For longer lines and vertical lines, two or more pressure gauges shall be installed at locations decided by the Engineer-in-Charge.

For lines containing check valves any of the following alternatives shall be adopted for pressure testing:

- Whenever possible pressurize up-stream side of valve.
- Replace the valve by a temporary spool and reinstall the valve after testing.
- Provide blind on valve flanges and test the upstream and downstream of the line separately and remove the blind after testing. At these flanges, temporary gaskets shall be provided during testing and shall be replaced by permanent gaskets subsequently.
- For check valves in lines 1½" and below flapper or seat shall be removed during testing (if possible). After completion of testing the flapper/seat shall be refitted.

Gas lines when hydrostatically tested shall be provided with additional temporary supports during testing as directed by the Engineer-in-Charge.

Piping which is spring or counter-weight supported shall be temporarily supported, where the weight of the fluid would overload the support. Retaining pins for spring supports shall be removed only after testing is completed and test fluid is completely drained.

When testing any piping system, air or steam of approximately 2 kg/ cm^2g may be used as preliminary test to detect missing gaskets etc. as this avoids the necessity of draining the line to make repairs. However, steam shall not be used for this purpose, if the steam temperature is more than the design temperature of the line.

For jacketed pipes testing of core pipes shall be done on individual pieces where the pipe is continuously jacketed, before it is jacketed. The outer jacket shall be tested separately as a system. For piping with discontinuous jacketing the core pipe and the jacket shall be tested as separate continuous systems.

5.3 Testing Media, Test Pressure and Test Pressure Gauges

5.3.1 Testing Media

In general all pressure tests shall be hydrostatic using iron free water, which is clean and free of silt. Test fluid temperature shall be min. 5 °C. Maximum chloride content in water for hydrostatic testing for SS piping shall be 15- 20 ppm.

Air shall be used for testing only if water would cause corrosion of the system or overloading of supports etc. in special cases as directed by Engineer-in-Charge.

If operating fluid in the line is much lighter than testing fluid, the additional weight of testing fluid may render piping supports (as designed) inadequate. This will call for additional temporary supports. The typical examples are flare and vapor lines. It is preferable that hydrostatic testing is avoided in such systems and instead pneumatic testing may be specified.

Where air/water tests are undesirable, substitute fluids such as gas oil, kerosene, methanol etc. shall be used as the testing medium, with due consideration to the hazards involved. These test fluids shall be specified in the line list given to the contractor.

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5.3.2 Test Pressure

The hydrostatic/ pneumatic test pressure shall be as indicated in the line list or as per the instruction of Engineer-in-Charge.

The selection of the piping system for one individual test shall be based on the following:

- Test pressure required as per line list.
- Maximum allowable pressure for the material of construction of piping.

Depending upon the above requirements and based on construction progress, maximum length of piping shall be included in each test.

5.3.3 Test Pressure Gauge

All gauges used for field testing shall have suitable range so that the test pressure of various systems falls in 35% to 65% of gauge scale range. Pressure gage dial shall be minimum of 150 mm. Size of Bourdon shall not be less than 75% of nominal diameter of dial range. Gauge shall be of a good quality and in first class working condition.

Prior to the start of any test or periodically during the field test programme, all test gauges shall be calibrated using a standard dead weight gauge tester or other suitable approved testing apparatus. Any gauge showing an incorrect zero reading or error of more than ± 2% of full scale range shall be discarded. The Engineer-in-Charge shall check the accuracy of master pressure gauge used for calibration. Calibration certificate shall be furnished for the pressure gages.

5.4 Testing Procedure

5.4.1 Hydrostatic Test

All vents and other connections used as vents shall be left open while filling the line with test fluid for complete removal of air. In all lines for pressurizing and depressurizing the system, temporary isolation valves shall be provided if valved vents, drains do not exist in the system.

Pressure shall be applied only after the system / line is ready and approved by the Engineer-in-charge.

Pressure shall be applied by means of a suitable test pump or other pressure source which shall be isolated from the system as soon as test pressure is reached and stabilized in the system.

A pressure gauge shall be provided at the pump discharge for guidance in bringing the system to the required pressure.

The pump shall be attended constantly during the test by an authorized person. The pump shall be isolated from the system whenever the pump is to be left unattended.

Test pressure shall be maintained for a sufficient length of time not less than 10minutes. Test pressure shall be released only after physical checking of all the joints and attachments are completed, to permit thorough inspection of all joints and connections for leakage or signs of failure. Any joint found leaking during a pressure test shall be retested to the specified pressure after repair.

The pump and the piping system to be tested are to be provided with separate pressure indicating test gauges.

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Care shall be taken to avoid increase in the pressure due to temperature variation during the test.

5.4.2 Pneumatic Test

When testing with air, pressure shall be supplied by means of a compressor. The compressor shall be portable type with a receiver, after cooler and oil separator.

Piping to be tested by air shall have joints covered with a soap and water solution so that the joints can be examined for leaks.

All other details shall be same as per hydrotesting procedure (specified above).

5.5 Completion of Testing

After the hydrostatic test has been completed, pressure shall be released by opening the vents, in a manner and at a rate so as not to endanger personnel or damage equipment.

All vents shall be opened before the system is to be drained and shall remain open till all draining is complete, so as to prevent formation of vacuum in the system. After draining, lines / systems shall be dried by air. In services like dry air, ethylene etc., small traces of water can cause problem. For such lines hot air drying is to be done after hydro-test.

After testing is completed the test blinds shall be removed and equipment / piping isolated during testing shall be connected using the specified gaskets, bolts and nuts. These connections shall be checked for tightness in subsequent pneumatic tests to be carried out by the contractor for complete loop / circuit including equipment (except rotary equipment).

Pressure test shall be considered complete only after approved by the Engineer-in-Charge. Defects, if any, noticed during testing shall be rectified immediately and retesting of the system/ line shall be done by the contractor at his cost.

5.6 Test Records

Records in triplicate shall be prepared and submitted by the contractor for each piping system, for the pressure test done in the proforma provided/approved by the Engineer-in-Charge. Records shall also be submitted for the PMI undertaken as per EIL Std. Specification No. 6-82-0002.

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SPECIFICATION
FOR
CATHODIC PROTECTION SYSTEM
FOR TANK BOTTOM PLATE

Rev.	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman
					Approved by	
1	15.10.24	REAFFIRMED	PTR	NSB	RC	MN
0	15.10.18	ISSUED AS STANDARD SPECIFICATION	PTR	NSB	BRB	RKT

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Abbreviations:

AC	Alternating Current
AJB	Anode Junction Box
BS	British Standards
BIS	Bureau of Indian Standards
CEA	Central Electricity Authority
CIMFR	Central Institute of Mines and Fuel Research
CJB	Cathode Junction Box
CP	Cathodic Protection
CPPSM	Cathodic Protection Power Supply Module
CPTR	Cathodic Protection Transformer Rectifier
CTE	Coal tar enamel
Cu/CuSO4	Copper/Copper Sulphate
DC	Direct Current
ERTL	Electronics Regional Testing Laboratory
FBE	Fusion Bonding Epoxy
HV	High Voltage
HMWPE	High Molecular Weight Poly Ethelene
IS	Indian Standards
$\mu A/mm^2$	Micro-ampere per square millimeter
mA/mm^2	Milli-ampere per square millimeter
MMO	Mixed Metal Oxide
NACE	National Association of Corrosion Engineers
PDB	Power Distribution Board
PE	Polyethylene
PVC	Polyvinyl Chloride
RMU	Remote Monitoring Unit
TSP	Tank to Sand Potential
VDR	Vendor Data Requirement

SMMS Standards Committee

Convenor: Mr. Rajesh Chitara

Members:
Ms. Nivedita S Bhattacharyya
Mr. Samiran Das
Mr. P. Thirupathi Reddy
Mr. M.S. Gunjiyal (Pipeline Projects)
Dr. Sudip paul (Structural)
Mr. Brij Raj Meena (Projects)
Mr. Rajesh Sinha(Inspection)

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1.0 SCOPE

This specification covers the philosophy to be adopted for the design and engineering of the cathodic protection system for the Tank bottom plate (external surface) including corrosion survey of the electrolyte (sand).

2.0 APPLICABLE CODES AND STANDARDS

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:

i)	NACE	:	SP0193-2016, External Cathodic Protection of On-Grade Carbon Steel Storage Tank Bottom
ii)	BS	:	EN 16299:2016, Cathodic Protection of External Surface of Above Ground Storage Tank Bases in Contact with Soil or Foundations
iii)	VDE	:	0150, protection against corrosion due to stray currents from DC installations.
iv)	IS/ IEC: 60079	:	Electrical Apparatus for Explosive Gas Atmosphere
v)	IS/ IEC: 60529	:	Classification of Degree of Protection Provided by Enclosures
vi)	OISD-GDN-180:		Lightning Protection

2.2 The equipment shall also confirm the provisions of CEA regulations and other statutory regulations currently in force in the country.

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

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

3.0 SYSTEM IMPLEMENTATION

All work to be performed and supplies to be effected as a part of CP system shall require specific review by Owner or his authorized representative. Major activities requiring review shall include but not be limited to those mentioned in vendor data requirement (VDR) form attached with MR/Tender.

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4.0 CORROSION SURVEY

4.1 General

4.1.1 The corrosion survey includes the measurement of sand resistivity survey and chemical analysis for design of CP system which shall be carried out by Contractor. The corrosion survey shall also include collection of additional data as required for completeness of the job.

4.1.2 To carry out sand resistivity measurement, Wenner's 4-pin method or an equivalent soil/sand box method approved by Owner/ Owner's representative shall be used. Survey instruments shall have maximum AC and DC ground current rejection feature.

4.1.3 Care shall be taken to ensure that the resistivity readings are not influenced by the presence of foreign structures/piping, and earth currents (if any) etc.

4.2 Report

On completion of all field work, a report incorporating all the results generated from surveys and details of additional data collected (e.g. nearby structures, details of hazardous area classification, location proposed for CPTR units, power source details etc.) shall be prepared. The report shall also contain detailed interpretation of survey results and resistivity data, to form a design basis for cathodic protection. This report shall also include various drawings prepared in connection with the above work. Soil resistivity values shall be plotted on semi-log graph sheets.

5.0 CATHODIC PROTECTION DESIGN PARAMETERS

A distinctly independent impressed current cathodic protection system shall be provided to protect the external surfaces of the Tank bottom plates as specified.

Unless otherwise stated in the data sheets, the following parameters shall be used for design of permanent cathodic protection system:

5.1	Protection Current Density Range	:	10-30 mA/m2 (at 25 ^{0}C operating temperature)
5.2	If operating temperatures of Bullet exceed 25 deg. C, protective current density shall be corrected @ 0.5mA/ m2/ deg. C.		
5.3	Sand resistivity	:	200 Ohm-m
5.4	Tank plate natural potential	:	(-) 0.45 V (w.r.t. Cu/CuSO4 ref. cell)
5.5	Anode	:	Ti-MMO wire anode
5.6	Current capacity of anode	:	30 mA/m (for design purpose)
5.7	Design life of CP system	:	30 years, unless specified elsewhere

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5.8 Anode ground bed loop resistance including anode to ground resistance, anode and cathode cable resistances : 1 Ohm (max.)

5.9 Scheme for Cathodic Protection System of a Tank bottom plate (external surface)

5.9.1 Each Tank bottom plate CP system shall be independent and exclusive. The scheme defined below shall be applicable.

5.9.2 Impressed Current Cathodic Protection (CP) System shall be provided for sand side corrosion prevention of Tank bottom plate.

5.9.3 Anodes employed for CP System of Tanks shall be mixed metal oxide coated on titanium wire anode, piggyback connected with anode lead cable, factory pre-packed with coke breeze.

5.9.4 The anode strings shall be located under the Tank in sand bed. Specific installation requirements of String Anode shall be as follows:

- Anode strings shall be distributed in loops shall be installed in the sand cushion under the tank at a separation distance of 1000mm from the Tank bottom external surface.
- Separation distance between consecutive String anode strings shall be uniform and shall be maximum 1000 mm.
- Two consecutive anode strings shall form a continuous loop.
- Two consecutive anode loops be connected to different AJBs located opposite-along the Tank centreline.
- The above anode distribution is based on the assumption that temperate of the sand at 1000mm distance from tank bottom external surface shall be below 75 deg.C

5.9.5 Highest of number/length of anodes calculated as per design parameters defined under clause 5.1 to 5.8 and that worked out as per clause 5.9.4 shall be provided.

5.9.6 Free ends of each string anode shall be terminated to AJB.

5.9.7 Cathodic Protection Transformer-Rectifier unit (CPTR Unit) of suitable rating (25V/25A or 50V/50A or 75V/75A) shall be installed to energize the anode strings for Vessels.

5.9.8 CPTR Unit shall have two outgoing positive header cables, which shall be terminated to 2 nos. AJBs to be installed on opposite sides of the Tank along its diameter.

5.9.9 CPTR Unit shall have one out going negative header cable, which shall be connected cathode junction box cum test stations (CJB) located at Tank for the drainage connection and potential measurement.

5.9.10 Two drainage cables and two measurement cables from each Tank shall be terminated to its CJB.

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5.9.11 Minimum 5 no.s Cu/CuSO4 Permanent Reference cells shall be provided for each Tank which shall be able to measure the complete potential profile of the Tank.

5.9.12 Power supply for the CPTR Unit shall be drawn from the nearest Substation.

5.9.13 The reference cell cables and the measurement cables from each Tank shall be routed through the respective Monitoring Junction Box (MJB).

5.9.14 If required, a MJB may be integrated with CJB and a single/composite Cathode junction box cum Reference cell junction box (CRJB) may be provided.

5.9.15 The CPTR unit shall preferably have the built-in RMU module. In case RMU is not integral part of CPTR unit, then a separate RMU panel may be provided and both the equipments (CPTR Unit and RMU) shall be connected with communication cables for status monitoring and control purpose.

5.9.16 For monitoring of Tank to sand potentials, monitoring cables of reference cells shall be laid between MJB and CPTR unit & RMU. For CPTR unit at least three reference cells shall be connected and for RMU all the Reference cell cables shall be connected.

5.9.17 All Cable laying shall be done on existing cable route which shall be overhead cable trays/ cable trenches wherever possible. Underground Cable laying in paved/ unpaved areas shall be done through RCC trench/directly buried trenches respectively, wherever overhead cable trays/ cable trenches are not available.

5.9.18 Connection of drainage cables and measurement cables to the Tank shall be done by Thermit welding.

5.9.19 Minimum 3 no's of perforated HDPE pipes under the Tank shall be installed for measuring potential using portable reference cells. The HDPE pipes shall be installed at 120^0 apart from each other. The HDPE pipe shall be covered with geotextile cloth and shall be of 75mm diameter, slotted of 50 mm (2 inch) in length 0.15 mm width, 4 kg/cm2 pressure rating, sealed at one end. These HDPE pipes shall be installed perpendicular to each other and at a separation of 300mm from the tank bottom surface.

6.0 CATHODIC PROTECTION DESIGN CRITERIA

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

6.1 The Tank to Sand Potential (TSP) measurements shall be between (-) 0.85V (OFF) and (-) 1.20V (OFF) with respect to a copper/copper sulphate reference electrode.

6.2 A minimum polarization shift of (-) 100 millivolts can be accepted as an adequate level of cathodic protection for the Tank with the approval of Owner in exceptional cases. Discretion to use any of the criteria shall solely rest with owner/owner's representative.

6.3 A positive potential swing of 50 millivolts 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.

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7.0 SYSTEM DETAILS

7.1 The system shall include the following major equipment/ sub-systems unless otherwise specified in project specifications:

- Power Distribution Board
- CPTR units.
- Remote monitoring unit
- MMO Anodes
- Anode junction box
- Cathode junction box
- Measurement Junction box
- Permanent reference cells
- Cables

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

7.3 All equipment/ materials shall conform to the relevant specifications included in the tender document.

7.4 The CPTR unit and RMU etc. shall be located in safe non-hazardous areas. However all junction boxes shall be flame proof, Temperature class T3 (min.) & suitable for Gas Group specified in datasheet.

7.5 The electrical and electronic equipments installed in hazardous area shall be flame proof type and shall meet the requirements as per IS/ IEC: 60079 and shall be weather proof IP-65 as per IS/IEC:60529.

7.6 Hazardous area certificate from CIMFR or equivalent test house of country of origin, applicable PESO approval certificate, BIS license and original drawings referred in type test certificate shall be shown to the Inspection agency during inspection. The Certificate and BIS license must be valid at the time of dispatch.

7.7 Power Distribution Board

Power Distribution board (PDB) shall be provided incase multiple CPTR units are envisaged. PDB shall be fed through 1 no. 415V±10%, 50Hz±3% TPN feeder from Owner's substation and shall have required no. of outgoing feeder rated for 240V, SPN or 415V, TPN feeders.

7.8 CP Transformer Rectifier Unit

The Cathodic Protection Transformer Rectifier Unit (CPTR unit) shall confirm to the requirements mentioned in datasheet and shall be installed in non-hazardous area as specified in data sheets.

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7.9 Anode Beds/Loops

Anodes shall be supplied complete with tail cables, which shall be long enough for termination on their associated anode lead junction boxes without intermediate joints. Exact lengths and termination details shall be indicated in construction drawings.

Potential gradient around the anodes shall be within safety requirements with regard to interference on foreign structures and its effective boundary shall be defined.

7.10 MMO Anodes

Anodes shall be mixed metal oxide coated titanium wire anodes. The MMO wire anodes shall be piggyback connected with anode lead cable, factory pre-packed with coke breeze. The detail specification shall be as mentioned in data sheet.

7.11 Anode Junction Box

All cable tails from individual anodes shall be terminated onto the respective anode junction boxes, which shall be further connected to the positive cable coming from CP power source. Each anode circuit in junction shall have provision for measurement and control of individual circuit/anode current through variable resistors, shunts and links of suitable ratings.

7.12 Cathode Junction Box

Cathode junction box shall be provided near the Tank for connection of the negative drainage cables to the Tank. The negative of the CP power source shall be connected to the incoming circuit of the cathode junction box.

The incoming circuit and each out going circuits shall have provision for measurement and control of current through variable resistors, shunts and links of suitable ratings.

7.13 Monitoring Junction Box

All the reference cells provided under the Tank shall be connected to monitoring junction boxes. Measurement and control cables from monitoring junction box shall be connected to CPTR unit and RMU unit.

7.14 Permanent Reference Cells

Unless otherwise agreed, High purity copper/copper sulphate reference cells with proven high reliability shall be provided for stable Tank to sand potential measurement.

7.15 Cables

7.15.1. All the Power Cables i.e. Cables from Power feeder to PDB, PDB to CPTR Unit, PDB to RMU unit, and Positive/Negative Header cables shall be with annealed high conductivity stranded copper conductor, PVC insulated, 650/1100 V grade, armoured, PVC sheathed conforming to IS 1554 part-I.

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7.15.2. Anode lead cable shall be of 1CX16mm2 stranded copper conductor, 7 strands, insulated (Refer Sr. no. 1 or Sr. no. 2 of Table-1), unarmoured, with a double insulation system. The primary insulation shall be 0.04 inch thick irradiated cross-linked polyvinylidene floride (PVDF) or Ethylene Chlorotrifloroethylene (ECTFE) 1100 Volt grade. The secondary insulation shall be 0.065 inch thick HMWPE (Refer Sr. no. 3 of Table-1) sheathing jacket over the primary insulation.

Table-1

Sr no.	Insulation type	Insulation Specification*	
1.	polyvinylidene floride (PVDF) Irradiation cross linked	Tensile Break Streangth	4500 PSI (min)
		Break Elongation	50%
		Flexural Strength	8600 PSI (min)
		Resistivity	$2X10^{14}$ (min)
		Dielectric Constant	8 (min) at 100Hz
2.	Ethylene Chlorotrifloroethylene (ECTFE)	Tensile Break Streangth	6500 PSI (min)
		Break Elongation	100%
		Resistivity	$1X10^{15}$ (min)
		Dielectric Constant	2.5 (min) at 1MHz
3.	High Density Molecular Weight Polyethylene (HMWPE)	Color	Black
		Density	0.941 gm/cm^3
		ASTM D1248, Type 3, Class C, Category 5 or IEC 60502-1	
		Temperature rating	90°C

* Standard Test Method ASTM D638 shall be used to determine the tensile strength, Flexural Strength and Break Elongation. For the resistivity and dielectric contant tests, standard test methods ASTM D257and ASTM D150 shall be utilized.

7.15.3. The cables for reference cells, potential measurements shall be of copper conductor, HMWPE insulated, Aluminium backed by mylar/ polyster tape shielded, HMWPE sheathed, armoured, HMWPE over all sheathed type.

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SPECIFICATION
FOR
CATHODIC PROTECTION SYSTEM
FOR UNDERGROUND VESSELS

Rev.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
1	15.10.24	REAFFIRMED	PTR	NSB	RC	MN
0	15.10.18	ISSUED AS STANDARD SPECIFICATION	PTR	NSB	BRB	RKT

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Abbreviations:

AC	Alternating Current
AJB	Anode Junction Box
BS	British Standards
BIS	Bureau of Indian Standards
CEA	Central Electricity Authority
CIMFR	Central Institute of Mines and Fuel Research
CJB	Cathode Junction Box
CP	Cathodic Protection
CPPSM	Cathodic Protection Power Supply Module
CPTR	Cathodic Protection Transformer Rectifier
CTE	Coal tar enamel
Cu/CuSO4	Copper/Copper Sulphate
DC	Direct Current
ERTL	Electronics Regional Testing Laboratory
FBE	Fusion Bonding Epoxy
HV	High Voltage
HMWPE	High Molecular Weight Poly Ethylene
IS	Indian Standards
$\mu A/mm^2$	Micro-ampere per square millimeter
mA/mm^2	Milli-ampere per square millimeter
MMO	Mixed Metal Oxide
NACE	National Association of Corrosion Engineers
PDB	Power Distribution Board
PE	Polyethylene
PVC	Polyvinyl Chloride
RMU	Remote Monitoring Unit
VDR	Vendor Data Requirement
VSP	Vessel to Sand Potential

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Mr. Brij Raj Meena (Projects)
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1.0 SCOPE

This specification covers the philosophy to be adopted for the design and engineering of the cathodic protection system for the underground Vessels (external surface) including corrosion survey of the electrolyte (sand).

2.0 APPLICABLE CODES AND STANDARDS

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:

i)	NACE	:	SP-0285 Corrosion Control of Underground Storage Tank Systems by Cathodic Protection
ii)	BS	:	EN 13636:2004, Cathodic Protection of Buried Metallic Tanks and Related Piping
iii)	VDE	:	0150, protection against corrosion due to stray currents from DC installations.
iv)	IS/ IEC: 60079	:	Electrical Apparatus for Explosive Gas Atmosphere
v)	IS/ IEC: 60529	:	Classification of Degree of Protection Provided by Enclosures
vi)	OISD-GDN-180	:	Lightning Protection

2.2 The equipment shall also confirm the provisions of CEA regulations and other statutory regulations currently in force in the country.

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

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

3.0 SYSTEM IMPLEMENTATION

All work to be performed and supplies to be effected as a part of CP system shall require specific review by Owner or his authorized representative. Major activities requiring review shall include but not be limited to those mentioned in vendor data requirement (VDR) form attached with MR/Tender.

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4.0 CORROSION SURVEY

4.1 General

4.1.1 The corrosion survey includes the measurement of sand resistivity survey and chemical analysis for design of CP system which shall be carried out by Contractor. The corrosion survey shall also include collection of additional data as required for completeness of the job.

4.1.2 To carry out sand resistivity measurement, Wenner's 4-pin method or an equivalent soil/ sand box method approved by Owner/ Owner's representative shall be used. Survey instruments shall have maximum AC and DC ground current rejection feature.

4.1.3 Care shall be taken to ensure that the resistivity readings are not influenced by the presence of foreign structures/piping, and earth currents (if any) etc.

4.2 Report

On completion of all field work, a report incorporating all the results generated from surveys and details of additional data collected (e.g. nearby structures, details of hazardous area classification, location proposed for CPTR units, power source details etc.) shall be prepared. The report shall also contain detailed interpretation of survey results and resistivity data, to form a design basis for cathodic protection. This report shall also include various drawings prepared in connection with the above work. Soil resistivity values shall be plotted on semi-log graph sheets.

5.0 CATHODIC PROTECTION DESIGN PARAMETERS

A distinctly independent impressed current cathodic protection system shall be provided to protect the external surfaces the underground Vessel as specified.

Unless otherwise stated in the data sheets, the following parameters shall be used for design of permanent cathodic protection system:

5.1	Protection Current Density Range	:	10-30 mA/m2 (at 25 ^{0}C operating temperature)
5.2	If operating temperatures of Bullet exceed 25 deg. C, protective current density shall be corrected @ 0.5mA/ m2/ deg. C.		
5.3	Sand resistivity	:	200 Ohm-m
5.4	Vessel natural potential	:	(-) 0.45 V (w.r.t. Cu/CuSO4 ref. cell)
5.5	Anode	:	MMO wire anode
5.6	Current capacity of anode	:	30 mA/m
5.7	Design life of CP system	:	30 years, unless specified elsewhere

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5.8 Anode ground bed loop resistance including anode to ground resistance, anode and cathode cable resistances : 1 Ohm (max.)

5.9 Scheme for Cathodic Protection System of a Vessel

5.9.1 Each Vessel's CP system shall be independent and exclusive. The scheme defined below shall be applicable.

5.9.2 Impressed Current Cathodic Protection (CP) System shall be provided for sand side corrosion prevention of Vessel external surface.

5.9.3 Anodes employed for CP System of vessels shall be mixed metal oxide coated on titanium wire anode, piggyback connected with anode lead cable, factory pre-packed with coke breeze.

5.9.4 The anode strings shall be located around the Vessel. Specific installation requirements of String Anode shall be as follows:

- Anode strings shall be distributed in loops and shall be installed in the sand cushion surrounding the Vessel at a separation distance of 1000mm from the Vessel surface.
- Separation distance between consecutive String anode loops (vertical separation) shall be uniform and shall be limited to maximum 1000 mm.
- Two consecutive anode loops shall be connected to different AJBs located opposite-along the Vessel centreline.
- The above anode distribution is based on the assumption that temperature of the sand in pit at 1000mm distance from Vessel surface shall be below 75 deg.C

5.9.5 Highest of number/length of anodes calculated as per design parameters defined under clause 5.1 to 5.8 and that worked out as per clause 5.9.4 shall be provided.

5.9.6 Free ends of each string anode shall be terminated to AJB through loop connection.

5.9.7 Cathodic Protection Transformer-Rectifier unit (CPTR Unit) of suitable rating (25V/25A or 50V/50A or 75V/75A) shall be installed to energize the anode strings for Vessels.

5.9.8 CPTR Unit shall have two outgoing positive header cables, which shall be terminated to 2 nos. AJBs to be installed on opposite sides of the Vessel along its Centerline (TL-TL).

5.9.9 CPTR Unit shall have one out going negative header cable, which shall be connected to cathode junction box (CJB) located near Vessel for the drainage connection and potential measurement.

5.9.10 Two drainage cables and two measurement cables from each vessel shall be terminated to its CJB.

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5.9.11 Minimum 5 no.s $Cu/CuSO_4$ Permanent Reference cells shall be provided for each vessel which shall be able to measure the complete potential profile of the Vessel.

5.9.12 Power supply for the CPTR Unit shall be drawn from the nearest Substation.

5.9.13 The reference cell cables and the measurement cables from each Vessel shall be routed through the respective Monitoring Junction Box (MJB).

5.9.14 If required, a MJB may be integrated with CJB and a single/composite Cathode junction box cum Reference cell junction box (CRJB) may be provided.

5.9.15 The CPTR unit shall preferably have the built-in RMU module. In case RMU is not integral part of CPTR unit, then a separate RMU panel may be provided and both the equipments (CPTR Unit and RMU) shall be connected with communication cables for status monitoring and control purpose.

5.9.16 For monitoring of Vessel to sand potentials, monitoring cables of reference cells shall be laid between MJB and CPTR unit & RMU. For CPTR unit at least three reference cells shall be connected and for RMU all the Reference cell cables shall be connected.

5.9.17 All Cable laying shall be done on existing cable route which shall be overhead cable trays/ cable trenches wherever possible. Underground Cable laying in paved/ unpaved areas shall be done through RCC trench/directly buried trenches respectively, wherever overhead cable trays/ cable trenches are not available.

5.9.18 Connection of drainage cables and measurement cables to the Vessel shall be done by Thermit welding.

5.9.19 Minimum 3 no's of perforated HDPE pipes surrounding the Vessel shall be installed for measuring potential using portable reference cells. The HDPE pipe shall be covered with geotextile cloth and shall be of 75mm diameter, slotted of 50 mm (2 inch) in length 0.15 mm width, 4 kg/cm^2 pressure rating, sealed at one end.

6.0 CATHODIC PROTECTION DESIGN CRITERIA

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

6.1 The Vessel to sand potential (VSP) measurements shall be between (-) 0.85V (OFF) and (-) 1.20V (OFF) with respect to a Cu/CuSO4 reference electrode.

6.2 A minimum polarization shift of (-) 100 millivolts can be accepted as an adequate level of cathodic protection for the Vessel with the approval of Owner in exceptional cases. Discretion to use any of the criteria shall solely rest with owner/owner's representative.

6.3 A positive potential swing of 50 millivolts or more shall be considered sufficient to indicate the presence of an interaction/ interference situation requiring investigation and incorporation of mitigation measures.

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7.0 CATHODIC PROTECTION EQUIPMENTS

7.1 The system shall include the following major equipment/ sub-systems unless otherwise specified in project specifications:

- Power Distribution Board
- CPTR units.
- Remote monitoring unit
- MMO Anodes
- Anode junction box
- Cathode junction box
- Measurement Junction box
- Permanent reference cells
- Cables

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

7.3 All equipment/ materials shall conform to the relevant specifications included in the tender document.

7.4 The CPTR unit and RMU etc. shall be located in safe non-hazardous areas. However all junction boxes shall be flame proof, Temperature class T3 (min.) & suitable for Gas Group specified in datasheet.

7.5 The electrical and electronic equipments installed in hazardous area shall be flame proof type and shall meet the requirements as per IS/ IEC: 60079 and shall be weather proof IP-65 as per IS/IEC:60529.

7.6 Hazardous area certificate from CIMFR or equivalent test house of country of origin, applicable PESO approval certificate, BIS license and original drawings referred in type test certificate shall be shown to the Inspection agency during inspection. The Certificate and BIS license must be valid at the time of dispatch.

7.7 Power Distribution Board

Power Distribution board (PDB) shall be provided incase multiple CPTR units are envisaged. PDB shall be fed through 1 no. 415V±10%, 50Hz±3% TPN feeder from Owner's substation and shall have required no. of outgoing feeder rated for 240V, SPN or 415V, TPN feeders.

7.8 CP Transformer Rectifier Unit

The Cathodic Protection Transformer Rectifier Unit (CPTR unit) shall confirm to the requirements mentioned in datasheet and shall be installed in non-hazardous area as specified in data sheets.

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7.9 Anode Beds/ Loops

Anodes shall be supplied complete with tail cables, which shall be long enough for termination on their associated anode lead junction boxes without intermediate joints. Exact lengths and termination details shall be indicated in construction drawings.

Potential gradient around the anodes shall be within safety requirements with regard to interference on foreign structures and its effective boundary shall be defined.

7.10 MMO Anodes

Anodes shall be mixed metal oxide coated titanium wire anodes. The MMO wire anodes shall be piggyback connected with anode lead cable, factory pre-packed with coke breeze. The detail specification shall be as mentioned in data sheet.

7.11 Anode Junction Box

All cable tails from individual anodes shall be terminated onto the respective anode junction boxes, which shall be further connected to the positive cable coming from CP power source. Each anode circuit in junction shall have provision for measurement and control of individual circuit/anode current through variable resistors, shunts and links of suitable ratings.

7.12 Cathode Junction Box

Cathode junction box shall be provided near the Vessel for connection of the negative drainage cables to the Vessel. The negative of the CP power source shall be connected to the incoming circuit of the cathode junction box.

The incoming circuit and each out going circuits shall have provision for measurement and control of current through variable resistors, shunts and links of suitable ratings.

7.13 Monitoring Junction Box

All the reference cells provided around the Vessel shall be connected to monitoring junction boxes. Measurement and control cables from monitoring junction box shall be connected to CPTR unit and RMU unit.

7.14 Permanent Reference Cells

Unless otherwise agreed, High purity copper/ copper sulphate reference cells with proven high reliability shall be provided for stable Vessel to sand potential measurement.

7.15 Cables

7.15.1. All the Power Cables i.e. Cables from Power feeder to PDB, PDB to CPTR Unit, PDB to RMU unit, and Positive/ Negative Header cables shall be with annealed high conductivity stranded copper conductor, PVC insulated, 650/1100 V grade, armoured, PVC sheathed conforming to IS 1554 part-I.

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7.15.2. Anode lead cable shall be of 1CX16 mm^2 stranded copper conductor, 7 strands, insulated (Refer Sr. no. 1 or Sr. no. 2 of Table-1), unarmoured, with a double insulation system. The primary insulation shall be 0.04 inch thick irradiated cross-linked polyvinylidene floride (PVDF) or Ethylene Chlorotrifloroethylene (ECTFE) 1100 Volt grade. The secondary insulation shall be 0.065 inch thick HMWPE (Refer Sr. no. 3 of Table-1) sheathing jacket over the primary insulation.

Table-1

Sr no.	Insulation type	Insulation Specification*	
1.	polyvinylidene floride (PVDF) Irradiation cross linked	Tensile Break Strength	4500 PSI (min)
		Break Elongation	50%
		Flexural Strength	8600 PSI (min)
		Resistivity	$2X10^{14}$ (min)
		Dielectric Constant	8 (min) at 100Hz
2.	Ethylene Chlorotrifloroethylene (ECTFE)	Tensile Break Strength	6500 PSI (min)
		Break Elongation	100%
		Resistivity	$1X10^{15}$ (min)
		Dielectric Constant	2.5 (min) at 1MHz
3.	High Density Molecular Weight Polyethylene (HMWPE)	Color	Black
		Density	0.941 gm/cm^3
		ASTM D1248, Type 3, Class C, Category 5 or IEC 60502-1	
		Temperature rating	90°C

* Standard Test Method ASTM D638 shall be used to determine the tensile strength, Flexural Strength and Break Elongation. For the resistivity and dielectric constant tests, standard test methods ASTM D257and ASTM D150 shall be utilized.

7.15.3. The cables for reference cells, potential measurements shall be of copper conductor, HMWPE insulated, Aluminium backed by mylar/ polyester tape shielded, HMWPE sheathed, armoured, HMWPE over all sheathed type.

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टैंकों के लिये कैथोडिक प्रतिरक्षण प्रणाली हेतु स्थापना, प्री-कमिशनिंग, परीक्षण और कमिशनिंग के लिए विनिर्देश

SPECIFICATION FOR INSTALLATION, PRE-COMMISSIONING, TESTING AND COMMISSIONING OF CATHODIC PROTECTION SYSTEM FOR TANKS

Rev.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
0	26 02 20	ISSUED AS STANDARD SPECIFICATION	AKD	NSB	SA	RKT

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Abbreviations:

AJB	:	Anode Junction Box
CJB	:	Cathode Junction Box
CP	:	Cathodic Protection
CPTR	:	Cathodic Protection Transformer Rectifier
DC	:	Direct Current
EIL	:	Engineers India Limited
ICCP	:	Impressed Current cathodic Protection
IS	:	Indian Standards
MMO	:	Mixed Metal Oxide
NACE	:	National Association of Corrosion Engineers
OISD	:	Oil Industry Safety Directorate
PDB	:	Power Distribution Box
TRU	:	Transformer Rectifier Unit

Electrical Standards Committee

Convenor: Ms. Sumita Anand

Members: Mr. Parag Gupta
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Ms. ANP Singh
Ms. N.S. Bhattacharya
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1.0 OBJECTIVE

This procedure defines the methodology, requirements, responsibilities and equipment required for the Impressed Current Cathodic Protection System Installation, Pre-commissioning and Commissioning of the tank bottom plate to ensure CP contractor conform to the specifications and other applicable codes and standards

2.0 SCOPE

The scope of this document is to describe the procedures for typical requirement for wire anode installation, Pre-commissioning and Commissioning of an Impressed Current Protection System works for Tank bottom plates and provide adequate Quality Assurance / Control of workmanship and inspection at site. Pre-commissioning inspection and testing will be carried out to conform satisfactory installation works as per the project specification design and drawings.

The contractor shall have all necessary construction equipment, tools and tackle and testing instruments to carry out the erection works and to commission the system as specified. These equipment shall be brought to site by contractor before start of work.

3.0 REFERENCES

i) Project Specification for CP system for Crude Tanks
ii) CP System Design & Detail Calculation Document for Tank Bottom Plates.
iii) Overall CP Equipment and Cable Route Layout.
iv) NACE : RP-0193 : External Cathodic Protection of on-grade carbon steel storage tank bottom
v) IS/ IEC : 60529 : Classification of Degree of Protection Provided by Enclosures
vi) OISD-GDN-180 : Lightning Protection

4.0 INSTALLATION

4.1 Prior to start of installation, contractor shall verify that equipment and complete materials have been received. Handling, shifting to required site location, installation, pre-commissioning, testing and commissioning shall be done by contractor with utmost care. Manufacturer's instructions and the requirements given in their technical manual shall be strictly adhered. The substation/control room wherein the equipment to be installed shall be clean, dry and free from all debris. Care shall be taken to observe the correct lifting arrangements and to make sure that the slings are attached to the manufacturer's designated lifting points, where applicable. No parts shall be subjected to undue strains or sudden stresses which could cause damage to the equipment.

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

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

Manufacturer checklist, manual for erection, installation and any specific requirement for equipment handling, installation and commissioning shall be strictly adhered to.

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4.2 Following activities shall be done by contractor during various stages of installation

4.2.1 STAGE-I:

i) Making the cable trench for pre-packed Mixed Metal Oxide (MMO) wire anodes considering the number of Strings as per design calculation.

ii) Check continuity of anode and cable before installation in tank pad to ensure healthiness.

iii) Laying of pre-packed Mixed Metal Oxide wire Anodes in Tank sand pad, one by one at its full length.

iv) Jointing of Pre-packed Mixed Metal Oxide wire Anodes end with connecting lead cable by using Inline splice kits at front side of Tank as per Inline splice Kit jointing procedure.

v) Provide anode identification marks on anode lead cable of each loops coming out from tanks

4.2.2 STAGE-II

i) Making box type pocket for Reference Cell, position as per requirement

ii) Checking healthiness of Permanent Reference Cell before installation with respect to calibrated Master Reference Cell.

iii) Check continuity of reference cell cable before installation in tank pad to ensure healthiness.

iv) Installation of Reference Cell ($Cu\text{-}CuSO_4$) inside pocket and sand filling with layer by layer compaction with wooden pallet.

v) Jointing of Reference Cell end with connecting reference lead cable by using jointing ferrule and sealing compound kit.

vi) Provide reference cell identification mark on cable of each cell coming out from tanks.

vii) Insert perforated pipe as per approved design and drawing

4.2.3 STAGE-III

Activities which are to be performed outside the Tank sand pad foundation:

i) Installation of all junction boxes on a mounting frame in front of the Tank as per approved design and drawing.

ii) Termination & connection of all the cables in the junction boxes.

iii) Installation of grounding cell (DC Decoupler) in enclosure & connecting the cables from Tank to grounding cells.

iv) Connection of the outgoing cable from Grounding cell to the earthing grid.

v) Installation of TRU panels.

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vi) TR-Unit connection of all incoming & outgoing cables & termination

vii) Generation of installation report in standard format.

5.0 PRE-COMMISSIONING AND TESTING

i) After the equipment is installed properly in accordance with specifications, design documents, drawings and contractor shall carry out all pre-commissioning checks and tests as per EIL format in the presence of Engineer-in-charge and test readings shall be recorded and furnished to EIL in triplicate.

ii) It is anticipated that various installation checks have been previously accomplished and accepted during installation of CP equipment and facilities or otherwise to be carried out in conjunction with the commissioning activities.

iii) 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, wiring properly dressed and labeled, sealing of unused cable entries, checking of all safety interlocks, control/interface functions as per requirement etc.

iv) The contractor shall bring to site all required tools, tackles and testing instruments for carrying out field testing. Contractor shall use only calibrated measuring and test instruments and shall maintain valid calibration record.

v) The inspection/test data sheets associated with pre-commissioning and commissioning of cathodic protection system shall be provided by vendor.

5.1 General Inspection

Prior to commissioning of the CP system and before energizing the transformer rectifier unit, the following activities shall be performed.

i) Ensure that minimum 50% of product level is maintained in the structure to have proper contact with soil.

ii) Review all test and inspection data sheets that have been previously accomplished during CP installation. All installation data results to be verified to ensure that inspection and testing have been carried out successfully.

iii) Review all CP design drawings, deviations if any shall be noted and incorporated in the as-built drawings.

iv) Visual inspections to be performed to ensure that all above ground (exposed) CP components and facilities are not physically damaged during or after CP installation works. Any discrepancies to be noted and necessary corrective actions shall be taken prior to commissioning.

v) All CP cables to be checked for proper termination and identification as per schematic drawings.

