indicator shall be provided on the panel to indicate the position of the feeder trolley viz. 'ISOLATE', 'TEST' and 'SERVICE'.
f. It shall be possible to withdraw the circuit breaker trolley up to the 'TEST' and 'ISOLATE 'position without opening the front door.
g. Automatic safety shutter shall be provided in all C.B. Panels for all openings, which will provide access to the live parts of the switchgear upon withdrawal of any portion of the switchgear components parts. This feature may also be provided for other feeders, if feasible.
h. There shall be provision for pad locking the trolley in all the three positions for complete safety.
i. Feeder compartments shall be totally closed from all sides, with a door on the front side.
j. The draw out portion of the cubicles shall be effectively connected to the earth bus through scraping contacts. It must be ensured that the draw out portion gets earthed both in service and test positions.
k. Fixed Type / Non Draw out Type
l. All power as well as control connections of the feeder are fixed type i.e. by bolts or screws.
m. All feeder equipment to be mounted on a plate, which in turn is fixed within the compartment by screws.

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5.19 BUS BARS & INSULATION MATERIALS

5.19.1 The MCC shall have main horizontal and riser busbars, air insulated / sleeved, (as specified in Data Sheet), housed in a separate compartment, segregated from all other compartments, with sheet steel barriers. Busbars shall be of high conductivity electrolytic copper or aluminum, suitable for carrying the rated and short time current without overheating. Busbars shall be adequately supported on insulators to withstand dynamic stresses due to short circuits. Busbar support design should ensure free thermal expansion. Maximum busbar temperature shall not exceed 850 C under normal operating condition and 200°C under short-circuit condition.

5.19.2 For double front MCC, separate set of vertical busbars shall be provided for front and rear section of MCC.

5.19.3 All busbar connections and bus taps to individual feeders shall be either by means of1100 / 650 V grade multi-strand annealed copper conductor PVC insulated wires or links insulated with shrunk PVC sleeves. Busbars shall be color coded for easy identification of three phases. Feeders rated above or equal to 63A shall have link connection with busbar / busbar dropper.

5.19.4 All insulating materials used in manufacture shall be non-hygroscopic and shall be treated for preventing fungus growth. Surface of insulators shall be highly glazed and treated with silicone compound to minimize accumulation of dust, condensation of moisture and tracking. The insulating materials shall preferably be non-carbonizing type.

5.19.5 Busbar risers / vertical busbars shall be rated to carry 125% of the rated current of all feeders connected to the risers. These also shall be able to withstand full fault current as specified in datasheet.

5.19.6 Busbars for main horizontal and risers shall be of uniform section throughout.

5.19.7 The minimum cross section of neutral busbars shall be more than half the size of busbars for phase.

5.19.8 Busbars of different voltage level shall be fully segregated from each other.

5.20 EQUIPMENT / COMPONENTS

5.20.1 All feeders to be provided with appropriate components and protective devices as called for in Single Line Diagram, Control Schematic and Data Sheet.

5.20.2 Indicating meters and instruments and protective relays of the incoming feeder shall be mounted in a separate compartment adjacent to the incoming feeder compartment. For outgoing feeders these may be mounted in the same compartment.

5.21 CIRCUIT BREAKER & SAFETY INTERLOCKS

5.21.1 The circuit breakers shall be of air break and of horizontal draw out construction, with 3poles and isolable bolted neutral link or 4 poles as specified in Data Sheet.

5.21.2 Circuit breakers may be hand operated or power operated, as called for in the Data Sheets.

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The closing mechanism of the circuit breakers shall be of one of the following types: -

a. Hand operated, spring charged, independent manual type.

b. Motor wound, spring charged with a provision of manual charging.

5.21.3 The operating mechanism shall be mechanically and electrically trip-free and non-pumping. Anti-pumping feature may be built in or a separate anti-pumping relay may be provided. A mechanical closing device may be provided, if feasible. A mechanical trip device suitable for front of board operation and a mechanical 'ON-OFF' indicator shall be provided. Trip device should be shrouded to prevent inadvertently operation. A series or shunt trip coil, as called for in the Data Sheets shall be provided for tripping the circuit breakers. Wattage of shunt trip coils will be sufficiently high to prevent it from picking up or holding on with specified number of indicating lights wired in series with the same.

5.21.4 Provision shall be made for remote closing and tripping of the circuit breakers, with electrically operated mechanism. A 'local/remote' selector switch shall also be provided wherever called for in the Data Sheets. In case of spring charged mechanism, 'Spring Charged' and 'Spring Discharged' indication (mechanical) shall be provided.

5.21.5 Interlock shall be provided to prevent plugging in or withdrawal of circuit breaker trolley unless it is open. Any attempt to do so shall trip the circuit breaker. Interlock to prevent closing of circuit breaker, unless it is in 'SERVICE' or 'TEST' position and correctly locked in that position shall be provided.

5.21.6 The circuit breaker compartment door shall be interlocked to prevent access to a breaker which is in SERVICE or TEST position

5.21.7 Main contacts shall have ample area and adequate contact pressure to carry the rated and short time current without excessive temperature rise. The contacts shall be adjustable for wear and easily replaceable. Main contacts shall open before and close after the arcing contacts, when these are provided. Arcing contacts shall be easily accessible for inspection and replacement. The tips of main and arcing contacts shall be silver plated or shall be of suitable material, to minimize erosion of contacts due to arcing.

5.21.8 Auxiliary switches directly operated by the breaker mechanism shall be provided for control and interlocks. A minimum of six normally open and six normally closed contacts shall be provided. The contacts shall be rated for 10Amp. at 240V A. C. / D.C. All spare contacts shall be wired up to terminal block. Auxiliary contacts in the "trip" circuit shall close before the breaker main contacts close and shall open after the main contacts have opened. All other contacts shall operate simultaneously with the main contacts.

5.22 AUTO / MANUAL TRANSFER SCHEME

The below mentioned scheme is applicable for switchboard with two incomers & bus coupler.

5.22.1 Normally both the incomers & bus coupler circuit breakers shall be so interlocked that at any given point of time, any two out of three circuit breakers can be closed at a time. This is to avoid paralleling of two incomers.

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5.22.2 The auto transfer scheme (ATS) shall have provisions as mentioned below:

a. In case of sustained under voltage on any of the incomers, the affected incomer shall be tripped automatically. After checking that the voltage on the bus-section connected with other incomer is healthy & after ensuring that the voltage on the bus-section connected with the affected (tripped) incomer is less than 40% of normal rated voltage, the bus coupler shall be closed automatically.
b. When the voltage on the affected incomer returns to normal, it shall be possible to close the tripped incomer. This shall automatically trip the bus coupler breaker, after momentary paralleling, thus reverting the system to normal operating mode with closed incomers & open bus coupler.
c. The above ATS scheme shall be blocked in case of any bus faults.

5.22.3 To achieve operation as mentioned in 5.22.2 above, each incomer & bus coupler shall be provided with 4 position selector switch viz. manual / off / individual / auto, to permit various options of operation of each breaker. ATS shall be effective only in auto mode.

5.22.4 Also a common 4 position (off / trip IC1 / trip BC / trip IC2) trip selector switch shall be provided in bus coupler panel to bypass the interlock as mentioned in 5.22.1 above, under emergency or routine maintenance conditions, to facilitate & permit manual changeover after momentary paralleling & manual tripping of any breaker without affecting health of bus & system, after momentary paralleling. The system shall permit this operation while ensuring following:

a. Select any of the already closed breaker for tripping, by trip selector switch, thus selected breaker trips only after momentary paralleling, after a preset time delay.
b. During momentary paralleling / manual changeover, closure of any of the third breaker shall trip the desired / selected breaker. In case selected breaker (for tripping) fails to trip, the last breaker which is closed for momentary paralleling /manual change over, shall trip automatically, after a preset time delay, bringing the system back to original operating condition.

5.23 SWITCH – DISCONNECTOR

5.23.1 Switch disconnections shall be two position (ON / OFF) type, TP / TPN as specified in datasheet, heavy duty load break, quick make and break type complying with the requirements of IS 13947 Part-3 and suitable for front of board operation. Switch disconnector for switch disconnector fuse shall be of minimum AC 22 category and switch disconnect or for motor starter feeder shall be of AC 23 category.