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5.2 Pre-Commissioning Check List

5.2.1 Transformer Rectifier

5.2.1.1 The following information to be obtained and recorded as a minimum

i) TR unit ID
ii) TR unit Manufacturer
iii) TR type/ model/ Sl. No.
iv) Sun Shade
v) TR Input and Output Rating
vi) Date of Inspection
vii) Name of Inspector

5.2.1.2 **Inspection**

The following inspections and checks shall be performed and recorded when the TR unit is in switched off condition.

i) Visual inspection of each TR (transformer rectifier) unit to be performed to ensure correct installation and that the unit has not been physically damaged prior to operation. Any discrepancies will be noted and rectified.

ii) All panel connections and terminals to be checked for tightness. Any loose connection shall be tightened.

iii) The polarity of the DC output cable to be verified to ensure that the positive output cables are connected to the anode terminals and the negative terminals are connected to the tank.

iv) Verify that the power supply to the Transformer Rectifier (TR) corresponds to the required rating. Measure and record the AC supply voltage at the input terminals of the transformer rectifier circuit breaker.

v) Verify and ensure that the Transformer Rectifier is properly grounded to the earthing system.

vi) Ensure that all fuses are of proper current and voltage ratings. Check the continuity of all fuses and spares by an ohmmeter.

vii) Measure the insulation resistance between Transformer & TR body and earthing resistance between TR and earth.

viii) Check whether the output knobs are in minimum position.

ix) Check the colour of silica gel.

x) Ensure that TR (oil cooled) has at least minimum level of oil, if necessary add more.

5.2.1.3 **Total Circuit Resistance Test**

i) After proper polarity of the DC output cables have been confirmed and the cables have been labelled with permanent tags, disconnect the anode and the cathode cables from the DC output terminal of the Transformer Rectifier.

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ii) Using a four-pin resistance meter with P1/C1 and P2/C2 terminal shorted, connect the test leads of the instruments across the DC cables and measure the resistance.

iii) This testing will be done to measure the overall circuit resistance of the CP system and to ensure that no short circuit exist between the anode (positive) and cathode (negative).

iv) The result will be recorded in the pre-commissioning data sheet.

5.2.2 **Anode Inspection**

i) Verify that the anode have been properly checked and accepted for compliance with the drawings and design during the installation works.

ii) Based on the above, check the power feed connections and verify that the cable is properly terminated and identified at the Anode Junction Box (AJB). Any discrepancies shall be rectified.

iii) The tests shall be performed at the AJB between the anode feeders. Continuity test to be carried out between all anode feeders lead cable to ensure electrical continuity of all anodes.

iv) The result will be recorded in the AJB pre-commissioning data sheet.

5.2.3 **Junction Boxes & PDB**

5.2.3.1 The following information shall be obtained and recorded as minimum:

i) Junction Box & PDB ID
ii) Number of Circuits
iii) Resistor Rating if present
iv) Shunt Rating if present
v) Date of Inspection and Name of the Inspector

5.2.3.2 The following inspections shall be performed at each junction box.

i) A visual inspection of the junction box & PDB will be performed to ensure correct installation in accordance with the drawings and that the junction boxes & PDB have not been physically damaged prior to operation. Any discrepancies will be noted.
ii) All cable connections and terminals shall be checked for tightness. Any loose connections shall be tightened.
iii) All cables are to be checked for proper tagging and to ensure it is as per design/drawing.
iv) The result will be recorded in the pre-commissioning format.

5.2.4 **Natural Potential measurement**

Before energizing the transformer rectifier, the natural potential of tank (partially filled with product) base plate should be measured and recorded using permanent reference electrodes as well as using portable reference electrode.

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5.2.4.1 Potential Measurement using Permanent Reference Electrodes

i) The tank to soil potential measurement is obtained using high impedance multimeter (min. 10 Mega ohms).

ii) Attach the test lead from the positive terminal of the meter to the tank at the junction box.

iii) Attach the test lead from the negative terminal of the meter to the permanent reference electrode point at the junction box.

iv) The tank potential in millivolts is read directly from the meter.

v) Natural potential measurement using permanent reference electrode to be carried out at all reference electrode locations.

vi) Record the millivolts reading with polarity on the corresponding data sheet.

NOTE:

When product level is low, tank bottom may not have a good contact with the electrolyte thus affecting the tank to soil potentials. This error can be minimized by ensuring that there is sufficient level of the product in the tank during commissioning.

6.0 COMMISSIONING

After successful pre-commissioning of the cathodic protection equipment, the CP system is ready for testing, start up and commissioning. The contractor shall carry out complete testing and commissioning of material and equipment as per Inspection and test plans (ITP).

6.1 Before switching "ON" the transformer rectifiers, the following condition should be met.

i) All CP cables inside junctions and TR are to be checked and corrected for any discrepancies.

ii) Natural potential of all structures involved in cathodic protection system has been measured and recorded.

iii) Tanks are to be full or minimum half-filled with electrolyte.

iv) A close visual inspection of electrical equipment in hazardous area 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.

6.2 Commissioning Steps

The steps described below should be followed systematically during execution of final commissioning.

i) The transformer rectifier has been previously checked and tested during the pre-commissioning stages and the results are recorded in the data sheet. Read and study the transformer rectifier data sheet & operation manual to familiarize the system and result of the pre-commissioning test.

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ii) Set the transformer rectifiers output control to 0% range and switch "on " the transformer rectifier.

iii) Gradually adjust the transformer rectifier's output power in manual mode.

iv) Measure and record the tank to soil potential.

6.2.1 The following procedures should be followed when measuring the tank to soil potential:-

i) For tanks with permanent reference electrodes, at each reference cell box, connect the negative lead of the meter on the reference cell and positive on the tank. Record each reference electrode reading with respect to negative.

ii) Increase the transformer rectifier output in manual mode until the tank bottom potential reaches the value as per specification [-850 to -1100 mV (typical)]. The "On" potential is not a true representation of the tank protected potential. The instant "off" potential will be measured for final reading & conclusion. Before taking instant off potentials, the transformer rectifier should be kept energized until adequate polarisation is achieved (typically 24 to 48 hrs).

iii) Instant "Off" potential measurement is required to determine the IR drop free potential of the tank.

iv) Final tank to soil potential (instant off and on) will be measured by switching the rectifier output using current interrupter. Current interrupter shall be hooked-up to the transformer rectifier and programmed to switch in 1:4 ration (1 second off and 4 second on or any other cycle in the same ratio). Instant Off potential measurement is required to determine the IR drop free potential of the tank.

v) Instant Off potential can be measured by the following procedures:

a) Switch off the transformer rectifiers.
b) Disconnect the positive header cable connected in the positive terminal of the transformer rectifier.
c) Install the Current interrupter in series with the positive header cable and positive terminal of the transformer rectifier.
d) Set the current interrupter in 1:4 ration i.e. 1 second off and 4 seconds on cycle or any other cycle in the same ratio.
e) Record the instant "off" and instant "on" potential in the commissioning data sheet. After recording, disconnect the current interrupter and return the transformer rectifier to its original connection.

vi) Check and record individual powers feed current in the junction box and record the results. Current shall be measured using digital clamp meter or digital multi meter.

vii) Check and record the output voltage and current in the transformer rectifier.

a) Check and record the output voltage and current in the transformer rectifier, when the instant 'OFF' potential value at all the reference electrode is in the range specified in the Specification (-0.850 to -1.1 V typical) after 48 hrs of polarization.

b) AVCC MODE: After recording the TR output DC voltage and current in Manual Mode at which all the reference electrodes show -0.850V to -1.1V in instant 'OFF' (typical figure) condition as described above, changeover the operation to constant

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voltage in AVCC mode and set the DC output voltage at the predetermined voltage recorded during Manual Mode of operation at which all the reference electrodes having potential in the range specified in the specification (typically -0.850V to -1.1V voltage) if necessary to ensure optimal protection potential at all the reference electrodes. Record the corresponding DC output current for the set voltage. This will be the final setting at which the unit will be left for operation and handed over to client. Individual current output of all the anode loops to be measured and recorded in AVCC mode voltage setting.

The results will be recorded in the commissioning data sheet.

7.0 RECORDS

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

ii) All equipment layout drawings shall be marked by the contractor for "AS BUILT STATUS" and two sets of hard copies shall be submitted to EIL.

8.0 HEALTH, SAFETY & ENVIRONMENT

i) Necessary PPE shall be utilized.
ii) Only trained / experienced personnel shall be deployed for this activity.

9.0 PRECAUTION

i) Care shall be taken for the proper connection of cables including Positive Header cable from Anode Junction Box to Positive (+ve) Terminal of TR Unit & Negative Header Cable from Structure to Negative (-ve) Terminal of the TR unit and interconnection cables

iii) Before the systems facilities are put into operation, necessary tests shall be carried out to establish that equipment's, devices and wiring connection have been correctly set up and connected in good condition for projected operation.

iv) Proper PPE shall be used.

v) Trained personnel to be deployed for Commissioning.

vi) Care should be taken while using MCB, AC/DC cable operation.

10.0 EQUIPMENT AND TOOLS

i) Portable Reference Electrodes ($Cu/CuSO_4$)
ii) Digital Multimeter
iii) Clamp-on meter
iv) Megger
v) CP / Electrical Tool Box
vi) Crimping tool

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11.0 REPORTS

All the parameters recorded during the Testing & Commissioning at site will be recorded in inspection format as per approved QAP.

12.0 FORMATS (TYPICAL)

12.1 Pre-Commissioning Inspection and Test Plat Format

Project	
Client/Owner	
Consultant	
Main Contractor	
CP Contractor	
Ref. Document	
Report No.	

Check Sheet			
Sl. No.	**Activity**	**Contractor**	**EIL/Owner**
1	Approval of Pre-Commissioning Check Procedure	P	A
2	Pre Commissioning Checks For Cu/$CuSO_4$ Reference Electrode and Anode using Anode Tail Cable	P	RM / W
3	ICCP System Cable Termination and Tagging	P	RM / W
4	ICCP unit Working Condition (No Load Condition)	P	W
5	Pre-Commissioning Checks of Earthing, Termination & Tagging for TR Unit and Junction Boxes	P	RM / W
Legends: A-Approval, RM-Random Check, W-Witness all, P- Perform			
Remarks:			

For CP Vendor		For Main/EPC Contractor		Client/EIL	
Name		Name		Name	
Sign		Sign		Sign	
Date		Date		Date	

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12.2 Quality Assurance Plan (QAP)

Project	
Client/Owner	
Consultant	
Main Contractor	
CP Contractor	
Ref. Document	
Report No.	

Check Sheet					
Sl. No.	**Activity**	**CP Vendor**	**EPC Contractor**	**EIL/Owner**	**Remarks**
1	Approval of Procedure for Testing & Commissioning	S	R	A&R	
2	Checking of Parameters as Per Procedure	P	W	R&W	
3	Measuring of Natural Potential	P	W	R&W	
4	Measuring IR value of TR unit	P	W	R&W	
5	Measuring of TR Unit Input & Output	P	W	R&W	
6	Check Circuit Resistance	P	W	R&W	
7	Measuring Of Structure To Electrolyte Polarized Potential With Portable/ Permanent Cu/$CuSO_4$ Reference Cell.	P	W	R&W	
8	Measuring of Individual Anode Loop Current	P	W	R&W	
9	Measuring On - Instant Off Readings	P	W	R&W	
10	Running TR Unit in Auto mode (AVCC mode)	P	W	R&W	
11	Central Monitoring System (CMS)	P	W	R&W	
Legends: A-Approval, R- Review of Records, W-Witness All, P-Perform, S-Submitted By					

For CP Vendor		For Main/EPC Contractor		Client/EIL	
Name		Name		Name	
Sign		Sign		Sign	
Date		Date		Date	

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12.3 Pre-Commissioning Check Format

Project	
Client/Owner	
Consultant	
Main Contractor	
CP Contractor	
Ref. Document	
Report No.	

Pre-commissioning- Check Sheet			
Item-1	**Ref. Cell No.**	**Native Potential Reading (Volt)**	**Remarks**
1.1	RE-1		
1.2	RE-2		
1.3	RE-3		
....	....		
1.n	RE-N		
Item-2	**Anode String No.**	**Continuity test**	
2.1	A-1	OK/ Not OK	
2.2	A-2	OK/Not OK	
2.3	A-3	OK/Not OK	
...	....	OK/ Not OK	
2.n	A-N	OK/ Not OK	
Item-3	**TRU (no load test in manual mode)**	**Reading**	
3.1	AC input voltage	Volt	
3.2	AC input current	Amp.	
3.3	DC output voltage	Volt	
3.4	DC output current	Amp.	
Remarks (overall):			

For CP Vendor		For Main/EPC Contractor		Client/EIL	
Name		Name		Name	
Sign		Sign		Sign	
Date		Date		Date	

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12.4 Commissioning Check Format

Project	
Client/Owner	
Consultant	
Main Contractor	
CP Contractor	
Ref. Document	
Report No.	

Check Sheet (potential measurement using permanent $Cu/CuSO_4$ electrode)			
Item-1	**TRU**	**Reading**	**Remarks**
1.1	AC input voltage	Volt	
1.2	AC input current	Amp.	
1.3	DC output voltage	Volt	
1.4	DC output current	Amp.	
Item-2	**Permanent Ref. Cell No.**	**Initial Reading (Volt)**	**Reading after 24 hrs (Volt) 48 hrs (Volt)**
2.1	RE-1		
2.2	RE-2		
2.3	RE-3		
....	....		
2.n	RE-N		
Item-3	**Activity**	**Reading**	**Remarks**
3.1	Natural PSP		
3.2	Energised PSP		
3.3	ON PSP		
3.4	Instant Off PSP		
3.5	100 mV Shift		
Remarks (overall):			

For CP Vendor		**For Main/EPC Contractor**		**Client/EIL**	
Name		Name		Name	
Sign		Sign		Sign	
Date		Date		Date	

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वेसल्स के लिए कैथोडिक प्रतिरक्षण प्रणाली हेतु स्थापना, प्री-कमीशनिंग, परीक्षण और कमिशनिंग के लिए विनिर्देश

SPECIFICATION FOR INSTALLATION, PRE-COMMISSIONING, TESTING AND COMMISSIONING OF CATHODIC PROTECTION SYSTEM FOR VESSELS

Rev.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
0	26 02 20	ISSUED AS STANDARD SPECIFICATION	AKD	NSB	SA	RKT

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Abbreviations:

AJB	:	Anode Junction Box
CJB	:	Cathode Junction Box
CP	:	Cathodic Protection
CPTR	:	Cathodic Protection Transformer Rectifier
DC	:	Direct Current
EIL	:	Engineers India Limited
ICCP	:	Impressed Current Cathodic Protection
IS	:	Indian Standards
MMO	:	Mixed Metal Oxide
NACE	:	National Association of Corrosion Engineers
OISD	:	Oil Industry Safety Directorate
PDB	:	Power Distribution Box
TRU	:	Transformer Rectifier Unit

Electrical Standards Committee

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Mr. Parag Gupta
Mr. M K Sahu
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1.0 OBJECTIVE

This procedure defines the methodology, requirements, responsibilities and equipment required for the Impressed Current Cathodic Protection System Installation, Pre-commissioning and Commissioning of the vessel (external) to ensure CP contractor conform to the specifications and other applicable codes and standards

2.0 SCOPE

The scope of this document is to describe the procedures for typical requirement for wire anode installation, Pre-commissioning and Commissioning of an Impressed Current Cathodic Protection System works for vessel (external) and provide adequate Quality Assurance / Control of workmanship and inspection at site. Pre-commissioning inspection and testing will be carried out to conform satisfactory installation works as per the project specification design and drawings.

The contractor shall have all necessary construction equipment, tools and tackle and testing instruments to carry out the erection works and to commission the system as specified. These equipment shall be brought to site by contractor before start of work.

3.0 REFERENCES

i) Project Specification for CP system for vessels

ii) CP System Design & Detail Calculation Document for vessels (external).

iii) Overall CP Equipment and Cable Route Layout.

iv) NACE : SP-0285 : Corrosion control of underground storage tank systems by Cathodic Protection

v) IS/ IEC: 60529 : Classification of Degree of Protection Provided by Enclosures

vi) OISD-GDN-180 : Lightning Protection

4.0 INSTALLATION

4.1 Prior to start of installation, contractor shall verify that equipment and complete materials have been received. Handling, shifting to required site location, installation, pre-commissioning, testing and commissioning shall be done by contractor with utmost care. Manufacturer's instructions and the requirements given in their technical manual shall be strictly adhered. The substation/control room wherein the equipment to be installed shall be clean, dry and free from all debris. Care shall be taken to observe the correct lifting arrangements and to make sure that the slings are attached to the manufacturer's designated lifting points, where applicable. No parts shall be subjected to undue strains or sudden stresses which could cause damage to the equipment.

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

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

Manufacturer checklist, manual for erection, installation and any specific requirement for equipment handling, installation and commissioning shall be strictly adhered to.

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4.2 Following activities shall be done by contractor during various stages of installation

4.2.1 STAGE-I

When the sand bed reaches at the bottom level of vessel shell, the activities involved are as given below:

i) Making of slot in sand pad for Pre-packed MMO Wire Anode cable as per applicable drawing at surrounding of vessel sand layer.

ii) Check continuity of anode and cable before installation in sand pad to ensure healthiness. This shall be followed at each stage of anode installation.

iii) Provide anode identification marks on anode lead cable of each loops coming out from vessels. This shall be followed at each stage of anode installation.

iv) Laying of Pre-packed MMO Wire Anode at bottom sand layer of vessel as per drawing.

v) Making of pocket in sand pad for Ref. Cell as per applicable drawing at surrounding of vessel sand layer.

vi) Checking healthiness of Permanent Reference Cell before installation at different stages with respect to calibrated Master Reference Cell.

vii) Check continuity of reference cell cable before installation at different stages in sand pad to ensure healthiness.

viii) Laying of Ref. Cell inside the pocket & sand fill with proper compaction by using wooden pallet.

4.2.2 STAGE-II

When the sand bed reaches up to middle Level of the vessel shell, the activities involved are as given below.

i) Making of slot in sand pad for Pre-packed MMO Wire Anode cable as per applicable drawing at surrounding of vessel sand layer.

ii) Laying of Pre-packed MMO Wire Anode at Middle sand layer of vessel as per drawing.

4.2.3 STAGE-III

When the sand bed reaches the Top level of the vessel shell, the activities involved are as given below.

i) Making of slot in sand pad for Pre-packed MMO Wire Anode cable as per applicable drawing at surrounding of vessel sand layer.

ii) Laying of Pre-packed MMO Wire Anode at bottom sand layer of vessel as per drawing.

iii) Jointing of Pre-packed MMO Wire Anode strings end with anode lead cable by using In-line splice kits.

iv) Laying of Cathode cleat cable and its termination at CJB.

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v) Laying of Measurement cleat cable and its termination at CJB.

vi) Connecting Cathode cable with cleat by Thermit welding on the Vessel.

vii) Connecting Measurement cable with cleat by Thermit welding on the Vessel.

viii) Making of pocket in sand pad for Ref. Cell as per applicable drawing at surrounding of vessel.

ix) Laying of Ref. Cell inside the pocket & sand fill with proper compaction by using wooden pallet.

4.2.4 STAGE-IV

The Activities which are to be performed outside the Mound area, the activities involved are as given below.

i) Installation of junction boxes (AJB, CJB) with mounting frame.

ii) Termination & connection of all the cables in the junction boxes (AJB, CJB etc.)

iii) Installation of Transformer rectifier unit.

iv) TR-unit connection of all incoming & outgoing cables & termination.

5.0 PRE-COMMISSIONING AND TESTING

i) After the equipment is installed properly in accordance with specifications, design documents, drawings and contractor shall carry out all pre-commissioning checks and tests as per EIL format in the presence of Engineer-in-charge and test readings shall be recorded and furnished to EIL in triplicate.

ii) It is anticipated that various installation checks have been previously accomplished and accepted during installation of CP equipment and facilities or otherwise to be carried out in conjunction with the commissioning activities.

iii) 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, wiring properly dressed and labeled, sealing of unused cable entries, checking of all safety interlocks, control/interface functions as per requirement etc.

iv) The contractor shall bring to site all required tools, tackles and testing instruments for carrying out field testing. Contractor shall use only calibrated measuring and test instruments and shall maintain valid calibration record.

v) The inspection/test data sheets associated with pre-commissioning and commissioning of cathodic protection system shall be provided by vendor.

5.1 General Inspection

Prior to commissioning of the CP system and before energizing the transformer rectifier unit, the following activities shall be performed.

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i) Review all test and inspection data sheets that have been previously accomplished during CP installation. All installation data results to be verified to ensure that inspection and testing have been carried out successfully.

ii) Review all CP design drawings, deviations if any shall be noted and incorporated in the as-built drawings.

iii) Visual inspections to be performed to ensure that all above ground (exposed) CP components and facilities are not physically damaged during or after CP installation works. Any discrepancies to be noted and necessary corrective actions shall be taken prior to commissioning.

iv) All CP cables to be checked for proper termination and identification as per schematic drawings.

5.2 Pre-Commissioning Check List

5.2.1 Transformer Rectifier

5.2.1.1 The following information to be obtained and recorded as a minimum

i) TR unit ID
ii) TR unit Manufacturer
iii) TR type/ model/ Sl. No.
iv) Sun Shed
v) TR Input and Output Rating
vi) Date of Inspection
vii) Name of Inspector

5.2.1.2 **Inspection**

The following inspections and checks shall be performed and recorded when the TR unit is in switched off condition.

i) Visual inspection of each TR (transformer rectifier) unit to be performed to ensure correct installation and that the unit has not been physically damaged prior to operation. Any discrepancies will be noted and rectified.

ii) All panel connections and terminals to be checked for tightness. Any loose connection shall be tightened.

iii) The polarity of the DC output cable to be verified to ensure that the positive output cables are connected to the anode terminals and the negative terminals are connected to the vessel.

iv) Verify that the power supply to the Transformer Rectifier (TR) corresponds to the required rating. Measure and record the AC supply voltage at the input terminals of the transformer rectifier circuit breaker.

v) Verify and ensure that the Transformer Rectifier is properly grounded to the earthing system.

vi) Ensure that all fuses are of proper current and voltage ratings. Check the continuity of all fuses and spares by an ohmmeter.

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vii) Measure the insulation resistance between Transformer & TR body and earthing resistance between TR and earth.

viii) Check whether the output knobs are in minimum position.

ix) Check the colour of silica gel.

x) Ensure that TR (oil cooled) has at least minimum level of oil, if necessary, add more.

5.2.1.3 **Total Circuit Resistance Test**

i) After proper polarity of the DC output cables have been confirmed and the cables have been labelled with permanent tags, disconnect the anode and the cathode cables from the DC output terminal of the Transformer Rectifier.

ii) Using a four-pin resistance meter with P1/C1 and P2/C2 terminal shorted, connect the test leads of the instruments across the DC cables and measure the resistance.

iii) This testing will be done to measure the overall circuit resistance of the CP system and to ensure that no short circuit exist between the anode (positive) and cathode (negative).

iv) The result will be recorded in the AJB pre-commissioning data sheet.

5.2.2 **Anode Inspection**

i) Verify that the anode have been properly checked and accepted for compliance with the drawings and design during the installation works.

ii) Based on the above, check the power feed connections and verify that the cable is properly terminated and identified at the Anode Junction Box (AJB). Any discrepancies shall be rectified.

iii) The tests shall be performed at the AJB between the anode feeders. Continuity test to be carried out between all anode feeders lead cable to ensure electrical continuity of all anodes.

iv) The result will be recorded in the AJB pre-commissioning data sheet.

5.2.3 **Junction Boxes & PDB**

5.2.3.1 The following information shall be obtained and recorded as minimum:

i) Junction Box & PDB ID
ii) Number of Circuits
iii) Resistor Rating if present
iv) Shunt Rating, if present
v) Date of Inspection and Name of the Inspector

5.2.3.2 The following inspections shall be performed at each junction box.

i) A visual inspection of the junction box & PDB will be performed to ensure correct installation in accordance with the drawings and that the junction boxes & PDB have not been physically damaged prior to operation. Any discrepancies will be noted.

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ii) All cable connections and terminals shall be checked for tightness. Any loose connections shall be tightened.
iii) All cables are to be checked for proper tagging and to ensure it is as per design /drawing.
iv) The result will be recorded in the pre-commissioning format.

5.2.4 **Natural Potential measurement**

Before energizing the transformer rectifier, the natural potential of vessel (partially filled with product) should be measured and recorded using permanent reference electrodes as well as using portable reference electrode.

5.2.4.1 **Potential Measurement using Permanent Reference Electrodes**

i) The vessel to soil potential measurement is obtained using high impedance multimeter (min. 10 Mega ohms).

ii) Attach the test lead from the positive terminal of the meter to the vessel at the junction box.

iii) Attach the test lead from the negative terminal of the meter to the permanent reference electrode point at the junction box.

iv) The vessel potential in millivolts is read directly from the meter.

v) Natural potential measurement using permanent reference electrode to be carried out at all reference electrode locations.

vi) Record the millivolts reading with polarity on the corresponding data sheet.

6.0 COMMISSIONING

After successful pre-commissioning of the cathodic protection equipment, the CP system is ready for testing, start up and commissioning. The contractor shall carry out complete testing and commissioning of material and equipment as per Inspection and test plans (ITP).

6.1 Before switching "ON" the transformer rectifiers the following condition should be met.

i) All CP cables inside junctions and TR are to be checked and corrected for any discrepancies.

ii) Natural potential of all structures involved in cathodic protection system has been measured and recorded.

iii) A close visual inspection of electrical equipment in hazardous area 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.

6.2 Commissioning Steps

The steps described below should be followed systematically during execution of final commissioning.

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i) The transformer rectifier has been previously checked and tested during the pre-commissioning stages and the results are recorded in the data sheet. Read and study the transformer rectifier data sheet & operation manual to familiarize the system and result of the pre-commissioning test.

ii) Set the transformer rectifiers output control to 0% range and switch "on " the transformer rectifier.

iii) Gradually adjust the transformer rectifier's output power in manual mode.

iv) Measure and record the vessel to soil potential.

6.2.1 The following procedures should be followed when measuring the vessel to soil potential:-

i) For vessels with permanent reference electrodes, at each reference cell box, connect the negative lead of the meter on the reference cell and positive on the vessel. Record each reference electrode reading with respect to negative.

ii) Increase the transformer rectifier output in manual mode until the vessel bottom potential reaches the value as per specification [-850 to -1100 mV (typical)]. The "On" potential is not a true representation of the vessel protected potential. The instant "off" potential will be measured for final reading & conclusion. Before taking instant off potentials, the transformer rectifier should be kept energized until adequate polarisation is achieved (typically 24 to 48 hrs).

iii) Instant "Off" potential measurement is required to determine the IR drop free potential of the vessel.

iv) Final vessel to soil potential (instant off and on) will be measured by switching the rectifier output using current interrupter. Current interrupter shall be hooked-up to the transformer rectifier and programmed to switch in 1:4 ratio (1 second OFF and 4 second ON or any other cycle in the same ratio). Instant Off potential measurement is required to determine the IR drop free potential of the vessel.

v) Instant Off potential can be measured by the following procedures:

a) Switch off the transformer rectifiers.
b) Disconnect the positive header cable connected in the positive terminal of the transformer rectifier.
c) Install the Current interrupter in series with the positive header cable and positive terminal of the transformer rectifier.
d) Set the current interrupter in 1:4 ratio i.e. 1 second off and 4 seconds on or any other cycle in the same ratio.
e) Record the instant "off" and instant "on" potential in the commissioning data sheet. After recording, disconnect the current interrupter and return the transformer rectifier to its original connection.

vi) Check and record individual powers feed current in the junction box and record the results. Current shall be measured using digital clamp meter or digital multi meter.

vii) Check and record the output voltage and current in the transformer rectifier.

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a) Check and record the output voltage and current in the transformer rectifier, when the instant 'OFF' potential value at all the reference electrode is in the range specified in the Specification (-0.850 to -1.1 V typical) after 48 hrs of polarization.

b) AVCC MODE: After recording the TR output DC voltage and current in Manual Mode at which all the reference electrodes show -0.85V to -1.1V in instant 'OFF' (typical figure) condition as described above, changeover the operation to constant voltage in AVCC mode and set the DC output voltage at the predetermined voltage recorded during Manual Mode of operation at which all the reference electrodes having potential in the range specified in the specification (typically -0.850V to -1.1V voltage) if necessary to ensure optimal protection potential at all the reference electrodes. Record the corresponding DC output current for the set voltage. This will be the final setting at which the unit will be left for operation and handed over to client. Individual current output of all the anode loops to be measured and recorded in AVCC mode voltage setting.

The results will be recorded in the commissioning data sheet.

7.0 RECORDS

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

ii) All equipment layout drawings shall be marked by the contractor for "AS BUILT STATUS" and two sets of hard copies shall be submitted to EIL.

8.0 HEALTH, SAFETY & ENVIRONMENT

i) Necessary PPE shall be utilized.

ii) Only trained / experienced personnel shall be deployed for this activity.

9.0 PRECAUTION

i) Care shall be taken for the proper connection of cables including Positive Header cable from Anode Junction Box to Positive (+ve) Terminal of TR Unit & Negative Header Cable from Structure to Negative (-ve) Terminal of the TR unit and interconnection cables

ii) Before the systems facilities are put into operation, necessary tests shall be carried out to establish that equipment's, devices and wiring connection have been correctly set up and connected in good condition for projected operation.

iii) Proper PPE shall be used.

iv) Trained personnel to be deployed for Commissioning.

v) Care should be taken while using MCB, AC/DC cable operation.

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10.0 EQUIPMENT AND TOOLS

i) Portable Reference Electrodes ($Cu/CuSO_4$)

ii) Digital Multimeter

iii) Clamp-on meter

iv) Megger

v) CP / Electrical Tool Box

vi) Crimping tool

11.0 REPORTS

All the parameters recorded during the Testing & Commissioning at site will be recorded in inspection format as per approved QAP.

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12.0 FORMATS (TYPICAL)

12.1 Pre-Commissioning Inspection and Test Plat Format

Project	
Client/Owner	
Consultant	
Main Contractor	
CP Contractor	
Ref. Document	
Report No.	

Check Sheet			
Sl. No.	**Activity**	**Contractor**	**EIL/Owner**
1	Approval of Pre-Commissioning Check Procedure	P	A
2	Pre Commissioning Checks For Cu/$CuSO_4$ Reference Electrode and Anode using Anode Tail Cable	P	RM / W
3	ICCP System Cable Termination and Tagging	P	RM / W
4	ICCP unit Working Condition (No Load Condition)	P	W
5	Pre-Commissioning Checks of Earthing, Termination & Tagging for TR Unit and Junction Boxes	P	RM / W
Legends: A-Approval, RM-Random Check, W-Witness all, P- Perform			
Remarks:			

For CP Vendor		For Main/EPC Contractor		Client/EIL	
Name		Name		Name	
Sign		Sign		Sign	
Date		Date		Date	

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12.2 Quality Assurance Plan (QAP)

Project	
Client/Owner	
Consultant	
Main Contractor	
CP Contractor	
Ref. Document	
Report No.	

Check Sheet					
Sl. No.	**Activity**	**CP Vendor**	**EPC Contractor**	**EIL/Owner**	**Remarks**
1	Approval of Procedure for Testing & Commissioning	S	R	A&R	
2	Checking of Parameters as Per Procedure	P	W	R&W	
3	Measuring of Natural Potential	P	W	R&W	
4	Measuring of TR Unit Input & Output	P	W	R&W	
5	Measuring IR (insulation resistance) value of TR unit	P	W	R&W	
6	Check Circuit Resistance	P	W	R&W	
7	Measuring of Structure To Electrolyte Polarized Potential With Portable/ Permanent Cu/$CuSO_4$ Reference Cell.	P	W	R&W	
8	Measuring of Individual Anode Loop Current	P	W	R&W	
9	Measuring On - Instant Off Readings	P	W	R&W	
10	Running TR Unit in Auto mode (AVCC mode)	P	W	R&W	
11	Central Monitoring System (CMS)	P	W	R&W	
Legends: A-Approval, R- Review of Records, W-Witness All, P-Perform, S-Submitted By					

For CP Vendor		For Main/EPC Contractor		Client/EIL	
Name		Name		Name	
Sign		Sign		Sign	
Date		Date		Date	

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12.3 Pre-Commissioning Check Format

Project	
Client/Owner	
Consultant	
Main Contractor	
CP Contractor	
Ref. Document	
Report No.	

Pre-commissioning- Check Sheet			
Item-1	**Ref. Cell No.**	**Native Potential Reading (Volt)**	**Remarks**
1.1	RE-1		
1.2	RE-2		
1.3	RE-3		
….	….		
1.n	RE-N		
Item-2	**Anode String No.**	**Continuity test**	
2.1	A-1	OK/ Not OK	
2.2	A-2	OK/Not OK	
2.3	A-3	OK/Not OK	
…	….	OK/ Not OK	
2.n	A-N	OK/ Not OK	
Item-3	**TRU (no load test in manual mode)**	**Reading**	
3.1	AC input voltage	Volt	
3.2	AC input current	Amp.	
3.3	DC output voltage	Volt	
3.4	DC output current	Amp.	
Remarks (overall):			

For CP Vendor		For Main/EPC Contractor		Client/EIL	
Name		Name		Name	
Sign		Sign		Sign	
Date		Date		Date	

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12.4 Commissioning Check Format

Project	
Client/Owner	
Consultant	
Main Contractor	
CP Contractor	
Ref. Document	
Report No.	

Check Sheet (potential measurement using permanent $Cu/CuSO_4$ electrode)			
Item-1	**TRU**	**Reading**	**Remarks**
1.1	AC input voltage	Volt	
1.2	AC input current	Amp.	
1.3	DC output voltage	Volt	
1.4	DC output current	Amp.	
Item-2	**Permanent Ref. Cell No.**	**Initial Reading (Volt)**	**Reading after 24 hrs(Volt) 48 hrs (Volt)**
1.1	RE-1		
1.2	RE-2		
1.3	RE-3		
....	....		
1.n	RE-N		
Item-3	**Activity**	**Reading**	**Remarks**
3.1	Natural PSP		
3.2	Energised PSP		
3.3	ON PSP		
3.4	Instant Off PSP		
3.5	100 mV Shift		
Remarks (overall):			

For CP Vendor		For Main/EPC Contractor		Client/EIL	
Name		Name		Name	
Sign		Sign		Sign	
Date		Date		Date	

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अग्निरोधक विद्युत वितरण बोर्ड के लिए विनिर्देश

SPECIFICATION FOR FLAMEPROOF POWER DISTRIBUTION BOARDS

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by: Standards Committee Convenor	Approved by: Standards Bureau Chairman
0	31.03.22	ISSUED AS STANDARD SPECIFICATION	SAC/RKS	ANPS	MKS	SM

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Abbreviations:

AC	Alternating Current
BIS	Bureau of Indian Standards
CEA	Central Electricity Authority
CT	Current Transformer
DGMS	Directorate General of Mines Safety
EIL	Engineers India Limited
FRLS	Flame Retardant Low Smoke
GI	Galvanised Iron
IEC	International Electro-technical Commission
IP	Ingress Protection
IS	Indian Standards
kW	Kilo Watt
kWH	Kilo Watt Hour
MR	Material Requisition
MV	Medium Voltage
MCB	Miniature Circuit Breaker
MCCB	Moulded case circuit breaker
NABL	National Accreditation Board for Testing and Calibration Laboratories
PDB	Power Distribution Board
PESO	Petroleum and Explosives Safety Organisation
PO	Purchase Order
PVC	Poly Vinyl Chloride
SPN	Single Phase and Neutral
SWG	Standard Wire Gauge
SS	Stainless Steel
TPN	Three Phases and Neutral
XLPE	Cross Linked Poly Ethylene

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1.0 SCOPE

This specification covers the requirements of design, manufacture, testing, packing and supply of free standing flameproof Power Distribution Board (PDB) for field power distribution to MOVs, soot blowers, auxiliary motors, electric heat tracing, high masts etc. suitable for installation in hazardous locations handling flammable liquids and gases/ vapours.

2.0 CODES AND STANDARDS

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

IS : 5	:	Colours for ready mixed paints and enamels.
IS : 1248	:	Direct acting indicating analogue measuring instruments and their accessories
IS : 2824	:	Method for determining the proof and the comparative tracking indices of solid insulating materials
IS : 5082	:	Wrought aluminum and aluminum alloy bars, rods, tubes and sections for electrical purposes
IS : 5578	:	Guide for marking of insulated conductor
IS : 11353	:	Guide for uniform system marking and identification of conductors and apparatus terminals
IS : 12640	:	Residual current operated circuit breakers
IS : 13703	:	Low voltage fuses for voltages not exceeding 1000V AC or 1500V DC
IS : 16227/ IEC 61869	:	Instrument transformers (Current transformers & Voltage transformers)
IS/IEC 60255		Measuring Relays & Protection Equipment
IS/IEC 60269	:	Low voltage fuses
IS/IEC 60079-0	:	Electrical apparatus for explosive gas atmospheres (General requirements).
IS/IEC 60079-1	:	Electrical apparatus for explosive gas atmospheres (Equipment Protection by Flameproof Enclosures "d").
IS/IEC 60529	:	Degree of protection provided by enclosures (IP Code).
IS/IEC 60898	:	Electrical Accessories circuit breakers for over protection for household and similar installations
IS/IEC 60947	:	LV switchgear and control gear.
IS/IEC 61439	:	Low voltage switchgear and control gear assemblies

2.2 In case of imported equipment, only IECEx (or equivalent, if more stringent than the applicable IEC) certified equipment shall be used.

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

2.4 In case Indian standards are not available for any equipment, standards issued by IEC or equivalent agency (if more stringent than IEC) shall be applicable.

2.5 In case of any conflict between requirements specified in various applicable documents for the project, the most stringent requirement shall govern. However, Owner's/ EIL's decision in this regard will be final and binding.

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3.0 GENERAL REQUIREMENTS

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

3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 10 years from the date of supply.

4.0 SITE CONDITIONS

4.1 The equipment shall be suitable for installation and satisfactory operation in tropical, humid and corrosive atmosphere as prevalent in refineries, petrochemical and fertilizer plants, which are classified as hazardous. The power distribution boards shall be designed to operate under site conditions as specified in the data sheet. If not specifically mentioned therein, a design ambient temperature of 40° C and an altitude not exceeding 1000m above mean sea level shall be considered.

4.2 All the equipments described in this specification are intended for continuous duty with the specified rating under the specified ambient conditions unless indicated otherwise.

5.0 POWER SUPPLY

5.1 PDB shall be suitable for 415V, 50Hz, TPN incoming supply.

5.2 The outgoing of PDB shall be 415V TP/TPN power supply circuits and/or 240V SPN circuits as specified in the data sheet/ job specification.

6.0 CERTIFICATION

The equipment shall have test certificates issued by NABL accredited/ Central Government labs in India/ IECEx-approved/ equivalent labs. All equipment (indigenous & imported) shall also have valid statutory approvals, as applicable, for the specified location, and marking as per IS/IEC 60079 and as required by statutory authorities. All indigenous flameproof equipment shall have valid BIS license. All flameproof equipment shall have PESO approval.

7.0 TECHNICAL REQUIREMENTS

7.1 Construction

7.1.1 The Flameproof PDB shall be designed for service at project ambient temperature and shall be suitable for continuous operation without harmful effect with voltage and frequency variations as specified in the data sheets. The flameproof PDB shall have rated current and fault level rating as specified in the datasheet/ job specification.

7.1.2 The Flameproof PDB shall be free standing on a self-supporting pedestal mounting steel framework of angles and channel section, suitable for installation on concrete base with front access for operation and maintenance. The Flameproof PDB shall be fixed type, in single front execution, assembled in single line up with multiple flameproof cubicles housing feeders, cable terminations and bus bar. The arrangement shall provide adequate spacing between enclosures for direct vertical installation of power and control cables, entering enclosures from bottom/ top as specified in data sheet/ job specification. Adequate spacing and clearances shall be provided both on the top and at the bottom for maintenance works.

7.1.3 The devices and components mounted inside the cubicles shall have adequate clearances. The quantity and type/rating of components inside each cubicle shall be in accordance with the statutory test certificate details.

7.1.4 The enclosure of the flameproof PDB shall be made of cast light metal alloy. The enclosure of the flameproof PDB intended for use in units handling sulphuric acid/ other corrosive materials shall be made of stainless steel grade SS-316L, if specified in MR/Tender.

7.1.5 The flameproof PDB shall be suitable for use in outdoor open locations and shall have minimum IP-55 degree of protection. It shall preferably be provided with integral canopy.

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However, where the enclosure has been certified without integral canopy, a separate canopy shall be accepted for installation over the PDB. The separate canopy shall be made of at least 1.6 mm (16 gauge) galvanized sheet steel/stainless steel minimum SS-304. The canopy shall be suitable for providing protection against rain from top two sides and front.

7.1.6 The flameproof PDB shall be provided with gaskets made of non-inflammable and self-extinguishing material.

7.1.7 All metal surfaces shall undergo manufacturer's standard cleaning/ painting / powder coating cycle. After preparation of under surface, the panels shall be painted with two coats of epoxy based final paint or epoxy powder coated with minimum coating thickness of 80 microns, with colour shade as below:

- Flameproof Ex'd' (Gas group IIA/IIB) : Dark admiralty grey shade 632 of IS-5/ RAL 7031
- Flameproof Ex'd' (Gas group IIC) : Light yellow shade 355 of IS-5 / RAL 1012.

All unpainted steel parts shall be suitably treated to prevent rust formation. If these parts are moving elements, then these shall be greased with non-solidifying grease. However, in case of stainless steel flameproof power distribution boards, finish shall be Electropolish/ Buffed/ equivalent finish.

7.1.8 A warning inscription "DO NOT OPEN WHEN ENERGIZED" shall be provided on each enclosure. The warning inscription shall be embossed on the enclosure or a separate warning plate with above inscription shall be fixed to the enclosure with screws. The warning plate shall be of nickel plated brass or stainless steel.

7.1.9 All accessories like nuts, bolts, washers etc. shall be made of stainless steel SS-304, as minimum.

7.1.10 Main bus bars shall be of high conductivity electrolytic aluminium having uniform current rating, for specified fault level throughout their length. The bus bars shall be sized depending upon the maximum expected current and to limit the specified maximum operating temperature at specified design ambient temperature. Bus bars shall be supported by non-hygroscopic insulators. Bus bars shall be colour coded for identification of phases and neutral.

7.1.11 Copper earth bus of suitable size for specified fault level shall be provided throughout the length of the PDB. The earth bus shall be provided with alternate bands of yellow and green. All earth connection wires shall be suitably colour coded. All the non-current carrying metallic parts of the board shall be inherently bonded together. Each flameproof PDB shall be provided with two earthing studs with lugs on the exterior of the board suitable for termination of earth bus bar.

7.1.12 Neutral and earth bars shall be suitable for connecting the neutral and earth conductors of the circuits. The earth bars shall be drilled and tapped unnumbered brass link bars with stud bolts and screws. The neutral and earth terminals shall 10% more than the number of circuit breakers.

7.1.13 Provision shall be made for the bonding of earth conductor, cable glands and cable armouring at cable termination point.

7.1.14 Each cubicle shall be provided with space heater rated for 240V AC supply, provided with a switch, fuse or double pole MCB and thermostat having variable setting range of 30-70 °C, to prevent moisture condensation.

7.1.15 The PDB shall be provided with suitable sized cable entries as mentioned in datasheet/ job specification for incoming and outgoing cables. Unless otherwise specified, the PDB shall be suitable for bottom cable entry. Top cable entry shall be provided if specified in data sheet/ job specification.

All connections to incoming and outgoing cables shall terminate in terminal block, which shall be adequately sized for termination of the cables as specified in MR/ Tender. Sufficient space shall be provided inside the PDB for easy connection of Purchaser's cable. Suitable terminal blocks/ terminal studs, adequately rated, shall be provided for cable termination of each of the

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feeders. Adequate number of terminals shall be provided for terminating incoming and outgoing cable entries. Board shall be supplied complete with double compression type nickel plated brass flameproof cable glands and Tinned copper lugs for incoming and outgoing cables. Flameproof nickel plated brass sealing plugs shall be supplied, for plugging the unused cable entries. The quantity of sealing plugs shall be equal to 20% of the total number of outgoing cable entries.

7.1.16 Inside the PDB, the wiring for power, control, signaling protection and instrument circuits shall be done with FRLS, PVC/ XLPE insulated copper conductor & BIS approved having 660/ 1100 V grade insulation. For modules rated above 100A, preferably copper strip connections shall be used. The control connections shall be done with 660V grade PVC/ XLPE insulated FRLS wires having stranded copper conductors. Minimum size of control wire shall be 1.5 mm^2 copper for circuits having fuse rating 10 A or less. For higher fuse rating control circuits, minimum 2.5 mm^2 copper conductor shall be used. Each wire shall be identified at both ends by self-sticking wire marker tapes or PVC ferrules. Cable sheath colours to be consistent with the phase/ neutral/ earth circuit to which they are connected. Only one conductor shall be connected to each terminal; additional linked terminals shall be provided where more connections are required. All terminals shall be shrouded. All wiring shall be clearly identified at both ends by individual non-ambiguous characters using barrel type ferrules/ marker tapes.

7.1.17 Clamp type terminals shall be acceptable for wires upto 10 mm^2 size. For conductors larger than 10mm^2, bolt type terminals with crimping lugs shall be provided. Each wire shall be terminated at a separate terminal. A minimum of 10% spare terminals shall be provided on each terminal block. Shorting links shall be provided for all CT terminals.

7.1.18 A Tag plate indicating Tag Number, engraved, 3 ply laminate fixed with screws shall be provided on each PDB. Nameplates shall also be provided for each incoming and outgoing feeder. A separate nameplate shall be provided to indicate the name of manufacturer, testing agency, test certificate number, serial number, BIS license number, applicable gas group as per IS/IEC 60079, statutory agency (PESO) approval number and any additional marking required by statutory authority. The nameplates shall be Al anodized or SS-304 engraved type or laser-marked and permanently fixed on the equipment. In case the standard details given above are embossed on the enclosures, the same need not be repeated on the name plate.

7.2 Equipment/ Component Specification

7.2.1 The Flameproof PDB shall be provided with incoming and out-going feeder with MCCBs/switches/ switch fuse unit/ MCBs as per data sheets/ job specification.

Unless otherwise specified, main incomers shall be suitable for 415V incoming TP/TPN power supply and provided with microprocessor based MCCB/ Switch along with CT, Ammeter, Voltmeter with selector switches and R,Y,B indicating lamps on line side.

7.2.2 The TPN outgoing feeders shall be with MCCB or switch fuse as specified in data sheet/ job specification. Further contactor, CT, ammeter, 3 pole ELCB with maximum sensitivity of 30 mA shall be provided for outgoing feeders as specified in MR/ Tender.

7.2.3 The SPN outgoing feeders, shall have 2 pole isolation, i.e. Phase and Neutral. Each outgoing circuit shall comprise of Miniature Circuit Breaker (MCB) with thermal over current and magnetic short circuit releases. 2 pole Earth Leakage Circuit Breaker (ELCB) (M9 Category) with maximum sensitivity of 30 mA & power contactor, CT, ammeter of required rating shall be provided if specified in data sheet/ job specification. MCB shall be double pole for single phase circuits. MCB rating shall be such that it shall not operate on starting current.

7.2.4 MCCBs shall be provided with spring assisted quick make/ break manually operated trip free mechanism with external operating handle mounted on the cubicle. MCCBs shall have provision for padlocking in OFF position. The ON and OFF position shall be clearly indicated.

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7.2.5 Where specified, the MCCBs for feeder circuits such as those for Motor Operated Valve Actuators shall be suitable for motor duty. MCCBs as part of motor starter module shall be current limiting type and type tested for type-2 co-ordination as per IS/ IEC-60947 considering energy efficient motors of IE-3 type unless otherwise specified elsewhere.

7.2.6 MCB shall have minimum breaking capacity of 9kA unless otherwise specified. Positive ON/ OFF indication shall be provided.

7.2.7 All switches shall be load break, heavy duty/ motor duty, air break type with the operating handle. All switches other than rotary switches shall be lockable in OFF position. Rating of switches for starter module shall meet the requirements of AC-23 duty as per IS/ IEC 60947 and minimum rating shall be as specified in job specification/ data sheets.

7.2.8 All contactors shall be air break type, equipped with main contacts and provided with 1NO+1NC potential free spare auxiliary contacts wired to the terminal block for owner's use. The main contacts of contactor for motor starter module shall have AC-3 or AC-4 rating as per package requirements. Unless specified otherwise, the coil of the contactor shall be suitable for operation on 240 V, 1 Phase, AC supply.

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

7.2.10 Bimetal relays shall be provided for protecting the motor from thermal overload. Bimetal thermal overload relays shall be manually reset type with the reset push button provided on the cubical door. Bimetal relays shall be three elements, positive acting ambient temperature compensated type with adjustable setting range and built-in single phasing prevention feature, which operates even with 50% rated current at the time of single phasing.

7.2.11 All contactor controlled motor feeders for auxiliary motors etc. shall meet the requirements of type-2 co-ordination as per IS/IEC: 60947 considering energy efficient motors of IE-3 type, unless otherwise specified elsewhere.

7.2.12 Current transformers for metering shall have an accuracy class 1.0 and instrument security factor not greater than 5. Protective current transformers shall have an accuracy class 5P and an accuracy limit factor greater than 10.

7.2.13 All measuring AC instruments shall be moving iron, flush mounting type for incomer and outgoing feeders. The accuracy class for all instruments shall be 1.0 as per IS-1248. Ammeters shall suitable for 1 Ampere CT secondary. Minimum size of ammeter shall be either 72mm x 72 mm or 65 mm diameter. For Ammeters of motor feeders 80% of the scale length shall cover 100% of the CT primary current uniformly and the balance 20% of the scale shall cover 100-800% of the CT primary. A red mark corresponding to the full load current of the motor shall be provided on the ammeter dial. The ammeter front glass shall be toughened. The kW/ kWH meters shall be suitable to measure unbalanced loads on 3 phases 4- wire system. Test terminal block shall be provided for kWH meters.

7.2.14 All control/ selector switches shall be rotary back-connected types having a cam operated contact mechanism with knob type handle. Ammeter selector switch shall have make before break feature on its contacts. The selector switch shall generally have 4 positions, three for reading 3 phase currents and the fourth position for OFF. The voltmeter selector switch shall also have 4 positions. Three positions shall be used to measure phase-to-phase voltage and fourth shall be OFF position.

7.2.15 Auxiliary relays/ contactors shall generally be used for interlocking and multiplying contacts.

7.2.16 All selector switches shall have minimum two poles for each position. Each position of switch shall be indelibly marked on the PDB. Exact configuration of selector switch (e.g. LOCAL-OFF-REMOTE etc.) shall be as per datasheet/ job specification.

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7.2.17 Indicating lamps shall be cluster LED type or SMD chip type LED with colour lens of minimum 25mm diameter. The following indicating colours shall be used.

Closed/ ON	:	Red
Open/ OFF	:	Green
Fault trip	:	Amber

7.2.18 Push button colours shall be as follows:

Stop/open/emergency stop	:	Red
Start/close	:	Green
Reset	:	Black
Test	:	White

The 'Stop' push button shall be stayput type.

All motor starter feeders shall have Stop and Reset push buttons and ON and Trip indication lamps.

8.0 INSPECTION, TESTING AND ACCEPTANCE

8.1 During fabrication, the equipment shall be subjected to inspection by Owner/ EIL or by an agency authorized by the Owner/ EIL, if specified/ agreed in Approved Inspection Test Plan. Manufacturer shall furnish all necessary information concerning the supply to Owner's/ EIL's inspector. All routine/ acceptance tests shall be carried out at manufacturer's works under his care and expense.

8.2 Type test certificates from NABL accredited/ Central Government Labs in India/ IECEx-certified/ equivalent Labs, Manufacturer's works test reports, applicable PESO approval and BIS license and original drawings referred in type test certificates shall be shown to the inspection agency on demand during inspection. The test certificates, BIS license and PESO approval must be valid at the time of despatch.

8.3 Test certificates of bought out components shall be shown to the inspection agency on demand during inspection.

8.4 All equipments shall be subjected to various routine / acceptance tests as per Approved Inspection & Test plan.

9.0 PACKING AND DESPATCH

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for the selected mode of transportation, i.e. by ship/ rail or trailer and shall be wrapped in polythene sheets before being placed in crates/ cases to prevent damage to finish. The crates/ cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Center of gravity', 'Weight', 'Owner's particulars', 'PO no.' etc., shall be clearly marked on the packages together with other details as per purchase order.

The equipment may be stored outdoors for long periods before installation. The packing should be suitable for outdoor storage in areas with heavy rains and high ambient temperature unless otherwise agreed. A set of instruction manuals for installation, testing and commissioning, a set of operation & maintenance manuals and a set of final drawing shall be enclosed in a waterproof cover along with the shipment.

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मध्यम एवं उच्च वोल्टेज केबल एवं असेसरिज के लिए विनिर्देश

SPECIFICATION FOR MEDIUM AND HIGH VOLTAGE CABLES & ACCESSORIES

Rev. No	Date	Purpose	Prepared by	Checked by	StandardsCommitteeConvenor	Standards Bureau Chairman
					Approved by	
9	30/06/22	REVISED AND ISSUED AS STANDARD SPECIFICATION	RG	RSR	MKS	SM
8	20/01/17	REVISED AND ISSUED AS STANDARD SPECIFICATION	RG	MKS	BRB	RN
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6	11/04/11	REVISED AND ISSUED AS STANDARD SPECIFICATION	PS	ANPS	UAP	DM

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Abbreviations:

ASTM	:	American Society for Testing and Materials
BIS	:	Bureau of Indian Standards
BS	:	British Standard
CEA	:	Central Electricity Authority
DGMS	:	Director General of Mines and Safety
EIL	:	Engineers India Limited
EPR	:	Ethylene Propylene Rubber
FR	:	Flame Retardant
FRLS	:	Flame Retardant Low Smoke
FS	:	Fire Survival
ICEA	:	Insulated Cable Engineers Association
IEC	:	International Electro technical Commission
IEEE	:	The Institute of Electrical & Electronic Engineers
IS	:	Indian Standards
LF	:	Low Frequency
NEMA	:	National Electrical Manufacturers Association
PE	:	Polyethylene
PO	:	Purchase Order
PVC	:	Polyvinyl Chloride
UV	:	Ultra Violet
XLPE	:	Cross linked Polyethylene

Electrical Standards Committee

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1.0 SCOPE

This specification along with data sheets covers requirements for design, manufacture, testing at works and supply of Fire survival Medium voltage cables and Flame Retardant Low Smoke Medium & High Voltage cables and cable jointing / terminating accessories for medium and high voltage systems.

2.0 STANDARDS

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

IS: 209	:	Specification for zinc.
IS: 1554 Part-1	:	PVC insulated (heavy duty) electric cables for working voltages upto and including 1100V (including amendment no. 1, 2, 3, 4 & 5)
IS:1554 Part-2	:	Specification for PVC insulated (heavy duty) electric cables for working voltages from 3.3 kV up to and including 11 kV (including amendment no. 1, 2, 3 & 4)
IS: 3961(Pt-6)	:	Recommended current rating for cables: Part- 6 Cross-linked Polylene insulated PVC sheathed cables
IS: 3961(Pt-7)	:	Recommended current ratings for cables part 7 cross-linked insulated thermoplastic sheathed cables
IS: 3975	:	Mild steel wires, strips and tapes for armouring of cables.
IS: 5831	:	PVC insulation and sheath of electric cables.
IS: 6380	:	Specification for elastomeric insulation and sheath of electric cables.
IS: 7098 Part-1	:	Cross linked polyethylene insulated PVC sheathed cables for working voltage upto and including 1100V (including amendment no. 1,2,3,4 & 5)
IS: 7098 Part-2	:	Cross linked polyethylene insulated thermoplastics sheathed cables for working voltages from 3.3 kV up to and including 33 kV (including amendment no. 1 & 2)
IS: 8130	:	Conductors for insulated electric cables and flexible cords.
IS: 10418	:	Drums for electric cables.
IS:10462 (Pt-1)	:	Fictitious calculation method for determination of dimensions of protective coverings of cables: Part - I Elastomeric and thermo-plastic insulated cables.
IS: 10810	:	Methods of test for cables: - Part 41: Mass of zinc coating on steel armour - Part 58: Oxygen index test - Part-61: Flame retardant test - Part-62: Fire resistance test for bunched cables. - Part-63: Measurement of Smoke density of Electric cables under fire conditions
IS: 13573 (Pt-1):		Cable accessories for extruded power cables - part 1 for working voltages for 1.1 kv upto and including 3.3kV (E) - test methods and test requirements
IS: 13573 (Pt-2):		Cable accessories for extruded power cables - part 2 for working voltages for 3.3kV (UE) upto and including 33kV (E) - test requirements
IS: 13573 (Pt-3):		Cable accessories for extruded power cables - part 3 for working voltages for 3.3kV (UE) upto and including 33kV (E) - test methods
IS: 16269	:	Recommended short circuit ratings of electric cables with rated voltage from 1.1kV to 220kV

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IEC: 60331-21	:	Tests for electric cables under fire conditions circuit integrity – Procedures and requirements – Cables of rated voltage up and including 0.6/1.0kV.
IEC: 60332-1	:	Test of the fire behaviour on single core or single cable (flame retardancy)
IEC: 60332-3	:	Tests of the fire behaviour on bunched cables (reduced flame propagation)
IEC-60754-1	:	Test on gases evolved during combustion of materials from cables, Determination of the amount of halogen acid gas content
IEC: 61034	:	Measurement of smoke density of cables burning under defined condition
NEMA-WC53	:	Standard test methods for extruded dielectric power, control, instrumentation and portable cables for test.
IEEE-383	:	Standard for qualifying electrical cables and splices for nuclear facilities
ASTM-G-154	:	Standard practice for operating fluorescent light apparatus for UV exposure of non metallic materials.
ASTM-D-2863	:	Measurement of minimum oxygen concentration to support candle like combustion of plastics
BS: 7846	:	Electric cables- 600/1000V armoured fire resistant cables having thermosetting insulation and low emission of smoke and corrosive gases when affected by fire.

2.2 The cables and accessories shall also conform to the provisions of CEA Regulations and other statutory regulations, as applicable.

2.3 In case of any conflict between requirements specified in various applicable documents for the project, the most stringent one shall prevail. However, Owner's decision in this regard will be final and binding.

3.0 GENERAL CONSTRUCTION

3.1 The cables shall be suitable for laying in trays, trenches, ducts, and conduits and for underground-buried installation with uncontrolled backfill and possibility of flooding by water and chemicals.

3.2 Outer sheath of all cables shall be black in colour and the minimum value of oxygen index shall be 29% at 27 ± 2 ° C. In addition suitable chemicals shall be added into the PVC compound of the outer sheath to protect the cable against rodent and termite attack. However, for earthing cables; colour of outer sheath shall be green.

3.3 All cables covered in this specification shall be Flame Retardant Low Smoke (FRLS) or Fire Survival (FS). The outer sheath of FRLS cables shall possess flame propagation properties meeting requirements as per IS-10810 (Part-62) category AF. FRLS cable shall be identified by indenting, embossing or printing the appropriate legend i.e. 'FRLS, Category – C2' throughout the cable length. FRLS properties shall be as per IS:10810 Part 61 & 62, IEC-60332 Part 1 & Part 3, IEEE-383, IEC-61034, IEC-60754 Part 1, ASTM-D-2863.

3.4 Sequential marking of the length of the cable in metres shall be provided on the outer sheath at every one metre. The embossing/engraving shall be legible and indelible.

3.5 The overall diameter of the cables shall be strictly as per the values declared by the manufacturer in the technical information subject to a maximum tolerance of ±2 mm up to overall diameter of 60mm and ±3mm for beyond 60mm.

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3.6 PVC/ Rubber end caps shall be supplied free of cost for each drum with a minimum of eight per thousand metre length. In addition, ends of the cables shall be properly sealed with caps to avoid ingress of water during transportation and storage.

3.7 The joints in armour wire/strips shall be made by brazing or welding and any surface irregularities shall be removed. A joint in any wire/strip shall be at least 300mm. from the nearest joint in any wire/strip in the complete cable.

3.8 The cables meant to be used in mining area under the jurisdiction of DGMS shall satisfy the following

(a) "DGMS CERTIFIED" to be embossed at outer sheath at regular interval.

(b) Cables to be used in Mines shall have copper conductor only.

(c) The resistance of armour shall not exceed that of the conductor as specified in IS-8130 by more than 33%. To satisfy this, substitution of galvanised steel wire/strip in armouring by the required number of tinned copper wires/strips is permissible.

(d) For mining cables, the size and type of armour shall be such that the combined conductance of armour shall be equivalent to 75 percent of the conductance of the largest conductor of the cable.

3.9 Medium Voltage Cables

3.9.1 All power/control cables for use on medium voltage systems shall be heavy-duty type, 650/1100V grade with aluminium/ copper conductor (as mentioned in datasheet / Material requisition), XLPE insulated, inner-sheathed, armoured/ unarmoured and overall PVC sheathed. XLPE insulated cables shall meet the requirement specified in IS-7098 (Part-1).

3.9.2 The conductors shall be stranded for all sizes of MV power cable. Conductors of nominal area less than 16 mm^2 shall be circular only. Conductors of nominal area 16 mm^2 and above may be circular or shaped as per IS 8130. Cables with reduced neutral conductor shall have sizes as per Table- 2 of IS 7098 (Part-1).

3.9.3 The core insulation shall be with XLPE compound applied over the conductor by extrusion. It shall conform to the properties given in Table-1 of IS: 7098 (Part-1).

3.9.4 The inner sheath shall be applied over the laid-up cores by extrusion and shall be of PVC conforming to the requirements of Type ST-2 PVC compound as per IS: 5831. The minimum thickness of inner sheath shall be as per Table-5 of IS: 7098 (Part-1). Single core cables shall have no inner sheath.

3.9.5 All cables shall be provided with armour except those specifically specified as unarmoured. For single core cables intended for use on AC system, the armouring shall be of non-magnetic material. For multicore cables, the armour shall be by single round galvanised steel wires where the calculated diameter below armouring does not exceed 13 mm and by galvanised steel strips where this dimension is greater than 13 mm. Requirement and methods of tests for armour material and uniformity of galvanisation shall be considered as per IS - 3975 and IS - 10810 (Part 41). The dimensions of armour shall be considered as per method (b) of Table-6 of IS - 7098 (Part -1). For single core cables, the armour shall be with H4 grade hard drawn aluminium round wire of 2.5 mm diameter for cable having calculated diameter under armour upto 55 mm. In case of calculated diameter under armour is more than 55 mm. Table-6 of IS: 7098 (Part-1) shall be followed for dimension of armour.

3.9.6 The outer sheath for the cables shall be applied by extrusion and shall be formulated for lower smoke and shall be of PVC compound conforming to the requirements of type ST-2

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compound as per IS: 5831. The minimum and average thickness of outer sheath for unarmoured cables and minimum thickness of outer sheath for armoured cables shall be as per Table-8 of IS: 7098 (Part -1).

3.9.7 For XLPE insulated cables, it shall be possible to continuously operate the cable at a maximum conductor temperature of 90°C under full load condition and 250°C under short-circuit condition.

3.9.8 The fire survival cables shall meet the following additional requirements :

i) The insulation shall be of EPR or equivalent material with glass mica tape below or above insulation.

ii) The cables shall meet requirement of circuit integrity test for a minimum period of 3 hours at maximum temperature of 950° C.

3.10 High Voltage Cables

3.10.1 Power cables from 3.3kV and up to and including 33kV systems shall be Aluminium/ Copper conductor, XLPE insulated, sheathed, armoured/ unarmoured and overall PVC sheathed.

3.10.2 The conductors shall be stranded and compacted circular for all cables.

3.10.3 All cables rated 3.8/ 6.6kV and above shall be provided with both conductor screening and insulation screening. The conductors shall be provided with non-metallic extruded semi conducting screen.

3.10.4 The core insulation shall be with cross linked polyethylene insulating compound dry cured, applied by extrusion. It shall be free from voids and shall withstand all mechanical and thermal stresses under steady state and transient operating conditions. It shall conform to the properties given in Table-1 of IS: 7098 (Part-2).

3.10.5 The insulation screen shall consist of non-metallic extruded semi-conducting compound in combination with a non-magnetic metallic copper screen. The copper screen for all the three cores together shall be capable of carrying the single line to ground fault current value and the duration specified in the data sheet. For single core cable, copper screen provided shall be capable of carrying the single line to ground fault current value and the duration specified in the data sheet. For screen sizing, final temperature shall be considered as 200°C under adiabatic condition as per IS: 16269.

3.10.6 The conductor screen, XLPE insulation and insulation screen shall all be extruded in one operation by 'Triple Extrusion' process to ensure perfect bonding between the layers. The core identification shall be by coloured strips or by printed numerals.

3.10.7 The inner sheath shall be applied over the laid up cores by extrusion and shall conform to the requirements of type ST 2 compound of IS: 5831. The extruded inner sheath shall be of uniform thickness. The minimum thickness of inner sheath shall be as per Table-5 of IS: 7098 (Part-2). In case of single core cables, there shall be extruded inner sheath between insulation metallic screen and armouring.

3.10.8 All cables shall be provided with armour except those specifically specified as unarmoured. For single core cables intended for use on AC system, the armouring shall be of non-magnetic material. For multicore cables, the armour shall be by galvanised steel strips. Requirement and methods of tests for armour material and uniformity of galvanisation shall be as per IS-3975 and IS -10810 (Part 41). The dimensions of armour shall be as per method (ii) of Table-6 of IS -7098 (Part -2). For single core cables, the armour shall be with H4 grade hard drawn aluminium round wire of 2.5 mm diameter for cable having calculated diameter under armour

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upto 55 mm. In case of calculated diameter under armour is more than 55 mm. Table-6 of IS: 7098 (Part-2) shall be followed.

3.10.9 The outer sheath of the cables shall be applied by extrusion over the armouring and shall be of PVC compound conforming to the requirements of Type ST 2 compound of IS: 5831. The minimum and average thickness of outer sheath for unarmoured cables and minimum thickness of outer sheath for armoured cables shall be as per Table-7 of IS: 7098 (Part-2).

3.10.10 The thickness of the insulation, inner sheath shall be governed by values given in Table-4 and Table-5 of IS: 7098 (Part -2).

4.0 CABLE ACCESSORIES

4.1 The termination and straight through jointing kits for use on the systems shall be suitable for the type of cables offered as per this specification and shall meet requirements of IS 13573.

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

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

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

4.5 Terminating Kits

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

4.6 Jointing Kits

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

5.0 INSPECTION, TESTING AND ACCEPTANCE

The cables shall be tested and inspected at the manufacturer's works. Manufacturer shall furnish all necessary information concerning the raw material supply to EIL/ Owner's inspectors. The inspector shall have free access to the manufacturer's works for the purpose of inspecting the process of manufacture in all its stages and will have the power to reject any material, which appears to be of unsuitable description or of unsatisfactory quality. For HV cables, the vendor shall give at least 2 weeks advance notice to the purchaser, regarding the date of testing to enable purchaser's representative to witness the tests.

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5.1 Cables

5.1.1 After completion of manufacture of cables and prior to despatch, the cables shall be subjected to type, routine, acceptance and special tests as detailed below. The test reports for all cables shall be got approved from the Engineer before despatch of the cables.

5.1.2 All routine tests, acceptance tests, type tests and additional type tests for improved fire performance shall be carried out as listed in IS: 7098 (Part-1 & Part-2) on XLPE insulated cables.

5.1.3 The test requirements for PVC sheath of cables shall be as per latest revision of IS: 5831.

5.1.4 Test for Resistance to Ultra Violet Radiation: This test shall be carried out as per ASTM-G-53 or ASTM-G-154 on outer sheath. The retention value of tensile strength and ultimate elongation after the test shall be minimum 60 % of tensile strength and ultimate elongation before the test. Test certificates with respect to this test (not older than one year) from recognised testing laboratory to be furnished for review by EIL before despatch clearance of cables. In case test certificates are not available, test is to be conducted by vendor at his own cost in any recognised test laboratory or in house testing laboratory, before despatch clearance of cables. Sampling for this test is to be done randomly once for each order, provided outer sheath remains same.

5.1.5 Acceptance tests as per IS-7098 (Part-1 & Part-2) and the following special tests to be performed on the cables as per sampling plan for all cables. However these tests are required to be witnessed by EIL/ Owner for HV cables.

a. Accelerated water absorption test for insulation as per NEMA-WC-53 (for XLPE/ EPR insulated cables). Test certificates with respect to this test (not older than one year) from recognised testing laboratory to be furnished for review by EIL before despatch clearance of cables. In case test certificates are not available, test is to be conducted by vendor at his own cost in any recognized test laboratory or in house testing laboratory, before despatch clearance of cables. Sampling for this test is to be done randomly once for each order, provided type of insulation remains same.

b. Oxygen Index Test: The test shall be carried out as per IS-10810 (Part 58). Sampling to be done for every offered lot/size as per sampling plan.

c. Flammability Test: The test shall be carried out on finished cable as per IS-10810 (Part 61 & 62). Sampling for these tests is to be done randomly once for each order, provided outer sheath remains same. The acceptance criteria for tests conducted shall be as under:

Part-61-The cable meets the requirement if there is no visible damage on the test specimen within 300 mm from its upper end

Part-62-The maximum extent of the charred portion measured on the test sample should not have reached a height exceeding 2.5 m above the bottom edge of the burner at the front of the ladder.

d. Test for rodent and termite repulsion property shall be done by analysing the property by chemical method.

5.1.6 Following tests shall be carried out to prove FRLS property of the cable.

a. Critical oxygen index as per ASTM-D-2863 i.e. Determination of % of oxygen required for combustion at room temperature of FRLS sheath which shall remain as 29% (min.)

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b. Temperature index as per ASTM-D-2863 i.e. to determine at what temperature normal oxygen content of 21% in air will support combustion of FRLS sheath which shall remain as 250°C.

c. Halogen acid gas emission as per IEC-60754 Part 1 i.e. to determine the % of release of hydrochloric acid gas from the FRLS sheath under fire which shall be 20% (max.)

d. Smoke Density Test shall be as per ASTM D - 2843 and Smoke Density Rating of FRLS Sheath shall be 60% (max.).

5.1.7 The test for circuit integrity for fire survival cables shall be carried out as per IEC-60331 (Part-21).

5.2 Cable Accessories

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

6.0 PACKING AND DESPATCH

6.1 Cables shall be despatched in non-returnable steel drums of suitable barrel diameter, securely packed, with the take-off end fully protected against mechanical damage. Ferrous parts used shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit or storage.

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

6.3 Cables shall be supplied in drum lengths as follows:

6.3.1 **MV Cables**

-	Multicore Power cables upto 50 mm^2	:	2000 m
-	Multicore Power cables from 70 mm^2 up to 500 mm^2	:	1000 m
-	Single Core Power cables upto 630 mm^2	:	1000 m

6.3.2 **HV Power Cables Upto 11kV Grade**

-	Three Core cables upto 400 mm^2	:	750 m
-	Single Core cables upto 400 mm^2	:	1000 m
-	Single Core cables above 400 mm^2 and upto 1000 mm^2	:	750 m

6.3.3 **HV Power Cables Above 11kV Grade and upto 33kV Grade**

-	Three Core cables upto 300 mm^2 grade	:	500 m
-	Single Core cables upto 400 mm^2	:	1000 m
-	Single Core cables above 400 mm^2 and upto 1000 mm^2	:	500 m

However exact drum lengths shall be finalised during order execution. A tolerance of ± 3 % shall be permissible for each drum. However overall tolerance on each size of cable shall be limited to (-2%) to (+0%).

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संचार, अग्नि चेतावनी और कंट्रोल पेयर्ड केबल के लिये विनिर्देश

SPECIFICATION FOR COMMUNICATION, FIRE ALARM AND CONTROL PAIRED CABLES

Rev.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
7	07/04/21	REVISED AND ISSUED AS STANDARD SPECIFICATION	RG	MKS	PG	SM
6	01/04/16	REVISED AND ISSUED AS STANDARD SPECIFICATION	RG	MKS	BRB	RN
5	27/04/11	REVISED AND ISSUED AS STANDARD SPECIFICATION	PS	ANPS	UAP	DM
4	25/04/08	REVISED AND ISSUED AS STANDARD SPECIFICATION	ANPS	UAP	JMS	VC
3	21/03/03	REVISED AND ISSUED AS STANDARD SPECIFICATION	UAP	AAN	VPS	SKG

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Abbreviations:

ASTM	:	American Society for Testing and Materials
BIS	:	Bureau of Indian Standards
BS	:	British Standard
CEA	:	Central Electricity Authority
DGMS	:	Director General of Mines and Safety
DOT	:	Department of Telecommunications (Government of India)
EIL	:	Engineers India Limited
EPR	:	Ethylene Propylene Rubber
FR	:	Flame Retardant
FRLS	:	Flame Retardant Low Smoke
FS	:	Fire Survival
IEC	:	International Electro technical Commission
IEEE	:	The Institute of Electrical & Electronics Engineers
IS	:	Indian Standards
LF	:	Low Frequency
PE	:	Polyethylene
PO	:	Purchase Order
PVC	:	Polyvinyl Chloride
UV	:	Ultra Violet
XLPE	:	Cross Linked Poly Ethylene

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1.0 SCOPE

The intent of this specification is to define the requirements for design, manufacture and supply of Flame Retardant Low Smoke type and Fire Survival type paired PVC sheathed control cables and cables for use in plant communication & fire alarm systems and jelly filled telecommunication cables.

2.0 CODES AND STANDARDS

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

2.1 BIS and other Standards

ASTM-D-883	:	Standard terminology relating to plastics.
ASTM-D-2863	:	Measurement of minimum oxygen concentration to support candle like combustion of plastics.
ASTM-G-154	:	Standard practice for operating fluorescent light apparatus for UV exposure of non-metallic materials.
ASTM-D-924	:	Standard test method for dissipation factor (or power factor) and relative permittivity (dielectric constant) of electric insulating liquids.
BS-6234	:	Specification for polyethylene insulation and sheath of electric cables.
IS-694	:	Polyvinyl Chloride Insulated Unsheathed and Sheathed Cables/cords With Rigid and--Flexible Conductor for Rated Voltages--Up to and Including 450/750V.
IS-1554 (Part-1)	:	PVC insulated (heavy duty) electric cables: Part 1 for working voltages up to and including 1100V.
IS-3975	:	Mild steel wires, formed wires and tapes for armouring of cables.
IS-5831	:	PVC insulation and sheath of electric cable.
IS-6380	:	Elastomeric insulation and sheath of electric cables.
IS-7098 (Part-1)	:	Cross Linked polyethylene insulated PVC sheathed cables: For working voltage up to and including 1100 V.
IS-8130	:	Conductors for insulated cables and flexible cords.
IS-9938	:	Recommended colours for PVC insulation for LF wires and cables.
IS-9968	:	Elastomer insulated cables: Part 1 For working voltages upto and including 1100 V.
IS-10418	:	Drums for electric cables.
IS-10462 (Part 1)	:	Fictitious calculation method for determination of dimensions of protective coverings of cables (Part-1: Elastomeric and thermoplastic insulated cables).
IS-10810	:	Methods of Test for Cables: - Part 41: Mass of zinc coating on steel armour. - Part 58: Oxygen index test. - Part-61: Flame retardant test. - Part-62: Fire resistance test for bunched cables. - Part-63: Measurement of Smoke density of Electric cables under fire conditions.
IS-12444	:	Continuously cast and rolled electrolytic copper wire rods for electrical conductors.
IEC: 60331-21	:	Tests for electric cables under fire conditions circuit integrity – Procedures and requirements – Cables of rated voltage up and including 0.6/1.0kV.
IEC: 60332-1	:	Test of the fire behavior on single core or single cable (flame retardancy).

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IEC-60332-3	:	Tests of the fire behavior on bunched cables (reduced flame propagation).
IEC-61034	:	Measurement of smoke density of cables burning under defined condition.

2.2 **DOT Standards**

GR/WIR-06/03	:	Specification for cable - switchboard (Screened and Unscreened) - Generic requirements.
GR/CUG-01/03	:	Specification for solid polythene insulated fully filled, polythene sheathed underground telecom cables.

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

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

2.5 In case Indian standards are not available for any material, standards issued by IEC or equivalent agency shall be applicable.

2.6 In case of any contradictions between various referred standard/specification/data sheet and statutory regulations, the most stringent one shall govern and decision of owner/EIL in this regard will be final and binding.

3.0 GENERAL CONSTRUCTION

3.1 Cables shall be suitable for installation in following conditions:

i. Above ground in open-air locations (trays/ ducts) in tropical, humid and corrosive atmosphere prevalent in refineries/ petrochemical plants with severe weathering and exposure to solar radiation.

ii. Directly buried in underground trenches, conduits with uncontrolled back-fill and possibility of flooding by water and chemicals.

iii. Design ambient air temperature of 40°C/ ground temperature of 30°C.

3.2 The joints in armour wire/strips shall be made by brazing or welding and any surface irregularities shall be removed. A joint in any wire/strip shall be at least 300mm from the nearest joint in any wire/strip in the complete cable.

3.3 The cable meant to be used in mining area under jurisdiction of DGMS shall satisfy the following:

a. "DGMS CERTIFIED" to be embossed at outer sheath at regular interval.
b. The resistance of armour shall not exceed that of the conductor as specified in IS: 8130 by more than 33%. To satisfy this, substitution of galvanized steel wire/strip in armouring by the required number of tinned copper wires/strips is permissible.
c. For mining cables, the size and type of armour shall be such that the combined conductance of armour shall be equivalent to 75% of the conductance of the largest conductor of the cable.

4.0 TECHNICAL REQUIREMENTS FOR NON JELLY FILLED CABLES

4.1 The control cable shall be heavy duty type, 650/1100V grade with copper conductor, XLPE insulated, twisted pair, individual pair screened/shielded, overall screened/shielded, inner sheathed, armoured and PVC overall outer sheathed.

4.2 Non jelly filled communication and fire alarm cables shall in general conform to the requirements of DOT specification GR/WIR-06/03.

4.3 **Conductors**

4.3.1 The size of conductor shall be as per job requirements/data sheets.

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4.3.2 The conductors shall consist of annealed, high conductivity copper wire, smoothly drawn, circular in cross-section, uniform in quality, free from defects and uniformly coated with pure tin and shall conform to Cl. 3.0 of DOT specification GR/WIR-06/03.

4.3.3 The conductor shall be stranded for the control cables and shall be solid for fire alarm and communication cables.

4.4 **Insulation**

4.4.1 For fire alarm and communication cable, the core insulation shall be with PVC compound applied over the conductor by extrusion.

4.4.2 For control cable, the core insulation shall be with Cross Linked Poly Ethylene (XLPE) compound cured, applied over the conductor by extrusion. It shall be free from voids and shall conform to the properties given in Table-1 of IS: 7098 (Part-1).

4.4.3 PVC Insulation shall meet the following requirements:

Conductor Diameter (Area)	Type of Insulation	Thickness of Insulation (Minimum)
Up to 0.5mm ($0.2mm^2$)	Type-A as per IS-5831	0.18 mm
Above 0.5mm ($0.2mm^2$) & up to 0.71mm (0.4mm2)		0.26 mm
Above 0.71mm ($0.4mm^2$) & up to 0.9mm (0.63mm2)		0.31 mm
Above 0.9mm ($0.63mm^2$) & up to 1.12mm ($1mm^2$)		0.39 mm
Above 1.12mm ($1mm^2$) & up to 1.38mm ($1.5mm^2$)		0.58 mm
1.78mm ($2.5mm^2$)		0.71 mm

4.4.4 The nominal thickness of XLPE insulation for $1.5mm^2$ and $2.5mm^2$ conductor size control cables shall be 0.7mm in line with Table-3 of IS: 7098 (Part-1).

4.4.5 The colour used for insulation shall conform as nearly as practicable to the standard colours as per IS-9938. The wire insulation shall have colours in accordance with Table-2 of DOT specification GR/WIR-06/03. The applied colour shall neither have deleterious effect on the electrical, mechanical or ageing properties of basic insulation nor shall get damaged by any friction etc.

4.4.6 For single pair cables, the colour shall be incorporated in the insulation.

4.4.7 For multi pair cables, cores shall have uniform pattern of continuous spiral (Pitch not exceeding 25mm) to facilitate easy identification. This may be done by the application of one or more coloured strips on a base colour or by direct extrusion.

4.4.8 Alternately, colouring may consist of concentric coloured rings or dots or dashes on the base colour. The coloured rings, dots or dashes shall have a width of not less than 1.0mm and shall be repeated along the length of the insulation at an interval not less than 15mm and not more than 25mm.

4.4.9 The dots or dashes shall be applied on diametrically opposite sides of the insulation, so that all colours are visible when the insulation is viewed from any side.

4.4.10 In addition to colouring, control cables shall also be identified with prominent and indelible Alpha Numeric numerals on the outer surface of the insulation/ screen. Colour of the numbers shall contrast with the colour of insulation with a spacing of maximum 50mm between two consecutive numbers.

4.5 **Twisting**

The two insulated conductors of a pair shall be uniformly twisted with a suitable right hand lay, which shall not exceed 80mm.

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4.6 **Core Formation**

The core formation shall conform to Cl. 6.0 of DOT specification no. GR/WIR-06/03.

4.7 **Screen/ Shield**

4.7.1 The control cables shall be provided with individual pair screen/shield and also overall screen/shield. Fire alarm and communication cables shall be provided with overall screen/shield. The screen/shield shall be of aluminium tape with minimum thickness of 0.04mm. The overlap shall be minimum 3mm for cables up to 50 pair & minimum 6mm for cables above 50 Pair. The screen/shield shall be backed by an outer protective layer of 0.13mm PVC tape or other non-hygroscopic material lapped applied longitudinally or helically with overlap.

4.7.2 The cables shall be provided with a drain wire. Drain wire shall have a minimum cross-section of 0.5mm^2, shall be composed of multistrand bare tinned annealed copper conductor. The drain wire shall be in continuous contact with the aluminium side of the overall screen/shield. The drain wire resistance including screen shall not exceed 30 ohm/km.

4.8 **Ripcord**

A non-metallic ripcord of suitable quality shall be laid longitudinally under the inner sheath & overall screen/shield. The ripcord when pulled shall cut through the sheath and strip the core.

4.9 **Inner Sheath**

4.9.1 An extruded inner sheath of type ST1 PVC, as per IS-5831, with minimum thickness as per Table-4 of IS-1554 (Part-1) shall be provided for PVC insulated cable. For XLPE insulated cable, an extruded inner sheath of type ST2 PVC, as per IS-5831, with minimum thickness as per Table-5 of IS-7098 (Part-1) shall be provided. It shall be applied over the laid up core, by extrusion to fit closely on it.

4.9.2 The inner sheath shall be as circular as possible. It shall be possible to remove the inner sheath without damage to the insulation.

4.9.3 When one or more layers of non-hygroscopic tape is helically applied over the laid up cores, as a binder, the thickness of such tape(s) shall not be construed as a part of the inner sheath.

4.10 **Armour**

4.10.1 The cables shall be provided with armouring, made of hot dip galvanized steel wire /strip over the inner sheath.

4.10.2 The armour shall be by means of 1.4mm thick round wires for cables with under armour diameter up to 13mm. For cables with an under armour diameter above 13mm, the armour shall be of flat steel strip with thickness as per IS-1554 (Part-1) or IS-7098 (Part-1), as applicable.

4.11 **Outer Sheath**

4.11.1 The cables shall be provided with an extruded PVC sheath for external protection. The PVC shall be type ST1 PVC, as per IS-5831 for PVC insulated cable and type ST2 PVC, for XLPE insulated cable.

4.11.2 All cables covered in this specification shall be flame retardant low smoke (FRLS). The outer sheath shall be with oxygen index minimum 29% at 27$\pm$2^{0}C and shall possess flame propagation properties meeting requirements as per IS: 10810 (Part-62) category AF. FRLS cables shall be identified by indenting, embossing or printing an appropriate legend i.e. 'FRLS, Category – C2' throughout the cable length. FRLS properties shall be as per IS: 10810 Part 61 & 62, IEC-60332 Part 1 & Part-3, IEEE-383, IEC-61034, IEC-60754 Part-1, ASTM-D-2863.