5.23.2 Switch disconnections shall be interlocked with compartment door to prevent opening or closing of the door in the closed (ON) position of the switch disconnect or`, in case of compartmentalized switchboard. Provision for padlocking the switch disconnect or in open or closed position also to be made.

5.23.3 All live terminals on the Switch disconnect or shall be adequately shrouded to prevent accidental contact and danger to the personnel.

5.23.4 Switch disconnections shall be rated for 125% of circuit full load current with minimum rating of 25 Amps.

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5.23.5 Height of operating handle of switch disconnections in MCC shall be between 300mmand 1800mm from the bottom of base frame of MCC.

5.23.6 Switch disconnect or shall be provided with 1 NO + 1 NC auxiliary contacts.

5.24 MOULDED CASE CIRCUIT BREAKER (MCCB)

5.24.1 MCCBs shall be 3 pole or 4 pole conforming to as IS-13947 (Part 2) specified in Data Sheet and Single Line Diagram

5.24.2 MCCBs shall have microprocessor based thermal over current and short-circuit adjustable releases.

5.24.3 In case of motor loads, the overload and short circuit characteristic shall be selected to avoid minimum tripping during starting.

5.25 MOTOR PROTECTION CIRCUIT BREAKER (MPCB)

5.25.1 MPCBs shall conform to IS-13947 (Part 1,2& 4) and shall have the short circuit breaking capacity as called for. MPCBs shall provide overload, short circuit & single phasing protection.

5.25.2 MPCBs shall have 1NO + 1NC integral auxiliary contacts and 1NO + 1NC fault signaling contacts.

5.26 FUSES

5.26.1 All fuses shall be non-deteriorating high rupturing capacity, link type mounted in suitable fuse carriers or fuse bases, conforming to IS 13703.

5.26.2 Fuses for motor feeders shall be properly co-ordinated with overload relay so that they do not operate-during starting of the respective motors and shall provide adequate protection for all feeder components.

5.26.3 For switch fuse feeders, the rating of the fuse, if not specified, shall be same as that of the switch rating.

5.26.4 Fuses shall be provided with operation indicators and it shall be possible to change fuses with the circuit live.

5.26.5 All fuses in control, indication and metering circuit shall be HRC, link type. Insulated fuse pulling handles shall be supplied for each size of fuse with the MCC.

5.27 CONTACTORS

5.27.1 Contactors shall be magnetic, air break type generally as per IS 13947 Part-4 suitable for Type 2 co-ordination.

5.27.2 All power contactors shall be rated for 125% of feeder full load current. Minimum rating shall be not less than 9 Amps.

5.27.3 Coil voltage shall be as specified in Data Sheets. Contactor coils shall operate satisfactorily and drop OFF at voltages as given in IS 13947 Part-4.

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5.27.4 Power contactor's making and breaking capacities shall be suitable for AC3 / AC4categories of duty as per IS 13947 (Part- 4), unless the contactors are required for special duty, in which case, they will be suitably derated. For AC3 duty making capacity shall be minimum 10 times rated current and breaking capacity shall be minimum 8times rated current. For AC4 duty making capacity shall be minimum 12 times rated current and breaking capacity shall be minimum 10 times rated current.

5.27.5 All power contactors shall be provided with 2 Normally Open (NO) and 2 Normally Closed (NC) auxiliary contacts; preferably, convertible from NO to NC and vice versa.

5.27.6 All contactor coils to be suitable for tropical climatic conditions specified in Data Sheets.

5.27.7 Insulation Class for Coils - Class 'H'. Reversible contactors shall be electrically and mechanically interlocked.

5.27.8 All the terminals shall be shrouded such that they offer protection against finger contacts under IP 20 degree of protection.

5.28 BIMETAL RELAYS

5.28.1 All bimetal overload relays shall be of hand reset type with at least one NO and one NC contact with reset type push buttons, mounted on door such that it shall be possible to reset the O / L relay with door closed. Overload relay for application involving heavy duty starting with long acceleration time shall be adjustable storable type of CT operated relay.

5.28.2 All bimetal relays shall have built-in single phasing prevention feature and ambient temperature compensation.

5.28.3 Range of bimetal relays shall be generally 70% to 110% of circuit full load current.

5.29 MOTOR PROTECTION RELAYS

5.29.1 Whenever specifically called for, microprocessor-based motor protection relay in addition to overload relay shall also provide. Motor protection relay shall have following bare minimum features: -

a. Thermal over load with pre-alarm (49)
b. Over current (51)
c. Earth fault (64)
d. Locked rotor protection (51LR)
e. Current unbalance (negative sequence) (46)

5.30 INDICATING LAMPS

5.30.1 Indicating lamps shall be low burden type with series resistor. Lamps shall be LED or filament type except where neon lamps are specifically called for. Lamp covers shall be provided with interchangeable cultured lenses of Perspex or equivalent unbreakable material. It should be noted that lenses should not get discolored in course of time, duet the heat generated by the lamps. Requirement of indicating lamps will be indicated in

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Data Sheets. Lamp holder provided shall be suitable for easy removal / insertion of lamps.

5.30.2 When neon lamps are used on D.C. circuits, they shall be tested for operation at specified D.C. voltage without any ripple content. Generally following color code shall be followed for indicating lamps. The color of indicating lamps shall normally be the following unless otherwise specified:

Red - Feeder 'ON'

Green - Feeder 'OFF'

White - 'Trip Circuit Supervision'

Amber - Auto Trip

White - 'Spring Charged'

RYB - Potential Indication for 3Ph A.C. supply

5.31 CURRENT TRANSFORMERS

5.31.1 Current Transformers shall conform to latest edition / amendment of IS-2705.

5.31.2 The design and construction shall be sufficiently robust to withstand thermal and dynamic stresses due to maximum short circuit current, available at the point of installation of current transformer.

5.31.3 Secondary terminals of the C.T. shall be brought out suitably to a disconnecting /shorting link type terminal block which will easily be accessible for testing and external connections.

5.31.4 Terminals shall be marked in accordance with IS 2705. A name / rating plate as per IS2705 shall be provided on each current transformer which shall be easily readable after opening the door.

5.31.5 Current transformers shall preferably be capable of being left open on the secondary side with the primary circuit carrying rated full load current without overheating or damage.

5.32 CONTROL TRANSFORMER

5.32.1 Normally Common Control transformer with 100% Standby shall be provided in all motor control center’s unless specified otherwise. Control transformer shall be double wound, air cooled type with one leg of secondary earthed unless otherwise specified.

5.32.2 Control transformers to be capable of withstanding secondary short circuit for not less than 15 seconds.

5.32.3 VA rating of the Control transformer to be adequate to supply about 150% of the control loads of the MCC. Voltage regulation of the Control transformer shall be limited to 4%.

5.32.4 The control transformer shall be provided with easy changeover arrangement for feeding the complete bus from either transformer or independently

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5.32.5 The control transformers shall have ± 2.5 % and ± 5 % tapping on primary side.

5.33 CONTROL AND SELECTOR SWITCHES

5.33.1 Control and selector switches shall be of rotary type, provided with suitable nameplate engraved with switch operating positions.

5.33.2 Breaker control switch shall be of pistol grip type spring return, with position indicator, sequence interlock and normal after closing (NAC) contact (when specifically called for).

5.33.3 Selector switches shall have stay put positions with oval handle. The number of contacts and their operation in each switch shall be as per the requirement specified in Data Sheets of Contact Development Diagram.

5.34 INSTRUMENTS AND RELAYS

5.34.1 All relays and instruments shall be flush mounting type. The instruments shall preferably be of the rectangular shape and shall have adequate scale length. Protective relays shall be in accordance with the protective scheme specified. All relays and instruments shall be mounted in dust-tight, damp-proof, tropicalized cases. Instruments and relays shall be able to withstand a high voltage test of 2000 volts (rms) for one minute. Wherever possible, metering instruments and relays shall be draw out type. Minimum size of indicating instruments will be 96 mm sq. for incoming feeders. Indicating instruments for outgoing feeders, may be 72 mm sq.