4.11.3 In addition, suitable chemicals shall be added to the PVC compound of the outer sheath to protect the cable against rodent and termite attack.

4.11.4 The thickness of outer sheath shall be as per IS-7098 (Part 1) for XLPE insulated cable and as per IS-1554 (Part-1) for PVC insulated cable.

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4.11.5 The outer sheath shall fit tightly on the armour and shall be applied in such a manner that no undue residual strain is left in the material.

4.11.6 The outer sheath shall be red in colour for cables to be used for fire alarm system, grey in colour for cables to be used for telephone & communication system and black in colour for control cables.

4.11.7 Sequential marking of the length of the cable, in meters, shall be provided on the outer sheath at every one meter. The marking shall be legible and indelible by suitable method.

4.11.8 The overall diameter of the cables shall be strictly as per the values declared in the data sheet, subject to a maximum tolerance of $\pm$2mm.

4.11.9 The fire survival cables (if specified in specification/ data sheet) shall meet the following additional requirements:

i) The insulation shall be of EPR or Silicone rubber or equivalent material with glass mica tape below or above insulation.

ii) The cables shall meet requirement of circuit integrity test for a minimum period of 3 hours at maximum temperature of 950^0 C.

iii) Vendor shall have the test certificate for circuit integrity test as per IEC: 60331-21.

4.12 **Cable Capacitance**

4.12.1 The core to core capacitance of the cables shall not exceed 100nF/km at 1kHz.

4.12.2 The core to screen capacitance for the screened cables shall not exceed 250nF/km at 1kHz.

5.0 TECHNICAL REQUIREMENTS FOR JELLY FILLED CABLES

5.1 Jelly filled telecom cables shall in general conform to the requirements of DOT specification GR/CUG-01/03.

5.2 **Conductors**

5.2.1 The conductors shall consist of annealed, high conductivity solid copper wire, smoothly drawn, circular in cross-section, uniform in quality, free from defects and uniformly coated with pure tin and shall conform to Cl. 3.0 of DOT specification GR/CUG-01/03.

5.3 **Insulation**

5.3.1 Each conductor shall be insulated with insulating grade PE conforming to Cl. 4.0 of DOT specification GR/CUG-01/03.

5.4 **Twisting**

The two insulated conductors of a pair shall be uniformly twisted with a suitable right hand lay, which shall not exceed 150mm.

5.5 **Core Formation**

The core formation shall conform to Cl. 6.0 of DOT specification GR/CUG-01/03.

5.6 **Filling Compound**

5.6.1 The cable core shall be filled with a suitable stable water resistant compound, which shall be compatible with the insulation, binders and tapes used in the cable.

5.6.2 It shall be homogeneous and uniformly mixed material containing an anti-oxidant.

5.6.3 The compound shall not obscure the identification of the colour of the insulation of the conductors.

5.6.4 It shall not contain dirt, metallic particles or other foreign matter.

5.6.5 The compound shall be readily removable from the insulated conductors by wiping.

5.6.6 It shall be free from any unpleasant odour and shall have no toxic or dermatic hazards.

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5.6.7 The flash point of the compound shall not be less than 200°C.

5.6.8 The volume resistivity measured at 100°C shall not be less than 10^{10} ohm-cm.

5.6.9 The permittivity at 1 MHz tested as per ASTM D-924 shall not be greater than 2.3 at 20°C.

5.7 **Core Wrapping**

At least one closed helical or longitudinal application of a non-hygroscopic and non-wicking polyester tape or tape of any other suitable material shall be provided over the cable core.

5.8 **Screen/ Shield**

5.8.1 The cables used for telephone system shall be provided with overall screen/shield. The screen/ shield shall be of aluminium tape with minimum thickness of 0.2mm. The overlap shall be minimum 3mm for cables having maximum diameter over inner sheath < 30mm & minimum 6mm for cables having maximum diameter over inner sheath ≥ 30mm. The screen/shield shall be coated with 0.05 mm nominal thickness polythene/copolymer on both sides. The thickness of the composite tape shall be 0.3mm ± 15%.

5.8.2 The aluminium tape shall be electrically continuous throughout the length of the cable.

5.9 **Inner Sheath**

5.9.1 The inner sheath shall be as circular as possible and free from pinholes and other defects. It shall be possible to remove the inner sheath without damage to the insulation.

5.9.2 The inner sheath shall be of polythene conforming to type 03C or H03C of BS 6234 and shall contain a suitable antioxidant system. The material shall be virgin as per ASTM D-883 and meet the requirements of Cl. 10.1 of DOT specification no. GR/CUG-01/03.

5.9.3 The thickness of inner sheath shall conform to Table-6 of DOT specification no. GR/CUG-01/03.

5.9.4 The maximum diameter over inner sheath shall conform to Table-7 of DOT specification no. GR/CUG-01/03.

5.10 **Armour**

5.10.1 The cables shall be provided with bedding and armour over the inner sheath.

5.10.2 The bedding shall consist of two close helical lappings of polythene or polypropylene tape. Each tape shall be applied with a minimum of 5% overlap.

5.10.3 The armour shall be made of hot dip galvanized steel tape of thickness as per Table-8 of DOT specification GR/CUG-01/03.

5.11 **Outer Sheath**

5.11.1 The external protection shall consist of a polythene sheath conforming to the material specification defined in Clause 5.9 above.

5.11.2 The thickness of outer sheath shall conform to Table-9 of DOT specification GR/CUG-01/03.

5.11.3 The outer sheath shall be as circular as possible and free from pinholes and other defects.

5.11.4 Colour of outer sheath shall be grey.

5.11.5 The maximum diameter over outer sheath shall conform to Table-7 of DOT specification GR/CUG-01/03.

5.12 **Cable Capacitance**

The average mutual capacitance of the pairs measured at 800 to 1000Hz shall be 52 ± 3 nF/km. However, the mutual capacitance of individual pairs shall be within the limits of 52 ± 4.5 nF/km.

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6.0 INSPECTION, TESTING AND ACCEPTANCE

6.1 The cables shall be tested and examined at the manufacturer's works. All the materials employed in the manufacture of the cable shall be subjected to examination, testing and approval by EIL/ Owner. Manufacturer shall furnish all necessary information concerning the supply to EIL/ Owner's inspectors. The inspector shall have free access to the manufacturer's works for the purpose of inspecting the process of manufacture in all its stages and will have the power to reject any material, which appears to be of unsuitable description or of unsatisfactory quality.

6.2 The following acceptance tests shall be conducted on the completed jelly filled cables as per the test procedures given in DOT specification GR/CUG-01/03 and this specification:

i. Measurement of diameter of conductor, over inner sheath & over outer sheath.
ii. Measurement of thickness of insulation, inner sheath, screen, armour & outer sheath.
iii. Measurement of resistance of conductor.
iv. Measurement of resistance unbalance.
v. Continuity check & measurement of resistance of Poly-al tape.
vi. Colour coding.
vii. Conductor continuity test.
viii. Mutual capacitance test.
ix. Capacitance unbalance test.
x. Cross talk test.
xi. Attenuation test.
xii. Insulation resistance test.
xiii. Dielectric strength test.
xiv. Drip test.
xv. Armour galvanization test.
xvi. Conductor annealing test.
xvii. Measurement of drum length.

6.3 Following tests shall be carried out to prove FRLS property of the cable:

a. Critical oxygen index as per ASTM-D-2863 i.e. Determination of % of oxygen required for combustion at room temperature of FRLS sheath which shall remain as 29% (min.)

b. Temperature index as per ASTM-D-2863 i.e. To determine at what temperature normal oxygen content of 21% in air will support combustion of FRLS sheath which shall remain as 250°C.

c. Halogen acid gas emission as per IEC-60754 Part 1 i.e. To determine the % of release of hydrochloric acid gas from the FRLS sheath under fire which shall be 20% (max.)

d. Smoke Density Test shall be as per ASTM- D - 2843 and Smoke Density Rating of FRLS Sheath shall be 60% (max.).

6.4 The test for circuit integrity for fire survival cables shall be carried out as per IEC-60331 (Part-21).

6.5 The following tests shall be conducted on the completed non jelly filled cables as per the test procedures given in DOT specification GR/WIR-06/03 and this specification:

6.5.1 **Acceptance tests**

i. Measurement of diameter of conductor, over inner sheath & over outer sheath.
ii. Measurement of thickness of insulation, inner sheath, screen, armour & outer sheath.
iii. Measurement of resistance of conductor.
iv. Colour coding.
v. Conductor continuity test.

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vi. Mutual capacitance test.
vii. Capacitance unbalance test.
viii. Insulation resistance test.
ix. High voltage test.
x. Armour galvanization test.
xi. Conductor annealing test.
xii. Measurement of drum length.

6.5.2 **Special Tests**

The non-jelly filled cables shall also be subjected to following special tests:

i. Oxygen index test as per IS-10810 (Part 58).
ii. Flammability test on finished cable as per IS-10810 (Part 61 & 62).
iii. Test for rodent and termite repulsion property shall be done by analyzing the property by chemical method.

The special test shall be conducted on one sample from each lot. The sample will be selected by the inspector.

7.0 PACKING AND DESPATCH

7.1 Cables shall be dispatched in non-returnable steel drums of suitable barrel diameter, securely packed, with the take-off end fully protected against mechanical damage.

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

7.3 The drum lengths for cables shall be as below:

a.	Upto 6 pairs	: 2000 meter
b.	Above 6 pairs & upto 10-pair, upto 0.9 mm dia	: 2000 meter
c.	Above 6-pairs & upto 10 pairs, above 0.9 mm dia	: 1000 meter
d.	Above 10 pairs & upto 50 pairs	: 1000 meter
e.	Above 50 pairs & upto 100 pairs	: 500 meters
f.	Above 100 pairs	: As per job requirement (subject to max. length of 500 meters)

7.4 A tolerance of ± 3% shall be permissible for each drum. However overall tolerance on each size of cable shall be limited to -2% to +0% only.

7.5 For non-jelly filled cable, PVC/ rubber end caps shall be supplied free of cost for each drum with a minimum of eight per thousand meter length. In addition, ends of the cables shall be properly sealed, with caps, to avoid ingress of moisture/ water during transit and storage.

7.6 For jelly filled telephone cables, the ends of the cable shall be sealed by thermo shrinkable end caps of adequate wall thickness. Alternately ends may be sealed by enclosing them in rubber or PVC caps of wall thickness not less than 1.8mm. The caps shall be secured to the outer sheath with hose clips or ties or black adhesive tape or heat shrinkable sleeves.

7.7 The cables may be stored outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage, in areas with heavy rains and high ambient temperature.

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SPECIFICATION FOR ELECTRICAL EQUIPMENT INSTALLATION

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	13 08 19	REVISED & ISSUED AS SPECIFICATION	RM	RS	SA	RKT
4	21 05 14	REAFFIRMED & ISSUED AS SPECIFICATION	FA	SA	BRB	SC
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1	26 08 97	REVISED & ISSUED AS STANDARD SPECIFICATION	RR	VPS	SG	AS

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Abbreviations:

AC	:	Alternating Current
ACDB	:	AC Distribution Board
AL	:	Aluminium
BIS	:	Bureau of Indian Standards
CCoE	:	Chief Controller of Explosives
CD	:	Compact Disc
CEA	:	Central Electricity Authority
CIMFR	:	Central Institute of Mining and Fuel Research
CT	:	Current Transformer
CTC	:	Carbon Tetrachloride
CU	:	Copper
DC	:	Direct Current
DCDB	:	DC Distribution Board
DGMS	:	Directorate General of Mines and Safety
Ex(d)	:	Flameproof
FRP	:	Fibre Reinforced Plastic
HV	:	High Voltage
IR	:	Insulation Resistance
IS	:	India Standard
LV	:	Low Voltage
HMI	:	Human Machine Interface
MV	:	Medium Voltage
OISD	:	Oil Industry Safety Directorate
OSR	:	Oil Surge Relay
OTI	:	Oil Temperature Indicator
PF	:	Power Factor
PI	:	Polarisation index
PRV	:	Pressure relief Valve
PT	:	Potential Transformer
SLD	:	Single Line Diagram
UPS	:	Uninterrupted Power Supply
VRLA	:	Valve Regulated Lead Acid
WTI	:	Winding Temperature Indicator
PESO	:	Petroleum and Explosives Safety Organization

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1.0 SCOPE

This specification defines the requirements for the installation, field inspection, testing and commissioning of electrical equipment, forming part of electrical power distribution and utilisation system, including Communication and Fire alarm system.

2.0 CODES AND STANDARDS

2.1 The work shall be carried out in the best workmanlike manner in conformity with this specification, EIL 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.
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. CEA Regulations.
b. Regulations laid down by CEA/Electrical Inspectorate.
c. Regulations laid down by PESO/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 OF EQUIPMENT

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,where applicable. No parts shall be subjected to undue strains or sudden stresses which could cause damage to the equipment.

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

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.

Manufacturer checklist, manual for erection and installation and any specific requirement for equipment handling, installation and commissioning shall be strictly adhered to.

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3.1 Switchboards and Bus Ducts

3.1.1 The term switchboard here includes all HV / MV/ LV switchboard panels, motor control centers, power and lighting distribution boards, UPS panels, ACDB, Battery 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 and if specified in the tender document tyre mounted hydraulic trolley shall be used.

The panels shall be preferably kept inside the packing cases till foundations are ready. Proper rain/sun/dust protection shall be ensured till switchboards are installed.

3.1.2 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.. 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 for a minimum period of 48 hours. Proper level of base frames shall be maintained throughout and shall be checked with water level/spirit level. Steel Shims shall be provided below base frame wherever required.

3.1.3 The switchboard panels shall be taken out from the packed cases and shifted one by one to their 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. Gap if any found between panels shall be suitably sealed using sealing compound or T-profile. The lifting, racking in and out operation of the breaker and all other motions shall be free from any obstruction.

The panels shall be checked for correct vertical position using Plumb line and spirit levels. The switchboard panels shall be tack welded at suitable intervals to base channel.

After erection of switchboard panels, all uncovered portions of floor cutouts shall be covered with 6 mm thick removable chequered plates finished with floor level. The design of the chequered plates shall be such that the maximum allowable deflection is L/200 (where L is the span of the chequered plates in meters) for a live load of 500 kg./sq. meters.

Additional stiffer shall be provided at the bottom if required. Suitable lifting arrangements shall be provided for chequered plates. The chequered plates shall be painted with a coat of red oxide zinc chromate primer after proper surface preparation as per specifications. Where specified, panels' cutouts provided for future use shall be filled with lean concrete.

3.1.4 After completion of Installation of switchboards, all the cubicles, switchboard components such as switches, starters, CT and PT chambers, bus bar 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

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voltage equipment shall be insulated. Interconnection wiring between shipping sections shall be done by contractor.

All the wiring connections shall also be checked. Contact resistance of all bus bar joints and contactors shall be checked. Insulator shall be checked for any damage. All the starters, switches, contacts shall be cleaned with CTC 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 less movement. All openings shall be kept completely closed to avoid ingress of any foreign particles inside the panel.

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.

3.1.5 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.

3.1.6 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

3.1.7 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.

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

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

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

3.1.11 **Pre-Commissioning Check List**

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

i. 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.

ii. 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.

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iii. That the polarity test and ratio test of all the PTs and CTs 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.

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

v. That all the protective relays including both conventional and microprocessor based numerical relays and thermal overload relays/electronic motor protection 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 HMI in case the same is provided.

vi. That IR Value has 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.

vii. Following tests shall be ensured for all CTs

- Insulation resistance test
- Ratio test through primary injection
- Polarity test
- Knee point voltage for class PS CTs

viii. Following tests shall be ensured for all PTs

- Insulation resistance test
- Ratio test through primary injection
- Polarity test

ix. Following tests shall be ensured for all breakers

- Insulation resistance test
- Breaker closing, opening sequence using 3 pole timers
- High voltage test both in open and close condition for HV breaker
- Contact resistance of all three poles using 100A DC Kit

x. Following tests shall be ensured for all meters

- Calibration of meters
- Functional verification and settings

xi. Following tests shall be ensured for all relays

- Secondary injection test
- Relay settings
- Timing check with timers
- Any other test recommend by the supplier

xii. Following tests shall be ensured for all bus bars

- Tightness of all nuts/bolts using Torque wrench
- IR value
- Contact resistance using 100A DC Kit
- Cleaning of bus bar chamber using vacuum cleaner
- Conducting jelly shall be applied on AL/CU joints as per manufacturer's recommendations
- HV test in case of HV switchboard

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xiii Following tests/Checks shall also be performed on the switchboards

- Functional verification of individual feeders including all spare feeders
- Simulation test for under voltage tripping of related feeders such as motor feeder, capacitor feeders etc
- Verification of control supply schemes
- Stability test for all differential protections
- Simulation test for bus auto/manual change over scheme, fast bus transfer scheme
- Checks for all panel illuminations, indicating lamps, sockets
- All upstream and down stream interlocks

3.1.12 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 levelling shall be checked with spirit level and pendulum weight.

The sandwiched busducts shall be stacked vertically for installation such that each phase and neutral busbar of each sandwich busduct are vertically aligned in a line. This arrangement would allow for shorting of busbars across sandwich busducts before connecting to switchboard.

Pre-commissioning check list

Before commissioning any bus duct, following points shall be checked and ensured for safe energising of the bus ducts

- All joints are tightened using torque trench
- Cleaning of bus duct chamber with vacuums cleaner
- Silica gel breather shall be connected if supplied. If required, silica gel shall be reactivated as per the instruction of engineer in charge.
- Space heater circuit shall be checked and tripping through thermostat shall be ensured
- Contact resistance shall be measured for all phases/neutral using 100A DC kit
- High voltage test in case of HV bus ducts

3.2 Transformers

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, care shall be taken to avoid slings touching other parts.

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3.2.1 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.

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

i. Dents on tank wall or cooling tubes, radiators
ii. Damage to protruding parts like valves, sight glass etc.
iii. Loosening of bolts due to vibration in transit.
iv. Cracked or broken bushings.
v. Oil leakage particularly along welds.

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

3.2.3 Contractor shall examine the transformer base, oil pit, fire walls and foundations made by the civil contractor. It shall be ensured that oil spills can not 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 foundations. The transformers shall be levelled, aligned and checked for free movement on the channels or rails. Stoppers shall be provided to the transformers immediately to prevent any movement. Normally transformers upto 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 in different 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 CTs bushings and other wiring shall be checked for tightness and correctness before replacing the lid or tightening all the bolts. Gravels shall be filled in the transformer bay, soak pit as per requirement.

3.2.4 **Topping of transformer with oil**

Before topping up with oil, transformer shall be fitted 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 with conservator tank, the rate of oil flow shall be reduced when the level is almost upto 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.

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3.2.5 **Transformer Oil**

i. Sample of oil from transformer shall be taken from both top and bottom of the tank. In case of oil filled cable box with a separate conservator, separate oil samples shall be taken from cable box.

ii. **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 the methods prescribed.

iii. Dissolved Gas analysis (DGA) of transformer oil sample may be carried out at site as per IS-9434.

3.2.6 Drying out of the transformers, if required, shall be carried out and record maintained in accordance with IS: 10028. Normally a streamline filter shall be used for drying-up. IR value versus time of both windings along with OTI/WTI and filtrations machine temperature curve for IR value Vs time shall also be plotted and recorded during the drying-up process.

Precautions when drying

i. The maximum sustained temperature to which transformer oil may be subjected shall be limited to 80^0 C.

ii. The transformer shall be carefully monitored throughout the drying out process and all observations shall be carefully recorded.

iii. 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 megohms / kV at 60^0 C temperature with a 5 kV Megger may be a rough indication for stopping the dehydration.

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

i. 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.

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

3.2.8 **Pre-commissioning Check List**

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

i. 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.

ii. Oil level, in the transformer conservator tank and all the bushings is upto the marked point and the oil has been tested for dielectric strength and acidity.

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iii. Silicagel is in reactivated condition. The breather pipe is clear from any blocking and contains oil upto the proper level.

iv. The explosion vent diaphragm does not have any dents. Accumulation of any oil and air had been released.

v. 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 been 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 upto 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.

vi. Buchholz relay (of main tank as well as that of oil filled cable box, as applicable) 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.

vii. Metering equipment has been tested and polarity test of PT's and transformer winding is satisfactory. Phase sequence and connections have been checked for proper vector group.

viii. Ratio test and winding resistance on all the tap positions is satisfactory.

ix. Gaps of arcing horns for the bushings where provided are in order and earth connections for the surge diverters have been checked.

x. Winding and oil temperature thermometer pockets contain oil and the winding and oil temperature settings on dial gauges are in order.

xi. Transformers fitted with fans for forced air cooling have been checked up for starting and stopping of the fans both in manual and auto mode and air-displacement has been verified.

xii. Simulation tests for all external interface connection alarm, annunciation and trip circuits have been checked and are in order.

xiii. Insulation resistance of all the control circuits and IR value of the transformer windings and all the incoming and outgoing cables have been checked.

xiv. Valves in the cooling system and valve between the buchholz relay and the conservator tank are in open position.

xv. Setting of all the protective relays is at the desired value and DC Trip supply is healthy.

xvi. Magnetic, current and magnetic balance test have been conducted

xvii Simulation test for WTI,OTI,PRV (of main tank as well as that of oil filled cable box, as applicable), OSR

xviii Settings of WTI/OTI as per the instruction of the manufacturer

xix Earth resistance value for the neutral earthing

xx Before charging, it is ensured that water sprinker system, if provided, is installed and is operational.

xxi In case the fire protection system of transformer is by Nitrogen injection system, testing of this system is ensured.

xxii In case of power transformer rated 50MVA and above, SFRA (sweep frequency response analysis) has been conducted at site.

xxiii tan delta test of transformer has been conducted for 50 MVA and above transformer.

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3.2.9 **Observations after Commissioning**

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

i. The inrush magnetizing current and no-load current.
ii. Alarm, if any, or if any relay flag has operated.
iii. Voltage and current on all the three phases.
iv. Transformer hum or abnormal noise.
v. Circulation of oil and leakages.
vi. Record current, voltage, cooling air temperature, winding temperature and oil temperature readings, hourly for 24 hours.
vii. Cable end boxes for any over-heating.

3.3. HV and MV MOTORS

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

3.3.2 Electrical contractor shall keep the motor space heater energised as per the directions of Engineer-in-charge. Electrical contractor shall measure the insulation resistance of motor windings and PI in case of HV motors. Insulation resistance of the motors shall be measured between the winding of the machine and its frame by means of a 500 / 1000 V Meggar in case of 415 V motors. A minimum value of 1 megohm for 415 V motors 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.

i. Blowing hot air from external source.
ii. Putting the motor in oven.
iii. Placing heaters or lamps around and inside after making suitable guarding and covering arrangements so as to conserve the heat.

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.

i. By locking the motor so that it can not 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 90^0 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.

ii. By blasting hot air from external source, Maximum temperature of winding while drying shall be 70^0 C to 80^0 C (thermometer) or 90^0 C to 95^0 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 readings and, till steady temperature is reached. In case it is essential, the drying process can be supplemented by blower.

3.3.3 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.

3.3.4 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.

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

3.3.6 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

3.3.7 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 from the driving end with reference to the phase sequence R, Y, B.

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

3.3.9 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.

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

i. 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.

ii. 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.

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

3.4. Batteries/Battery charger

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 manufacturer's instructions. Interrow connections shall be made with the leads supplied by the manufacturer. Functional check shall be done on the battery charger including battery charging and discharging, recharging as per the recommendation of the manufacturer.

3.5. Neutral Earthing Resistor

The neutral earthing resistor shall be inspected for any damage to the resistor grid and other components. The resistor shall be levelled and installed. All covers etc. shall be checked for

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tightness to ensure that the enclosure of the resistor is dust, vermin and weatherproof. Earthing conductors shall be taken from the out end terminal of the resistor, for connection to earth electrodes and to the main grid. Check such as IR, operation of space heater, earth resistance shall be done before the commissioning.

3.6 Welding Receptacles

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.

3.7 Push Button/Control Stations

The push buttons / control stations shall be installed near to the motors to be controlled. Individual channel supports shall be installed as per EIL standard. If control stations for hazardous areas are to be supplied by contractor, these shall be of Ex (d) type, tested by CIMFR and approved by PESO 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.

3.8 Gang operated Isolators/outdoor Disconnectors

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 levelled 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.

3.9 Contractor shall provide the following items in substation, as per CEA Regulations.

3.9.1 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.

3.9.2 First aid boxes containing ointments and medicines for immediate treatment of injuries (As prescribed by Indian Red Cross Society or equivalent).

3.9.3 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.

3.9.4 Danger boards (HV, MV) shall be provided on transformer bay gate, switchboards, entrance to switchgear room and at other places as required by Engineer-in-charge.

3.10 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 are 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.

4.0 EQUIPMENT COMMISSIONING

4.1 Field inspection, testing and commissioning of the complete electrical installation shall be carried out as per EIL specification no. 6-51-0087.

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After the equipment is installed properly in accordance with drawings and specifications, contractor shall carry out all pre-commissioning checks and tests as per EIL format in the presence of Engineer-in-charge and test readings shall be recorded and furnished to EIL in triplicate.

4.2 All equipment layout drawings shall be marked by the Contractor for "AS BUILT STATUS" and two sets of hard copies shall be submitted to EIL.

5.0 LIST OF CONSTRUCTION EQUIPMENT

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.

5.1 Equipment

i. Portable grinder.
ii. Portable welding machine.
iii Portable gas cutting / welding set.
iv. Pipe threading machine.
v. Pipe bending machine (hydraulic).
vi. Portable drill machine suitable to take up drilling for different sizes as per requirement.
vii Dewatering pump sets (diesel driven).
viii. Power Hacksaw.
ix. Conduit dye set.
x. Hydraulic crimping machine with round/hexagonal dye set.
xi. Hand crimping tool.
xii. Portable electric blowers, vacuum cleaners.
xiii. Miscellaneous items such as slings, pulleys, tarpaulins, wooden sleepers, ladders. etc. as required.
xiv. Safety belts, safety goggles, and gloves.
xv. Separate tool kit for each Electrician.
xvi. Hydraulic/Hand held grease gun

5.2 Test Instruments

i. Insulation tester 1000 V hand driven.
ii. Insulation tester 2500 V motor/hand driven.
iii. Insulation tester 5000 V motor/hand driven
iv. Phase sequence indicator.
v. Earth Resistance tester.
vi. Single phase variac
vii. 3 phase variac of adequate capacity.
viii. Secondary and primary injection testing kit.
ix. Multimeter, both analogue and digital
x. Portable Ammeters, Wattmeters, P.F. meters.

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xi. Portable Voltmeters.
xii. Clip on meters of different ranges.
xiii. Tacho-meter.
xiv. Kelvins double bridge for measurement of very low resistance.
xv. D.C. high -pot test kit.
xvi. A.C. high -pot test kit.
xvii. Oil filtration machine of adequate capacity.
xviii. Lux Meter to measure illumination levels.
xix. Breaker timing 3 pole kit
xx. Timers
xxi. 100A DC milli volt drop (Contact resistance) kit
xxii. Vibration measuring Instrument
xxiii. Thermo meters

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केबल डालने के लिए विनिर्देश

SPECIFICATION
FOR
CABLE INSTALLATION

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	24.01.24	REVISED AND ISSUED AS STANDARD SPECIFICATION	DKC	RS	MKS	MN
5	26.02.18	REVISED AND ISSUED AS STANDARD SPECIFICATION	DC/RM	RS	BRB	RN
4	21.11.13	REVISED AND ISSUED AS SPECIFICATION	FA	SA	UAP/JMS	SC
3	25.04.08	REVISED AND ISSUED AS SPECIFICATION	RKS	SSM	JMS	VC
2	28.02.03	REVISED and ISSUED AS SPECIFICATION	HKM	RSG	VPS	SKG
1	04.08.97	REVISED and ISSUED AS STANDARD SPECIFICATION	RR	VPS	SG	AS

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Abbreviations:

BIS	:	Bureau of Indian Standards
BS	:	British Standards
CCOE	:	Chief Controller of Explosives
CD	:	Compact Disc
CEA	:	Central Electricity Authority
CIMFR	:	Central Institute of Mining and Fuel Research
DC	:	Direct Current
DGFASLI	:	Directorate General Factory Advice Service & Labour Institutes
DGMS	:	Directorate General of Mines and Safety
EHV	:	Extra high voltage
ET	:	Electrical Thread
FGL	:	Finished Ground Level
FLP	:	Flame Proof
FRP	:	Fibre Reinforced Plastic
GI	:	Galvanized Iron
HV	:	High Voltage
IS	:	Indian Standards
ISMC	:	Indian Standard Medium Channel
MS	:	Mild Steel
OISD	:	Oil Industry Safety Directorate
PVC	:	Poly Vinyl Chloride
RCC	:	Reinforced Concrete Cement
SWG	:	Standard Wire Gauge
FO	:	Fibre Optic

Electrical Standards Committee

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Ms. Arvind NP Singh
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Mr. Rajesh Sinha (Inspection)
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1.0 SCOPE

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

2.0 CODES AND STANDARDS

2.1 The work shall be carried out in the best workman like manner in conformity with this specification, EIL 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 upto and including 33 KV rating.
IS:10810(Part 43)	Method of Test for cables ; Part 43 Insulation resistance.
IS:10810(Part45)	Method of Test for cables ; Part 45 High voltage test.
OISD RP- 147	Inspection and safe practice during electrical installation
OISD 173	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. CEA Regulations

b. Regulations laid down by CEA/Electrical Inspectorate.

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

d. The petroleum rules (Ministry of Industry, Government of India)(As applicable)

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

3.0 MATERIAL SPECIFICATIONS

All materials and hard wares 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.

3.1 Cable Trays

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

3.1.1 Pre-fabricated hot dipped galvanised trays

The cable trays shall comply with the requirements specified in EIL installation standard enclosed with the specification/Tender.

3.1.2 Site fabricated angle iron trays

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

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mm MS flat for tray width upto 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.

3.1.3 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. Bottom most cable tray shall also be provided with GI sheet from the bottom side for the protection of the cables from the hydrocarbon pipes located below. GI Covers also shall be provided for the top most cable trays located outdoors.

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

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

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.

3.1.4 **FRP type cable trays**

The cable trays shall comply with the requirements specified in EIL standard specification and installation standard enclosed with the specification/Tender

3.2 Cable Glands

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. Cable glands forming a part of relevant FLP enclosure shall be FLP type, tested by CIMFR or any other recognized independent testing laboratory and approved by CCoE/DGMS or any other statutory authority as applicable. Indigenous FLP glands shall have valid BIS license as per the requirements of statutory authorities. All cable glands shall comply with the requirements given in IS/IEC-60079 Part 0.

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

3.3 Connectors

Terminations of cables with stranded conductor shall be made with crimped type tinned copper solder less lugs which shall be suitable for the cable size mentioned in cable schedule.

Cable lug material shall be selected based on the applicable as under. For HV cable terminations, heavy duty, long barrel, crimping type lugs shall be supplied. Sector shaped/ circular barrel lugs shall be provided for making connections for cables having sector shaped/ circular geometry of conductors respectively.

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Copper conductor cable & copper bus bar/ terminals	Tinned copper
Copper conductor cable & Aluminium bus bar/ terminals	Bi-metallic (Copper barrel with Aluminium palm)
Aluminium conductor cable & Copper bus bar/terminals	Bi-metallic (Aluminium barrel with tinned Copper palm)
Aluminium conductor cable & Aluminium bus bar/ terminals	Aluminium

3.4 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/signal cable by the terminal numbers to which the cores are connected, for ease of identification. Ferrule shall be printed type.

4.0 CABLE LAYING

4.1 General

Cable installation shall include power, control, lighting, fire alarm, telephone and communication cables. These shall be laid in trenches/ cable trays /Duct 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 Engineer-in-charge.

4.1.1 EHV, 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.

The individual cable fixing clamps and spacers for laying of single core cables shall be of non-magnetic material. As a general practice, the metallic sheath, screen and armour of single core cables shall be earthed at one point to keep the same at earth potential unless otherwise stated. The continuity of armour and semiconductor screen shall be broken at each joint. 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.

If straight through joints are required to be provided on single core cables, armour shall be broken at joints as per manufacturer's recommendations. For single core cables, armour shall be earthed at one end for the cable run length as per manufacturer's recommendation. The armour & screen of EHV cables shall be earthed at one end/both end and surge voltage limiters shall be installed at the straight through joints as specified in job specification/data sheet.

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 minimum spacing of 300 mm from power and control cables

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. Street lighting cables shall be laid on the other side of road berm area.

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Above ground FO cable shall be laid in HDPE ducts and shall run in cable trays of control cables, underground FO cables shall be laid in HDPE duct above layer of control cables & shall be protected with sand & bricks.

Fire barriers shall be deployed at locations where cable enter/exit the substation above ground or/and cable enter/exit between cable cellar to switchgear room through cutouts. Fire barriers shall be as per job specification.

At every 30 meter distances cable tray shall be painted with tray numbers as per cable layout drawings for identification purpose.

The earth continuity of cable trays shall be maintained by providing bonding jumpers as per earthing schedule while changing the level of cable trays.

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

Cables shall be laid in directly buried trench or in RCC trench (underground trench) or in cable tray along pipe sleepers or in over head trays as shown on cable layout drawings. RCC covers of trenches shall be effectively sealed to avoid ingress of chemicals and oils.

Overhead trays shall be installed 2700 mm (minimum) above grade level and 300mm above FGL in case cable trays are installed along with pipe sleepers. At road crossings overhead trays shall be installed at 7000 mm (minimum) above grade level or cables shall be routed through 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.

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

4.1.3 Cables shall be neatly arranged in the trenches / trays in such a manner that criss-crossing 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 or branch cable trench as indicated in cable layout drawing. Pipe sleeves shall be laid at an angle of maximum 45 to the trench wall. Bending radii of pipes shall not be less than 12D. 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. Different rows of cable trays in cable cellar below the cutout shall be so fixed such that the trays don't obstruct cable entry to the panels.

4.1.4 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 stainless steel straps (2mm thick, 20 mm wide and of enough length) securely fastened to the cable and wrapped around it.

Each underground cable shall be provided with cable tags of stainless steel straps securely fastened every 30 m of its underground length with at least one tag at each end before the cable

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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. Cable route markers shall extend 600mm above ground.

4.1.5 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 covered with an approved PVC end cap or rubber insulating tape.

4.1.6 Each row of cables shall be laid in place and before covering with sand. All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/lined trench. Every cable shall be given an insulation test in presence of Engineer-in-charge/Owner before filling the cable trench with sand Any cable which is found defective shall be replaced.

4.1.7 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.

4.1.8 Cables for road crossings shall be taken through ERC (Electrical Road Crossing)/cable duct as shown in the cable layout drawings and sleeves/ducts shall be effectively sealed thereafter.

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.

4.1.9 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.

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

4.2 Cables Laid Direct in Ground

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 as per installation standards. Maximum number of cable layers in trench shall be preferably limited to 6 layers.

Minimum depth of directly buried cable trench shall be 750 mm for medium voltage and 900 mm for HV Cables. The depth and the width of the trench shall vary depending upon the number of layers of cables as per EIL installation Standards.

Cables shall be laid in buried trenches at depth as shown in the cable layout drawings. It is to be ensured 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 or stone dust. This sand /stone dust shall be leveled and cables laid over it. These cables shall be covered with 150 mm of sand on top of the largest diameter cable and sand shall be lightly compacted. A flat protective covering of 75 mm thick second class red bricks or concrete tiles as per specification shall then be laid and the remainder of the trench shall then be back - filled with natural soil, rammed and leveled.

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4.3 Cables Laid in Concrete Trench

Cables shall be laid in 5 or 6 tiers in concrete trench as shown on layout drawings. Concrete cables trenches shall be filled with sand /stone dust in hazardous area, switchyard and in transformer bay 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.

Minimum depth of RCC cable trench shall be 500mm for all voltage grades with 300mm clearance between the bottoms of the trench cover and top of the cable. The depth and the width of the trench shall vary depending upon the number of layers of cables and bending radius required for cables as per EIL installation Standards

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

4.4 Above Ground Cables

4.4.1 Cables installed above grade shall be run in cable trays, clamped on walls, ceiling or structures and shall be run parallel or at right angles to beams, walls or columns. 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 tray shall contain only one layer of cables as far as possible for power cables. However control cables may be laid in multiple layers in the cable trays. For power & control cables at least 20% space shall be kept as spare in cable trays after completion of cable laying for future use.

4.4.2 Individual/group of cables which run along steel/concrete structures shall be taken through 60/100/150 mm slotted channel tray or channel ISMC-75/100. Cables shall be supported so as to prevent sagging. In general, distance between supports shall be approximately 300 mm for cables upto 25 mm diameter and maximum 450 mm for cables larger than 25 mm dia. to prevent the sagging of cables.

4.4.3 Cable laid on supporting angle in cable trenches, structures, columns and vertical run of cable trays shall be suitably clamped by means of GI 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.

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

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

4.4.6 All GI 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

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shall be undertaken well before paving is completed and necessary co ordination with paving agency shall be the responsibility of Electrical Contractor.

Following guide shall be used for sizing of GI. 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 and above cables in a pipe - 40% of pipe cross-sectional area occupied by cables.

4.4.7 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.

4.4.8 Fire proofing of end of power cables at least 1 meter at each end as per OISD norms for the refinery and Petroleum industry, shall be carried out as per the recommendation of the paint supplier .Rates for the fire proofing of cables shall be included in the cable installation and no separate payment shall be made for the painting.

5.0 TERMINATIONS

5.1 All cables up to 1100V grade and higher levels shall be terminated at the equipment by means of compression type cable glands suitable for the cable size. They shall have a screwed nipple with 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 stainless steel straps 2mm thick and securely fastened to the cable, wrapped around it) and also along the route at regular intervals, by cable tag numbers.

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

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

5.3 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.

5.4 Contractor shall drill holes for fixing glands wherever necessary. Gland plate shall be of non-magnetic material/ aluminium sheet in case of single core cables. All unused cable entries on equipment/panels shall be plugged/sealed.

5.5 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 armour shall not be exposed after termination is complete.

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 centre line of holes. After fixing bottom plate, uncovered cable holes/gaps shall be sealed with cold setting compound.

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

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

5.8 The cable joints shall be avoided as far as possible . In case a joint is unavoidable, the following shall be insured:

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

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

5.9 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 be brought to the notice of Engineer-in-charge by contractor. After termination is complete, all the bolts, nuts, hard wares of terminal box shall be properly placed in its position and tightened.

5.10 All cables glands installed outdoor shall be provided with suitable sized shrouds and rates for the same shall be included in the scope of the termination of the cable glands. No separate payment is envisaged for the same.

6.0 TESTING AND COMMISSIONING

6.1 Field testing and commissioning of electrical installation shall be carried out as per EIL specification.

6.2 Before energising, 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.

For cables upto 1.1 KV grade 1000 V Megger and for H.V. Cables 2.5 KV / 5 KV Megger shall be used.

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

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a) All 1100 volts grade power cables in which straight through joints have been made.
b) All cables above 1100 V grade.
c) The DC High Voltage test shall be performed as detailed below in the presence of the Engineer-in-charge or his authorized representative only.

Cables shall be installed in final position with the entire 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.
In each test, the metallic sheath/screen/armour shall be connected to earth.

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

All test readings shall be recorded and submitted to EIL in triplicate sets.

6.7 Cable schedule, cable layout drawings, Interconnection drawings shall be revised and marked by contractor for 'AS BUILT STATUS' and two sets of copies along with CD shall be submitted to EIL.

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अर्थिंग डालने के लिए विनिर्देश

SPECIFICATION FOR EARTHING INSTALLATION

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	26 02 19	REVISED AND ISSUED AS SPECIFICATION	DC	RS	BRB	RKT
4	26 03 14	REVISED AND ISSUED AS SPECIFICATION	FA	SA	BRB	SC
3	25 04 08	REVISED AND ISSUED AS SPECIFICATION	RKS	SSM	JMS	VC
2	28 02 03	REVISED & ISSUED AS SPECIFICATION	HKM	RSG	VPS	SKG
1	16 07 97	REVISED & ISSUED AS STANDARD SPECIFICATION	RR	VPS	SG	AS

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Abbreviations:

BIS	:	Bureau of Indian Standards
CD	:	Compact Disc
CEA	:	Central Electricity Authority
DGMS	:	Director General Mines and Safety
GI	:	Galvanized Iron
IEC	:	International Electrotechnical Commission
IS	:	Indian Standard
MS	:	Mild Steel
OISD	:	Oil Industry Safety Directorate
PESO	:	Petroleum and Explosive safety organization.
UPS	:	Uninterrupted Power Supply

Electrical Standards Committee

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

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1.0 SCOPE

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 CODES AND STANDARDS

2.1 The work shall be carried out in the best workman like manner in conformity with this specification, EIL 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/IEC:62305	Protection 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.
OISD GDN 180	Lightning protection.

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

a. CEA Regulations

b. Regulations laid down by CEA/Electrical Inspectorate.

c. Regulations laid down by PESO/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 MATERIAL SPECIFICATIONS

3.1 All materials and hardware 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.

3.2 The main earth grid conductor shall be hot dip galvanised 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.metre. Earth electrodes and Earth plate shall be as per EIL Installation Standards.

4.0 EARTHING NETWORK

4.1 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 equipments.

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4.2 The earth conductor shall be laid along cable trays/cable trench/pipe racks/ buried in pavement/ below finished grade level as indicated on the earthing layout drawing. Where lined cable trenches are available, the earth conductor shall be preferably 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 the overhead 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 through copper flexible (insulated) . 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.

4.3 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 jointed by means of welding, lap welding with an overlapping of strip equivalent to double the width of the strip and all four sides(three on the Top and one bottom) shall be continuously welded. All joints at tappings 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.

5.0 INSTALLATION OF EARTH ELECTRODE

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

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. However in the areas where there is physical limitation to meet the above separation distance between two electrode, the mutual spacing can be reduced to a value not less than the driven depth of each earth electrode.

5.2 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.

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

5.4 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.

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

5.6 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.

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5.7 Individual earth electrodes shall be provided for each lightning arrestor, each dropper of building earthing protection system and flood light mast.

5.8 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.

5.9 Top of earth pit shall be flushed with finished floor level in paved areas. In unpaved areas, top of earth pit shall be projected 100 mm above finished ground level.

6.0 CONNECTION

The earth system connections shall generally cover the following:

- Equipment earthing for personnel safety
- System neutral earthing
- Static and lightning protection

6.1 The following shall be earthed.

- System neutral
- Current and potential transformer secondary neutral
- 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.
- Steel structures/columns, rail loading platforms etc.
- Cable trays and racks, lighting mast and poles
- Storage tanks, spheres, vessels, columns and all other process equipment.
- Fence and Gate for electrical equipment (e.g. transformer yard etc.)
- Cable shields and armour
- Flexible earth provision for Wagon, Truck
- Shield wire
- Ladder, staircase as per layout drawing/job specification.

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

6.2 All process pipelines shall be bonded and earthed at the entry and exist points of unit battery limit of hazardous area.

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

6.4 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/earthing layout drawing.

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6.5 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. Each down conductor shall be provided with an earth electrode with test pit and all earth electrodes shall be interconnected through underground strip. Lightning protection system may be bonded to electrical safety earthing system, inside ground. Lightning down conductor shall be brought to earth electrode in shortest straight path as feasible to minimise surge impedance.

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

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

6.8 Plant instrument system clean earthing, UPS system clean/safety earth, Data concentrator panel, HMI etc shall be separate from the electrical earthing system, if mentioned in job specification/ layout drawings.

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

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

Equipment foundation bolts shall not be used for earthing connection.

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

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

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

6.14 The reinforcements of sub-station building coulumns/beams and the sub-station floor slab shall be connected to main earth grid.

7.0 TESTING AND COMMISSIONING

7.1 Field inspection, testing and commissioning of electrical installation shall be done as per EIL standard specification.Earthing systems/connections shall be tested as follows:

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

7.3 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:

- 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.
- For lightning protection, the value of 5ohms as earth resistance shall be desirable, but in no case it shall be more than 10 ohms.

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7.4 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 one 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 armour.

e) At one point on fence enclosing electrical equipment.

7.5 All earthing layout drawings shall be marked by contractor for 'AS BUILT STATUS' and two sets of hard copies plus 1 set of soft copy, shall be submitted to EIL. For projects, where layout drawings have been prepared based on 3D modeling, contractor shall carryout necessary changes for 'AS BUILT STATUS' in the 3D model.

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विद्युत संस्थापनों के साइट निरिक्षण, परिक्षण व कमीशनिंग के लिए विनिर्देश

SPECIFICATION FOR FIELD INSPECTION, TESTING AND COMMISSIONING OF ELECTRICAL INSTALLATIONS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	13 08 19	REVISED & ISSUED AS STANDARD SPECIFICATION	RM	RS	SA	RKT
3	10 6 14	REAFFIRMED & ISSUED AS STANDARD SPECIFICATION	AKG	SA	BRB	SC
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0	02 08 01	ISSUED AS STANDARD SPECIFICATION	UAP	RR	VPS	MI

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Abbreviations:

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

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1.0 SCOPE

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

2.0 CODES AND STANDARDS

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

SP-30(BIS)	National Electrical Code.
IS 1255	Code of practice for installation and maintenance of power cables up to & including 33 kV rating.
IS-7816	Guide for testing Insulation resistance of rotating machines.
IS 10810(Part 43)	Method of Test for cables; Part 43 Insulation resistance.
IS 10810(Part 45)	Method of Test for cables; Part 45 High voltage test.
IS 12729	HV Switchgears
OISD 137	Inspection of Electrical Equipment.
OISD 147	Inspection and safe practice during electrical installation.

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

a. CEA Regulations
b. Regulations laid down by CEA / Electrical Inspectorate.
c. Regulations laid down by Tariff Advisory Committee/Loss prevention council.
d. Regulations laid down by PESO/DGMS (as applicable).
e. The petroleum rules (Ministry of Industry, Government of India).
f. Any other regulations laid down by central / state / local authorities / insurance agencies

3.0 FIELD INSPECTION, TESTING AND COMMISSIONING

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

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

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

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

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

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

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

- Earth resistance measurement for each earth electrode, and the earthing system as a whole.
- Lighting installation shall be tested for correct illumination levels, with fittings installed. Fittings shall be operated only with specified type of a lamp or tube.

3.6 After the above tests and inspection are completed, control circuits shall be tested for correct operation under all operating combinations and proved correct before applying power to main circuit.

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

3.8 A close visual inspection of electrical equipment in hazardous areas shall be made to ensure that equipment is suitable for the classified zone and gas group and correctly installed, with all covers, bolts, nuts and hardwares intact and there is no physical damage mark seen on the enclosure

3.9 Site Acceptance Test procedure for specific equipment shall be furnished by the respective equipment vendor in line with testing requirements as per relevant standard, this specification & relevant equipment specifications. The Site Acceptance Test Procedure/ Site Testing Procedure shall be duly reviewed by the site Engineer-in-Charge. The contractor shall provide necessary assistance to the equipment vendor to perform Site acceptance testing to enable the equipment vendor to perform the same.

3.10 All pre-commissioning checks and tests shall be carried out as per the directions of Engineer-in-charge. In addition to the equipment manufacturer's instructions, pre-commissioning check requirements shall also be complied. All tests shall be carried out by contractor in the presence of EIL/Owner's representatives

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3.11 The contractor shall bring to site all required tools, tackles, and testing instruments for carrying out field testing. Contractor shall use only calibrated measuring and test instruments and shall maintain valid calibration records.

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

3.12.1 **Cables**

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

Rated voltage of the Cable	**DC Test Voltage in Volts**	**Minimum Insulation resistance in Mega ohms**
Lighting and power circuit wiring	250	1
650/1100V grade cables	1,000	10
1,900/3,300V grade cables	1,000	200
3,800/6,600V grade cables	1,000	200
6,350/11,000V grade cables	5,000	200
8,700/15,000V grade cables	5,000	200
12,700/22,000V grade cables	5,000	200
19,000/33000V grade cables	5,000	200
38000/66000V (72500V) grade cables	5,000	500

3.12.2 **HV, MV and Miscellaneous Switchboards**

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

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

3.12.3 **Generators and Motors**

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

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

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3.12.5 **Transformers**

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

Rated voltage of the Transformers	**DC Test Voltage in Volts**	**Minimum Insulation resistance in Mega ohms at 40 °C**
Up to 600V	1,000	100
601 to 5000V	2,500	1,000
5001 to 15,000V	5,000	5,000
15001 to 35,000V	5,000	10,000
35001 to 66,000V	5,000	10,000
66001 to 132,000V	5,000	10,000

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

3.13 High-voltage Testing

3.13.1 DC high voltage test shall be conducted as per following table on all HV feeder cables and also on 1100 V grade cables where straight through joints have been made. This table shall be used as a reference and the DC high voltage test shall be conducted considering equivalent IS/ IEC voltage grades upto 66kV

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

*U_o : Phase Voltage

U : Line Voltage

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

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

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

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

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

3.13.3 DC Voltage test of the cable over-sheath shall be conducted as per IEC 60840 & IEC 60229:- A D.C. voltage of 4kV per millimetre of specified thickness of extruded over-sheath shall be applied with a maximum of 10kV D.C. between the underlying metallic layers and the outer electrode, for a period of 1 min. All metallic layers under over-sheath shall be connected together.

This test requires that the over-sheath has an outer "electrode" which may be moist backfill or a conductive layer.

No breakdown of the over-sheath shall occur during the test

3.13.4 AC voltage test of the cable insulation shall be conducted as per IEC 60840, rated voltage may be applied for 24 hours.

3.14 All protective relays including thermal overload relays shall be tested by secondary injection current. Primary injection tests shall be carried out for differential protection, restricted earth fault protection at full/reduced current to ensure correctness of complete wiring.

3.15 Before energizing any equipment, 'COMMISSIONING CLEARANCE FORM' as per standard format shall be duly filled in by contractor and submitted to EIL/owner.

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

4.0 RECORDS

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

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पैकेज उपस्कर के विद्युत उपकरणों हेतु विनिर्देश

SPECIFICATION FOR ELECTRICS OF PACKAGE EQUIPMENT

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	28.03.23	Revised and issued as standard specification	AP/GK	RS	MKS	SM
5	21.03.18	Revised and issued as standard specification	NV/GK	VKJ	BRB	RN
4	21.11.13	Revised and issued as standard specification	VB	VKJ	UAPJMS	SC
3	25.04.08	Revised and issued as standard specification	RS	IKG	JMS	VC
2	28.03.03	Revised and issued as standard specification	LS	AAN	VPS	SKG

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Abbreviations:

AC	:	Alternating current
ASB	:	Auxiliary Service Board
BASEEFA	:	British Approval Service for Electrical Equipment's in Flammable Atmosphere
BIS	:	Bureau of Indian Standard
CEA	:	Central Electricity Authority
CIMFR	:	Central Institute of Mines and Fuel Research
CRCA	:	Cold Rolled Cold Annealed
CT	:	Current Transformer
DC	:	Direct current
DCDB	:	Direct Current Distribution Board
DGMS	:	Directorate General of Mines Safety
EIL	:	Engineers India Limited
ELCB	:	Earth Leakage Circuit Breaker
FM	:	Factory Mutual
GI	:	Galvanised Iron
HRC	:	High Rupturing Capacity
IE	:	Indian Electricity
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical & Electronics Engineer
IP	:	Ingress Protection
KW	:	Kilo Watt
LCIE	:	Laboratoire Central des Industries Electriques
LDB	:	Lighting Distribution Board
LED	:	Light Emitting Diode
MCB	:	Miniature Circuit Breaker
MCC	:	Motor Control Centre
MCCB	:	Moulded Case Circuit Breaker
MDB	:	Main Distribution Board
MS	:	Mild Steel
MV	:	Medium Voltage
NEC	:	National Electric Code
NEMA	:	National Electrical Manufacturers Association
PCC	:	Power Control Centre
PMCC	:	Power- Cum- Motor Control Centre
PTB	:	Physikalisch- Technische Bundesanstalt
PVC	:	Poly Vinyl Chloride
SWG	:	Standard Wire Gauge
UL	:	Underwriter's Laboratories
V	:	Volt
VDE	:	Verband Deutscher Elektrotechniker

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1.0 SCOPE

1.1 This specification defines the requirements for design, engineering, shop-supervision, testing, supply, installation, testing and commissioning of electrical equipment and facilities for package equipment as covered in the job Specifications and data sheets.

1.2 For the purpose of this specification, the term `package equipment' or `package' denotes the complete integrated equipment to be supplied by the vendor comprising of all main and auxiliary equipment and associated local panel(s). The package equipment may be mounted on a common skid and/or installed on a common platform/area in the field, as specified elsewhere. Unless otherwise specified, the local panel shall include the power distribution to various loads along with the necessary controls, interlocks, indications and alarms. The local panel may either be mounted on the equipment skid/platform or separately but not very far from the main equipment.

1.3 It is not intended to cover all aspects of design but to indicate the basic requirements only. Vendor shall ensure that the design and installation on the skid is carried out as per good engineering practice, relevant codes and shall meet the requirements of safety, reliability, ease of maintenance and operation, aesthetics, scope of future expansion and maximum interchangeability of the equipment. Vendor shall acquaint himself with EIL standards, specifications, inspection test plans and field testing procedures as deemed necessary for proper execution of work.

1.4 Compliance with this specification and /or review of any of the vendor documents shall not relieve the vendor of his responsibility and his contractual obligations with regard to the completeness and satisfactory operation of the package.

2.0 STATUTORY REQUIREMNTS

2.1 All electrical equipment and the complete package shall meet the requirements of this specification and enclosed data sheets, in addition to the relevant Publications and Codes of Practice of Bureau of Indian Standards, EIL Standards, statutory regulations and good engineering practices. Complete system must also conform to the latest revisions of the following:

a) CEA Regulations
b) Fire Insurance Regulations
c) Petroleum Rules and any other regulations laid down by Chief Controller of Explosives
d) The Factory Act and regulations laid down by Factory Inspectorate
e) Regulations laid down by local statutory authorities and Electrical Inspectorate

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

2.3 Vendor shall provide all assistance required for obtaining approvals from statutory authorities for materials, plant design/ drawings and complete installation.

2.4 Where Indian Standards do not exist, the relevant IEC/ BS/ VDE/ IEEE/ NEMA standards shall apply. Any other international standard may also be followed provided it is equivalent to or more stringent than the standards specified above.

2.5 In case of any contradiction between various referred standard / specification /datasheet and statutory regulations, most stringent requirement shall prevail. However owner's /EIL's decision in this regard will be final and binding.

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3.0 GENERAL REQUIREMENTS

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

3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment at least for 10 years from the date of supply.

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

4.0 SITE CONDITIONS

The equipment shall be suitable for continuous operation under the site conditions specified elsewhere. If not specifically mentioned, a design ambient temperature of maximum 40^0C and an altitude not exceeding 1000 meters above mean sea level shall be considered for design purpose.

5.0 AREA CLASSIFICATION AND EQUIPMENT SELECTION

5.1 In case of storage, handling or processing of flammable materials within the battery limits of the package, area classification shall be carried out in line with IS: 5572, Indian Petroleum Rules, OISD standard-113 and DGMS guidelines where applicable. Where specified, the vendor shall furnish an `Area Classification Drawing' indicating the zones of hazardous area and the applicable gas groups and temperature class (T rating). A list of flammable materials handled along with their properties like flash point, ignition temperature, explosive limits etc. shall also be furnished.

5.2 All the electrical equipment installed in hazardous areas shall be selected as per IS-16724:2018 / IEC-60079-14, where applicable, and shall meet the requirements of relevant IS, IEC or NEC Standards and statutory regulations. However, electrical equipment for Zone-2 areas as a minimum shall be Ex 'e'/ Ex 'n' type as specified in data sheet, subject to the same being acceptable to the concerned statutory authorities. Increased safety (Type Ex 'e') equipment shall not be used in zone-1 areas. Ordinary industrial electrical equipment (even though permitted for use in Div.2 area as per NEC, USA) shall not be used in Zone-2 areas.

5.3 Electrical equipments for hazardous areas shall be certified by CIMFR/ ERTL/ Karandikar Lab or equivalent recognised independent test house of country of origin such as BASEEFA / ATEX/ LCIE / PTB / UL / FM. All equipment (indigenous and imported) shall also have valid statutory approvals i.e. PESO as applicable for use in the specified hazardous area. All indigenous flameproof equipments shall have valid BIS license and marking as required by statutory authorities

5.4 Electrical equipment for hazardous areas shall, generally, be suitable for gas groups IIA and IIB and temperature Class -T3 as applicable to the selected type of explosion protection. In case of hydrogen or hydrogen-hydrocarbon mixtures having more than 30% hydrogen, the gas group to be considered, shall be IIC.

5.5 All electric motors for agitators/mixers and metering pumps handling flammable materials and oil sump pumps, shall be flameproof (Type Ex-de), irrespective of the area being classified as Zone-2 or Zone-1.

5.6 In case the package equipment is to be located in a classified hazardous area, the same shall be indicated in the data sheet. In such a case, the offered equipment/package shall conform to

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whichever are the more stringent requirements, i.e. either due to materials being handled in the package or hazardous location in which package is installed.

6.0 EQUIPMENT SPECIFICATIONS

6.1 General Requirements

6.1.1 Specifications of all equipments/items, shall be furnished by the vendor for owner's review. However, certain minimum requirements for the major equipment are highlighted in this section.

6.1.2 All equipments and components shall be new and supplied by approved reputed manufacturers. Equipment requiring specialised maintenance or operation shall be avoided as far as possible and prototype equipment shall not be accepted. All equipments shall be complete with all necessary weather and anticorrosion protection including tropicalization to prevent damage due to climate, saline atmosphere, dust and corrosive vapours.

6.1.3 All equipment / material shall be protected for inland / marine transport, carriage at site and outdoor storage during transit and at site. Vendor shall be responsible for any damage to the equipment during transit. All packages shall be clearly, legibly and durably marked with uniform block letters giving the relevant equipment/ material details. Each package shall contain a packing list in a waterproof envelope.

6.1.4 All electrical components and equipment shall be sized to suit the maximum load under the most severe operating conditions. Rated voltage and frequency for the equipment shall be as indicated in enclosed data sheet.

6.1.5 All spares required for testing and commissioning the package shall be included by vendor in his scope of supply along with any special tools and tackles required for operation and maintenance.

6.2 Medium Voltage Motors

All medium voltage induction motors shall meet the requirements of the enclosed data sheet and EIL standard specification.

6.3 Power Distribution Board/Local Panel for Safe Area

6.3.1 This shall meet the requirements of data sheets and the following specific requirements.

6.3.2 Unless otherwise specified, the Power Distribution Board (PDB) may be incorporated as part of the Local Panel. The PDB shall include necessary power distribution equipment as applicable for the package equipment in addition to the associated controls, interlocks, indications and alarms. All motor starters shall be Direct-on-line type unless specified otherwise.

6.3.3 The panel shall be free standing, metal enclosed, dust and vermin proof type having minimum IP-42 degree of protection as per IS:13947 (Part-1). Panels for outdoor locations shall be weatherproof and supplied with a sheet steel kiosk or have internal and external doors with a rain shelter. The panel shall be designed to ensure maximum safety during operation, inspection, connection of cables and maintenance with energised busbars and without any special precautions. Ample space shall be provided inside the panel for any future addition of components in the panel. Power and control equipment shall be segregated inside the panel as far as practicable. The maximum height of the operating handle/switches shall not exceed 1800mm and the minimum height shall not be below 300mm.

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6.3.4 The panel shall have an integral base frame and shall be sheet steel clad, fabricated out of 14 SWG CRCA sheet steel except that doors and covers may be of 16 SWG thickness. Necessary stiffeners shall be provided on doors / covers to prevent buckling. Large size doors and covers or those on which substantial relays/meters are mounted shall be fabricated out of 14 SWG CRCA sheet steel. All doors shall be hinged type, and all covers, doors, openings and gland plates shall be provided with neoprene gaskets. All hardware shall be corrosion resistant. All bolts, nuts and washers shall be secured against loosening and shall be made of galvanized, zinc passivated or cadmium plated high quality steel. Unless otherwise specified, the panel shall be suitable for bottom cable entry. The gland plate and cable glands shall be provided with the panel.

6.3.5 For the Flameproof Power Distribution Board / Local Panels, to be installed in a hazardous area, vendor to refer EIL standard specification 6-51-0007 attached elsewhere (if applicable).

6.3.6 Outgoing motor feeders shall be provided with switch, fuse, thermal overload relay with single phasing preventor or Motor Protection Relay and contactors for operation / safety isolation. All switches shall be load-break, heavy duty, air-break type with the operating handle mounted on the compartment door. Load break switch or MCCB shall be provided as main incoming switch complete with necessary mechanical interlocks, door interlock and defeat mechanism. Motor duty switches of AC-23 duty are also acceptable for outgoing motor feeders.

6.3.7 All fuses shall be non-deteriorating HRC cartridge, pressure fitted, link type. The contactors shall be air-break having AC-3 duty rating. Power contactors shall be rated for 100% of the maximum continuous current (e.g. rated current of motor) with a minimum rating of 16 Amperes with AC-3 duty. Contactor coils shall be suitable for 240V AC control supply.

6.3.8 Thermal overload relays shall be three element, positive acting, ambient temperature compensated type with adjustable setting range and built-in protection feature against single phasing which can operate even with 50% rated current. The relays shall be manual reset type with the reset push button provided on the cubicle door.

6.3.9 All indicating instruments shall be moving iron, flush mounting type of 72mm x 72mm square pattern of at least 1.5 accuracy class. LEDs provided for indication shall be cluster type with adequate brightness and minimum 2Nos LEDs chips per light. LEDs shall be connected in parallel and each LED chip having diameter not less than 3mm.

6.3.10 All control/selector switches shall be rotary back connected type having a cam-operated contact mechanism with knob type handle. Ammeter selector switches shall have contacts with make before break feature and additional locking facility shall be provided where required.

6.3.11 All motor feeders shall be provided with a STOP (red) push button and necessary START (green) push button and control/interlock switches. STOP push buttons shall have stay put feature and additional locking facility shall be provided where required.

6.3.12 Current transformer fed ammeter shall be provided for all motors, which may have variable loading or are required for process control. Feeders of 30 Amperes rating and above shall be provided with a CT and ammeter as a standard. The current transformers shall have an accuracy class 1.0 and instrument security factor not greater than 5.

6.3.13 All auxiliary devices for control, indication, measurement and alarm such as push buttons, control and selector switches, indicating lamps, metering instruments, annunciators etc. shall be mounted on the front door of the panel. Components requiring frequent inspection shall be easily accessible.

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6.3.14 Control supply for the equipment shall normally be derived from an adequately sized transformer in the panel connected across two phases.

6.3.15 Adequate number of potential-free contacts shall be provided in the control panel for any remote control monitoring of the package equipment.

6.3.16 The panel shall be provided with an anti-condensation heater controlled through a switch fuse /MCB and an adjustable thermostat.

6.3.17 Inside the panel, the wiring for power, control and signaling circuits shall be done with BIS approved flame retardant PVC insulated copper conductors having 660/1100V grade insulation. Power wiring shall be sized for the nominal rating of associated switch/contactor. Minimum size of control wires shall be 1.5mm² copper for control circuits having fuse rating 10 amperes or lesser. For control circuits with higher fuse rating, minimum 2.5mm² copper conductor shall be used. Wiring for AC and DC circuits shall have different colour coding. Clamp type terminals shall be acceptable for direct termination of wires upto 10mm² size. For conductors larger than 10 mm², bolted type terminals with crimping lugs shall be provided. Each wire shall be terminated at a separate terminal. A minimum of 10% spare terminals shall be provided on each terminal block. All incoming and outgoing wires from the panel shall terminate on a suitable terminal strip/block. No such wire shall terminate/emanate directly from a panel component. However, in case power supply connections are to be looped, the loop wires are to be crimped together before fixing on terminal strip, such that loop continuity is not lost in case wire is removed from terminal strip.

6.3.18 An adequately sized earth bus shall be provided in the panel for connection to the main earth grid. All non-current carrying metallic parts of the mounted equipment shall be earthed. Doors and movable parts shall be earthed using flexible copper connections. The earth bus shall be provided with alternate bands of yellow and green. All earth connection wires shall be suitably colour coded.

6.3.19 Engraved nameplates shall be provided for all auxiliary devices mounted on the front of the panel. Nameplate or polyester adhesive stickers shall be provided for each equipment inside the panel.

6.3.20 All metal parts shall be thoroughly cleaned degreased and made free from rust. After application of the primer, the panel shall be spray painted with two coats of final paint. Colour shade of the final paint shall be RAL 7032 for indoor Electrical Equipment and RAL 7031 for Outdoor Electrical equipment, unless otherwise specified. Powder coating of panel shall also be acceptable.

6.3.21 At least one outgoing feeder of each rating and type shall be provided as spare in the PDB.

7.0 CABLING SYSTEM

7.1 Unless otherwise specified, a single point power supply shall be provided by the owner through an aluminium/copper conductor, XLPE insulated, armoured cable terminated at the Power Distribution Board/Local Panel. The vendor shall provide all power and control cabling between the PDB/ Local panel and the package equipments.

7.2 Power and control cables for 415V system shall be of 1100V grade Fire retardant low smoke type XLPE insulation with copper conductors up to 16mm² and aluminum conductors beyond 16mm², PVC inner sheath, armouring and overall PVC sheath as per IS: 7098 (Part-I). The conductor size shall be minimum 2.5mm² copper. All power and control cables shall have extruded inner and outer sheaths. Outer sheath of cables shall be black in colour and the minimum value of oxygen index shall be 29 at 27± 2 °C. In addition, suitable chemicals shall be added into the PVC compound of the outer sheath to protect the cable against rodent and

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termite attack. Adequate derating factors shall be used for sizing the cables. At least one spare core shall be provided in all control cables. All cable / wire shall be BIS approved.

7.3 All cabling on the equipment skid/platform shall be in GI cable trays/conduits. All cable trays and accessories shall be prefabricated and hot dip galvanised. The minimum amount of galvanising shall be 610g/m². All cables shall be identified close to their termination point by cable number punched on 2mm thick aluminium straps securely fastened to each cable. In case of control cables, all cores shall be identified at both ends by their terminal numbers using PVC ferrules as per interconnection diagrams. All equipments shall be supplied with double compression type nickel plated–brass cable glands and tinned copper lugs.

7.4 In case, PDB/Local Panel installed away from the equipment skid/platform, necessary cable trenches/trays between panel and equipment shall be in owner's scope, unless otherwise specified.

8.0 EARTHING SYSTEM

8.1 Earthing system design and installation shall generally be as per IS: 3043. One or more number of G.I. earth plates shall be provided for the package equipment depending upon its size. All metallic non-current carrying parts of electrical apparatus, current and potential transformer secondaries, structural steel, vessels etc. shall be connected by at least two distinct separate earth conductors to an earth plate. All earth plates shall be bonded together and shall have the provision for interconnection to owner's main earth grid at two points. Earth plates shall be of 360x80x10mm size and shall be provided with adequate number of tapped holes. Earth continuity bonding shall be provided across all pipe flange joints.

8.2 All hardware used for earthing installation shall be hot dip galvanised or zinc passivated. The amount of galvanizing shall be min. 610 g/m². Specially provided bolts, lugs and spring washers shall be used for all earthing connections of equipment.

8.3 Unless specified otherwise in data sheet, equipment earthing shall be as per standard equipment earthing schedule.

8.4 Earthing connections to equipment shall be made by means of bolts, lugs and spring washers provided specifically for this purpose.

9.0 LIGHTING SYSTEM

9.1 General lighting for area in which package is to be installed shall be provided by purchaser, unless specified otherwise in data sheet.

9.2 Any other lighting requirements such as Local panel lighting shall be provided by vendor and shall be with LED fixtures. Power for such local lighting shall be obtained from a suitable feeder in PDB/Local Panel. All lighting circuits shall have provision for isolation in both phases and neutral for packages to be installed in hazardous areas.

10.0 INSPECTION, TESTING AND COMMISSIONING

10.1 All equipment shall be tested and inspected at vendor's works before dispatch to ensure compliance with the relevant specifications and agreed quality assurance/ testing plan. The owner or his authorized representative may visit the works during manufacture of various electrical equipment / materials to assess the progress of work as well as to ascertain that only quality raw materials are used for the same. He shall be given full assistance to carry out the inspection. Purchaser's representative shall be given minimum two weeks' advance notice for witnessing the final testing. The minimum testing / inspection requirements for all components /equipments shall conform to the requirements stipulated in applicable codes and

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standards. Test certificates including test records and performance curves etc. shall be furnished by the vendor.

10.2 Vendor shall submit the field testing procedures for purchaser's approval. Field tests as per the approved procedures shall be performed on the electrical system/ equipment before its being put into service. All test equipment required for this purpose shall be arranged by the vendor, in case testing and commissioning at site is included in his scope, and test reports shall be approved by the site-in-charge before acceptance of the complete package.

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SPECIFICATION FOR ELECTRIC SURFACE HEATING SYSTEM

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	02 08 19	REVISED AND REISSUED AS STANDARD SPECIFICATION	PK	SV	SA	RKT
4	07.07.14	REVISED AND REISSUED AS STANDARD SPECIFICATION	PK	SA	BRB	SC
3	09.03 09	REVISED AND REISSUED AS STANDARD SPEC	RS	UAP	JMS	ND
2	17.02.04	REVISED AND ISSUED AS STANDARD SPECIFICATION	RKM	AAN	VPS	SKG
1	30 11 98	REVISED AND ISSUED AS STANDARD SPECIFICATION	NS	RR	VPS	AS

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Abbreviations:

BASEEFA	:	British Approvals Service for Electrical Equipment for Flammable Atmospheres
BIS	:	Bureau of Indian Standards
CCOE	:	Chief Controller of Explosives
CEA	:	Central Electricity Authority
CIMFR	:	Central Institute of Mining and Fuel Research
CT	:	Current Transformer
DGMS	:	Directorate General of Mines Safety
ELCB	:	Earth Leakage Circuit Breaker
ERTL	:	Electronics Regional Test Laboratory
FM	:	Factory Mutual Research Corporation
GI	:	Galvanised Iron
IEC	:	International Electro Technical Commission
IEEE	:	Institute of Electrical & Electronics Engineers
IP	:	Ingress Protection
IS	:	Indian Standards
LCIE	:	Laboratorie Central Des Industries Electriques
LDP	:	Local Distribution Panel
MCB	:	Miniature Circuit Breaker
MS	:	Mild Steel
OISD	:	Oil Industry Safety Directorate
PDB	:	Power Distribution Board
PEM	:	Project Engineering Management
PESO	:	Petroleum and Explosives Safety Organisation
PO	:	Purchase Order
PVC	:	Polyvinyl Chloride
RTD	:	Resistance Temperature Detector
SWG	:	Standard Wire Gauge
TPN	:	Three Phase Neutral
UL	:	Underwriters Laboratories

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1.0 GENERAL

1.1 This specification and project data sheets define the requirements for system design, engineering, supply, installation, testing and commissioning of electric surface heating (ESH) devices as applied to fluids/materials in piping and associated equipments, both in safe and hazardous areas (classified as Zone -2), in accordance with applicable standards.

1.2 Contractor shall ensure that the design, product selection and installation are carried out as per good engineering practices, which shall also include the requirements of safety, reliability, ease of maintenance and operation.

1.3 Compliance with this specification and /or approval of any of the contractor's documents shall not relieve the contractor of his responsibility towards the contractual obligation with regard to the completeness and satisfactory operation of the electric surface heating system.

2.0 CODES AND STANDARDS

2.1 The equipments covered by this specification shall comply with the requirements of the latest edition of applicable standards issued by BIS, IEC and IEEE including the following:

IS-5	:	Colours for ready mixed paints and enamels
IS-1554	:	PVC insulated (heavy duty) electric cables.
IS/IEC 60079-1	:	Electrical equipment with type of protection 'd'
IS-3043	:	Code of practice for earthing
IS-5571	:	Guide for selection of electrical equipment for hazardous area.
IS/IEC-60079-15	:	Electrical equipment with type of protection 'n'.
IS-8623	:	Specification for low voltage switchgear and control gear assemblies.
IS/IEC-60079-0	:	General requirements for electrical apparatus for explosive gas atmosphere.
IS-13703	:	Specification for low voltage fuses
IS/IEC-60947	:	LV switchgear and control gear.
IEC-61439	:	Low voltage switchgear & controlgear assemblies
IS/IEC 60079-30-1	:	Electrical apparatus for explosive gas atmosphere Electrical resistance trace heating Part-1, General & testing requirements
IS/IEC 60079-30-2	:	Electrical apparatus for explosive gas atmosphere-Electrical resistance trace heating
IEC 60751	:	Industrial platinum resistance thermometer sensor Part-2, Application guide for design, installation and maintenance
IS/IEC 60529	:	Degree of protection provided by enclosures (IP Code)
IEEE-515	:	Standards for the testing, design, installation and maintenance of Electrical Resistance Heat Tracing for Industrial applications.
IEC/IEEE-60079-30-1	:	Explosive atmospheres Electrical resistance trace heating - General & testing requirements
IEC/IEEE-60079-30-2	:	Explosive atmospheres-Electrical resistance trace heating-Application guide for desing, installation and maintenance

In case of conflict between requirements specified in various referred standards/specification/data sheets/and the statutory regulations, the most stringent one shall prevail. However, owner's decision in this regard shall be final and binding.

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2.2 In addition, work shall conform to the following statutory requirements as applicable.

- CEA regulations
- Fire insurance regulations
- Regulations laid down by Chief Controller of Explosives/DGMS as applicable.
- Indian Petroleum Rules
- OISD guidelines/standards
- Regulations laid down by local authorities from time to time.

2.3 Where Indian Standards do not exist, the relevant IEC, IEEE standards shall apply.

3.0 SYSTEM DESIGN REQUIREMENTS

3.1 Electrical Surface Heating

3.1.1 The design shall be based on continuous and reliable service, safety to personnel and equipment, ease of maintenance and interchangeability, wherever applicable.

3.1.2 a) Product classification approach shall be followed for determining heating device's sheath temperature unless otherwise agreed.

b) Systems approach may be permitted in those instances where the sheath temperature determination as per product classification approach exceeds 200° C.

c) In exceptional cases requiring high maintenance temperatures as specified in project data sheet, the design may be based on systems approach wherein the electric heating tape may not necessarily be certified under product classification approach.

d) In case of system approach, the design of the electric heating system shall be based on stabilised design approach where the maximum surface temperature of the heating device shall be determined without temperature control.

e) In system approach, Controlled design approach shall be used either in case of constant wattage cables or in case of self regulating/ power limiting trace systems when maintenance temperature is more than121 degree.

f) Double insulation technique shall not be permitted.

g) The following table shall be followed for selection of the heat tracing system

Maintenance temperature	Operating (Continuous power ON)	Exposure/ Intermittent Power OFF	Tracer type	Approach (Product/ system)
<=121	<=121	<=250	Self Regulating	Product
From 121 to 150	From 121 to 150	<=250	Self Regulating	Product/Stabilised (Refer c,d & e)
From 151 to 200	From 151 to 200	<=250	Self Regulating / Power Limiting	Product/Stabilised (Refer c,d & e)
>200	>200	Any	Mineral Insulation	Controlled

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h) The heating tape shall be suitable for continuous/ intermittent exposure temperature under power ON/power off condition as specified in project data sheet.

i) All necessary type test certificates including those for 'T' rating, service life bench mark performance test shall be furnished.

3.1.3 Overlapping of heating tapes shall be permitted only in case of heating tapes with burnout proof feature.

3.1.4 The heating tapes shall be suitable for use in area defined in project data sheet. It shall be provided with corrosion resistant tinned copper braid for both safe and hazardous area applications. For applications requiring high exposure temperature, the braid may be of nickel plated copper. An outer sheath over the metallic braid shall also be provided for corrosion resistance and additional mechanical protection. Fluropolymer overjacket shall be used over metallic braid in areas where exposure to hydrocarbon based chemical solutions or vapours are expected.

3.1.5 The surface temperature of the heating tapes/electrical equipment intended to be used in hazardous area shall not exceed 200 °C (T3 rating) unless otherwise specified in the project data sheet.

3.1.6 The selection of heating tapes and other devices shall be done by the contractor considering the following:

- Specified maintenance/heating temperature requirements,
- Minimum design ambient temperature
- Intermittent Exposure temperature
- Operating temperature
- Design temperature
- Thermal insulation (Type and thickness)
- Tolerance on supply voltage and voltage drop on feeding cables
- Minimum heater output rating at operating conditions
- Site environment conditions
- Specified hazardous area classification and 'T' rating
- Design margin

3.1.7 If specified in data sheet, for critical applications where heat up time is an important factor during start up or power shut down, extra heating capacity shall be taken into design in addition to that required for temperature maintenance.

Apart from above, there may be a need to heat up (to melt) the contents within a certain period under specified ambient condition, additional heating capacity need to be installed for such duty.

3.1.8 The method of calculation of heat loss and related parameters shall be as per guidelines given in the standards. The losses from each part of the surface shall be calculated using the appropriate formula and added together to determine the total heat loss. A minimum design margin of 10% shall be considered on the rate of heat loss calculated.

3.1.9 The tracer shall withstand the highest equilibrium pipe temperature that occurs when the heating tape is continuously energised at the maximum ambient temperature and at the maximum operating voltage. The maximum continuous exposure temperature of the heating

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tapes in "Power ON" condition shall be more than the highest equilibrium pipe/equipment temperature or 20°C above the specified maintenance temperature of the pipes/equipment whichever is higher.

3.1.10 Heat tracer shall have temperature withstand capacity of not less than the maximum operating temperature

3.1.11 Heating tape used for piping and other equipments that will undergo periodic steam cleaning shall have intermittent exposure minimum withstand temperature with power off as specified in project data sheets. Tracer shall be suitable for withstanding exposure temperature for "power OFF" condition for cumulative duration of at least 1000 hrs.

3.1.12 The heat output at the end of the heater tape shall meet the minimum heat loss requirement, considering negative tolerance on supply voltage, voltage available at the end of the tape and considering minimum heater output rating at operating conditions.

3.1.13 Extra heater tape length shall be provided for valves, flanges, pipe supports and similar heat sinks. The heater tapes shall be installed so as to permit easy maintenance or removal of the valve, pipe support or similar heat sink however, installation shall be done without overlapping.

3.1.14 Each heater circuit shall be provided with independent thermostat (temperature set point manually adjustable) / RTD with multi circuit control and monitoring system for energy conservation requirements. The type of temperature sensing device i.e. thermostat or RTD shall be as per data sheet. The location of thermostats/RTD shall be decided at the most strategic points which are governed by process / site conditions. The capillary of the thermostat tube shall have mechanical protection.

3.1.15 Number of circuits shall be decided considering all possible flow conditions.

3.1.16 Suitable flexible material shall be used for proper positioning of the heater tape on pipeline, equipment. No increase in allowance on heat output shall be permitted on this account.

3.2 Electrical Power Distribution

3.2.1 Power supply shall be provided in owner's substations for feeding power to the PDBs or LDPs. In case bulk supply to heat tracing system is considered, PDBs shall be provided for distributing power to LDPs. Power supply to the heater tapes shall be provided from LDPs located in the field at strategic locations /load centres to be decided by the contractor.

3.2.2 For power cable sizing, total voltage drop from owner's switchgear to heater tape shall be limited to 5% under full load condition. The voltage drop between owner's switchgear to PDB/LDP shall be 3% and PDB/LDP to heater tape shall be 2%.

All power cables (from substation to PDB/LDP and LDP to heater tape) shall be properly sized to carry current without undue temperature rise under site derated conditions. The derating shall take into account ambient air temperature/ground temperature, grouping and proximity of cables with each other, thermal resistivity of soil etc. as applicable for installation.

Further, the selected cable size shall also be adequate to carry the maximum anticipated heater start up current while the heating device is at minimum temperature.

3.2.3 3 core-armoured cables shall be used for power supply to heater tape for single-phase circuits. (2 cores for phase and neutral and third core for earth conductor).

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3.2.4 The incoming cables to PDBs / LDPs shall be four core (conductor size for neutral shall be same as that for phase conductors).

3.2.5 Thermostats, if used, in power circuit, as well as Components used in the local distribution panels shall be sized for 125 % of starting current at rated voltage and considering maximum heater output rating.

3.2.6 The load shall be balanced in all the 3 phases to the extent possible in each LDP.

3.2.7 **Monitoring Facility**

Unless otherwise specified in the data sheet, the monitoring facility for power supply healthiness of feeders in LDP feeders shall be done by providing one auxiliary contactor in each feeder which shall remain energised under power supply healthy condition. The contact (Normally open) of this auxiliary contactor of all feeders shall be wired in series in each LDP to give one common alarm contact for remote annunciation (open to alarm) against loss of voltage, earth leakage, and fault.

4.0 EQUIPMENT AND MATERIAL SPECIFICATIONS

All materials to be used for the job shall be field proven in similar services and under similar conditions with proven track record. The workmanship shall be of high quality in every respect.

The main heater tape shall be as detailed in section 3.1. The requirements in respect of other items are detailed below.

4.1 Power Distribution Boards (PDB)/ Local Distribution Panels (LDP)

4.1.1 PDB/LDP shall conform to attached EIL specifications and data sheet. PDB shall preferably be installed in outdoor safe areas.

4.1.2 PDBs/LDPs intended for installation in outdoor safe areas shall be housed in outdoor kiosk to make it totally weather protected. Necessary glass windows shall be made in outdoor kiosk, so that the operator can see all indications and energised / de-energised position of different switches/ MCCB's and other device from outside without opening the door and without taking any special precautions.

4.1.3 The incomer feeder of PDB shall be isolator /breaker feeder and shall have voltmeter with selector switch, ammeter, ammeter selector switch indication lamps .Outgoing feeder shall be switch fuse feeder with ON/OFF/trip indication lamps.

4.1.4 LDP incomer shall be TPN load break switch feeder of required rating. The incomer feeder shall have voltmeter with selector switch, ammeter, ammeter selector switch and 3 Nos. pilot lamps for supply indication. Each out going circuit shall comprise of Miniature Circuit Breaker (MCB) with thermal over current and magnetic short circuit releases, Earth Leakage Circuit Breaker (ELCB) (M9 Category), power contactor of required rating if thermostat rating is inadequate. MCB shall be double pole for single phase circuits. MCB rating shall be such that it shall not operate on starting current. The ELCB shall have nominal 30 mA and 30-msec.-trip rating, in case this setting results in nuisance tripping, ELCB may be selected above 30 mA but not greater than 300mA and 150 msec. Ammeter (CT operated) and indication lamp for feeder status shall be provided for each outgoing circuit. Indication circuit shall include the status of the thermostat (ON/OFF) installed in the field.

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4.1.5 PDB/LDP shall have 20% spare feeders, which shall include minimum of one spare feeder of each rating.

4.2 General Requirements

4.2.1 Junction boxes /power connectors used for power cable / heater tape termination shall be weatherproof for use in safe areas. Flameproof Ex-d junction boxes /power connectors shall be used for hazardous areas as a minimum.

4.2.2 All power, control and signal cables shall be as per specifications attached.

4.2.3 All outdoor enclosures shall be provided with IP 55 protection.

4.2.4 All equipments such as PDB's/LDPs, thermostats etc intended for installation in hazardous area shall be of flameproof type with, Temp. Class T3 and suitable for applicable gas group (IIA, IIB or IIC) as per project data sheet. The enclosure shall also have IP-55 weather protection. Canopy shall be provided for additional weather protection.

4.2.5 Nickel plated brass double compression cable glands shall be used for cable termination in all equipments.

4.2.6 Heater tape termination and support clamps shall withstand the maximum temperatures, temperature cycling and thermal expansion of piping or equipment to be heated. These shall not be affected by rainwater, firewater spray and site environment.