5.34.2 Relays shall be microprocessor based numerical type or electromechanical type as specified. Electro-Mechanical type relays shall be provided with hand reset type mechanical operation indicator of direct acting type or fitted with an auxiliary unit, where required. The auxiliary unit shall be shunt reinforcing, shunt seal-in or series seal-in type, as specified. It shall also be provided with minimum two pairs of self, hand or combined self and hand reset type contacts, as specified.

5.34.3 C.T. secondary rating and current setting range of relays shall be as specified in the drawing.

5.35 ANNUNCIATORS

5.35.1 Annunciators when specified in Data Sheet shall have audible alarm and visual display through translucent plastic window of preferably 50 mm x 65 mm size engraved with appropriate function in block letters on each window. "ACKNOWLEDGE", "RESET" and "LAMP TEST" push buttons shall be provided common for the annunciation system on the MCC.

5.35.2 On receipt of an alarm impulse, audible alarm shall be sounded and lamp inside appropriate window shall start flickering. On pressing of "ACKNOWLEDGE" button the audible alarm shall stop sounding and lamp shall become steady. By pressing "RESET "button the trouble lamps shall not reset unless the alarm condition has disappeared.

5.35.3 Annunciator shall provide seal-in lamp indication and audible alarm shall be ready to operate for any new alarm condition immediately after audible alarm is reset for a previous alarm condition.

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5.36 INDICATING/RECORDING INSTRUMENTS

All indicating instruments shall be of industrial grade 'A' accuracy, suitable for flush mounting and in accordance with IS1248. Selector switches to be provided for ammeters and voltmeters as called for in Data Sheets. Kilowatt hour meters shall be in accordance with IS 722, suitable for flush mounting. Ammeters for motor feeders shall have an extended suppressed scale up to six times the rated current (e.g. 0-5/30). Where specified, these can be a part of combined metering and protection module.

5.37 PUSH BUTTONS

Push buttons shall be provided on front door.

Stop Push Button - with stay put feature, (preferably lockable) with mushroom head.

Reset Push Button - for hand resetting of BMR.

Start Push Button - Shrouded type spring return (to be provided only if called for).

Colors of the push buttons:

Stop - red

Start - green

Reset - black or yellow

5.38 EARTHING

The MCC shall be provided with a continuous earth bus having sufficient cross section to carry the specified fault current for specified duration without exceeding the safe temperature throughout its entire length. All non-current carrying metal work of the MCC shall be effectively bonded to this earth bus. Bonding washers (star washers) shall be used when sections of MCC are bolted together to ensure earth continuity.

5.39 INTERNAL WIRING

5.39.1 MCC shall be complete with all internal wiring and ready for Purchaser's external cable connections at the outgoing terminals. All inter-modular wiring within the MCC for control and interlock looping shall be carried out by the MCC-manufacturer. All control wiring inside the MCC shall be carried out with 1200 / 650 V Grade PVC insulated wires of grey color. Minimum size of conductor for power circuits shall be 2.5 sq. mm copper or 6 sq. mm aluminum. Conductor material will be specified in Data Sheets.

5.39.2 All control wiring except CT secondary wiring shall be carried out with minimum 1.5 sq.mm copper conductor. CT secondary wiring shall be carried out with 2.5 sq. mm copper conductor.

5.39.3 All wiring shall be securely fixed and neatly arranged to enable easy tracing of wires.

5.39.4 All terminal blocks and wires shall be tagged for identification in accordance with IS 5578and IS 11353.All wiring for external connections shall be brought out to the individual terminals on readily accessible terminal block. All terminal blocks shall be

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shrouded or provided with transparent covers. All unused contacts shall be wired to terminal block. Clamp type control terminal blocks shall be provided for outgoing control cables.

5.39.5 Minimum 20% or 4 nos. spare terminals shall be provided for future use. Control terminal block of different voltages shall be separated by means of an insulating barrier.

5.39.6 Power terminals, if of busbars, shall have terminal holes and fitted with cable lugs and bolts suitable for the cables specified.

5.40 MARSHALLING CABINET

5.40.1 Marshaling cabinet shall be provided in each shipping section of MCC for DC interface.

5.40.2 Terminals for DCS input and DCS output contacts shall be segregated and separate terminal blocks shall be provided.

5.40.3 Screened control cable shall be used for wiring of potential-free contacts from the modules to the marshaling cabinet.

5.40.4 Unless otherwise specified, 8 nos. terminals shall be considered for each module to be prewired in marshaling cabinet (from each module of each shipping section of each MCC)

5.41 SPACE HEATERS

5.41.1 Adequately rated anti-condensation space heaters shall be provided in each breaker panel and in cable alleys of the MCC to maintain MCC inside temperature, 5°C above outside ambient temperature.

5.41.2 Space heater shall be strip type, rated for operation on 240V, single phase, 50 Hz. aluminum unless otherwise specified.

5.41.3 Each space heater shall be complete with a rotary type ON/OFF switch, HRC fuse in the phase, neutral link in neutral and a control thermostat. A separate DP isolator and link type HRC fuses shall be provided in motor feeders for control of space heaters of motors. These shall be wired through a 'NC' contact of the contactor / circuit breaker for motor control.

5.42 AUXILIARY SUPPLY

5.42.1 Auxiliary AC supply for control, indication, space heater etc. shall be derived within the MCC. Vendor shall provide auxiliary control/supply bus in the MCC throughout its length for further distribution inside the MCC. Vendors shall also provide suitable switch and fuse or MCB in each sub-circuit as per requirement. These control / auxiliary supply busbars shall be fully and effectively segregated from main power busbars.

5.42.2 DC supply, if specified in Data Sheet, shall be made available to each MCC through external duplicate DC feeders. Vendor shall provide change - over switch for the same.

5.43 CABLE TERMINATIONS

5.43.1 Cable entry to MCC shall be either from top or bottom of the MCC as specified in the Data Sheets.

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5.43.2 Ample space shall be provided in the cable compartment to accommodate PVC insulated aluminum conductor cables as specified in the Data Sheets.

5.43.3 Removable undrilled gland plate shall be provided for termination of cables.

5.43.4 Access for cabling shall be from the rear / front. The cubicle width shall be adequate for a cable jointer to enter and work within the cubicle during cable jointing.

5.43.5 Power / control termination shall be properly shrouded so that there is no accidental touch to other live terminals while working on any terminal block. For this, Power terminations shall be properly shrouded and segregated from terminal blocks of other feeders.

5.43.6 All power and control terminals from fixed portion of the panel shall be wired up to power and control terminals in respective cable alley for external cable termination.

5.44 PAINTING AND FINISHING

5.44.1 All metal surfaces shall be thoroughly cleaned and degreased to remove scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The surface shall be prepared by applying a coat of phosphate paint and coat of yellow zinc chromate primer. The surface shall be made free from all imperfections before undertaking the finishing coat. After preparation of the surface, the switchboard shall be powder coated with two coats of epoxy based final paint. Color shade of final paint shall be as specified in datasheet.

5.44.2 The finished panels shall be dried in stoving ovens in dust free atmosphere. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint etc. All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust formation. If these parts are moving elements then they shall be greased.

5.45 NAME PLATES AND LABELS

5.45.1 One nameplate giving designation of the MCC shall be affixed prominently on top of the MCC. Details of designation will be specified.

5.45.2 Labels giving following details shall be affixed on each feeder compartment.

a. Feeder No.
b. Equipment Reference Number and Description
c. Rating (KW / KVA / AMP)

5.45.3 All components whether mounted inside the MCC or on the door shall be permanently and clearly labeled with reference number and/or letter of their function. (Rating of fuse shall form a part of the fuse designation.)

5.45.4 All labels shall be non-corrodible, preferably laminated plastic, with white letters on black background. Labels for feeder designation shall be fixed on the front side of respective feeder with chrome plated, self-tapping, countersunk head screws. These labels shall be identical size to permit interchange. Spare feeders shall have blank labels to enable engraving in later stage, if necessary.