4.2.7 Electric surface heating system shall be complete with all accessories for fixing and installing the heater tape and junction boxes, power connectors, T connectors, end connectors etc.

4.2.8 Each heater shall be tagged with non-corrosive metallic tag indicating heater number, type and pipe line/equipment number.

4.2.9 Pipe lines, instruments and vessels heated with heater tape shall be provided with suitable metallic caution signs visible from all sections of the heated system. Caution signs on traced pipe lines shall not be more than 6 m apart. In addition, each instrument, level gauge, vessel etc. that by the nature of their function require operation or maintenance, shall carry an individual sign. The sign shall read "Electric surface heated" and shall be of size 200 mm x 60 mm (minimum).

4.2.10 All electrical equipments to be supplied by the contractor be epoxy painted. Unless otherwise specified, the colour shade shall be shade 632 as per IS: 5.

4.3 Local Thermostats

4.3.1 Capillary Type

The capillary shall not be more than 5 m long. The contacts of thermostat used for direct switching shall have a minimum rating of 16 A. Each contact shall not be loaded with more than 75% of its nominal rating. The temperature setting accuracy shall be better than $\pm$ 5% of set value.

4.3.2 Flameproof and weather protected (IP-55) thermostats shall be used in classified areas. All thermostats shall be factory calibrated, non-indicating type, equipped with internally adjustable set point.

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4.4 RTD with Multi Circuit Control and Monitoring Facility

4.4.1 RTD shall be 3 wire type with platinum element having 100 ohms resistance at 0°C, selected for desired temperature range.

4.4.2 The element shall be of highly refined material of reference grade and shall have been stress relieved. RTD calibration shall be as per IEC-60751-2.

4.4.3 Multi circuit temperature controllers (provided in PDB/LDP) shall have facility to connect required numbers of RTDs. Controllers shall be of Heat tracer supplier make. Controllers shall be connected preferably in ring topology to central monitoring system through RS-485 / FO cable. Location of central monitoring system shall be as defined in job specific documents. All data available in LDPs shall be available at central monitoring system. The HMI for central monitoring system shall be industrial type and supplied with latest configuration & latest version of Microsoft windows and all softwares provided shall be suitable for the same. HMI shall be capable for storage of more than 1 year data of all connected LDPs including 20% margin capacity. HMI shall have provision for communicating all data to owner DCS on Modbus TCP/IP through FO cable.

4.4.4 All components for the system shall be suitable for hazardous area in line with area classification requirements.

4.4.5 Provision for monitoring of following minimum alarm conditions shall be provided in LDP for all circuits

- Low / high temperature
- RTD failure
- Communications failure
- Ground-fault
- Low / high current

Additionally actual analogue temperature value shall also be communicated.

4.4.6 Central monitoring system provided in LDP shall have provision to communicate with upper level system/automation. The type of protocol for communication with upper level system shall be as defined on the data sheet.

5.0 INSPECTION, TESTING AND ACCEPTANCE

5.1 All equipment and materials to be supplied by contractor shall be subject to inspection by EIL/Owner, at manufacturer's works. Manufacturer shall furnish all necessary information concerning supply to EIL / owner's inspectors. The inspector shall have free access to the manufacturer's works for the purpose of inspecting the process of manufacture in all its stages to assess the progress of works as well as to ascertain the quality of raw materials used.

5.2 All routine and acceptance tests as specified by the applicable standard codes and enclosed EIL specifications shall be conducted. Shop tests shall be witnessed by Inspector of EIL / Owner or of an agency authorised by owner.

5.3 For equipment bought from sub-suppliers, certified test reports of tests carried out at the manufacturer's works shall be submitted. The sub-supplier at his works shall conduct normally all routine tests as specified in the relevant standards.

5.4 All sundry installation materials brought to site directly, will be inspected and approved by Engineer-in-charge before installation.

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6.0 INSTALLATION

6.1 Heater Tape

6.1.1 Before installation of heater tapes on pipes and other equipments, contractor shall arrange to clean properly the surfaces to the extent required.

6.1.2 Installation shall be done in accordance with applicable standards.

6.1.3 Heating tapes shall not be installed until pipe lines and equipment have passed all required tests and clearance is given by engineer-in-charge.

6.1.4 Heaters and controls shall be carefully located and installed to prevent damage during normal operation and maintenance.

6.1.5 The electric surface heating for instruments, valves and flanges shall be done in such a way that servicing of instruments, opening of valves and servicing of flanges is possible with ease and without disconnecting wiring.

6.1.6 Field installation works shall be carried out in such a manner that the work of other agencies (piping, insulation contractor etc.) operating at the site is not hampered due to any action of the contractor and proper coordination with other agencies shall be contractor's responsibility.

6.2 Cabling System

6.2.1 Cable shall preferably be laid in overhead / surface mounted cable trays along the pipe rack/ pipe track wherever available. GI cable trays shall be used unless otherwise specified. Cable trays shall be supported at a distance not exceeding 3000 mm. Tray widths shall be preferably 300 / 450 mm and shall be arranged in single/ multi-tiers as required. All supporting steel shall be painted before laying of cables.

6.2.2 All power, control, signal cables in unpaved areas shall be directly buried unless specified otherwise. After required earth excavation, cable shall be laid at a depth of not less than 750 mm and shall be covered with 150 mm of sand on top of the largest diameter cable followed by a protective covering of 75 mm thick second-class red bricks. The remainder of the trench shall then be back filled, rammed and levelled. Where underground cables cross roadways, pipe sleepers at grade etc., they shall be taken through existing Electric Road Cross (ERC) or duct. Cables rising from grade shall be protected by GI conduits up to a min. of 300 mm above grade and open ends shall be sealed. Cable route markers shall be provided by contractor for underground-buried cable trench at an internal of 30 m.

Cables in paved areas shall be taken in trenches provided by purchaser. The trench covers shall be removed by contractor and shall be reinstated after cable laying. Trenches in hazardous area shall be completely filled up with sand.

Where trenches are not available in paved areas, contractor shall take cables in GI sleeves to be laid in paved area or through overhead cable trays.

6.2.3 All power and control cables shall be of continuous lengths without intermediate joints. All cables shall be identified close to their termination point by cable number (as per cable schedule), punched on 2 mm thick aluminium strap securely fastened to the cable. Each underground cable shall be provided with identity tags made of lead securely fastened at every 30 m of its underground length with at least one tag at each end before the cable enter/leaves the ground. In case of control cables, all cores shall be identified at both ends by their terminal numbers using PVC ferrules as per interconnection diagrams.

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6.2.4 All PVC cables up to 1.1 kV grade shall be terminated at the equipment by means of double compression type cable glands and crimping type lugs. All cable entries shall be through bottom only unless otherwise approved.

6.3 Earthing System

6.3.1 All metallic non current carrying parts of electrical apparatus, PDBs, LDPs, Heater tape mounting accessories, junction boxes, thermostats etc. shall be earthed.

6.3.2 For earthing of PDB/ LDP and other equipment and devices, contractor shall tap from the nearest available existing main earth grid by providing two runs of 40 x 5 GI strip. Amount of galvanizing shall be 610 g/sq. mm (Min).

Joints and tapings with the main earth grid shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below grade shall be welded and suitably protected by giving two coats of bitumen and covered with hessian tape. Earthing network shall be augmented by providing additional earth electrode in test pits where required.

Multiple earth connections shall be taken from suitably located earth plates connected to earth grid. Equipment handling more than 250 V power shall be earthed at two points. Size of strip/ conductor for LDP shall be same as that of the earth grid.

For connection from earth plate to different equipment mountings, and accessories of surface heating system, GI wire rope/ PVC insulated aluminium conductor cable as specified on the data sheet shall be used. Size of earth wire shall be such that the current rating is at least 60 % of power cable rating / equipment rating. Minimum size shall however be 6 sq. mm. for aluminium wire / 8 SWG for GI wire.

6.3.3 All hardware used for earthing installation shall be hot dip galvanised /zinc passivated / chromium plated. Spring washers shall be used for all earthing connections of equipment.

7.0 FIELD TESTING AND COMMISSIONING

7.1 Inspection during installation and after completion of installation shall be carried out by contractor's adequately trained supervisor /engineer in accordance with guidelines given in the standards. Contractor at no extra cost to the owner shall rectify any defect pointed out by EIL/OWNER'S site-in-charge.

7.2 Before any part of the electric surface heating system is energised, the precommissioning tests shall be carried out. This shall include and be not limited to the following:

- Insulation resistance tests
- Continuity test
- Earth loop impedance

Field testing and commissioning procedure shall be submitted by the contractor for owner/EIL approval.

All pre-commissioning checks and tests both for power distribution and heating system shall be carried out by the contractor in the presence of Engineer-in-charge. Test readings are to be recorded by contractor and copies of test certificates shall be furnished to EIL /owner.

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7.3 After inspection and pre-commissioning tests are carried out, contractor shall obtain necessary statutory approval of the system before energizing the installation. Current shall be noted at the time of initial energization of the circuits and again when readings have stabilized. All results shall be recorded and furnished to the owner to form part of system documentation.

8.0 CERTIFICATION AND APPROVALS

Electrical equipments for hazardous areas shall have type test certificates issued by recognised independent test house such as CIMFR/ERTL/BASEEFA/LCIE/UL/FM. All equipment (indigenous/imported) shall have valid statutory approvals (CCOE/DGMS) as applicable for use in specified hazardous area. All Indigenous flameproof equipment shall have valid BIS license and as required by statutory authorities.

9.0 PACKING AND DESPATCH

All equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for transportation by selected mode i.e. by ship/rail or trailer. The equipment shall be wrapped in polythene sheets before being placed in the 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 particulars, PO No. etc. shall be clearly marked on the package together with other details as per purchase order.

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

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DESIGN PHILOSOPHY FOR ELECTRICAL FACILITIES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
7	15 10 19	REVISED AND ISSUED AS STANDARD SPECIFICATION	DA/JLC	PG	SA	RKT
6	27 08 14	REVISED AND ISSUED AS STANDARD SPECIFICATION	RS	PG	BRB	SC
5	15 04 09	REVISED AND ISSUED AS STANDARD SPECIFICATION	AM	UAP	JMS	ND
4	31 03 04	REVISED AND ISSUED AS STANDARD SPECIFICATION	AKG	AAN	VPS	SKG
3	01 12 99	REVISED AND ISSUED AS STANDARD SPECIFICATION	UAP	AAN	VPS	AS

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Abbreviations:

A	:	Amperes	LAN	:	Local Area Network
AC	:	Alternating Current	LCIE	:	Laboratoire Central des Industries Electriques
ACB	:	Air Circuit Breaker	LDB	:	Lighting Distribution Board
ACDB	:	AC Distribution Board	LDP	:	Local Distribution Panel
AN	:	Air Natural	LED	:	Light Emitting Diode
APFC	:	Automatic Power Factor Correction	LV	:	Low Voltage (Up to 250V)
API	:	American Petroleum Institute	MCB	:	Miniature Circuit Breaker
ASB	:	Auxiliary Service Board	MCC	:	Motor Control Centre
ATEX	:	ATmospheres EXplosibles	MCCB	:	Moulded Case Circuit Breaker
BASEEFA	:	British Approval Service for Electrical Equipment in Flammable Atmospheres	MCP	:	Manual Call Point
BIS	:	Bureau of Indian Standards	MPPT	:	Maximum Power Point Tracker
CEA	:	Central Electricity Authority	MOV	:	Motor Operated Valve
CIMFR	:	Central Institute of Mining and Fuel Research	MV	:	Medium Voltage (Above 250V and up to 650V)
CPRI	:	Central Power Research Institute	MVA	:	Mega Volt Ampere
CT	:	Current Transformer	NEC	:	National Electric Code
DB	:	Distribution Board	NFPA	:	National Fire Protection Association
DC	:	Direct Current	NGR	:	Neutral Grounding Resistor
DCDB	:	DC Distribution Board	NGT	:	Neutral Grounding Transformer
DCS	:	Distributed Control System	NIFPS	:	Nitrogen Injection Fire Protection System
DG	:	Diesel Generator	ODC	:	Over Dimension Consignment
DGCA	:	Director General Civil Aviation	OFC	:	Optical Fibre Cable
DGMS	:	Director General Mines Safety	OISD	:	Oil Industries Safety Directorate
DOL	:	Direct On Line	OLTC	:	On Load Tap Changer
ECS	:	Electrical Control System	ONAF	:	Oil Natural Air Forced
EHV	:	Extra High Voltage (Above 33 kV)	ONAN	:	Oil Natural Air Natural
ELCB	:	Earth leakage Circuit Breaker	PCC	:	Power Control Centre
ELR	:	Earth Leakage Relay	PCU	:	Power Conditioning Unit
EOT	:	Electrically Overhead Travelling	PDB	:	Power Distribution Board
EPABX	:	Electronic Private Automatic Branch Exchange	PESO	:	Petroleum and Explosives Safety Organisation
ERTL	:	Electronic Regional Test Laboratories	PMCC	:	Power Cum Motor Control Centre
FA	:	Fire Alarm	PTB	:	Physikalisch-Technische Bundesanstalt
FM	:	Factory Mutual	PV	:	Photo Voltaic
FRLS	:	Flame Retardant Low Smoke	PVC	:	Polyvinyl Chloride
GI	:	Galvanised Iron	RCC	:	Reinforced Cemented Concrete
GIS	:	Gas Insulated Switchgear	RTCC	:	Remote Tap Changing Controller
HDPE	:	High Density Poly Ethylene	RTD	:	Resistance Temperature Detector
HMI	:	Human Machine Interface	RTU	:	Remote Terminal Unit
HV	:	High Voltage (Above 650V and up to 33 kV)	RVT	:	Residual Voltage Transformer
HVAC	:	Heating Ventilation and Air Conditioning	SPV	:	Solar Rooftop Photo Voltaic
IAC	:	Internal Arc Classification	SVL	:	Surge Voltage Limiter
IEC	:	International Electro-Technical Commission	TRV	:	Transient Recovery Voltage
IEEE	:	Institute of Electrical and Electronics Engineers	UL	:	Underwriter's Laboratory
IES	:	Illumination Engineering Society	UPS	:	Uninterrupted Power Supply
IS	:	Indian Standards	V	:	Voltage
kV	:	Kilo Volt	VFD	:	Variable Frequency Drive
kVA	:	Kilo Volt Ampere	VRLA	:	Valve Regulated Lead Acid
kVAR	:	Kilo Volt Ampere Reactive	VT	:	Voltage Transformer
kW	:	Kilo Watt	XLPE	:	Cross Linked Poly Ethylene
kWH	:	Kilo Watt Hour	X/R	:	Impedance/ Resistance

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1.0 SCOPE

This specification along with the applicable project design data sheet shall form the basis for developing detailed design and engineering for electrical facilities including electrical power system, Electrical equipment, Electrical control system, Plant communication system, Fire detection & alarm system and electrical installation etc.

2.0 CODES AND STANDARDS

The main codes and standards, considered as minimum requirements, as applicable, are as mentioned below. Latest version of these shall be followed:-

IS-732	:	Code of practice for electrical wiring installations
IS-1646	:	Fire safety of buildings (General): Electrical Installations – Code of Practice
IS-2189	:	Selection, Installation and Maintenance of automatic fire detection and alarm system – Code of Practice
IS-3034	:	Fire safety of industrial buildings: Electrical generating and distributing stations – Code of Practice
IS-3043	:	Code of practice for Earthing
IS-3646	:	Code of practice for Interior Illumination
IS-3716	:	Application guide for Insulation Coordination
IS-4051	:	Code of practice for installation and maintenance of electrical equipment in mines
IS-5216	:	Recommendation on safety procedures and practices in electrical work
IS-5572	:	Classification of hazardous areas (other than mines) having flammable gases and vapours for electrical installations
IS-6665	:	Code of practice for Industrial Lighting
IS-7689	:	Guide for Control of undesirable static electricity
IS-7752	:	Guide for improvement of power factor in consumer installations
IS-8478	:	Application guide for on load tap changers
IS-9676	:	Reference ambient temperature for electrical equipment
IS-10028	:	Code of practice for selection, installation and maintenance of transformer
IS-10118	:	Code of practice for selection, installation and maintenance for switchgear and control gear
IS-10561	:	Application guide for Power Transformer
IS-12360	:	Voltage bands for electrical installations including preferred voltages and frequencies
IS-13234	:	Guide for short circuit calculations in three phase AC systems
IS-16724/ IEC 60079-14	:	Explosive Atmospheres – Electrical installations design, selection and erection
SP-30	:	National Electrical Code (NEC) - BIS Publication
OISD-RP-110	:	Recommended practices on static electricity
OISD-STD-113	:	Classification of Area for electrical installation at Hydrocarbon processing and handling facilities
OISD-STD-137	:	Inspection of electrical equipments
OISD-RP-147	:	Inspection and safe practices during electrical installation
OISD-RP-149	:	Design aspects for safety in electrical systems

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OISD-STD-173	:	Fire Protection System for Electrical Installations
OISD-GDN-180	:	Lightning Protection
IS/IEC 60079-0	:	Electrical apparatus for explosive gas atmospheres – General requirements.
IS/IEC 60079-1	:	Explosive Atmospheres: Equipment protection by flameproof enclosures "d"
IS/IEC 60079-2	:	Explosive protection by pressurized enclosures "p"
IS/IEC 60079-5	:	Explosive Atmospheres: Equipment protection by powder filling "q"
IS/IEC 60079-6	:	Explosive Atmospheres: Equipment protection by Oil immersion "o"
IS/IEC 60079-7	:	Explosive Atmospheres: Equipment protection by increased safety "e"
IS/IEC 60079-10-2	:	Explosive Atmospheres: Classification of areas: Combustible dust atmosphere.
IS/IEC 60079-11	:	Explosive Atmospheres: Equipment protection by intrinsic safety "i"
IS/IEC 60079-15	:	Electrical apparatus for explosive gas atmosphere – Construction, test and marking of type of protection ``n" electrical apparatus.
IS/IEC 60079-18	:	Explosive Atmospheres: Equipment protection by encapsulation "m".
IS/IEC 60079-20-1	:	Electrical apparatus for explosive gas atmosphere: Data for flammable gases and vapours relating to the use of electrical apparatus.
IS/IEC 60079-31	:	Explosive Atmospheres: Equipment dust ignition protection by enclosure "t".
IS/IEC 62305-1	:	Protection against lightning: General Principles
IS/IEC 62305-2	:	Protection against lightning: Risk Management
IS/IEC 62305-3	:	Protection against lightning: Physical damage to structures and life hazard
IS/IEC 62305-4	:	Protection against lightning: Electrical and electronics systems within structure
API-RP-545	:	Recommended Practice for Lightning Protection of Aboveground Storage Tanks for Flammable or Combustible Liquids

3.0 STATUTORY REQUIREMENTS

The latest version of the following statutory regulations shall be followed for design of electrical system, as applicable for the particular project/ industry.

- Indian Electricity Act.
- Central Electricity Authority Regulations.
- The Factory Act.
- The Petroleum Rules.
- The Mines Act.
- Requirements of other statutory bodies as applicable, e.g. CEA/ State Electrical Inspectorate, PESO, DGMS.
- Oil Industry Safety Directorate.

4.0 SYSTEM DESIGN PHILOSOPHY

4.1 General

The electrical system shall be designed to provide:

- Safety to personnel and equipment both during operation and maintenance.

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- Reliability of Service.
- Minimal fire risk.
- Ease of maintenance and convenience of operation.
- Automatic protection of all electrical equipment through selective relaying system.
- Electrical supply to equipment and machinery within the design operating limits.
- Adequate provision for future extension and modification.
- Suitability for applicable environmental factors.

4.2 Area Classification and Equipment Selection

4.2.1 All the areas within the battery limits shall be classified for the degree and the extent of hazard from flammable materials. Classification of hazardous areas shall be done in accordance with Petroleum Rules, DGMS regulations (where applicable), IS-5572 (for flammable gases & vapours), IS/IEC 60079 Part 10 Sec 2 (for explosive dust atmosphere), OISD standards and Process Licensors recommendations.

4.2.2 Following factors shall be considered for proper selection of electrical equipment for use in hazardous area:

- Area classification i.e. Zone.
- Gas classification i.e. Group - The characteristic of the minimum gas or vapour involved in relation to the ignition current or minimum ignition energy & minimum safe gap data.
- Dust classification i.e. Group - The characteristic of the dust involved.
- Temperature classification - The ignition temperature of the gas, vapour or dust involved or the lowest value of the ignition temperature if more than one combustible material is present.
- Environmental conditions in which apparatus is to be installed - The selected electrical apparatus shall be adequately protected against corrosive and solvent agencies, water ingress, thermal and mechanical stresses as determined by the environmental conditions.

4.2.3 All electrical equipment installed in hazardous areas shall be selected as per IS 16724/IEC 60079-14 and OISD-RP-149 as applicable and shall meet the requirements of relevant IS & Statutory regulations. Ordinary industrial electrical equipment (even though permitted for use in Div.2 area as per NFPA-70) shall not be used in Zone-2 areas. Type of hazardous area protection to be used for individual equipment shall be as specified in the project design data sheet.

4.2.4 Electrical equipment for hazardous areas shall be certified by CIMFR/ ERTL/ Karandikar Lab or equivalent recognised independent test house such as BASEEFA / ATEX/ LCIE / PTB / UL / FM. All equipment (indigenous and imported) shall also have valid statutory approvals i.e. PESO/ DGMS as applicable for use in the specified hazardous area. All indigenous flameproof equipments shall have valid BIS license and marking as required by statutory authorities.

4.3 Power System Design

4.3.1 The distribution system shall be designed in accordance with project specification/ design data taking into account all possible factors affecting the choice of the system to be adopted such as required continuity of power supply, flexibility of operation, operational costs, space availability and reliability of supply from available power sources, total load and the concentration of individual loads.

4.3.2 In general the design intent shall also be for reduction in energy consumption through the selection and utilization of efficient electrical equipment i.e. energy efficient motors, transformers, lighting equipment and other equipment notified from time to time.

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4.3.3 Power system studies shall be performed using standard software in support of design, as required.

4.3.4 Special attention is drawn to chapter IX of CEA regulations, which includes requirements for design of electrical system as applicable to Mines and oil fields installation.

4.4 Capacity of Electrical System

4.4.1 All the components of the electrical system shall be sized to suit the maximum load, under the most severe operating conditions. The amount of electrical power consumed by each process unit shall be calculated for its operation at the design capacity. System design shall permit direct on line starting of all motors unless specified otherwise.

4.4.2 For Electrical load analysis, loads shall be classified as continuous loads, intermittent loads and standby loads based on their operation. Following factors shall be applied to calculate the total operating load, unless otherwise specified:

100% (Continuous Loads) + 30% (Intermittent Loads)[1] + 10% (Standby Loads)[2,3,4]

Notes:
1. 30% of intermittent loads such as EOT cranes, MOVs, etc. or the largest intermittent load whichever is higher.
2. 10% for only those Standby Loads which are required in emergencies only, such as fire-water pumps or those of normally not running electrically driven units in stand-by mode for normally running turbine driven loads.
3. Driven equipment 'Standby' in 'Normal-Standby' combination shall not be considered as a standby load.
4. 10% of standby loads or the largest standby load whichever is higher.

4.5 System Voltages

System voltages shall be as defined in project design data sheet.

4.6 Voltage Drops

4.6.1 The maximum voltage drops in various sections of the electrical system under steady state conditions at full load shall be within the limits stated in the following table:

Sl. No.	System Element	Maximum Permissible Voltage Drop
a)	Cable between transformer secondary and Switchboards	0.5%
b)	Cable between PCC/PMCC and MCC or auxiliary switchboard i) MCC /Auxiliary Switchboard near PCC/PMCC ii) MCC/Auxiliary Switchboard situated remote from PCC/PMCC	 0.5% (Note-3b) 2 to 2.5% (Note-3a)
c)	Cables between HV Switchboard and HV Motor	3% (Note-4)
d)	Cable between PCC/PMCC and motor	5.5% (Note-4)
e)	Cable between MCC (situated near PCC / PMCC) and motors	4.5 to 5% (Note-4)
f)	Cable between MCC (situated remote from PCC / PMCC) and motors	3% (Note-4)

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g)	Cable between Auxiliary Switchboard / LDB and Lighting Panel/ Power panel	1 to 1.5% (Note- 2)
h)	Circuit between lighting panels and lighting points	4% (Note- 2)
i)	DC Supply Circuit (Electrical Controls)	5%
j)	DCDB to Control Room	2% (Note -1)
k)	UPS outgoing circuit	5% (Note - 1)

Note-1

Minimum voltage available across any instrument in the field/ control room/ Satellite rack room shall be as per instrumentation design basis. Distribution system for instrumentation supplies shall be designed accordingly. In case of any conflict between electrical project design data sheet and instrumentation design basis, the latter shall govern regarding instrumentation power supplies.

Note-2

In case of difficulty in achieving specified voltage drops in cables up to lighting panel, total 5.5% drop from Auxiliary switchboard/ LDB up to lighting points may be permitted.

Note-3

a) Higher voltage drop may be permitted between PCC / PMCC and remote mounted MCC/ASB, if overall voltage drop up to motor (from PCC / PMCC) is limited within 5.5%.

b) For large substations 1% drop may be permitted.

Note-4

For VFD fed motors, the maximum permissible voltage drop, as specified, shall be considered between VFD Panel and Motor.

4.6.2 The maximum voltage drop at various buses during start-up of large motor and/or motor reacceleration conditions shall be within the limits stated below:

S. No	System Element	Operating Condition	Max. Permissible Voltage Drop
a)	At the busbars of the worst affected Switchboard	Start -up of the large HV motor with other loads on the bus or reacceleration of a group of HV motors (Simultaneous start-up or group reacceleration of HV motors is not envisaged)	15 %
b)	At the busbars of the worst affected MV Switchboard (PCC/PMCC/MCC)	Start up of large MV motor with other loads on the bus or reacceleration of a group of MV motors (Simultaneous start-up or group reacceleration of MV motors is not envisaged)	10 %
c)	Cables between HV Switchboard and motor	Motor start-up or reacceleration	5 % (Note-a)

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d)	Cables between MV switchboard (PCC/PMCC/MCC) and motor	Motor start-up or reacceleration	15 % (Note-a)

Notes:

a) Higher voltage drop in motor cables may be permitted, in case the conditions given in Note b), c) and d) are complied.

b) The voltage available at the motor terminals during start-up must be sufficient to ensure positive starting or reacceleration of the motor (even with the motor fully loaded, if required), without causing any damage to the motor.

c) For medium voltage motors, the voltage available at the motor terminals must not be less than 75% of the rated value during start-up or reacceleration.

d) For high voltage motors, the voltage available at the motor terminals must not be less than 80% of the rated value during start-up or reacceleration.

4.7 System Earthing

4.7.1 System earthing for incoming supply and primary/secondary EHV/ HV/MV distribution systems shall be as per project design data. The system earthing point shall always be at the power source.

4.7.2 Neutral earthing system shall be solidly earthed for voltage system up to 650 V and above 11000 V (except in case of Mines and Oil fields installations where it shall be in line with Chapter IX of CEA regulations and statutory requirements).

4.7.3 For voltages between 3300 V to 11000 V, the neutral earthing system shall be resistance earthed. NGR rating shall be selected such that earth fault current is limited to not less than system charging current and shall be sufficient for selective & reliable operation of earth fault protection relay. The HV system earth fault current shall be limited to either 100% of highest CT rating of motor feeders or 50% of highest CT rating of Delta-Star transformer feeders or 10% to 20% of incomer CT rating whichever is higher. In general, a value of 600A for earth fault current may be considered for HV system unless specified otherwise.

4.7.4 For generators connected to switchboard via step up transformer, generator neutral shall be earthed through single phase transformer with secondary resistor. For generator directly connected to switchboard without generator transformer, generator shall be earthed via its own earthing resistor.

4.8 Short Circuit Capacities

Each short circuit interrupting device shall be designed to have rated short circuit breaking capacity and making capacity equal to or higher than the maximum value of short circuit current (rms) and peak value of short circuit current respectively, calculated at its location. The short circuit calculation shall also take into account increase in short circuit level due to direct or indirect connection of expected future load and future source, if specifically agreed upon. The related switchgears and bus-ducts shall withstand the above maximum available fault current for a minimum period of one second. The minimum size of conductor & metallic screen of high voltage cables and extra high voltage cables shall also be based on the short circuit withstand capacity for a minimum time period as dictated by the protection system and defined in project design data sheet.

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4.9 Insulation System

The insulation of electrical facilities shall be designed considering the system voltage, the system neutral earthing and the over voltages resulting due to system fault, switching or lightning surges. Lightning arresters and surge absorbers shall be provided where necessary.

4.10 Protection and Metering Schemes

4.10.1 The protective system shall be selected and coordinated to ensure the following:

a) Protection of equipment against damage, which can occur due to internal or external short circuits or atmospheric discharges.
b) Uninterrupted operation of those parts of the system, which are not affected by the fault.
c) Personnel and plant safety.

4.10.2 Protection relays shall be provided as specified in project design data sheet.

4.10.3 Metering shall be provided to keep a record of power consumption and supervision of all concerned parameters like current, voltage, power, frequency, power factor etc. as specified in project design data sheet.

4.10.4 Wherever numerical relays are provided, metering shall be part of numerical relay, unless otherwise specified.

4.11 DC Power Supply

4.11.1 Independent DC power supply systems shall be provided for the following requirements, unless otherwise specified:

- Plant shutdown system including DC instrumentation control supply (if required, as per instrumentation design basis)
- Electrical switchgear controls
- Critical DC motors power supply (if required)
- Critical DC lighting system

4.11.2 Fire alarm system control panels and EPABX telephone exchange shall be provided with dedicated DC system as part of the equipment.

4.12 Emergency Power Supply

4.12.1 The emergency power supply system, wherever envisaged and required as per project design datasheet, shall feed the following:

- Electrical loads essential for the safe shutdown of the plant.
- Emergency lighting.
- Communication system.
- Fire detection and alarm systems.
- D.C. Supply systems.
- UPS Systems.
- Fire fighting equipment excluding main firewater pump.
- Loads critical for process, plant and personnel safety.

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4.12.2 Emergency power supply could be from a different power source or Emergency Generator as per Project design data sheet. Rating specified for emergency generator shall be prime rating, unless otherwise specified. Where Emergency Generator is envisaged, emergency power supply shall be made available within a time period of 30 seconds from the instant of failure of normal supply.

4.12.3 The emergency generator shall generally not be required to run continuously in parallel with the normal power supply system. However, short time paralleling facility shall be provided for transferring load to normal power supply or other operational needs e.g. periodic testing etc. as required.

4.13 Uninterrupted Power Supply (UPS)

4.13.1 Uninterrupted power supply system shall be provided, as required for meeting critical loads that cannot withstand a momentary interruption in voltage (e.g. critical instrumentation, process control, HMI for substation automation system, ECS, Plant communication system, LAN system and other loads, as defined in project design data sheet).

4.14 Power Factor Improvement

Capacitor banks shall be provided, as specified in Project design data sheet, to improve the power factor to meet the minimum stipulated power factor by the power supply authorities. Automatic power factor correction shall be provided.

4.15 Plant Communication System

4.15.1 It shall consist of the following:

- Central exchange(s)/ Distributed intelligent nodes.
- Master control station(s) with inbuilt loudspeaker, microphone etc.
- Desk type call stations with inbuilt microphone, loudspeaker for installation in buildings.
- Wall/column mounting type call stations for hazardous/safe areas with external loudspeaker as per Operational requirements.
- Flashing beacon and acoustic hood for noisy areas.

4.15.2 Each exchange/ distributed intelligent node shall be designed to have at least 10% spare capacity.

4.15.3 Plant communication system shall have interface with fire alarm & detection system, EPABX telephone system, wherever specified.

4.16 Fire Detection and Alarm System

4.16.1 The Fire Detection and Alarm System shall be an independent system comprising of individual break glass type manual call points, automatic sensors e.g. smoke/heat detectors, multisensory detectors, linear beam detectors, hooters, exit signs, main panel, zonal panel, battery, battery charger and other hardware. Detail design, selection and installation of fire detection and alarm system including quantity and location of detections, MCP, etc. shall be as per IS 2189.

4.16.2 The system shall be designed to provide audio-visual indication at the main fire alarm panel to be located in fire station and zonal panels. Repeater panels shall be provided as specified in project design data sheet.

4.16.3 Electrical sirens shall be provided to cover entire plant area.

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4.16.4 Each panel and each loop / Zone shall have at least 10% spare capacity.

4.16.5 The fire detection system shall be interfaced with fire suppression system, HVAC system, pressurization system and plant communication system, wherever specified.

4.16.6 Heat detectors to be installed in battery room shall be intrinsically safe, gas group IIC type. Zener barrier shall be provided to limit the ignition energy.

4.17 Electrical Surface Heating System

4.17.1 Electrical surface heating system shall be provided for temperature maintenance of process pipes and associated equipments, if required as per process design basis.

4.17.2 The electrical equipments i.e. heat tracers, thermostat/ RTD, LDP, PDB, Junction boxes, connectors, splice boxes, etc. shall be suitable for applicable area classification, though PDBs shall be preferably located in safe area.

4.17.3 In general, the system shall be suitable for maintaining the temperature, unless otherwise specified. In case process fluid heating is desired, time duration and other parameters shall be as per process design data.

4.17.4 Skin effect electrical heat tracing system shall be provided for pipelines, if specified in project design data sheet.

4.17.5 In general, double/ sandwich insulation technique shall not be utilized for electrical heat tracing.

4.18 Substation Automation System

4.18.1 Substation Automation system shall be provided, if specified in project data sheet. The Substation Automation system shall broadly comprise of numerical relays, data concentrator panels (as required), Ethernet switches, interconnecting cables, HMI, laptop, printers and their associated software for monitoring of the Electrical system.

4.18.2 The communication protocol shall ensure transfer of all information including time stamping data from relay to Data concentrator/ HMI. Generally IEC-61850 based communication shall be provided, unless otherwise specified.

4.19 Electrical Control System

4.19.1 Electrical control system shall be provided (as required) to monitor and control electric power generation and distribution network of the plant. ECS shall broadly include distributed RTUs, Interface panels, I/O panels, servers, HMI, printers, fiber optic data highway, network switches etc. Base functionalities and advanced functionalities as specified in project design datasheet shall be provided.

4.19.2 If specified, there shall be provision of redundant connectivity of ECS system with DCS for serial data transfer.

4.20 Rooftop Solar Photovoltaic Power System

4.20.1 The grid connected photovoltaic (PV) solar system for converting solar energy to generate electricity shall be provided on the building rooftop. The solar system shall be photovoltaic based in which arrays of photovoltaic (PV) modules shall be installed on building roof top under clear sky, shade free, tilted towards south at an optimum inclination.

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4.20.2 The Grid connected Solar Rooftop Photo Voltaic (SPV) system shall consists of PV modules/ panels, Module Mounting Structure, Power conditioning Unit (PCU) having Maximum Power Point Tracker (MPPT), controls and protection, junction boxes, AC distribution board, data acquisition & monitoring system including weather monitoring instruments, cables, pipe conduits, earthing, lightning protection, overvoltage and surge protection, etc.

4.20.3 The system shall be without battery and shall be designed with necessary features to supplement grid power during day time.

4.20.4 Solar PV module array shall consist of high efficiency Solar Modules utilizing Crystalline Silicon solar PV cells

4.20.5 The power conditioning unit (PCU) shall be either located indoor or outdoor as specified in project design datasheet.

4.20.6 For specific applications, battery may be provided as part of solar photovoltaic (PV) system, if specified in project design data sheet.

5.0 EQUIPMENT DESIGN PHILOSOPHY

5.1 General

The equipment shall in general conform to EIL standard specifications. Equipments shall be selected and sized as per philosophy given below:

5.2 Transformers

5.2.1 All transformers except lighting transformers & isolation transformers shall generally be three phase, oil immersed, double wound type suitable for outdoor use, unless otherwise specified. Lighting transformers & isolation transformers shall be dry type, unless otherwise specified. Preferably transformers of variable frequency drive system and soft starter system shall be dry type located indoor adjacent to VFD/ soft starter panels.

5.2.2 100% standby transformers (for power, distribution and lighting) shall be provided in all unit, offsite and utility substations, unless otherwise specified.

5.2.3 In general kVA rating & percentage impedance ratio of each transformer shall be selected to limit the rated current and short circuit current to values which are within the current rating and interrupting capacity of associated switchgear available.

The kVA rating for power, distribution and lighting transformers shall be decided on the following basis and shall be as far as possible a standard value.

a) In systems having redundancy for transformers, with transformers having natural cooling i.e. ONAN/AN, each transformer shall be rated equal to or greater than the 8 hour maximum demand of the load plus 10% margin for future load growth.

b) In systems having redundancy for transformers, with transformers having forced cooling i.e. ONAF, each transformer shall be rated equal to or greater than the 8 hour maximum demand of the load plus 10% margin for future load growth (within 110% of it's self cooled (ONAN) rating) and shall be fitted with automatic forced air cooling fans.

c) Where redundancy in number of transformers is not provided, rating shall be equal to or greater than 8 hour maximum demand plus 10% margin for future load growth. Fan

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cooled rating, where provided, shall be reserved as spare capacity for further future load growth.

d) Where switchboard with three incomers and two bus coupler fed from three transformers is provided, transformer rating shall be finalized considering the load distribution pattern on the three buses of downstream switchboard during normal operations & also during outage of any one of the transformer. However in no case, transformer rating shall be less than 2/3rd of 8 hour maximum demand of the load plus 10% margin for future load growth.

5.2.4 Transformers connected directly to grid power supply shall be provided with OLTC to take care of variations in grid supply voltage.

5.2.5 For transformers having oil quantity equal to or above 2000 liters, Nitrogen Injection Fire Protection System (NIFPS) shall be provided, unless otherwise specified.

5.2.6 Distribution transformers shall be energy efficient type having energy efficiency level as specified in project design data sheet.

5.3 Switchgear

5.3.1 HV and EHV switchgears directly connected to grid/ power plant shall be provided with double bus arrangement, if justifiable in terms of operating flexibility, system extension and connection of differing priority loads to different buses.

5.3.2 Gas Insulated Switchgear (GIS) shall be provided for EHV system and HV system if specified in project design datasheet. In general, GIS may not be considered for voltages below 22 kV.

5.3.3 All switchgear and associated equipment fed from generators and transformers shall have rating at least equal to the rating of respective generators and transformers feeding it, under any circuit configuration. Generator incomer shall be rated w.r.t. maximum power output of the generator set over entire operating temperature range. Transformer incomer shall be rated at least equal to forced cooled rating of transformer or 110% of ONAN rating, whichever is higher.

5.3.4 Generator Circuit Breaker directly connected to generator shall be as per IEEE/IEC 62271-37-013.

5.3.5 Bus tie circuit breakers shall have rating higher of the following:

a) Largest incoming circuit breaker.

b) Maximum running load on either side of bus section.

The tie breaker rating shall not be less than the bus-bar current rating, unless otherwise specified.

5.3.6 HV and MV switchgears including components shall be natural air cooled type for achieving the required current rating inside the panel/cubicle at design ambient temperature. In case, natural cooled design is not available, forced cooling of components i.e. bus bars, circuit breaker etc. can be considered if specifically agreed upon.

5.3.7 All other switchgears not directly fed from generator and transformers shall have rating at least equal to the maximum demand under any circuit configuration plus a provision for 10% future load growth. Incomers of these switchgears shall be designed to cater to the complete load including 10% margin for future load growth.

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5.3.8 Spare outgoing feeders shall be provided in all switchgear. At least one number of each type of outgoing feeder or 10% of each type of outgoing feeder, whichever is more, shall be provided as spare in the HV and MV switchboards, except for capacitor feeder in HV switchboard.

5.3.9 Circuit breakers/contactors controlling motor feeders shall have a rating of at least 125% of the maximum continuous rating of the connected motors.

5.3.10 Separate feeders shall be provided in the switchboard for each load/motor. However, as an exception maximum two numbers welding receptacles or flood light masts may be connected to one power feeder.

5.3.11 All circuit breakers shall be of single break type having one pole per phase. Circuit breakers for all MV switchboards incomers and bus couplers including generator incomer shall be with four poles.

5.3.12 Rated short circuit breaking capacities and making capacities for all breakers and MCCBs shall be equal to or higher than the maximum specified value of the short circuit current and peak specified value of short circuit current respectively at the point of installation. MCCBs with backup fuses shall not be acceptable.

5.3.13 Air circuit breakers (ACB) shall be provided in MV switchboards for all feeders rated above 400A and switch fuse/MCCB/ACB shall be considered for feeder rated up to 400A. However in the feeders feeding power to small rated MCCs/ASBs/LDBs, switch-fuse feeders shall not be used.

5.3.14 Circuit breakers/Switch fuse units for capacitors shall, have a current rating of at least 135% of the capacitor rated current. Circuit breakers capability to interrupt applicable capacitive current shall be specifically verified.

5.3.15 The switchboard components viz. circuit breakers, main horizontal and vertical bus-bars, bus-bar joints, bus-bar supports etc. shall be designed to withstand the maximum specified short circuit current for a minimum time of 1 second, unless otherwise specified. Further, the switchboard shall be rated for Internal Arc Classification (IAC) for the short circuit current and duration as specified.

5.3.16 In general, for motors rated above 5.5 kW, CT in Y phase shall be provided in the switchgear for ammeter on the local control station/local control panel. Project design data sheet shall be referred for exact motor kW rating above which CT & ammeter need to be provided.

5.3.17 The maximum rating of bus bars for MCCs/ASBs/LDBs shall be limited to 1250 A or 40% of the feeding switchgear incomer rating, whichever is lower. Heavy duty type load break switch/ACB/MCCB for MCCs/ASBs and ACB/MCCB for lighting transformer fed LDBs, rated for maximum specified short circuit current & duration shall be used for incomer and bus coupler as specified in project design data sheet and these shall have suitable interlocks.

5.3.18 Special attention is drawn to Chapter IX of CEA regulations, which includes requirement of additional protective elements in switchgear applicable to Mines and Oil fields installations.

5.4 Bus Duct

The rating of bus ducts connected to breakers shall have same continuous and short circuit rating as that of breakers. Similarly bus ducts connecting two bus sections shall have same continuous and short circuit rating as that of main bus bars.

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5.5 Neutral Grounding Resistor

The NGRs shall be rated to withstand the fault current for 10 seconds.

5.6 Batteries

Batteries shall be of adequate capacity to meet the back-up requirements as envisaged in the duty cycle. While sizing the battery, temperature correction factor and ageing factor shall be considered in addition to the maintenance factor. Batteries shall be complete with battery racks and accessories.

5.7 DC Power Supply System

5.7.1 DC power supply system shall include battery bank, charger-cum-rectifier, DC distribution board and cell booster.

5.7.2 The battery charger/rectifier shall feed the load and keep the batteries under fully charged condition. Provision shall also be made for necessary boost charging/initial charging of battery.

5.7.3 The DC system shall have at least 10% spare capacity for future load growth.

5.7.4 Each battery charger and DCDB shall be sized to cater to selected battery capacity.

5.7.5 Each DCDB shall have at least 10% spare feeders with one no of each rating for future use.

5.7.6 Three pole power switch/ isolator outside battery room shall be provided for local isolation of battery during maintenance.

5.7.7 For dual redundant system, each system shall be provided in separate compartment with the common components mounted in another separate compartment, so that it is possible to do maintenance on one system while the other system is in operation.

5.8 Uninterrupted Power Supply System

5.8.1 UPS system shall include battery bank, rectifier transformer, rectifier-cum-charger, inverter, set of filter circuits, static switches, bypass transformer, facility for manual transfer between inverter supply & bypass line, facility for bypassing inverter & static switch for maintenance, AC Distribution board, cell booster and other associated accessories.

5.8.2 Each branch circuit of the UPS distribution system shall have a fused disconnect switch. The fuse shall be fast clearing semiconductor type and the fuse rating shall be co-coordinated with the rating of the UPS system. Normally the largest branch circuit rating shall not exceed 25% of the UPS system rating for feeders without isolation transformer and 10% of the UPS system rating for feeders with isolation transformer.

5.8.3 UPS system shall be sized to have at least 10% spare capacity for future load growth.

5.8.4 Each UPS ACDB shall have at least 10% spare feeders for future use by owner.

5.8.5 Power switch/ isolator outside battery room shall be provided for local isolation of battery during maintenance.

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5.9 Motors

5.9.1 In general, three phase squirrel cage induction motors designed for direct on line starting shall be used. Motors shall be totally enclosed, fan cooled type and suitable for continuous use. Synchronous motors and motors with variable frequency operation shall be designed for special application.

5.9.2 All motors shall be continuous maximum rated with possible exception of crane and hoist motors, soot blowers, turbine/engine starting motors etc. which may be rated for the envisaged duty cycle.

5.9.3 DOL start high voltage motors shall be suitable for starting under specified load conditions with 80% of the rated voltage at the terminals and DOL start medium voltage motors shall be suitable for starting under specified load conditions with 75 % of the rated voltage at the terminals. If required, large rated motor starting shall be through soft starter/ dedicated transformer as per project design data sheet. Voltage available at the motor terminals which are started through dedicated transformer shall be decided considering the speed torque characteristics of the driven equipment and ensuring the voltage dip at the source bus does not exceed the permissible limits as per project design data sheet.

5.9.4 MV Motors shall be energy efficient type having energy efficiency level as specified in project design data sheet.

5.9.5 VFD fed motor shall be suitable for converter duty application.

5.10 HV Capacitor Banks

5.10.1 The capacitor banks shall be supplied with series reactor and RVT (residual voltage transformer). All the capacitor bank equipment except APFC panel shall be suitable for outdoor location unless otherwise specified.

5.10.2 The capacitor bank in conjunction with series reactor shall provide minimum net required kVAR at rated nominal voltage. The insulation system shall be designed to withstand continuous over voltage of 110%.

5.10.3 Capacitor bank rating shall be sized considering the power factor correction requirement. The maximum rating of capacitor bank unit shall be restricted by the available capacitive breaking capacity of feeding switchgear in APFC panel.

5.11 Emergency Generator

5.11.1 The emergency generator set shall be designed to start automatically on power failure and feed the selected loads. It shall be capable of taking care of the load variations including the starting of the largest rated motor with specified base load. However, DG sizing shall not include boost charging loads for UPS and DC system batteries but shall only include float charging and service loads.

5.11.2 The regulation of generator voltage shall be automatic and necessary instruments for metering viz., Ammeter, Voltmeter, frequency meter, kWH meter, power factor meter, hour run counter etc. shall be included in control panel. Warning of abnormal conditions shall be incorporated prior to automatic trip to prevent unnecessary shutdown.

5.11.3 The unit shall be complete with necessary engine starting equipment, associated control panel and shall be suitable for remote starting. Emergency Generator shall have auto-starting

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arrangement but only with manual switching off feature. 'Fail to start' annunciation shall be provided, in case the engine fails to start.

5.11.4 The load shall be automatically switched on to the generator only after the requisite voltage build-up.

5.11.5 The Emergency generator set shall have at least 10% spare capacity for meeting future requirements.

5.11.6 Local line side circuit breaker shall be provided in DG control panel. Further isolation switch shall be provided for generator system neutral if specified in project specification.

5.12 Annunciation Panel

5.12.1 Audio-visual annunciation panels shall be provided, where specified in project design data sheet, to monitor the switchgear and other electrical equipments. In case hardwired panel is not envisaged, audio visual annunciations shall be provided as part of the HMI system.

5.12.2 Detailed annunciation schedule shall be based on but not limited to the following:

a) EHV & HV Switchgear
- Breaker-wise fault trip alarm
- Auto-changeover completed
- Auto-changeover failure
- Trip circuit status for each breaker
- Differential and restricted earth fault relay operation alarm
- Transformer trouble alarm
- DC supply failure alarm (Bus wise)
- PT secondary MCB trip alarm for all line and bus PTs
- Bus wire supervision alarm
- Alarms for SF6 gas system

b) MV Switchgear
- Incomer/ Bus coupler fault trip alarm
- Auto-changeover completed
- Auto-changeover failure
- Bus-wise group fault trip alarm for outgoing feeder breakers
- D.C. supply failure alarm (Bus-wise)
- PT secondary MCB trip alarm for all line and bus PTs

c) Operating status/fault conditions for UPS system.

d) Operating status/fault conditions for DC supply system.

e) Operating status/fault condition for DG sets.

f) Fault alarm for VFD panels

5.12.3 Annunciation panel shall be complete with acknowledge, test and reset pushbuttons. 10% spare windows for future use shall be provided in the panel. Generally, annunciation panel shall be fed from the UPS system/ DC system.

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5.13 Cables and Wires

5.13.1 Unless otherwise specified, EHV cables shall be single core type, copper/ aluminum conductor, XLPE insulated, corrugated Aluminium sheathed, unarmored, FRLS, PVC outer sheathed with overall conductive graphite coating. The exact type & construction of EHV cables shall be as specified in project design data sheet.

5.13.2 HV cables shall be dry cured XLPE insulated, armoured, extruded FRLS PVC outer sheathed with aluminum/copper conductor, as per project design data sheet. All cables rated 3.3 kV and above shall be provided with both conductor screening and insulation screening.

5.13.3 MV power cables shall be PVC/ XLPE insulated, armored/ unarmored, extruded FRLS PVC outer sheathed with aluminum/copper conductor, as per project design data sheet.

5.13.4 The control cables shall be twisted pair, copper conductor, PVC/ XLPE insulated, armoured, extruded FRLS PVC outer sheathed and overall shielded.

5.13.5 The power cables shall be sized based on the maximum continuous load current, the voltage drop during running & start up, system voltage, system earthing and also short circuit withstand criteria if applicable. The derating due to design ambient air temperature, ground temperature, depth of laying, grouping & proximity of cables with each other, thermal resistivity of soil, laying conditions etc. shall be taken into account.

5.13.6 Cables connected in parallel shall be of the same type, size, cross-section and terminations.

5.13.7 All power and control cables shall be in continuous lengths without any splices or intermediate joints. The cables used for lighting and wires in conduits shall have appropriate junction boxes with adequately sized terminals. Unless otherwise agreed, cable joints in hazardous areas shall not be permitted.

5.13.8 All incoming cables to switchgear/UPS/DC system/DBs and other equipment shall be sized for maximum anticipated load including 10% future growth. Cable for capacitor banks shall be sized for 135 % of the rated capacitor current.

5.13.9 The incoming cable for heat tracing power distribution panel shall be with four cores, the neutral conductor being of same size as the phase conductors.

5.13.10 All control cables shall have minimum 10% spare pairs/ cores.

5.13.11 Optical fiber cable (OFC) for data highway of Fire Alarm system, Plant communication system & Electrical control system (ECS) and for feeder differential relay etc. shall be laid in heavy duty flame retardant HDPE duct. The HDPE duct for each service shall be unique color coded as per project design data sheet for ease of identification of service.

5.14 Control Station

5.14.1 Each motor shall be provided with a control station/control panel in the field, unless otherwise agreed upon. Additional emergency stop push button station for air cooler motors, cooling tower motors and other motors located at higher elevations shall be provided at grade level. Further, emergency stop control station for transformers in transformer bay and at intermediate levels for conveyers shall also be provided. If specified, emergency open/ close control station located outside dyke wall for tank body MOVs shall be provided.

5.14.2 The control station shall include the following equipment as per individual requirement:

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- Start/stop push button
- Ammeter (as applicable)
- Local/ Off/ Remote selector switch (if specified)
- Speed lower/ raise switch, speed indication (for VFD motors, if specified)

5.14.3 Stop push button shall generally have stay put feature except in the case of critical drives such as lube oil pump etc.

5.15 Convenience Receptacles

5.15.1 These shall have the necessary mechanical interlocks and earthing facilities. The enclosure shall have suitable protection for site conditions specified (flame proof, weather proof, dust proof, corrosion resistant, etc.).

5.15.2 Adequate number of welding receptacles shall be provided at suitable locations to ensure accessibility with a 50 m length of trailing cable to any point in the process area and in substations & control rooms. These shall be rated for 63A suitable for 415V, 3 phase system with a scraping earth.

5.15.3 Adequate number of three-pin sockets for lamps and portable tools shall be provided at suitable locations to ensure accessibility with a 15 m length of cable to all manholes of process equipments, other important areas in the process units and in substation, control rooms and other buildings. These shall be rated for 15A, 240 V single phase with earth connection. Hand lamps and portable tools shall be earthed through flexible cords. In hazardous areas, flameproof hand lamps shall be rated for 24V.

5.15.4 If specified in project specification, dedicated 415V TPN load break switches/ receptacles shall be provided in the process units at suitable locations and elevations for feeding loads during shut down & maintenance activities.

5.16 Actuators for Motor Operated Valve

5.16.1 MOVs shall be provided with integral starters. MOV actuators shall be non- intrusive type unless specified otherwise. The necessary local/remote selector switch, open/ close control switches or push buttons, torque limit switches etc. shall be provided on actuator for local/remote control depending on the mode of selection. In case of failure of torque limit switches, the mechanical design shall be adequate to stall and trip the motor without damage.

5.16.2 The type of MOV control i.e. conventional type or 2 wire control or compatible with instrumentation field bus, etc. shall be as per instrumentation design basis.

5.17 EHV System

The EHV power supply arrangement shall be provided with either conventional switchyard having CT, VT, disconnector, circuit breaker, lighting arrestor, etc. located in outdoor fenced area or Gas Insulated Switchgear (GIS). The GIS panels shall be located indoor inside the substation building however, outdoor GIS can also be provided as per project specific requirement.

5.18 Variable Frequency Drive

5.18.1 VFD shall be provided with bypass as a standard practice, unless prohibited due to process requirement. In exceptional cases, wherein DOL starting of motor is not possible due to power system limitations, bypass complete with soft starter or no bypass can be considered as specified in project specification.

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5.18.2 Control supply to VFD shall be provided from either DC system or UPS system, as specified in project design data sheet.

5.18.3 VFD sizing shall be done to take care of voltage variation in the incoming power supply, voltage drop inside VFD module & equipment and voltage drop in outgoing cables to motor. Further minimum fault level of the incoming power supply shall be considering for harmonics analysis and sizing of associated components.

5.19 Generator

5.19.1 Generators shall be installed in Non-Hazardous area and shall be installed close to their step up transformer if provided. Further generator cooling system shall be independent of its acoustic enclosure ventilation system.

5.19.2 The generator rated power factor shall be 0.8 lagging, unless otherwise specified.

5.19.3 Bus ducts, if provided for connection between generator and transformer shall be phase segregated or phase isolated type to minimize the possibility of short circuits.

5.19.4 Generators shall be provided with its own MV auxiliary switchboard to cater its motor driven auxiliaries & other loads.

5.19.5 Generators shall be provided with necessary controls & protection devices for synchronizing, voltage control system suitable for island & parallel operation, reactive power control system to control generator power factor, devices to protect the generator & its prime mover and other features as specified in project design data sheet.

5.19.6 The synchronizing controls shall preferably be located from where control of voltage and frequency of generating system can be exercised.

6.0 SUBSTATION / MCC ROOM DESIGN PHILOSOPHY

6.1 The sub-stations shall be located in a safe area close to the load center. Proper access shall be provided/ ensured for operation/ maintenance of indoor and outdoor equipment.

6.2 EHV and HV sub-station switchgear floor shall be raised above grade level and the space below the switchgear room shall be utilized as cable cellar. The cable cellar floor shall be at least 300 mm above the approach road level and shall be paved and cemented. The cable cellar shall have a minimum clear height of 3.5 m and shall house all cable trays & their supports. Further, the cable cellar height of sub-station housing EHV GIS panels may be increased beyond 3.5 m as required to facilitate bending and termination of EHV cables.

6.3 The substation switchgear floor shall have a minimum clear height of 4.5 m. For switchgear floor provided with false ceiling, the minimum clear height below false ceiling shall be 4.5 m. Further, for switchgear floor without false ceiling, the clear height may be increased beyond 4.5 m, as required to accommodate bus duct, air conditioning duct/ pressurization duct etc.

6.4 MV sub-stations and MCC rooms shall be elevated by compacting the soil so that

- The finished floor level shall be above the approach road level to the building.
- The finished floor level shall be minimum 1000 mm above the surrounding grade level.
- The bottom of the cable trench within sub-station is minimum 150 mm above the surrounding grade level.

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6.5 In addition to the entry to substation for operating personnel, a separate entry of minimum 3m (W) x 3.5m (H) with rolling shutter shall be provided for drawing in all equipment for installation. The main entry for operating personnel for pressurized and air conditioning substations shall be provided with double door system with an airlock lobby. The Sub-station shall also have an emergency door opening outwards.

6.6 Sub-station wall adjacent to the transformer bays and walls separating transformers shall be 355 mm thick (inclusive of plastering) in case of brick construction or 230 mm thick in case of RCC construction.

6.7 Sub-station building shall be without any columns within the switchgear room to ensure optimum space utilization, unless otherwise specified.

6.8 Battery banks shall be located in a separate adequately ventilated room in the sub-station building, along with the necessary exhaust system and water connection with sink. Floor of the battery room and walls up to 1.5 m height shall have acid/alkaline resistant protective epoxy coating. Separate battery room may not be required for VRLA batteries, as the VRLA battery stack can be located in the air-conditioned room housing chargers and UPS systems. The battery room shall be provided with minimum two exhaust fans (flameproof, gas group IIC) and louvered opening in opposite wall/door.

6.9 UPS system and other electronics equipment e.g. Data concentrator, Substation Automation System, ECS, HMI, RTCC, variable frequency drive panels, soft starter panels, battery chargers, thyristor heater control panels, control & relay panels, excitation panel, digital voltage regulator panels, etc. shall be located in air-conditioned area, unless otherwise specified in project design data sheet.

6.10 Sub-station shall have fire extinguishers, first aid boxes and other safety equipment as per statutory requirements. Insulating mats of required voltage rating shall be provided in front and rear of switchboards and GIS panels. Further illuminated Single line diagrams depicting power supply arrangement of the sub-station shall be provided in the switchgear room.

6.11 Separation walls between transformers in all substations and safe inter transformer distances for switchyard transformers shall be as per OISD-STD-173. Fire protection for transformers and switchgear room shall be provided to comply with requirements of OISD-STD-116, 117 and 173.

6.12 Equipment like transformers, neutral grounding resistors, reactors and HV capacitor banks shall be located in outdoor bays adjacent to the sub-station building. The requirement of roof for bays shall be as defined in project design data sheet. All bays shall have well drained floor, surfaced with gravel or other suitable material.

6.13 In order to prevent oil, whether from a small leakage or outflow from transformer tank, from reaching and polluting the water bearing stratum, transformers shall have the following provisions, depending on the oil capacity of the transformer -

6.13.1 Oil Capacity upto 2,000 litres:

Transformers installed adjacent to sub-station/buildings or in Switchyards shall be provided with a layer of 100 mm deep stones of about 40 mm granulation, all around the transformer, for a width of 20% of the transformer height subject to minimum width of 800 mm. However complete transformer bay/ fenced area shall be provided with stone gravels.

6.13.2 Oil Capacity exceeding 2,000 litres:

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Transformers installed adjacent to sub-station/building or in Switchyards shall be provided with oil containing pits. Also Nitrogen Injection Fire Protection System (NIFPS) shall be provided for transformers, unless otherwise specified.

The oil containing pit may be shaped as per OISD STD-173. The pit shall extend all around the transformer for a width of 20% of the transformer height, with a minimum width of about 800 mm around the transformer tank/radiator. In case oil capacity exceeds 9,000 litres, in any chamber, provision shall be made for draining away of any oil, which may escape or leak from the tanks, to a waste oil tank.

6.14 NIFPS control panel shall not be kept in the same bay as of transformer, which is being protected by that panel. Piping from transformer to panel shall not block/ obstruct free movement.

6.15 The substation building shall be sized to maintain adequate clearances between equipment for ease of maintenance. The following minimum clearances around various equipment shall be maintained:

Sl. No.	Location	Clearance
a)	Front clearance for HV switchboard including HV GIS	2000 mm
b)	Front clearance for various switch boards/panels	1500 mm
c)	Clearance between front to front of two switchboards facing each other	2000 mm
d)	Rear clearance for panels having maintenance access from front only	Less than 200 mm or more than 750 mm
e)	Rear clearance for panels requiring maintenance from rear	1500 mm (HV swbd) & 1000 mm (MV swbd)
f)	Side clearance between two switch boards or from nearest obstruction	1000 mm after considering space for future panels as per cl. 6.16
g)	All around clearance for transformers	1000 mm
h)	All around clearance for NGR	1000 mm on two sides, 200 mm on other two sides
i)	All around clearance for capacitor bank/ series reactor	1000 mm
j)	Battery rack to wall clearance for - Single row, single/double tier - Double row, single tier - Double row, double tier - Multistep racks	 100 mm 100 mm 750 mm 750 mm
k)	Battery rack to rack clearance	750 mm
l)	Head room clearance below bus ducts or any other overhead equipment	2000 mm
m)	Front clearance for wall mounted equipment	1000 mm
n)	Front clearance for operation work station/ annunciation/ control panel/ HMI	2000 mm

Clear vertical clearance above the top of the highest equipment shall be minimum 1000 mm measured from the bottom of the lowest roof beam. However for the areas with false ceiling, minimum clearance of 750 mm shall be provided between false ceiling and top of any equipment.

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For EHV GIS, minimum all around clearance and vertical clearance shall be as per manufacturer recommendation.

6.16 In all Substations/ MCC rooms, space for future extension of switchboards shall be provided. One panel extension space on each side (for each Bus section) or two panel extension space on one side (in exceptional cases) shall be provided for all GIS, HV Switchboards, PCCs, MCCs, ASBs and LDBs. In addition, space for future extension of the substation/ MCC room building shall be considered, as specified in project design data sheet.

6.17 Necessary arrangement shall be provided in switchgear room for routing of pressure relief duct of switchboard, if provided, after co-ordination with pressurization/ air conditioning ducts/ bus ducts, in case the exhaust gases are required to be released outside substation building as per manufacturer's design. In case gases can be released inside switchgear room as per manufacturer design, absorber shall be provided at the end of pressure relief duct.

6.18 The DG sets shall be preferably located in a separate building other than the substation, in a safe area to reduce noise level in substation. However in case the same is located in the substation building, the DG set foundation shall be structurally delinked from the slab/floor of the rest of the substation building. Exhaust of diesel engine shall be kept away from the process/hydrocarbon handling areas and diesel day tanks shall be located outside the DG room. Suitable ventilation system shall be provided to avoid heat accumulation in the DG room.

6.19 Fire protection for transformers and substation shall be provided to comply to requirements of OISD-STD-173.

6.20 Exhaust fans shall be provided in the cable cellar for ventilation. However, fire integrity of wall between transformer bays and cable cellar/ switchgear hall shall not be compromised.

6.21 Overhead EOT crane of required capacity shall be provided in switchgear hall housing EHV GIS panels. However where EHV GIS isolating breaker panels are only envisaged, monorail arrangement can be considered in-lieu of EOT crane, if specifically agreed upon.

7.0 INSTALLATION DESIGN PHILOSOPHY

7.1 General

The installation work for equipments, cabling system, earthing system and lighting system shall generally conform to EIL standard specifications and installation standards.

7.2 Cabling System

7.2.1 Cabling system for various areas shall be as specified in Project design data sheet.

7.2.2 The cable trenches shall be sized depending upon the number and voltage grade of cables. The cable trenches in hazardous areas and in transformer bays/ substation cellar shall be filled up with sand/ stone dust. Where underground cables cross road ways, pipe sleepers at grade etc. they shall be protected by being drawn through sleeves/ culvert to provide a permanent crossing.

7.2.3 RCC cable trenches shall be sealed against ingress of liquid and gases wherever the trenches leave or enter a control room or substation. Pipes laid for mechanical protection shall be sealed at both ends. In case of direct burial, cable route markers shall be installed at 30 m interval all along the cable routes and where the direction of cable trench changes.

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Additionally, markers shall be provided at cable straight through joint locations. In cable trenches, earthing conductor shall also be installed and shall be regularly bonded to the earthing system.

7.2.4 Above ground cables shall be well supported on cable trays and suitably protected against mechanical damage. Routing shall be decided to avoid interference with hot surfaces or places subject to undue fire risk. Requirement of walkway for cable trays on overhead piperack shall be as specified in project design data sheet.

7.2.5 Cable trays, racks and trenches shall be sized to allow for 10 % space for future cables. Cable installations shall provide minimum cable bending radii as recommended by cable manufacturer. Separate trays shall be provided for EHV cables, HV Cables, MV power cables, MV control cables and plant communication cables to the possible extent. However, where specifically agreed upon in exceptional cases, HV and MV power, control cables may be laid together, with a barrier plate separating HV and MV cables. EHV, HV and MV power cables shall be laid in single layer on cable trays. MV power cables can be laid in maximum two layers in case of space constraint, if specifically agreed upon.

7.2.6 For EHV cables, the radius of cable trays bends and vertical distance between cable trays shall be finalized based on EHV cable sizes & laying requirements.

7.2.7 Separate cables shall be provided for AC and DC signal/control circuits, except for cables to Local control stations/ local control panels/ MOVs. Separate control cables shall be provided for status and command signals to ensure that mixing of two separate voltage sources shall not occur in a multi core cable.

7.2.8 Cables connected in parallel shall run together so that their length remains the same.

7.2.9 Type of cable tray and accessories shall be as specified in project design data sheet. For tray system design, in addition to self load and wind forces, following guidelines for design shall be considered.

a) Maximum Support span : 3000 mm

b) Cable load for

i.	150 mm wide cable tray	:	30 kg/linear meter
ii.	300 mm wide cable tray	:	60 kg/linear meter
iii.	600 mm wide cable tray	:	75 kg/linear meter
iv.	750 mm wide cable tray	:	75 kg/linear meter.

c) In addition to this, 70 kg concentrated load at center span shall be considered. All structural steel design shall be as per Indian Standards.

7.2.10 Bends, tees, reducers, crosses, droppers etc. shall have the required bending radii as required for various cable sizes.

7.2.11 All cables shall carry the cable tag numbers for easy identification.

7.2.12 Signal cables i.e. Instrumentation, communication, fire alarm, LAN and data highway, etc. shall preferably not be laid in the same trench/ tray along with electrical cables. In case these are laid in the same trench/ tray, a clearance of minimum 300 mm from electrical cables shall be provided. The overall cable layouts shall be designed for minimum interference between signal and power cables.

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7.2.13 For single core cables rated 33 kV and above, the armour and metallic screen shall have either single point bonding or cross bonding scheme. Both side bonding scheme shall not be considered due to reduction in cable current carrying capacity. The screen bonding scheme for complete cable route shall be finalized considering link boxes with/ without SVL as per screen/ sheath voltage calculation. Single core cables laid in trefoil formation, shall be braced with non-magnetic clamps suitable to withstand short circuit dynamic forces.

7.2.14 Cable tray covers shall be provided for top most cable trays and for the outermost tray of vertical droppers. Further, bottom cable tray covers shall be provided for cable trays crossing above hydrocarbon pipelines.

7.2.15 All above ground cable tray entries into buildings shall be properly sealed.

7.2.16 Fire proofing paint on cables shall be provided near end terminations of cables upto 1 meter.

7.2.17 Ariel Bunched Cables, wherever used, shall be erected with the minimum clear height of 6.0 m on roads with vehicular traffic and 3.5 m on roads where vehicular traffic is prohibited. These shall not pose any restriction for movement of ODC consignment, cranes and construction work.

7.3 Earthing and Lightning Protection System

7.3.1 All electrical equipment shall be suitably earthed. Earthing system shall, in general cover the following:

- Equipment earthing for personnel safety.
- System neutral earthing.
- Protection against Static and Lightning discharges.
- Separate clean earth system for Instrumentation, DCS, ECS etc. as per vendor specified requirements.

7.3.2 Plant earthing design shall generally be carried out in accordance with the requirements of CEA regulations and IS: 3043. The earthing system shall have an earthing network with required number of earth electrodes connected to it. The following shall be earthed:

- System neutral
- Current and potential transformer secondary neutral.
- Metallic non-current carrying parts of all electrical apparatus such as transformers, switchgears, motors, lighting / power panels, terminal boxes, control stations, lighting fixtures, receptacles, feeder pillars, NGT/ NGR Panels, etc.
- Steel structures, loading platform etc.
- Cable trays and racks, lighting mast and poles.
- Storage tanks, spheres, vessels, columns and all other process equipment.
- Electrical equipment fencing (e.g. switchyard, compact substation etc.)
- Cable shields and armour.
- Flexible earth provision for wagon, truck.
- Driven equipment handling Hydrocarbon if its base Plate is separate from motor base plate.
- Turbo driven equipment handling hydrocarbon.

7.3.3 Unless adequately connected to earth elsewhere, all utility and process pipelines should be bonded to a common conductor by means of earth bars or pipe clamps and connected to the earthing system at a point where the pipelines enter or leave the hazardous area except where conflicting with the requirements of cathodic protection.

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7.3.4 Lightning protection system for buildings shall be provided in accordance with IEC 62305 to protect structures from fire or mechanical destruction. External lightning protection comprising of air termination for intercepting lighting strikes, down conductors to safely conduct lightning current to ground and earth terminations to distribute lightning current in the ground shall be provided.

7.3.5 Lightning protection of storage tanks handling flammable liquids including floating roof tanks shall be done in accordance with OISD-GDN-180 and API-RP-545 complete with bypass conductors, shunts and accessories, etc. Self-conducting structures having metal thickness of more than 4.8 mm may not require air termination and down conductor, but shall be connected to earthing system, in line with OISD-GDN-180.

7.3.6 The resistance values of an earthing system to the general mass of earth should be as below:

- For the electrical system and equipment a value that ensures the operation of the protective device in the electrical circuit but not in excess of 4 Ohms. However, for the generating stations and large sub stations, this value shall not be more than 1 Ohm.
- 10 Ohms in the case of all non-current carrying metallic parts of major electric apparatus or any metallic object.
- For lightning protection, the value of 4 ohms as earth resistance shall be desirable but in no case it shall be more than 10 ohms.
- Earthing of Tanks shall comply to OISD-STD-173, API-RP-545. Earth resistance value for storage tanks shall not exceed 7 Ohms.
- All joints in pipelines, valves, plants, storage tanks and associated facilities and equipment for petroleum shall be made electrically continuous by bonding or otherwise; the resistance value between each joint shall not exceed 1 Ohm.
- Earth resistance of individual electrode to general mass of earth shall not exceed 2 Ohms in line with OISD-STD-137.

7.3.7 Earth rods and conductors shall be designed to cope with the conditions imposed. The earth conductor shall be adequately sized to carry the applicable maximum earth fault current without undue temperature rise. All joints shall be protected against corrosion.

7.3.8 All the electrical equipment operating above 250 volts shall have two separate and distinct connections to earth grid. Transformers, including lighting transformers shall be provided with two dedicated earth electrodes for earthing of neutral and transformer tank earthing.

7.3.9 All earth connections shall be visible for inspection to the extent possible. In all cases, connection to earth should be made in accordance with IS: 3043.

7.3.10 The main earthing network shall be used for earthing of equipment to protect it against static electricity. The lightning protection system shall be bonded with the main earthing network below ground, minimum at two points.

7.3.11 An approach for removing fire or explosion danger is to provide means for adequate dissipation and prevention of accumulation of static electricity, thereby ensuring that static discharges do not occur. One of the methods to eliminate risk of static electricity build up is earthing and bonding.
The subject of static accumulation caused by flow of petroleum products and the mitigation methods are dealt in detail in OISD-STD-110 and same shall be followed.

7.3.12 The earthing system shall comprise of earth conductors, earthing clamps, earth plates, earth electrodes in test pit etc. Normally earthing system shall have main earth grid alongwith suitably located disconnecting plates to provide multiple earth connections between earth grid & equipment and for connections between main earth grid & earth electrodes in test pit.

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All connections shall be adequately secured against loosening.

Connections between earth electrode and the disconnecting plates shall be done by GI strip. Connection between the disconnecting plate and various equipments shall be done by GI strip, GI wire or GI wire rope or cable as specified in project design data sheet.

7.4 Lighting System

7.4.1 Plant lighting system shall comprise:

a) Normal lighting
b) Emergency lighting
c) Critical lighting.

Normal and emergency lighting shall be fed by AC supply (415/240V, three phase four wire except in case of Mines and Oil fields where it shall be in line with Chapter IX of CEA regulations and statutory requirements) while critical lighting shall be fed by DC supply. Additional precautions as per Chapter IX of CEA regulations to be adopted in mines and oil fields shall not apply to apparatus above the ground level except where such apparatus may directly affect the safety of the persons employed in underground mines, open cast mines and oil fields.

7.4.2 All emergency and DC critical lighting fixtures and associated Junction Boxes in Hazardous areas shall be Flameproof type.

7.4.3 Normal lighting system shall provide enough illumination so as to enable plant operators to move safely within the accessible areas of plant to perform routine operation including reading of field instruments, operation of all valves etc. and to carry out all the necessary maintenance and adjustment to equipment.

7.4.4 Areas requiring AC emergency lighting shall include, but not be limited to, the following:

- All Areas requiring DC critical lighting.
- Strategic locations in process, utility areas where specific safety/shutdown operation are to be carried out.

Generally 20-25 % of the total lighting fixtures shall be fed from AC emergency supply.

7.4.5 Areas requiring DC critical lighting shall include, but not be limited to, the following:

- Control rooms
- Substations
- DG shed
- Central fire station
- Fire water pump house
- Compressor houses
- First aid center
- Emergency escape routes
- Non plant buildings as specified in project design data sheet.

DC critical lighting shall be provided in the pipe rack, exit/entry point only in case considered for process units

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Adequate number of self contained portable hand lamps and battery operated emergency lighting units shall be provided for immediate use for buildings where no DC supply is available.

7.4.6 During normal operation, both emergency and normal lighting shall be fed by normal power source. On failure of normal supply, emergency lighting load shall be transferred to emergency power supply source. Critical (DC) lighting shall be normally kept 'ON' and during failure of AC power; battery bank shall feed the critical lighting system.

7.4.7 Complete lighting shall be through LED lamps only, unless specified otherwise. Accordingly, LED lamp fixtures shall be provided for all types of lighting i.e. AC & DC lighting, indoor & outdoor lighting, hazardous area lighting, building lighting, decorative fixtures, street lighting, high mast lighting, etc. The chemical handling facilities shall be provided with chemical resistant fixtures.

7.4.8 Tall structures shall have aviation obstruction marker lighting as per DGCA civil aviation statutory regulations, Type C Medium intensity lighting fixtures, i.e. Red, fixed (not flashing), 2000cd.

7.4.9 Telescopic tubular high masts shall be provided for illumination of tank farm/general area. Generally street lighting poles may be avoided where lighting high masts can provide adequate illumination. The high masts shall be of continuously tapered polygonal cross section and fabricated out of steel plates. The masts shall be provided with motorized racking mechanism for lowering and hoisting lantern carriage.

7.4.10 Lighting system shall consist of lighting transformers, lighting distribution boards (LDBs), lighting and power panels, lighting fixtures, junction boxes etc. as required. All outdoor lighting shall be automatically controlled by means of photoelectric cell/synchronous timers with manual overriding control as specified. Lighting and power panels shall be fed from LDB through 415/415V, Dyn-11, dry type lighting transformer having taps up to +5%/ -7.5% (Refer clause 7.4.1 above for mine and Oil fields installations).

7.4.11 The lighting and power panels shall be provided with MCB & ELCB as incomer and Miniature Circuits Breakers (MCBs) for outgoing feeders control & protection of lighting circuits. ELCB may not be provided at the incomer of lighting and power panels, in case ELCB is provided in the outgoing feeders of LDBs/ASBs feeding to these lighting and power panels. MCBs shall not be loaded beyond 80% of rated capacity. A minimum of 20% of miniature circuit breakers of each panel shall be left as spares. In general, the load on each circuit shall be limited to 1.5 kW and MCB rating shall not be more than 16A. In areas having less lighting load, lighting transformer can be avoided subject to meeting the fault level rating at lighting panels within permissible limits, if specifically agreed upon

7.4.12 **Lighting Lux Levels**

Lighting system design shall be based on minimum illumination levels as specified below:

S NO.	AREA	LUX
a)	Main roads (along process units, power houses, workshops, etc.)	7-10
b)	Secondary roads (along storage tanks, settling basins, etc.)	3-5
c)	Tank farm	10
d)	Pump houses, Sheds	100
e)	Main operation platforms & access stairs	60
f)	Ordinary platforms	20
g)	Process areas, pipe racks, heat exchanger, heater, separators,	60

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	cooling tower, columns, pig launching/ receiving loading area, flare etc.	
h)	Switchgear room, Rack room	150-200
i)	Cable cellar	70
j)	Transformer bay	100
k)	Battery room	150
l)	Control room (Console Area), Laboratory	400
m)	Boiler house	150
n)	Charger/ UPS rooms	150-200
o)	Cooling Tower	60
p)	Switchyard	
	Operating area	100
	Other areas	50
q)	Warehouse	100
r)	Office, Operator Room	300
s)	Compressor operating area	200
t)	Watch room	100
u)	Stairs	50
v)	Corridors/ lifts	70
w)	Tube well, Gate & watchman booth	100
x)	Fire house, Garage	100-150

However, lighting levels in all areas shall take into consideration the requirements from point of view of safety, ease of operation and maintenance.

7.4.13 Lighting design shall conform to relevant Indian and International Codes and Standards, IES Hand Book and shall take into consideration the requirements from point of view of safety and ease in operation and maintenance. Maintenance factor (Light Loss Factor) shall be calculated considering lamp lumen maintenance factor, lamp survival factor and luminaire maintenance factor. Utilization factor (coefficient of utilization) shall be calculated considering reflectance from ceiling, wall and floor in case of indoor lighting and from nearby equipment/ structure in case of plant lighting. Maintenance factor shall not be more than 0.65 for indoor lighting and shall not be more than 0.6 for outdoor lighting. Utilization factor shall not be more than 0.8, however depends on light reflecting property of the material. Further, for dusty areas, maintenance factor as per relevant codes and standards shall be considered.

7.4.14 Wiring for lighting and convenience outlets in outdoor areas shall be carried out with PVC/ XLPE insulated armored FRLS cables run along the column/platforms and structures. Double compression cable glands required for terminating of armoured cables in lighting fixtures and junction boxes in hazardous areas shall meet the requirements of IS/IEC 60079-0. For outdoor/ indoor safe area equipment, double/single compression cable glands shall be used respectively.

7.4.15 Adequate number of ceiling fan points shall be provided in Administration Building, Offices, rooms allocated for operating and maintenance personnel etc.

7.4.16 Two pole isolation devices shall be used for controlling lighting fixtures and sockets in hazardous areas to isolate phase as well as neutral. (For all Mine and Oil field installations refer clause 7.4.1 above).

7.4.17 For buildings with false ceiling, concealed conduit wiring shall be employed below the false ceiling and surface conduit wiring above the false ceiling. Metsec channel shall be used above false ceiling for lighting circuit wiring in Sub-stations and control rooms.

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7.4.18 Adequate number of pull boxes shall be used to aid wire pulling and inspection. No joints shall be allowed inside these pull boxes.

7.4.19 Battery room shall have lighting fixtures mounted on wall in order to facilitate easy replacement of lamps. Switches controlling the lighting fixtures and exhaust fans shall be installed outside the battery room. Lighting fixtures, sockets and exhaust fans in battery room shall be flameproof type suitable for gas group IIC.

7.4.20 Locally mounted lighting fixtures on platforms, walkways, stairs shall be installed in such a way that maintenance can be done without the use of ladders.

7.4.21 Telephone wiring/ sockets and LAN wiring/ sockets (as required) shall be provided in plant and non plant buildings/ rooms which are normally manned during operation and maintenance of the plant.

7.4.22 LED solar lighting system shall be provided for street lighting purpose, if specified in project design data sheet.

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जंजीरबंद चरखी ब्लॉक के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR CHAIN PULLEY BLOCK

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
			Approved by			
6	13/05/22	REVISED AND REISSUED	RP/MS	RRS	NK	SM
5	14/12/16	REVISED AND REISSUED	AK	KCP	PB	RN
4	01/08/12	REVISED AND REISSUED	SPC	PB	AKN	DM
3	01/06/10	REVISED AND REISSUED	SPC	PB	MK/DM	ND

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Abbreviations:

IS	: Indian Standard
QA	: Quality Assurance

Static & Machinery Equipment Department (Packaged Equipment) Standards Committee

Convenor : Mr. Nalin Kumar

Members :
Mr. Shishupal Choudhary (Coordinator)
Mr. RR Shrivastava
Mr. KC Paikar
Mr. A Natarajan
Mr. Plaban Dan
Mr. Deepak Kumar
Mr. M. G. Venkitesh
Mr. Ayush Mathur (Projects)

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1.0 GENERAL

This specification outlines the minimum requirements for design, engineering, manufacture and assembly at shop, painting, inspection, testing and supply the Chain Pulley Block with or without geared trolley.

2.0 CODES AND STANDARDS

2.1 This standard is based on following Indian Standard, and the standards referred therein, which shall be deemed to be part of this standard.

IS - 3832	:	Hand operated Chain Pulley Blocks- Specification.
IS-15560	:	Specification for Point hooks with shank up to 160 Tonne.
IS-28	:	Phosphor Bronze Ingots and Castings
IS-304	:	High Tensile Ingots and Castings
IS-305	:	Aluminium Bronze Ingots and Castings

Latest revision of the above-mentioned standard as on the date of enquiry shall be applicable.

2.2 Other international standards may also be acceptable subject to their being equivalent or superior with prior approval of purchaser.

2.3 For provisions not covered by the above codes & standards, applicable engineering practices & norms shall govern.

3.0 TECHNICAL REQUIREMENTS

Technical requirements of Chain Pulley Block shall be as per Indian standards referred in clause 2.1 above, subject to the following additions, deletions and modifications:

3.1 **Addition / Deletion / Modification to IS 3832: 2005 (Reaffirmed 2020 including amendment)**

i) Clause no. 4.2.1 (Modification): Mechanism class 2 shall be considered for design of chain pulley Block unless otherwise specified in the data sheet.

ii) Clause no. 5.0 (Addition): Chain Pulley Block shall be detachable type suitable for mounting on geared trolleys of the same ratings/capacities, unless otherwise specified in job specification/data sheet.

iii) Clause no. 5.1 (Addition): The frame shall be built from steel plates with bolted/welded construction.

iv) Clause no. 5.2 (Addition): All gears shall be machine cut.

v) Clause no. 5.5 (Modification): Only anti friction bearing shall be used. Bearing shall have L_{10} life of minimum 25000 hrs.

vi) Clause no. 5.6 (Modification): The block shall be provided with adequate facilities for lubrication and same shall be clearly indicated in the maintenance manual.

vii) Clause no. 5.7.1 (Addition): Hook(s) (top -if applicable and bottom) shall be provided with safety latches to prevent accidental unhooking unless otherwise stated.

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viii) Clause no. 5.7.1.2 (Modification): First line to be modified as "Bottom hook shall be provided with thrust bearing to enable it to rotate freely under load so as to prevent twisting of the load chain.

ix) Clause no. 5.10.3 (Modification): The length of hand chain shall be such that the lowest point of the suspended loop shall be 400 mm (maximum) above operating level.

x) Clause no. 5.11 (Addition): The trolley for the chain pulley block shall be geared type, fabricated construction, 4 wheeled, driven by hand chain and shall have provision for mounting the chain pulley block. Trolley shall be designed to suit the suitable monorail beam size and the hoisting capacity.

xi) Clause no. 11.1 (Addition): Following shall also be marked on Chain Pulley block:

a) Tag number.

b) "Non Sparking Type" on chain pulley block suitable for hazardous area classification.