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5.46 DRAWINGS, INFORMATION AND CERTIFICATES

5.46.1 The Vendor shall furnish drawings in accordance with "Vendor Document Requirements" enclosed elsewhere.

5.46.2 Generally following drawings shall be furnished: -

a. General Arrangement Drawing showing front view, plan, foundation plan, floor cut out sand trenches for external cables, elevations, transport sections with weights;
b. Sectional drawings of various types of feeder, panels showing general constructional features, mounting details of various devices, busbars, current transformers, cable boxes, terminal boxes for control cables, etc.;
c. Schematic and control wiring diagrams for each type of feeder and protection including indicating devices, metering instruments, alarms, space heaters, etc. Vendor drawings to be based on Contractor's control wiring diagrams if furnished;
d. Terminal plans showing terminal numbers, ferrules markings, device terminal numbers, function etc.; and
e. Relay wiring diagrams

5.46.3 Vendor shall furnish required number of copies of above drawings as per Vendor Document Requirements for Purchaser's review. After final review, required number of copies and reproducible shall be furnished as final certified drawings. As built drawings shall be submitted after installation and commissioning.

The information furnished shall include the following: -

a. Technical literature giving complete information of the equipment;
b. Erection, operation and maintenance manual, complete with all relevant information, drawings and literature for auxiliary equipment and accessories, characteristics for relays, etc.
c. An equipment list with detailed specifications.

5.46.4 The Vendor shall submit CPRI test certificates for short circuit test and temperature rise test for the panels specified in Data Sheet.

6.0 INSPECTION AND TESTING

6.1 After completion of all work at the manufacturer's works, MCC shall be inspected and tests witnessed by the Purchaser's Representative. However, stage inspection may be carried out from time to time to check progress of work and workmanship.

The following tests shall be carried out: -

a. All routine tests specified in relevant Indian Standards shall be carried out on all circuit breakers.
b. Test for protective relay operation by primary or secondary injection method.
c. Operation of all meters.
d. Secondary wiring continuity test with a low voltage (6 volts) tester.
e. Insulation test with 500 volts megger, before and after H.V. test

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f. H.V. test on power and control circuits / components (2 KV for one minute).

g. Earth continuity test with a low voltage (6 volts) tester.

h. Simulating external circuits for remote operation of breaker, remote indicating lights and other remote operations, if any, for operational test.

i. Pick-up and dropout voltages for shunt-trip and closing coils.

j. C.T. Polarity Test.

k. Heat run test on busbar (if specified)

6.2 Vendor shall provide all facilities such as power supply, testing instruments and apparatus required for carrying out the tests. Required copies of test certificates for all the tests carried out along with copies of type test certificates and certificates from sub vendor for the components procured from them are to be submitted before dispatch of the MCC.

7.0 SPARES AND ACCESSORIES

7.1 TOOLS

7.1.1 One complete set of all special or non-standard tools per MCC required for installation, operation and maintenance of MCC shall be supplied. A suitable universal type circuit breaker handling truck shall be provided with each switchboard. The truck shall have platform of adequate mechanical strength for be a ring the weight of the largest circuit breaker and shall be provided with necessary guide rails and stops. The height of the platform shall be adjustable to suit the levels at which the different circuit breakers are mounted in the switchboard.

7.1.2 One complete set of all special or non-standard tools per switchboard required for installation, operation and maintenance of switchboard shall be supplied.

7.2 SPARES

7.2.1 The bidder shall provide with his quotation separate priced list of recommended operation and maintenance spares

8.0 MARKING, PACKING AND SHIPMENT

8.1 All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for transportation by ship/rail or trailer. The equipment shall be wrapped in air bubble 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.

8.2 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.

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Energising Quality

VCS Quality Services Pvt Ltd

STANDARD SPECIFICATION
FOR
NEUTRAL GROUNDING RESISTOR

VCS – SS – EL - 4030

02	09.03.2022	SP	RD	AA	HK
01	16.10.2019	MG	VV	AD	SK
00	05.07.2017	MG	RD	AD	SK
Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By

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REVISION RECORD

Rev.	Revision Date	Prepared by	Checked by	Approved by	Authorized by	Revision Description
00	05.07.2017	MG	RD	AD	SK	Issued for use as Standard
01	16.10.2019	MG	VV	AD	SK	New revision system updated
02	09.03.2022	SP	RD	AA	HK	New revision system updated

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ABBREVIATION

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

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1.0 SCOPE

1.1 These Specifications cover design, manufacture, assembly, performance, testing, inspection, packing and delivery to site of neutral grounding resistors and accessories required for resistance grounding of transformer winding neutrals / generator neutral.

2.0 REFERENCE DOCUMENTS

2.1 Neutral grounding resistance equipment and accessories used in design and Manufacture shall comply with all relevant Indian Standards Specifications current at the time of order, including amendments and agenda, and in particular few of which are listed below:

IS: 3043	Code of practices for earthing
IS:3427	Metal enclosed switch gear and control gear for voltage above 1000 V but not exceeding 11000 V.
IS:13947	L. V. switchgear and control gear
IEEE:32	Neutral Grounding Devices, Std. Requirements, Terminology and Test Procedure.
BS 731	High Voltage Porcelain Insulators
IS 2099	Bushings for alternating voltages above 1000V.
IS 2147	Degree of Protection provided by enclosures for low Voltage switchgear and control gear.

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

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

2.3 The NGR service conditions (ambient temperature/humidity, altitude, environment, etc.) shall be as specified in Data Sheet.

3.0 DEFINITION

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

OWNER / COMPANY	OWNER of the particular Project (Project Specific).
CONSULTANT	The party which is doing engineering, procurement, construction, pre-commissioning and assistance for commissioning, monitors and controls the overall project management.

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BIDDER / SUPPLIER / VENDOR	The party(s) which manufactures and / or supplies material, equipment, technical documents / drawings and services to perform the duties specified by Contractor.

4.0 MATERIAL

4.1 Name plates

4.1.1 Nameplates reading make, type designation number, resistor rating shall be fixed on the enclosure. The material and the markings on the nameplates shall be suitable to withstand atmospheric corrosion.

4.2 SPACE HEATER

4.2.1 Suitable space heater shall be provided inside the resistor cabinet to prevent condensation of moisture. This shall be rated to operate from 240 V, 50 Hz supply. The terminals of the space heater shall be brought out in a separate terminal box. The terminal box shall have IP-55 degree of protection.

4.2.2 The space heater shall be controlled with double pole switch, HRC fuse and thermostat. The switch shall be operable from the front without opening the terminal box cover. It shall be complete with tinned-copper lugs and nickel-plated brass, double-compression cable glands.

4.3 COOLING

4.3.1 The Neutral grounding resistor shall be natural air cooled. Forced cooling will not be used. However, if required, louvres can be provided in the enclosure. But wherever the louvres are being offered it shall be completed guarded on inside with a fine wire mesh to make it vermin-proof.

4.4 PAINTING

4.4.1 All metal surfaces shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The surface shall be prepared by applying a coat of phosphate paint and coat of yellow zinc chromate primer. The surface shall be made free from all imperfections before undertaking the finishing coat.

4.4.2 After preparation of the surface, the panels shall be powder coated with two coats of epoxy based final paint. Colour shade of final paint shall be as specified in Data Sheet. The finished panels shall be dried in stoving ovens in dust free atmosphere. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint etc.

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

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5.0 DESIGN

5.1 RESISTORS

5.1.1 The resistors shall be non-inductive, heavy duty cast iron alloy / cast stainless steel grids or punched stainless steel (SS304) of uniform thickness and cross section. The grid elements shall be assembled on metal tie rods which shall be supported on rigid supporting steel frame work. The grids shall be insulated from metal tie rods by mica tubes and shall be securely supported at sufficient number of points along the frame work so that no damage is caused to the grid due to vibrations and mechanical stresses. The various grid sections shall be suitably interconnected to obtain the specified ohmic resistance value.

5.1.2 The cast iron grid elements when used shall be given protective metal plating for corrosion resistance. The resistance element used shall withstand the high temperature attained by the grid elements during flow of rated fault current.

5.1.3 The steel frame shall be of one piece welded construction. The neutral grounding resistor (NGR) installed outdoor shall be provided with removable sheet steel covers all around (including top and bottom) the supporting steel frame to obtain a tank type enclosure for the resistance assembly.

5.1.4 The complete NGR assembly shall be dust, vermin and weatherproof suitable for installation outdoor or indoor as specified in the Data Sheet, compressed asbestos fiber gaskets shall be provided at places of bolted joints to make the enclosure dust-proof.

5.1.5 The complete assembly shall be mounted on suitable pin and cap type stand-off insulators. The enclosure shall be provided with lifting lugs on the steel frame to facilitate lifting of the complete unit.

5.1.6 A lifting lug shall be provided with cover where second cubicle is provided for out door installation.

5.2 Safety enclosers

5.2.1 A safety enclosure shall be provided for NGR. The purpose of the safety enclosure is to prevent personnel inadvertently coming in contact with the resistor unit or frames, which have been insulated with respect to ground by stand-off insulators.

5.2.2 This safety enclosure shall be of free-standing type with facility for bolting them to the resistor supporting structure. The enclosure shall be made up of galvanised wire mesh or screen fixed to its supporting frame of heavy angle steel. The side screws shall be of removable type to facilitate maintenance, adequate clearance shall be provided while designing the safety enclosure.

5.2.3 No safety enclosures shall be required where resistor units are not within the easily accessible height, e.g. where NGR units are mounted at a height to match with the neutral bushing height of the transformer.

5.2.4 It shall be possible to earth the cabinet or enclosure at two places and for this suitable size of studs shall be provided on the sides to accommodate the GI strip of size specified in the data sheet.

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5.2.5 Suitable slope shall be provided at the bottom complete with drain plug to drain water that may get collected in the enclosure.

5.3 Terminal details

5.3.1 Nature of terminal

The neutral side terminal of the resistor (i.e. the terminal to be connected to the transformer neutral) shall be brought out through the enclosure by using an outdoor type porcelain bushing (suitable for heavily polluted atmosphere) provided with terminal stud and associated nuts and washers.

The insulator class shall be as specified in the table against the service voltage.

Service Voltage	Class of insulator
3.3 kV	3.6 kV
6.6 kV	7.2 kV
11 kV	12 kV
22 kV	24 kV

5.3.2 Earth side terminal

The earth side terminal of NGR shall be brought out through the enclosure by using outdoor porcelain bushing of insulation class specified in table. Minimum two nos. of such terminals shall be provided. The bushings shall be complete with terminal stud and associated nuts and washers for connection to the earthing system with two numbers grounding conductors.

6.0 INSPECTION AND TESTING

6.1.1 During fabrication, the equipment shall be subjected to inspection by Consultant /Owner or by an agency authorised by the Owner. Manufacturer shall furnish all necessary information concerning the supply to Consultant /Owner's inspector. Test shall be carried out at Manufacturer's works under his care and expense.

6.1.2 The following tests shall be conducted.

a. Physical Inspection.
b. Measurement of resistance value at room temperature by Kelvin Double Bridge.
c. One minute power frequency high voltage withstand test.
d. Insulation resistance measurement to be done before and after the power frequency high voltage test.
e. Heat run test

6.1.3 Temperature rise test shall be conducted by passing the rated current for rated time on a limited resistor section in a proportionate test enclosure. The temperature rise shall be measured under simulated conditions ensuring that energy dissipation (I^2Rt) per unit volume of the test enclosure is less than or equal to the energy dissipation per unit volume of the complete neutral grounding resistor enclosure.

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6.2 Drawings and test certificates

6.2.1 The following drawings shall be furnished for approval:

a. Outline drawing with dimensions, weights etc.
b. Detailed drawings showing cross-sectional view, mounting details etc.
c. Copies of test certificates shall be furnished.

6.3 Quality assurance

6.3.1 Quality Assurance shall follow the requirements of the Company QA documents.

6.3.2 Quality Assurance will commence at the bid stage and follow through to completion and acceptance, thus ensuring total conformity to Purchaser's requirements.

6.4 Deviations

6.4.1 Deviations from specification must be stated in writing at the bid stage.

6.4.2 In the absence of such a statement, it will be assumed that the requirements of the Specification are met without exception.

7.0 MARKING, PACKING AND SHIPMENT

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

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INSTRUMENTATION WORKS

(Appendix-IV to Standard Specification of Work)

CONTENTS

LIST OF STANDARD SPECIFICATIONS

VOLUME-II OF III

S No.	Description	Document No.
1	Standard Specification of Pressure Gauge	VCS-SS-IN-5001
2	Standard Specification of Pressure Transmitter	VCS-SS-IN-5003
3	Standard Specification of Temperature Gauge with Thermowell	VCS-SS-IN-5101
4	Standard Specification of RTD with Thermowell	VCS-SS-IN-5102
5	Standard Specification of Temperature Transmitter	VCS-SS-IN-5103
6	Standard Specification of Pressure Safety Valve	VCS-SS-IN-5504
7	Standard Specification of Gas Over Oil Actuator Valve	VCS-SS-IN-5505
8	Standard Specification of Package Instrumentation	VCS-SS-IN-5602
9	Standard Specification of Cable	VCS-SS-IN-5801
10	Standard Specification of JBs & Cable Glands	VCS-SS-IN-5802
11	Standard Specification of Tubes & Fittings	VCS-SS-IN-5803
12	Standard Specification of F&G Detectors	VCS-SS-IN-5901
13	Standard Specification of Remote Terminal Unit	VCS-SS-IN-5903
14	Technical Specification of TIC Panel	C221052-00-IN-SS-5003
15	Standard Specification of Fire & Gas Detection System	VCS-SS-IN-5905
16	Standard Specification of OFC & Conduit	VCS-SS-IN-5910
17	Standard Specification of Electronic Marker Locator	C221052-00-IN-SS-5001

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VCS Quality Services Pvt. Ltd.

STANDARD SPECIFICATION
FOR
PRESSURE GAUGE

VCS–SS–IN-5001_02

02	11.05.2022	SV	KNC	HK	GVW
01	18.01.2020	KS	VB	KNC	AD
00	23.05.2019	ND	UM	KP	KNC
Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By

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REVISION RECORD						
Rev.	**Revision Date**	**Prepared by**	**Checked by**	**Approved by**	**Authorized by**	**Revision Description**
00	23.05.2018	Neha Dev	Udit Manichanda	K.Prasanth	Anupam Das	
01	18.01.2020					Format change and document numbering is revised.
		Karan Singh	Vinod Babu	Kedarnath Chakraborty	Anupam Das	
02	11.05.2022					VCS QMS Integration
		Sarita Verma	Kedar Nath Chakraborty	Hashim khan	GV Walimbe	

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ABBREVIATION

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
BS	British Standards
DIN	Deutsches institute fur Normung
FAT	Factory Acceptance Test
IEC	International Electro-technical Commission
IP	Ingress Protection
IS	Indian Standards
ISA	Instrument Society of America
ISO	International Organization for Standardization
NACE	National Association of Corrosion Engineers
NPT	Nominal Pipe Thread
SAT	Site Acceptance Test
SS	Stainless Steel

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1 SCOPE

This Standard Specification, together with the Data Sheets attached herewith, establishes the minimum technical and functional requirements for design, engineering, materials, fabrication, painting, inspection and testing, documentation, marking, packing and shipping of Pressure Gauge along with its accessories.

2 DEFINITIONS

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

Owner/ Purchaser/ Company	Owner of the particular Project (Project Specific).
Consultant	The party which comes out all or part of the engineering, procurement, construction, pre-commissioning and assistance for commissioning, monitors and controls the overall project management.
Bidder/ Manufacturer / Supplier / Vendor	The party(s) which manufactures and / or supplies material, equipment, technical documents / drawings and services to perform the duties specified by Contractor.
Works/ Shop	The place where the ITEM / UNIT is fabricated and tested and transported to Purchaser.
Datasheet	Technical data provided by the Purchaser / Owner / Company.
Standard Specification	Specifications Developed as Standard by the Company.
Job Specification	Specifications Developed pertaining to particular project / Job in regard.
Material Requisition	Requisition as raised to Supplier for Quotation of the item
Purchase Requisition	Requisition as raised to Supplier for Procurement of the item
Purchase Order	Legal Order supplied to Supplier for procurement of the Engineered Item
Site	The work place where the equipment is installed and commissioned.

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3 REFERENCE DOCUMENTS

3.1 Codes & Standards

The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the Purchaser's enquiry.

American Society of Mechanical Engineers

ASME B1.20.1	Pipe Threads
ASME B 16.5	Steel Pipe Flanges and Flanged Fitting
ASME B 16.20	Ring Joint Gaskets and Grooves for Steel Pipe Flanges

British Standards

BS 1780	Specifications for Bourdon Tube Pressure and Vacuum Gauges

Deutsches Institute fur Normung

DIN 50049	Document on Material Testing

Indian Standards

IS 3624	Specification for Pressure and Vacuum Gauges
IS 2147	Degree of Protection provided for Enclosures

International Electro technical Commission

IEC 529	Degree of Protection by providing Enclosures
EN 837	Pressure Gauges Part-t: Bourdon Type Pressure Gauges, Dimensions, Metrology, Requirements and Testing

3.2 Order of Precedence

In the event of conflict between Specifications, Data sheets, related standards, codes etc., the order of precedence shall be as follows:

a. Data sheets

b. Job Specifications

c. Standard Specifications

d. Codes and Standards

Vendor shall refer the matter to the Purchaser for clarification and only after obtaining the approval in writing, the same should proceed with the manufacture of the items in question.

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4 MATERIALS

Materials selected shall be in accordance with the Data Sheets and Standard Specifications. For corrosion service the material selected shall be in compliance with the requirements of NACE MR-0175 / IS0-15156 latest editions.

5 DESIGN

5.1 Pressure Element, Gauge Movement and Socket

The Pressure Gauges shall be used for local indication.

Pressure Gauge sensing element shall be SS316 and movement of SS304, as a minimum. Pressure Gauge measuring element shall generally be Bourdon / Bellows / Diaphragm type. In case of Bourdon type of Gauges, the size of the Bourdon tube shall not be less than 75% of the nominal diameter of the dial size.

The wetted parts of the Pressure Gauge, the Bourdon tube and socket must be compatible with the process media. If not compatible with the wetted parts of the Gauge, corrosion will occur. Corrosion of Gauge wetted parts will eventually cause gauge failure and possibly safety issues.

The material of construction of all accessories wetted by process shall be as per socket material.

Gauge construction shall ensure no leakage of process fluid from the sensor elements to atmosphere and between the high pressure and low-pressure side (in case of differential Pressure Gauges) under normal condition.

Primary elements shall withstand the specified overpressure for at least 30 minutes without having their elastic characteristics affected.

When any Gauge is used for steam pressures, a siphon filled with water must be installed between the Gauge and the line.

All Pressure Gauges with maximum operating pressure exceeding 60 Kg/cm2 shall be solid front type.

Over range protector and pulsation dampener, whenever used shall be of SS304, as a minimum. Pulsation Dampener shall be used for all pulsating services. It shall be floating pin type, externally mounted and externally adjustable.

5.2 Cases Dials

Unless specified otherwise the gauges shall be weather proof to IP 65 as per IEC 529/IS 2147 as a minimum.

When safety type cases are specified, they shall consist of a solid partition isolating the pressure element from the dial.

Pressure Gauge dial shall be white, non-rusting plastic with black figures. The dial face shall be marked with pressure element material; dial size shall be 150mm. Pointers shall have micrometer adjustment.

Cases shall normally be cast aluminum alloy or black phenol.

In general, dial markings and dial color shall be as per IS 3624. Protect Gauges from frequent pressure pulsations by using liquid-filled.

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5.3 Diaphragm Seals

Diaphragm seals, filled type or mechanical type shall be furnished where plugging of the element may occur or where suitable material is not available in highly corrosive services. When chemical seals are required, they shall be of the clean out type with flushing connection. Gauges specified with diaphragm seals shall have their diaphragms integral with the Gauges.

The sealing liquid for diaphragm seal Gauges shall be an inert liquid, compatible with the process fluid temperature.

For Gauges in oxygen and chlorine service, the sealing liquid shall be fluro lube or equivalent compatible with the specified service.

For diaphragm seal Pressure Gauges with flanged ends, the diaphragm shall be rated for the maximum allowable pressure of the associated flange.

5.4 End Connection

Process Pressure Gauges with 150mm dial sizes or larger are most often supplied with a ½ NPTM connection to best support the gauge. Where NPT connections have been specified, the threading shall be to ANSI/ASM 81.20.1.

When flanges are specified, unless otherwise stated, they shall be to ANSI / ASME B 16.5. Process connection shall be bottom entry type.

5.5 Accuracy

For a mechanical Pressure Gauge, accuracy is defined as a percentage of the full scale range. The following are general guidelines:

a. Test Gauges and standards: 0.25% through 0.10% full scale.

b. Critical processes: 0.5% full scale.

c. General industrial processes: 1.0% Less Critical Commercial Uses:2.0%

5.6 Range

Ranges shall be so specified that the Gauge normally operates in the middle third of the scale and shall confirm to IS-3624 standard dials, wherever possible.

Pressure range is approximately twice the normal operating pressure. The maximum operating pressure should not exceed approximately 75% of the full scale range. Pressure Gauges shall have an accuracy of ±0.5% as a minimum. Over range protection of 130% shall be used.

5.7 Name Plate

All Pressure Gauges shall be marked as per Manufacturer's standard and shall have a permanently attached stainless steel plate with the following, as a minimum detail:

d. Tag number as per Data Sheet

e. Manufacturer's name and trade mark

f. Gauge type, model no. Serial no.

g. Range of the Instrument.

h. Maximum working pressure and maximum vacuum rating of the element.

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i. Area classification

6 FABRICATION AND PAINTING

Vendor shall obtain approval in writing from the Purchaser before start of fabrication of Pressure Gauge. Vendor shall submit the required Specification, drawings & documents for approval. Also Vendor shall refer the relevant codes and standards for manufacturing herein.

7 INSPECTION AND TESTING

Vendor shall perform all inspection and testing as per Job Specification requirements, and as per relevant codes, prior to shipment. The inspection and testing for Pressure Gauge shall be carried out as per approved Inspection and Test Plan. Vendor shall submit the Inspection and Testing for Approval. Vendor shall submit the test certificates to the Company for the tests conducted during the manufacturing process like hydro test, material test, hazardous area certification test, calibration test and any other before Factory Acceptance Testing (FAT).

7.1 Factory Acceptance Testing (FAT)

Prior to FAT, Vendor shall submit to the Company a detailed FAT procedure, for review and approval, listing all the Pressure Gauges complete with the project approved tags, and highlighting the inspection and testing requirements of all such devices. FAT shall be carried out as per approved Inspection and Test Plan. FAT shall be carried out prior to shipment of the Pressure Gauge.

FAT procedures shall be submitted at least 4 weeks prior to FAT testing taking place. FAT shall be carried out at the manufacturing facilities. The tests shall be witnessed by the Company or their approved representative. FAT procedure will be signed off by the Vendor and Company or their approved representative at the successful completion and conclusion of testing.

The FAT shall be consisting of the following as a minimum:

a. Visual inspection

b. Dimensional check

c. Chemical and mechanical properties as per relevant material standards

d. Calibration

e. Functional test

f. A certificate to detail the results and records obtained during the FAT shall be made available for ratification by the Vendor on the date of test. Following certificates shall be submitted by the Vendor:

g. Mill test certificates relevant to the chemical analysis and mechanical properties of the materials as per the relevant Standards and Specifications.

h. NOT reports for radiography, ultrasonic, magnetic particle and liquid penetrate inspection.

i. Test report on operation of Gauges including operating time.

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j. Test report on hydrostatic test of Gauges.

k. Test report on Gauge assembly tests.

l. All other test reports and certificates as required by this Specification.

m. The certificates shall be valid only when signed by Purchaser's Inspector. Only those Gauges which have been certified by Purchaser's Inspector shall be dispatched from Manufacturer's works.

7.2 Site Acceptance Testing (SAT)

A SAT shall be carried out on completion of the installation of the equipment at site which shall be witnessed by the company / owner's representative. SAT shall be performed on the Pressure Gauge as per the approved test procedure. A comprehensive test procedure in compliance with the company specification shall be developed and issued to company / owner for review and approval.

The Site Acceptance Test (SAT), in general, shall demonstrate that the Gauge functions correctly and properly in accordance with the specified requirements.

8 MARKING, PACKING AND SHIPMENT

Following FAT completion, Vendor responsible for the Pressure Gauge shall ensure that all equipment and associated materials and accessories are designed properly, marked and packed, and secured for transit to site without damage.

Vendor shall provide and submit his standard "Marking, Packing and Shipping Procedures" for review by Company / Owner.

Vendor shall specify any conditions, normal or special, to be verified in intermediate storage and during transport.

Equipment shall be suitably packed including any dismantling, transit fastening and bracing necessary to prevent distortion or damage during transit.

Adequate protection shall be provided to prevent mechanical damage and atmospheric corrosion in transit and at the jobsite.

Preparation for shipment and packing will be subject to inspection and rejection by Company's inspectors. All costs occasioned by such rejection shall be to account of the Vendor.

9 SPARES AND ACCESSORIES

The following spare philosophy shall be followed in case it is not covered in Job Specification.

The Vendor shall include recommended Spare Parts List for start-up, pre-commissioning and two years operation as per the following;

a. Itemized recommended spare parts list for start-up and pre-commissioning.
b. Itemized recommended spare parts list for two years operation.

Vendor shall recommend accessories and special tools required for operation and maintenance of Pressure Gauge, for Company review.

All the spare parts furnished by Vendor shall be wrapped and packaged to preserve an original as-new condition under normal conditions of storage. The same parts shall be properly tagged with stainless steel tags and coded so that later identification as to their intended equipment usage shall be clear.

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All items supplied shall be packaged separately and clearly marked as "Spare Parts" and shipped with the equipment.

10 DOCUMENTATION

The following documentation shall be fulfilled by the Vendor, if it is not covered in Job Specification.

10.1 Documentation Required with Technical Bid

During bidding stage Vendor shall submit in his offer the following documents as a minimum:

a. Standard Specification, Data Sheets;

b. Bill of Materials including Vendor list, details of third party items;

c. Catalogues and Manuals;

d. Quality Assurance Plan;

e. A list of accessory items together with Manufacturer's name and part number;

f. Any other documents.

10.2 Documentation Required for Approval

Upon placement of Purchase Order, Vendor shall submit as a minimum the following drawings, documents and specifications for the Company's approval:

g. Specifications, Data Sheets;

h. Bill of materials including Vendor list, details for third party items;

i. Catalogues, Manuals and relevant drawings and documents;

j. Dimensional drawings;

k. Calibration certificates;

l. Material test certificates;

m. Procedures for FAT;

n. Quality Assurance Plan;

o. Any Other documents.

10.3 Guarantee & Warranty

Vendor shall guarantee that the complete scope of supply shall be safely and reliably meet all of the requirements of this Company Specification.

Vendor shall provide warranty support for a period of 12 months from the date of supply or 18 months from the date of manufacturing. Warranty shall apply to defective material workmanship and facility design .The cost of correction / replacement of any warranty items shall be borne by the Vendor, as per the purchase conditions of the Material / Purchase Requisition.

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The Job specifications / Data sheets shall be referred for any specific warranty / guarantee.

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VCS Quality Services Pvt. Ltd.

STANDARD SPECIFICATION
FOR
PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER

VCS-SS-IN-5003_02

02	11.05.2022	SV	KNC	HK	GVW
01	18.01.2020	KS	VB	KNC	AD
00	23.05.2018	ND	UM	KP	AD
Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By

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REVISION RECORD

Rev.	Revision Date	Prepared by	Checked by	Approved by	Authorized by	Revision Description
00	23.05.2018	Neha Dev	Udit Manichanda	K.Prasanth	Anupam Das	
01	18.01.2020					Format change and document numbering is revised.
		Karan Singh	Vinod Babu	Kedarnath Chakraborty	Anupam Das	
02	11.05.2022					VCS QMS Integration
		Sarita Verma	Kedar Nath Chakraborty	Hashim khan	GV Walimbe	

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ABBREVIATION

ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
FAT	Factory acceptance Test
IEC	International Electro technical Commission
IP	Ingress Protection
IS	Indian Standard
ISO	International Organization for Standardization
NACE	National Association of Corrosion Engineers
NPT	Nominal Pipe Thread
SAT	Site acceptance Test
SS	Stainless Steel

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1.0 SCOPE

This Standard Specification, together with the Data Sheets attached herewith, establishes the minimum technical and functional requirements for design, engineering, materials, fabrication, painting, inspection and testing, documentation, marking, packing and shipping of Pressure Transmitter /Differential Pressure Transmitter along with its accessories.

2.0 DEFINITIONS

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

Owner/ Purchaser/ Company	Owner of the particular Project (Project Specific).
Consultant	The party which comes out all or part of the engineering, procurement, construction, pre-commissioning and assistance for commissioning, monitors and controls the overall project management.
Bidder/ Manufacturer / Supplier / Vendor	The party(s) which manufactures and / or supplies material, equipment, technical documents / drawings and services to perform the duties specified by Contractor.
Works/ Shop	The place where the ITEM / UNIT is fabricated and tested and transported to Purchaser.
Datasheet	Technical data provided by the Purchaser / Owner / Company.
Standard Specification	Specifications Developed as Standard by the Company.
Job Specification	Specifications Developed pertaining to particular project / Job in regard.
Material Requisition	Requisition as raised to Supplier for Quotation of the item
Purchase Requisition	Requisition as raised to Supplier for Procurement of the item
Purchase Order	Legal Order supplied to Supplier for procurement of the Engineered Item
Site	The work place where the equipment is installed and commissioned.

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3.0 REFERENCE DOCUMENTS

3.1 Codes & Standards

The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the Purchaser's enquiry.

American Society of Mechanical Engineers

ASME B 16.5	Steel Pipe Flanges and Flanged Fitting
ASME B 16.20	Ring Joint Gaskets and Grooves for Steel Pipe Flanges
ASME B1.20.1	Pipe Threads

American Petroleum Institute (API)

API RP 551	Process Measurements Instrumentation

International Electro technical Commission

IEC-60529	Degree of Protection by providing Enclosures (IP Code)
IEC-60079-15	Electrical Apparatus with type of protection 'n'
IEC-60079-7	Electrical apparatus for explosive gas atmospheres increased safety 'e'
IEC-60605-1	Equipment Reliability Testing.
IEC-60068.2-13	Basic Environmental Testing Procedure for Electrical Components and Electronic Equipment.

Indian Standards

IS 2147	Degree of Protection provided for Enclosures

3.2 Order of Precedence

In the event of conflict between Specifications, Data sheets, related standards, codes etc., the order of precedence shall be as follows:

a. Data sheets

b. Job Specifications

c. Standard Specifications

d. Codes and Standards

Vendor shall refer the matter to the Purchaser for clarification and only after obtaining the approval in writing, the same should proceed with the manufacture of the items in question.

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4.0 MATERIALS

Materials requirements for Pressure/ Differential Pressure Transmitter shall be in accordance with the Data sheets and Company's Standard Specifications. For corrosion service the material selected shall be in compliance with the requirements of NACE MR-0175/ISO-15156 latest editions

Transmitter body studs shall be high tensile stainless steel or other corrosion - resistant material for higher stress levels.

5.0 DESIGN

5.1 General

The Pressure / Differential Pressure Transmitters shall be used in all cases where a continuous transmission of a pressure measurement is required in the control room for use in a control loop, or for indication or data acquisition.

Pressure / Differential Pressure Transmitters shall have an electronic state-of-art capacitance or any other type of sensor meeting all functional requirements. Element material for Transmitters shall be SS316 as a minimum.

Diaphragm seal element with capillary shall be used for congealing, corrosive and highly viscous services.

All Transmitters shall have an integral output meter. Remote mounted meters may be provided if required in addition. All Transmitters shall have accuracy of ±0.25% of full scale deflection, unless otherwise specified.

Transmitter shall be capable of working with a minimum load of 600 ohms and at a 24V DC supply.

All electronic modules shall be designed for short circuit protection.

The change in output due to change in ambient temperature should be very minimum.

Electronic Transmitters shall have externally adjustable zero and span. Setting adjustment shall have locking adjustment.

5.2 Process Connection

Process connection for Transmitters shall be ½ NPT or 2" flanged connection as per the Job Specification.

Process connection should be from bottom side.

3 Valve manifold in SS316 shall be used for Pressure Transmitter and 5 Valve manifold in SS316 shall be used for Differential Pressure Transmitter.

5.3 Equipment Protection

Transmitter shall be furnished with all necessary weather and anti-corrosion protection to prevent damage from saline and corrosive process atmosphere.

Over range protection shall be 130 % of range or maximum pressure whichever is higher.

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5.4 Enclosure Class

In addition to weatherproof, the Pressure Transmitter enclosure shall be explosion-proof to NEMA-7 and certified by third party statutory bodies like UL/FM/BASEEFA or equal for use in hazardous area.

5.5 Range

Where possible, Pressure Transmitters shall use the same range selection as Pressure Gauges. However, the range of a Transmitter shall always be within the range of the local gauge used to monitor its output.

The normal pressure shall not be read at greater than 75 % of the Transmitter calibrated range for instruments reading steady pressure. For fluctuating service, the normal pressure shall be not more than 60 % of the range:

5.6 Name Plate

All transmitters shall be marked as per Manufacturer's standard and shall have a permanently attached stainless steel plate with the following, as a minimum detail:

a. Tag number as per Data Sheet

b. Manufacturer's name and trade mark

c. Area classification

d. Adjustment range.

e. Element material.

f. Body material.

g. Service

6.0 FABRICATION

Vendor shall obtain approval in writing from the Purchaser before start of fabrication of Pressure/ Differential Pressure Transmitter. Vendor shall submit the required specification, drawings & documents for approval. Also Vendor shall refer the relevant codes and standards for manufacturing herein.

7.0 INSPECTION AND TESTING

Vendor shall perform all inspection and testing as per Job Specification requirements, and as per relevant codes, prior to shipment. The inspection and testing for Pressure Transmitter shall be carried out as per approved Inspection and Test Plan. Vendor shall submit the Inspection and Testing for Approval. Vendor shall submit the test certificates to the Company for the tests conducted during the manufacturing process like hydro test, material test, hazardous area certification test, calibration test and any other before Factory Acceptance Testing (FAT).

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7.1 Factory Acceptance Testing (FAT)

Prior to FAT, Vendor shall submit to the Company a detailed FAT procedure, for review and approval, listing all the Pressure/Differential Pressure Transmitter complete with the project approved tags, and highlighting the inspection and testing requirements of all such devices. FAT shall be carried out as per approved Inspection and Test Plan. FAT shall be carried out prior to shipment of the Pressure Transmitter.

FAT procedures shall be submitted at least 4 weeks prior to FAT testing taking place. FAT shall be carried out at the manufacturing facilities. The tests shall be witnessed by the Company or their approved representative. FAT procedure will be signed off by the Vendor and Company or their approved representative at the successful completion and conclusion of testing.

The FAT shall be consisting of the following as a minimum:

a. Visual inspection

b. Dimensional check

c. Chemical and mechanical properties as per relevant material standards

d. Calibration

e. Functional test

A certificate to detail the results and records obtained during the FAT shall be made available for ratification by the Vendor on the date of test.

7.2 Site Acceptance Testing (SAT)

A SAT shall be carried out on completion of the installation of the equipment at site which shall be witnessed by the Company / Owner's representative. SAT shall be performed on the Pressure / Differential Pressure Transmitter as per the approved test procedure. A comprehensive test procedure in compliance with the Company Specification shall be developed and issued to company / owner for review and approval.

The Site Acceptance Test (SAT), in general, shall demonstrate that the Pressure Transmitters functions correctly and properly in accordance with the specified requirements.

8.0 MARKING, PACKING AND SHIPMENT

Following FAT completion, Vendor responsible for the Pressure Transmitter shall ensure that all equipment and associated materials and accessories are designed properly, marked and packed, and secured for transit to site without damage.

Vendor shall provide and submit his standard "Marking, Packing and Shipping Procedures" for review by Company / Owner.

Vendor shall specify any conditions, normal or special, to be verified in intermediate storage and during transport.

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Equipment shall be suitably packed including any dismantling, transit fastening and bracing necessary to prevent distortion or damage during transit.

Adequate protection shall be provided to prevent mechanical damage and atmospheric corrosion in transit and at the jobsite.

Preparation for shipment and packing will be subject to inspection and rejection by Company's inspectors. All costs occasioned by such rejection shall be to account of the Vendor.

9.0 SPARES AND ACCESSORIES

The following spare philosophy shall be followed in case it is not covered in Job Specification.

The Vendor shall include recommended Spare Parts List for start-up, pre-commissioning and two years operation as per the following;

a. Itemized recommended spare parts list for start-up and pre-commissioning.

b. Itemized recommended spare parts list for two years operation.

Vendor shall recommend accessories and special tools required for operation and maintenance of Pressure / Differential Pressure Transmitter, for Company review.

All the spare parts furnished by Vendor shall be wrapped and packaged to preserve an original as-new condition under normal conditions of storage. The same parts shall be properly tagged with stainless steel tags and coded so that later identification as to their intended equipment usage shall be clear.

All items supplied shall be packaged separately and clearly marked as "Spare Parts" and shipped with the equipment.

10.0 DOCUMENTATION

The following documentation shall be fulfilled by the Vendor, if it is not covered in Job Specification.

10.1 Documentation Required with Technical Bid

During bidding stage Vendor shall submit in his offer the following documents as a minimum:

a. Standard Specification, Data Sheets;

b. Bill of Materials including Vendor list, details of third party items;

c. Catalogues and Manuals;

d. Quality Assurance Plan;

e. Any other documents.

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10.2 Documentation Required for Approval

Upon placement of Purchase Order, Vendor shall submit as a minimum the following drawings, documents and specifications for the Company's approval:

a. Specifications, Data Sheets;

b. Bill of materials including Vendor list, details for third party items;

c. Catalogues, Manuals and relevant drawings and documents;

d. Dimensional drawings;

e. Calibration certificates;

f. Material test certificates;

g. Procedures for FAT;

h. Quality Assurance Plan;

i. Any Other documents.

10.3 Guarantee / Warranty

Vendor shall guarantee that the complete scope of supply shall be safely and reliably meet all of the requirements of this Company Specification.

Vendor shall provide warranty support for a period of 12 months from the date of supply or 18 months from the date of manufacturing. Warranty shall apply to defective material workmanship and facility design. The cost of correction / replacement of any warranty items shall be borne by the Vendor, as per the purchase conditions of the Material / Purchase Requisition.

The Job specifications / Data sheets shall be referred for any specific warranty / guarantee.

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Energising Quality

VCS Quality Services Pvt. Ltd.

STANDARD SPECIFICATION
FOR
TEMPERATURE GAUGES AND THERMOWELLS

VCS-SS-IN-5101_02

02	11.05.2022	SV	KNC	HK	GVW
01	18.01.2020	KS	VB	KNC	AD
00	23.05.2018	ND	UM	KP	AD
Rev. No	Date	Prepared By	Checked By	Approved By	Authorized By

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REVISION RECORD						
Rev.	**Revision Date**	**Prepared by**	**Checked by**	**Approved by**	**Authorized by**	**Revision Description**
00	23.05.2018	Neha Dev	Udit Manichanda	K.Prasanth	Anupam Das	
01	18.01.2020					Format change and document numbering is revised.
		Karan Singh	Vinod Babu	Kedarnath Chakraborty	Anupam Das	
02	11.05.2022					VCS QMS Integration
		Sarita Verma	Kedar Nath Chakraborty	Hashim khan	GV Walimbe	

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ABBREVIATION

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
IEC	International Electro technical Commission
IS	Indian Standard
AARH	Average Arithmetic Roughness Heights
NACE	National Association of Corrosion Engineers
SAMA	Scientific Apparatus Makers Association
IP	Ingress Protection
SS	Stainless Steel

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