3.2 For offshore applications, load, hand and trolley chains shall be galvanized.

3.3 Special Requirements for Hazardous Area Chain Pulley Block

The materials for non-lubricated rubbing parts shall be of non-sparking type (non-ferrous). The suggested materials for such components are as follows:

	Part/Component	**Material of Construction**
A	**Lifting Mechanism**	
	Ratchet wheel, chain guides	Solid construction in Aluminium Bronze (IS - 305) / High Tensile Brass (IS - 304)
	Hand chain wheel	Solid construction of Aluminium Bronze / High Tensile Brass (IS- 304) / Phosphor Bronze (IS-28)
	Load chain wheel	Solid construction in Aluminium Bronze (IS - 305)/ High Tensile Brass (IS - 304)
	Hook (Top & bottom)	Bronze coated Forged Steel / bronze coated Forged alloy Steel/Forged Stainless Steel.
B	**Trolley Mechanism**	
	Hand chain wheel guides	Solid construction in Aluminium Bronze (IS-305) / High Tensile Brass (IS-304)/ Phosphor Bronze (IS-28)
	Hand chain wheel	Solid construction of Aluminium Bronze (IS-305) / High Tensile Brass (IS-304)/ Phosphor Bronze (IS-28)
	Ungeared and geared wheels	Solid construction in Aluminium Bronze (IS-305) / High Tensile Brass (IS -304) / SS or tyre of Aluminium Bronze (IS-305) / High Tensile Brass (IS-304) / SS shrunk fitted on core wheel of C55Mn75 or superior MOC

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4.0 INSPECTION AND TESTING

4.1 Equipment shall be subjected to stage-wise inspection and testing at vendor's/subvendor's works by purchaser/its authorised inspection agency. Vendor shall submit Quality Assurance (QA) procedures before commencement of fabrication. Approved QA procedures shall form the basis for equipment inspection.

4.2 **Testing at Works**

4.2.1 Vendor shall perform operational Proof Test, as a minimum, necessary to ensure that the material and workmanship conform to the requirement of Clause 9.2 of IS- 3832.

4.2.2 The trolley (if applicable) shall be tested for smooth operation under loaded condition.

4.2.3 Certificate of test and examination shall be issued with all the chain pulley blocks as specified in clause 10.2 of IS – 3832.

4.2.4 Any or all the tests, at purchaser's option, shall be witnessed by purchaser/its authorized inspection agency. However, such inspection shall be regarded as check-up and in no way absolve the vendor of his responsibility.

5.0 PROTECTION AND PAINTING

5.1 Surface preparation and painting shall be done as per vendor's standard painting suitable for corrosive industrial environment, unless otherwise specified in the Job Specification.

5.2 Stainless steel surfaces, both inside and outside, shall be pickled and passivated.

5.3 Machined and bearing surfaces shall be protected with varnish or thick coat of grease.

6.0 PACKAGING AND IDENTIFICATION

6.1 All packaging shall be done in such a manner as to reduce the volume. The equipment shall be properly packed to provide adequate protection during shipment. All assemblies shall be properly match marked for site erection.

6.2 Attachments, spare parts of the equipment and small items shall be packed separately in wooden-cases. Each item shall be appropriately tagged with identification of main equipment, item denomination and reference number of the respective assembly drawing

6.3 Detailed packing list in water-proof envelope shall be inserted in the package together with equipment.

6.4 Each equipment shall have an identification plate giving salient equipment data, make, year of manufacture, equipment number, name of manufacturer etc.

7.0 SPARE PARTS

7.1 Vendor shall submit recommended list of spare parts with recommended quantities and itemised prices for first two years of operation of the equipment. Proper coding and referencing of spare parts shall be done so that later identification with appropriate equipment will be facilitated.

7.2 Recommended spares and their quantities shall take into account related factors of equipment reliability, effect of equipment downtime upon production or safety, cost of parts and availability of vendor's service facilities around the proposed location of equipment.

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STANDARD SPECIFICATION FOR EARTHWORK FOR UNDERGROUND PIPING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	14 03 19	REAFFIRMED AND ISSUED AS STANDARD SPECIFICATION	AVM	AJS	RS	RKT
3	23 05 11	REVISED AND ISSUED AS STD SPEC	ALOK	RKS	RBB	DM

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Abbreviations:

IS	:	India Standard
RCC	:	Reinforced Cement Concrete
U/G	:	Underground

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1.0 SCOPE

This specification deals with earthwork in trenches and pits (for valves, manholes, catch pits etc.) for underground piping.

2.0 CODES & STANDARDS

IS: 783	Code of practice for laying of RCC pipes.
IS: 1200 (Part-I)	Method of measurement of building and civil engineering works.
IS: 3764	Excavation work – code of safety.
NOTE:-	Latest Edition of all Codes and Standards shall be followed.

3.0 MATERIAL

All workmanship and materials shall conform to the provisions of IS: 1200 (Part-1) and IS: 3764.

4.0 EARTHWORK IN EXCAVATION FOR TRENCHES / PITS FOR PIPELINES

4.1 Excavation

Plant, machinery and equipments for excavation shall be selected and deployed to provide optimum mechanization in excavation of trenches and pits. The selection for excavation and earth movement machinery etc. shall take into account type of materials to be excavated, method of excavation, prevailing weather conditions and type of transport to be used.

The excavation of area of cut shall be so timed that the bottom level is not exposed to the deteriorating influence of the weather for longer duration.

Excavation and earth moving equipment shall be deployed such that minimum damage is caused to the natural sub-soil structure of exposed formations.

The monitoring of soil deformations, ground water levels during and possibly after construction work shall be taken into consideration.

In the event, when excavation works are carried out in the vicinity of structures of any importance, the above monitoring shall be carried out within a distance, from the edge of the excavation of 5 to 15 times the excavation depth, depending upon the subsoil conditions and the stability of the neighboring structures.

4.2 Trenching work shall be carried out in all classes of soil including soft rock and excluding hard rock and shall be for all depths.

4.3 The trench shall be cut true to the line and level as per drawings.

4.4 If the trench is excavated below the required level than that indicated in the drawing, the extra depth shall be filled with concrete 1:5:10 or approved equivalent materials, as directed by the Engineer-in-Charge, at no extra cost to the owner.

4.5 In case of pressure piping, the trench shall be excavated generally as to provide a cover of 1000 mm or dia of pipe whichever is more. In case of gravity sewers/ pipes, the trench shall be excavated to conform to invert levels as per drawings. However in certain cases, the pipes may run at shallower levels or at deeper levels depending upon drawing, site condition etc.

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No rebate for lesser excavations, nor extra payment due to deeper excavations, shall be admissible in those cases where pipeline laying rates are inclusive of earthwork items. The rates quoted shall be deemed to cover all works connected with trenching, whether trenches are with single pipeline or have multiple pipelines in common trenches including road cutting and making good the same.

4.6 The width of the trench shall be sufficient to give free working space of personnel, equipment, supports and ancillaries on each side of the pipe. The free working space shall conform to IS: 783. Generally it shall not be less than 150 mm on either side or 1/3 dia of outer diameter of the pipe, whichever is greater.

4.7 When pipelines are running parallel, whether the trenching shall be individual or common, shall be decided by the Engineer-in-Charge and such decision shall be final and binding on the contractor. No extra shall be payable for common excavations.

4.8 All earthwork involved in excavations of all types of manholes, catch pits, valve chambers, inspection chambers, chambers for instrumentation tapping etc., which are coming on the alignment of U/G piping or as defined by drawing as a part of U/G piping work, shall be paid extra under Earth work in excavation, back filling and removal of surplus earth etc. under relevant clauses of the SOR.

4.9 Aspects such as variations in the soil conditions and the geological structure, depth of excavation, the existence of ground water and surface water, the type and extent of excavation, the topography of site, the proximity of items such as roads, buildings and buried services, construction traffic and activities near the excavation eg. Stock piling shall be taken into account when determining whether the sides of excavation should be free standing, sloping or temporary supported.

Suitable drainage and / or dewatering system like Well Point method / Bore well method etc. shall be provided to prevent or limit ingress of surface or sub surface water into excavation.

Serviceable materials intended for reuse should be used as soon as possible after excavation otherwise they should be stock piled at a location beyond 1.5m from the top edge of the excavation or beyond a distance equal to the depth of the excavation whichever is higher at a location approved by the Engineer-in-charge. If excavated serviceable material is not possible to be stacked within the limits specified above, due to some constraint, it shall be stacked away at a location approved by Engineer-in-Charge and paid separately under relevant item.

Areas used for temporary stockpiling of excavated material shall be kept clean and orderly, with excavated material kept by the side of road to avoid traffic movement. Excavated areas shall be restored to their original condition before completion of works.

All types of shoring and strutting, wherever necessary, shall be adopted to with hold the face of earth or cutting in slope, as per site requirements and direction of Engineer-in-Charge. Supports shall be maintained such that the integrity of the sides of the excavation is not impaired.

4.10 Any obstacle encountered during excavation shall be reported immediately to the Engineer-in-Charge and shall be dealt with as instructed.

4.11 The contractor shall maintain all excavated trenches and pits, in a dry and trim condition.

4.12 Necessary barricading and protection of slopes against slips due to traffic movement shall be provided to the satisfaction of Engineer-in-Charge. Necessary warning flags and lights shall be provided to caution traffic in the areas where trenches and/ or pits are provided.

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4.13 In case of road cutting, all road material i.e. metal etc., shall be taken out carefully and kept separately for reuse and road work shall be redone up to the original level, as it was prior to cutting the road, with the excavated road materials after laying and testing of the pipeline, within 10 days from the date of starting this work, at the cost of the contractor. The contractor shall provide suitable warning signs and barricades to prevent accidents.

Contractor shall also provide reasonable bye pass at his own cost when a road is cut for laying pipeline. Tankage dykes cut due to laying of the pipes, shall be redone conforming to the original specifications, by the Contractor at his own cost. Secondary dykes, to take care of any eventuality during construction, shall be provided by the Contractor at his own cost.

4.14 Dewatering shall be done in advance of the installation of the pipe to allow adequate inspection of padding of the bottom, if required. Dewatering shall be continued throughout during installation and backfilling.

The trench shall follow the gradient of pipeline as specified in the drawing. The contractor shall keep the trench in good condition, until the pipe is laid and tested. No extra claim shall be entertained due to its caving or setting down, either before or after the pipe is laid.

In case, pipe is lowered in caved trench and backfilled before being inspected by the Engineer-in-Charge, the Contractor shall re-excavate the trench for inspection and backfill it at his own cost.

5.0 BACKFILLING AND COMPACTION

Backfilling

Trenches shall be back filled with suitable materials which should be compacted to the same degree or better as the surrounding soils.

5.1 The soil used should be selected and approved by Engineer-in-Charge. Suitable material can be extracted from available excavated material. The soil should be free from rubbish, grass, organic matter, stones, building waste and Black Cotton Soil etc. It should be free from clods and hard lumps. In case good soil is not available from excavated material for back filling, trench shall be filled back with locally available coarse sand upto 30 cm. thick above the pipe and rest of trench shall be filled back with excavated soil upto required level.'

5.2 The filling should commence only after approval of Engineer-in-Charge is obtained and after the structures or pipes to be buried are tested and approved. Otherwise, if required, contractor shall uncover buried portion and refill at his own cost.

Temporary excavation supports should be removed as back filling and compaction proceeds, such that unacceptable movement of the supported ground does not occur.

Voids caused by extracted supports should be filled and compacted.

5.3 Filling should be done in layers. Each layer should be not more than 15 cm thick when loose and should be well rammed, with necessary watering, to obtain at least 90% of maximum laboratory dry density.

Compaction trials should be carried out on each soil type to be placed in backfill, in order to confirm the type of machine and number of passes required to obtain optimum compaction for given soil moisture contents. These trials should also be used to determine the variability of the proposed fill material for different weather conditions.

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5.4 Care must be exercised to protect cables, pipes, joints, and other features from damage due to backfilling and consolidation.

5.5 Filling should extend up to the level of original ground surface or as per drawing or as directed by Engineer-in-Charge. The finished surface should be properly trimmed and dressed. The adjoining area should be cleaned and no heaps of surplus earth should be left out.

6.0 TRANSPORTATION OF SURPLUS EARTH

Unserviceable materials and serviceable materials not intended for re-use shall be removed from the work site and disposed off at a location as approved by Engineer-in-charge.

The surplus earth is generated due to pipe laying, valve chambers, and manhole construction etc. Surplus earth is also generated due to voids in the back filled volume of earth. The removal of surplus earth shall include excavation, loading, transportation, dumping, stacking or spreading, as per the directions of Engineer-in-charge.

7.0 PAYMENT

7.1 Unless specifically stated in the schedule of rates, no separate payment for earthwork in excavation, backfilling, transportation, dewatering etc. shall be admissible and the payment for the same is deemed to have been included in the relevant items of the contract.

7.2 In case payment for earthwork is specified separately in the Schedule of Rates, the payment shall be based on the actual quantity of excavation, backfilling and transportation done, taking into consideration the slopes authorised by the Engineer-in-Charge for excavation, volume of backfilling calculated on the basis of excavation reduced by the volume of pipes.

7.3 In cases where hard rock excavation is involved, the matter shall be referred to Engineer-in-Charge, before proceeding with the work.

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STANDARD SPECIFICATION FOR CONCRETE PAVEMENT

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
4	04 07 19	REVISED AND ISSUED AS STD SPEC	SD	GS/AK	RS	RKT
3	23 05 11	REVISED AND ISSUED AS STD SPEC	ALOK	RKS	RBB	DM
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0	31 3 82	ISSUED AS STANDARD SPECIFICATION	RP	RPB	HVR	RCPC

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Abbreviations:

BS	:	British Standard
IRC	:	Indian Road Congress
IS	:	Indian Standard
MS	:	Mild Steel
PCC	:	Plain Cement Concrete
RCC	:	Reinforced Cement Concrete
DLC	:	Dry Lean Concrete

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1.0 SCOPE

This specification establishes the requirements of material, laying and finishing of concrete pavements and roads.

2.0 REFERENCE CODES AND SPECIFICATIONS

IS: 456	Plain and Reinforced Concrete-Code of Practice.
IS: 1834	Specification for Hot Applied Sealing Compounds for Joints in Concrete.
IS: 1838, Part-1	Specification for Preformed Fillers for Expansion Joints in Pavements and Structures (Non Extruding and Resilient Type): Part 1 Bitumen Impregnated Fibre.
IS: 2720, Part-8	Method of Test for Soils-Part 8: Determination of Water Content-Dry Density Relation Using Heavy Compaction.
IS: 9214	Method of Determination of Modulus of Sub-grade Reaction (k value) of Soils in the Field.
IRC: 57	Recommended practice for sealing of joints in concrete pavement
IRC-15	Standard Specifications and code of Practice for construction of concrete roads
MoRTH	Specification for Road and Bridge Works of Ministry of Road Transport and Highways
6-68-0002	Technical Specification - Civil & Structural Works - Materials.
6-68-0004	Technical Specification - Civil & Structural Works – Plain and Reinforced Cement Concrete.
7-65-0404	RCC Pavement Details
	MoRTH Specification for Road and Bridge

In case of conflict between the Clauses mentioned in this Specification and those in above Codes and Specifications, this Specification shall govern.

3.0 MATERIALS

3.1 Material for Cement Concrete viz. Cement, Sand, Coarse and Fine aggregate and water, Reinforcements Bars, Embedment, Inserts and Admixture etc. shall be as described in EIL Specification no. 6-68-0002.

3.2 Material for DLC shall be as described Specification for Road and Bridge Works of Ministry of Road Transport and Highways (MoRTH).

4.0 GRADES, TYPE OF CONCRETE MIX, PROPORTIONING AND BATCHING

4.1 The grades of concrete shall be as per standard / Job drawing.

4.2 Specification for Concrete mix, Mix Proportioning and Batching shall be as described in EIL Specification no. 6-68-0004 and IS: 456.

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5.0 EQUIPMENTS

All equipments like sub grade templates, hand tempers, vibrating screens, internal vibrators, longitudinal floats, bridges, push brooms, straight edges, edging tools etc. shall be on the worksite in first class working condition and shall have been inspected by the Engineer-in-Charge before paving operations are permitted to start. Throughout the construction period, the contractor shall maintain adequate equipment in first class working conditions to ensure the proper execution of the work.

6.0 PREPARATION OF SUB GRADE

6.1 The area where concrete is to be placed must be cleared of all loose material and virgin soil must be exposed. Such exposed surface must be consolidated properly to obtain 95% of Maximum Laboratory Dry Density of the soil. All soft patches must be worked out to remove the soft soil and selected approved earth must be filled back and compacted.

6.2 For areas, where pavement is to be laid on cutting / natural grade level, Sub grade shall be thoroughly compacted to 95% of laboratory dry density as per IS: 2720 Part VIII. For filled up areas, top 450 mm of the soil shall be compacted to 95% of laboratory dry density below pavement in layers of 150 mm.

6.3 The difference between the sub grade levels of Type-I, Type-II, Type-III and any other type (as per job drawing) Concrete pavements (due to difference in thickness of Type-I, Type-II, Type-III and any other type pavements) shall be achieved by stripping the grade level and not by filling. Hence, site-grading level below pavement shall be kept up to sub grade level of Type-II or Type-III as the case may be, to avoid filling of smaller thickness at later stage.

6.4 The sub grade or sub base for laying of the concrete pavement shall comply with the following requirements:

6.4.1 No soft spots shall be present in the sub grade.

6.4.2 The uniformly compacted sub grade or base course shall extend at least 300mm on either side of the area to be concreted.

6.4.3 The sub grade shall be properly drained.

6.4.4 The minimum modules of sub grade in wet condition, reaction obtained with a Plate Bearing Test as per IS: 9214, shall be 6.0 Kg/cm²/cm.

6.4.5 Sub grade shall be prepared to the lines and grades to match with the slope of pavement as shown on the drawings.

7.0 PREPARATION OF SUB BASE

7.1 The construction of the Dry Lean concrete sub base for cement concrete pavement shall conform to the requirements of section 601.0 of specification for Road and Bridge Works of Ministry of Road Transport and Highways (MoRTH) and EIL standard Drg. No. 7-65-0404/ Job drawing.

7.2 Sub Base layer shall be prepared to the lines and grades to match with the slope of pavement as shown on the drawings.

7.3 No concrete shall be placed around manholes or other structures until they have been brought to required grade and alignment. All sides of manholes / pits etc. shall have same elevation.

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7.4 A separation membrane shall be used between the concrete slab and the sub base (DLC) which shall conform to EIL standard Drg. No. 7-65-0404/ Job drawing. The separation membrane shall be laid flat without creases. Before placing the separation membrane, the sub-base shall be swept clean of all the extraneous materials using air compressor. Wherever overlap of plastic sheets is necessary, the same shall be at least 300 mm and any damaged sheeting shall be replaced at the Contractor's expense. The separation membrane may be nailed to the lower layer with concrete nails.

8.0 FORMS

8.1 All side Forms shall be of mild steel unless use of wooden sections is specially permitted. The steel forms shall be of MS channel sections and their depth shall be equal to thickness of the pavement. The sections shall have a length of at least 3.0m except on curves, where shorter sections may be used. These forms should be provided with ample bracing and supports to prevent the springing of the forms under the concrete pressure or thrust of machinery operating nearby.

8.2 The forms should be in a sufficient number and they should not be removed until concrete has hardened sufficiently.

8.3 In case wooden forms are permitted, these shall have minimum base width of 100 mm for 150mm or lesser thick slabs and 150mm for 200mm thick slabs.

9.0 REINFORCEMENT, MIXING & PLACING OF CONCRETE

9.1 Laying of Reinforcement

All reinforcement work shall confirm to IS: 456 and as described in EIL Specification no. 6-68-0004.

9.2 Mixing

Mixing shall be as described in EIL Specification no. 6-68-0004.

9.3 Placing

9.3.1 The place where concrete is to be poured should be clean and free from all loose dirt, wooden pieces, dust, standing water etc.

9.3.2 Walking on reinforcement layers is not permissible. Walkways of wooden planks or similar material can be placed with removable supports and should be independent of the reinforcement. The reinforcement position should not be disturbed nor should it sag during carriage and placement of concrete.

9.3.3 Placing and vibration should not take totally more than 20 minutes from time of mixing. Method of placing should be got approved by Engineer-in-Charge. Segregation during carriage and placement should be avoided. If during carriage concrete segregates, it should be remixed before placement.

9.3.4 Concrete should not be dropped from a height of over 1.5m.

9.3.5 To ensure bond and water tightness between old concrete surface and fresh concrete to be placed, the surface should be cleaned and roughened by "initial green cut" by wire brushing or chipping. The initial green may be done by wire brush after 6 hours of placing concrete in order to facilitate the work. Chipping can be done only after 48 hours. A layer of cement

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slurry with 1:1 mix (1 cement: 1 sand) should be poured to obtain a uniform coating on old concrete. Immediately thereafter, the fresh concrete should be poured.

9.3.6 Concrete shall be mixed in quantities required for immediate use and shall be deposited on the sub-grade in a single operation to the required depth and width of the pavement. Spreading shall be as uniform as possible to avoid re-handling of concrete. Where however, a certain amount of redistribution is necessary, it shall be done with shovels and not with rakes. Concrete shall be vibrated with internal vibrators. Concrete shall be placed continuously until completion of the part of the work between construction joints or as directed by Engineer-in-Charge continuously until completion of the part of the work between construction joints or as directed by Engineer-in-Charge.

9.3.7 **Placing in inclement weather**

All precautions shall be taken for concreting in extreme weather in accordance with the relevant clauses of IS: 456. Due protection shall be provided to prevent cement being blown away while proportioning and mixing during windy weather. No concreting shall be carried out in continuous heavy rains. Necessary arrangements to cover the freshly poured concrete shall be provided, to protect it from the direct rays of the sun and from drying winds.

9.3.8 All concreting placement should be co-coordinated with placement of conduits, inserts, embedded parts etc. executed either by same agency or separately.

9.3.9 Concrete shall be laid in panels as shown in the standard drawing or as directed by Engineer-in-Charge.

9.4 Compaction & Finishing

9.4.1 **Compaction**

The surface of the pavement shall be compacted either by means of power driven finish machine or a vibrating hand screed. For areas where width of the pavement is very small, hand consolidation and finishing shall be done as follows:

9.4.1.1 Concrete as soon as placed, shall be struck off uniformly and screeted to the crown and cross-section shown on the plans and to such level above the base that when compacted and finished, the pavement shall conform to the grade and cross-section indicated by the plans. The entire surface shall then be tamped until a close-knit dense surface is obtained.

9.4.1.2 The Tamper shall rest on the side forms and shall be drawn ahead with a swing motion in combination with a series of lifts and drops alternating with lateral shifts. The aim of this operation is compaction and screeding to the approximate level required. Subsequent tamping should advance 75 mm at a time in the direction in which the work is proceeding and in final stages, the tamping should be closer, about 12 mm at a time, until a level and dense surface is obtained.

9.4.1.3 If so directed by Engineer-in-charge, hand operated vibrating tamper consisting of normal type of hand tamper attached to a pneumatic or electric vibrating unit shall be used for compaction.

9.4.1.4 Segregated particles of coarse aggregate, which collect in front of the tamper, shall be thrown outside the forms or thoroughly mixed by hand with a mass of concrete already on the base.

9.4.1.5 Compaction by tamping shall be carried on till the mortar in the mix just works up to the surface. The surface shall be examined after compaction correction. If needed correction shall be made by adding or removing concrete, followed by further compaction and finishing.

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9.4.2 **Floating**

As soon as practicable, after concrete has been struck off and compacted, it shall be further smoothened and compacted by means of a longitudinal float, 1200 mm long and 75 mm wide, operated from a foot bridge.

9.4.3 **Straight Edging**

After floating is completed and excess water removed but while concrete is still plastic, the slab surface shall be tested for trueness with a straight edge and rectified, if necessary.

9.4.4 **Brooming**

After belting and as soon as surplus water has risen to the surface, the pavement shall be given a broom finish to produce corrugations of uniform appearance of not more than 1/16 inch in depth.

9.4.5 **Edging**

Before the concrete has its initial set, the edges shall be carefully finished with an edger of the radius required and pavement edge shall be left smooth and true to line.

9.5 Curing

Curing of concrete shall be as described in EIL Specification no. 6-68-0004.

10.0 JOINTS

10.1 Wherever called for on the drawings, expansion joints, construction joints and sealing joints shall be provided as per details indicated in the drawing and as directed by Engineer-in-Charge.

10.2 Sealing of Joints

10.2.1 After the curing, the temporary seal or other intruded materials of all expansion and contraction joints shall be removed completely and the slots filled with approved silicone sealant. It shall be self leveling low modulus type confirming to ASTM 5893. The sealant shall conform to IRC 57. The filler material for Expansion and Sealing joints shall be preformed fillers of Bitumen Impregnated Fiber, conforming to IS: 1838, Part-I.

10.2.2 The edges of the joints shall be thoroughly cleaned and a suitable primer as recommended by sealant manufacturer shall be applied in accordance with IRC:57.

10.2.3 The application of the sealing compound shall conform to the process as specified in IRC 57.

11.0 OPENING TO TRAFFIC

11.1 Traffic shall not be allowed for a period of 28 days after laying of concrete in pavement.

11.2 Before opening the pavement to traffic, all joints shall be filled and trimmed or topped out as required.

11.3 Sampling, testing and acceptance of concrete work for pavement / road shall be according to IS: 456 / IRC -15 as applicable.

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12.0 METHOD AND BASIS FOR PAYMENT

12.1 Plain and Reinforced Concrete

12.1.1 Payment for plane and reinforced concrete in pavements shall be made on cubic metre basis of the volume of the actual finished work done and shall be inclusive of cost of providing Forms, Pockets, Chamfers, Fillets, Grooves, Cement wash, Curing by normal moist curing or using curing compound etc. as directed by Engineer-in-Charge. The rates shall be deemed to include complete cost of getting the respective mix designs approved, making and testing concrete cubes and carrying out other tests including tests of various ingredients, as per specifications and as directed by Engineer-in-Charge.

12.1.2 No separate payment shall be made for any admixture used by the contractor for accelerating or retarding the strength of concrete or for achieving specified workability / water tightness. The rate quoted shall be deemed to be inclusive of all costs related to any such additive / admixture.

12.1.3 The rate shall however be exclusive of reinforcement, metal inserts, pipe sleeves and any filler material in expansion / sealing joints.

12.1.4 Where the strength of concrete mix (nominal or design mix) as indicated by tests, lies in between the strengths of two grades given in Table-1 of EIL Specification No. 6-68-0004 and it is accepted by owner/Engineer-in-charge, such concrete shall be classified as a grade belonging to the lower of the two grades between which it lies. In case the cube strength shows higher results than those specified for the particular grade of the concrete, it shall not be placed in the higher grade nor shall the Contractor be entitled for any extra payment on such account. The concrete giving lower strength than specified may be accepted at reduced rates after satisfying the safety of the structure by checking it with tests as specified or rejected entirely at the discretion of the Engineer-in Charge. The rejected concrete shall be dismantled at no extra cost to the owner and no payment or extension of time shall be granted for the concrete so rejected and the formwork and reinforcement used for the same. Cost of any material supplied by the Owner free of cost shall be recovered from the contractor at double the prevailing market rate. In case the concrete of lower strength can be improved by carrying out some strengthening measures entirely at the discretion of the Engineer-in-Charge, then Contractor shall carry out the said measures including all related tests at his own cost. If the Contractor is able to make up the strength to the required grade by such improvement measures to the entire satisfaction of Engineer-in-Charge, payment shall be made for the grade achieved. However, if the strength of concrete is not made up to the strength of required grade, payment shall be made only for the lower strength if such concrete is accepted by the Engineer-in-Charge.

12.1.5 Deductions for openings, pockets etc. shall be as specified in relevant Indian Standard Codes.

12.2 Reinforcement

12.2.1 Payment for plain round mild steel reinforcement bars and high strength deformed steel bars shall be on the basis of weight of bare steel, irrespective of any coating applied, in metric tons. The weight of the bar shall be derived from the sizes and corresponding unit weights given in hand book of Bureau of Indian Standards. Standard hook length, chairs, spacer bars and authorised laps only shall be included in the weight calculated. Binding wire shall not be weighed nor otherwise measured. Measurement for weight shall not include cutting allowance etc.

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12.2.2 Rate quoted for reinforcement shall include cost of supplying, decoiling, straightening, cleaning, cutting, bending, placing, binding, welding if required, and providing necessary cover blocks of concrete.

12.3 Joints

Payment for expansion joints, construction joints and sealing joints shall be made on running metre basis. The rate shall include cleaning of joints, filler material and sealing with approved compound, all material, labour etc. complete, as per drawing.

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भूमिगत और भूमि ऊपर गैल्वेनाइज्ड स्टील पाइपिंग प्रणाली से जल सप्लाई के लिए मानक विनिर्देशन (जल सेवाएं)

STANDARD SPECIFICATION FOR UNDERGROUND & ABOVE GROUND GALVANIZED STEEL PIPING (WATER SERVICES)

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	27.10.2025	REVISED & ISSUED AS STD. SPEC.	PREETI	RKS	SKN	M.Nandi
5	06.07.18	REAFFIRMED & ISSUED AS STD. SPEC.	LP	VG	RAJANJI SRIVASTAVA	R K TRIVEDI

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Abbreviations:

IS	Indian Standard
Kg/cm^2g	Kilogram per Square Centimeter Guage
MPa	Mega Pascal

General Civil Standards Committee:

Convenor: Mr. Samir Kumar Naskar

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Mr. Dinesh Deb Barma
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Mr. Raj Kumar Singh
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Mr. Vikram Kumar Gupta (Structural)

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1.0 SCOPE

This specification covers the fabrication and erection of Galvanized Steel piping, both underground and above ground, including excavation, backfilling for the piping and testing.

2.0 CODES AND STANDARDS

IS: 554	Indian Standard- Dimensions for pipe threads where pressure tight joints are made on the threads- Dimensions, Tolerances and Designation
IS: 778	Indian Standard- Copper alloy gate, globe and check valves for water works purposes
IS: 1239 Part I	Indian Standard- Steel Tubes, Tubulars and other wrought steel fittings- Specification (Part 1 Steel Tubes)
IS: 1239 Part II	Indian Standard- Steel Tubes, Tubulars and other Steel fittings- Specification (Part 2 Steel pipe fittings)
-	Piping Material Specification (PMS)
-	Valve Material Specification (VMS)

NOTE: -Latest Edition of all Codes, Specifications and Standards shall be followed.

3.0 MATERIALS

a) All Galvanised piping shall conform to relevant piping material specification class.
b) All valves shall conform to relevant piping/ valve material specification class.
c) All fittings shall conform to relevant piping material specification class.

4.0 EARTHWORK IN EXCAVATION AND BACKFILLING ETC.

All earthwork for underground piping shall be governed by the provisions of EIL specification 6-65-0006,"Earthwork for underground piping", to the extent applicable.

5.0 JOINTING AND ERECTION OF SCREWED/ FLANGED GALVANIZED STEEL PIPING

5.1 Screw socket Joints

The screwed end of all pipes shall be thoroughly cleaned and painted with a mixture of Red and White Lead or Teflon before jointing. The joint shall be made by winding a few threads of hemp round the ends of tubes and then screwing them into sockets to the full depth of threads. Exposed threads shall be coated with approved anticorrosive paint. No pipe shall be bent / offset to save fittings. The offset in pipes shall be made only after the permission of the Engineer-in-Charge. If threaded end of pipe is damaged, the contractor shall cut the end with hacksaw and shall prepare new threads conforming to IS: 554, to required length.

All fittings shall be of Galvanised Steel. Fitting includes all couplings, elbows, tees, bends, unions, nipples, reducers, flanges with nuts, bolts, gaskets and rubber insertion and all other fittings to make a complete job.

5.2 Flanged Joints

Flanged joints shall be made by painting the faces of the flanges with red lead and bolting up evenly on all sides with compressed asbestos gasket as per piping material specification.

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5.3 Valves

Flanged or screwed valves shall be installed in locations shown on the drawings as per specification for screwed or flanged joints.

6.0 JOINTING AND ERECTION OF WELDED GALVANIZED STEEL PIPING

Welded joints shall be made as per relevant piping specification(s).

7.0 FLUSHING & TESTING

Flushing and testing shall be as per specification no. 6-44-0013 (/job specification). Pipes or fittings which are found leaking shall be replaced/ redone, without extra payment.

8.0 PAYMENT

8.1 Payment shall be made on running meter basis of finished piping with fittings after testing etc. complete. No separate payment shall be made for earthwork in trenching and backfill, road cutting etc. Payment for valves and flanges etc. shall be made as per schedule of items on unit rate basis. The unions shall be provided at every 50 meter, unless otherwise stated in schedule of items / construction drawings. Rates shall include all incidental work such as transportation of all materials from Owner's store(s), custody, and fabrication and laying of underground piping.

8.2 The payment clause 8.1 is not applicable in case of LSTK Jobs.

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भूमिगत पाइपिंग के फैब्रिकेशन और उत्थापन के लिए मानक विनिर्देशन

STANDARD SPECIFICATION FOR FABRICATION AND LAYING OF UNDERGROUND PIPING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	25.11.24	REVISED & ISSUED AS STD. SPEC.	GS	GYAS	S K NASKAR	M NANDI
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Abbreviations:

ASME	AMERICAN SOCIETY FOR MECHANICAL ENGINEERS
dia.	DIAMETER
IS	INDIAN STANDARD
Kg/cm^2/minute	KILOGRAME/SQUARE CENTIMETRE/MINUTE
m	METRE
mm	MILLIMETRE
CS	CARBON STEEL

General Civil Standards Committee

Convener: Mr. Samir Kumar Naskar

Members:
Mr. Amitabh Kishore
Mr. Dinesh Deb Barma
Mr. Gyasuddin
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1.0 SCOPE

This specification covers the technical requirements for the execution of Piping Fabrication, Assembly, Laying and testing of the underground pipe work defined here under, for water and waste pipe lines.

i. Fabrication and erection of underground piping systems from piping materials in accordance with this specification and applicable drawings and standards.

ii. Fabrication and welding of reinforcement pads at branch pipe locations wherever required.

iii. Corrosion protection coating of underground piping.

iv. Repair of damaged corrosion protection coating and coating of field joints.

v. Fabrication and erection of drain assemblies, valves, strainers, instrument connection, flushing connection etc.

vi. Testing and flushing.

Underground piping systems shall be fabricated, installed, flushed, and tested in accordance with this specification and applicable codes, drawings and standards.

2.0 CODES & STANDARDS

ASME B31.3	Chemical Plant and Petroleum Refinery Piping.
6-65-0006	Standard specification for earth work for U/G piping.
6-44-0012	Standard specification for fabrication and erection of piping.
6-44-0013	Standard specification for inspection, flushing and testing of piping systems.
6-44-0016	Standard specification for Nondestructive examination requirement of piping
6-77-0001	Welding specification for the fabrication of piping
6-77-0005	Welding specification charts for piping classes
6-79-0011	Standard specification for corrosion protection tape coating for underground steel piping
6-79-0020	Standard specification for surface preparation and protective coating
6-71-0044	Standard specification for field joint coating (onshore pipeline)
6-71-0048	Standard specification for repair of polyethylene coating
----------	Job specification for 3LPE pre-coated pipes

NOTE 1: Latest Edition of all Codes and Standards shall be followed.
NOTE 2: In case job specification is available, same shall be followed.

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3.0 FABRICATION

3.1 The contractor shall fabricate all the pipe work in conformity with the Job/ Standard Specification for fabrication & Erection of Piping, and requirements of relevant general arrangement drawings/ isometrics. Where specific details of fabrication are not indicated on the drawings or not specified in the specification, fabrication and erection shall be done in accordance with ASME B 31.3.

3.2 The contractor shall be responsible for working to the exact dimensions as shown on the drawings, irrespective of individual tolerances permissible. Where errors and / or omissions occur on the drawings, it shall be the contractor's responsibility to notify the Engineer-in-Charge, prior to fabrication or erection. Dimensional tolerance for fabrication shall be as per EIL standard.

4.0 COATING & LAYING OF UNDERGROUND PIPING

4.1 Coating (for uncoated pipe)/ repair of coating (for pre-coated pipes & fittings)

Corrosion protection tape coating/ Painting of the underground lines shall be in accordance with Job/ Standard specification.

Repair of 3LPE coating of pre-coated pipes if required shall be as per Job/ Standard specification.

4.2 Laying

4.2.1 The Contractor shall lay the underground piping in accordance with the following clauses and as per the piping arrangement drawings and/ or isometrics issued during the course of construction.

4.2.2 The Contractor shall be responsible for alignment as per the drawing. Errors, if any, shall be rectified by the Contractor at his own cost.

4.3 Trenching

4.2.1 The trench shall be cut according to the drawing, true to the line, levelled with the help of sight rails provided at every 30 m, at change of direction / gradient and at any suitable distance, as directed by Engineer-in-Charge. The bottom elevation of pipe shall be maintained as shown in drawing

4.2.2 The width of the trench shall be sufficient to give free working space on each side of the pipe. The free working space shall conform to specifications. Generally, it shall not be less than 150 mm on either side or 1/3 of dia of pipe, whichever is greater.

4.2.3 If the trench is excavated below the required level as indicated in the drawing, the extra depth shall be filled with PCC 1:5:10 or approved equivalent material, as directed by the Engineer-in-Charge, at no extra cost to owner.

4.2.4 No excavated material shall be deposited within 1.5 meters from the excavated trench.

4.2.5 In case of road cutting, all materials i.e. metal, bricks etc., shall be taken out carefully and kept separately for reuse. Road work shall be redone up to the original level and profile with the excavated road materials /fresh material if required, after laying and testing of the pipe line, within 10 days from the date of starting the work, at the cost of the contractor. The contractor shall provide suitable slings and barricades to prevent accidents. He shall also provide reasonable by-pass at his own cost when a road is cut for laying pipeline.

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4.2.6 During excavation, if some obstacle is met with, the same shall be reported to the Engineer-in-Charge and dealt with as instructed by him.

4.2.7 The contractor shall do dewatering, shoring, strutting / timbering if required or do whatever might be required to excavate the trench, install the pipe in it and backfill the trench, in accordance with the specifications, at no extra cost to the Owner. Dewatering shall be done in advance of the laying of the pipe, to allow adequate inspection of padding of the bottom, if required. Dewatering shall be continued throughout during laying of the pipe and backfilling of the trench.

4.2.8 In muddy / slushy ground, the bed shall be provided with a layer of sand or lean concrete as directed by the Engineer-in-Charge.

4.2.9 The trench shall follow the gradient of pipeline as specified in the drawing. The contractor shall keep the trench in good condition, until the pipe is laid and tested. No extra claim shall be entertained due to its caving or settling down, either before or after the pipe is laid. All materials to shore the trench, in order to prevent caving, shall be furnished and removed by the Contractor, at no extra cost to the Owner.

4.2.10 In case pipe is lowered in caved trench and back filled before inspection by the Engineer-in-Charge, the Contractor shall re-excavate the trench for inspection and backfill it at his own cost.

4.3 Lowering & Laying

4.3.1 The pipe shall be lowered by mechanical method when the trench is ready and bottom of the trench is graded as per required pipe laying conditions and specifications.

4.3.2 By Machine

The shop coated pipe already transported to the pipe laying site in convenient length of pipe assembly, near the trench after hydrostatic testing, shall be placed on clean square cut skids suitably spaced, so as to keep the pipe away from touching the ground. The pipe may be lowered down in the trench by the launcher cranes with sufficient care, to protect the coating of the pipeline.

At tie in welds and other site fabrications, the contractor shall clean, prime, coat and wrap manually.

Also, short sections of pipelines, which are impracticable to shop-treat, may be hand treated, but only after obtaining prior written approval of the Engineer-in-Charge.

4.3.3 By Hand

Only in unavoidable circumstances and after obtaining approval of Engineer-in-Charge, the pipe may be lowered with the help of tripods and chain pulley blocks into the trench. However, if in the opinion of the Engineer-in-Charge, the temperature condition does not allow direct lowering, then the pipes shall be set down on clean square cut skids. The skids shall be so spaced as to keep the pipe away from touching the ground.

4.4 Method & Time of Lowering Pipe

4.4.1 Under favorable temperature conditions and using methods, which will not damage the coating, the pipe may be lowered into the trench.

4.4.2 Pipes previously set on skids, because of unfavorable temperature conditions, shall be lowered into the trench normally in the cool of the morning and only when the temperature of the pipes is below the softening point of the coating materials.

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4.4.3 All skid marks and other places of damage shall be thoroughly examined to ensure proper patching where necessary, before the pipe is finally lowered into the trench.

4.5 Handling Coated Pipe

4.5.1 Coated pipe shall not be placed in trench, until cave-in plugs, hard clods, stones, skids and welding rods etc. have been removed from there. Where the trench has a hard or jagged bottom, sufficient fine dirt or sand shall be placed therein, before the pipe is lowered.

4.5.2 Coated pipe shall not be handled or moved by means of cable or chains or by prying with skids or bars. It shall be tied and lowered by using lowering-in belts of a standard width and design, for the size of pipe being handled.

4.5.3 Coated pipe shall not be dragged along the ground or otherwise handled in a manner that will be detrimental to the coating.

4.5.4 Despite all precautions taken during handling of coated pipes, if the coating gets damaged, same shall be recoated by Contractor at site, at his own cost, as per directions of Engineer-in-Charge.

4.6 Lining up & Welding

4.6.1 The ends of the pipeline shall be kept securely closed, to prevent entry of any foreign material/ moisture, after lowering into the trench.

4.6.2 Before making joints, the pipe shall be laid carefully, so as to be perfectly aligned, in both plan and profile and the end closures provided shall be removed.

4.6.3 Tie-in shall be made in the coolness of the morning or when the ambient temperature is not exceeding 29^0C or softening temperature of the coating material, whichever is less. All bevelling, aligning and welding shall be in accordance with the welding specification given in the tender.

4.6.4 Free access shall be provided for the welding of the circumferential joints by increasing the width and depth of the trench at these points. There should be no obstruction to the welder from any side, so that good welded joint is obtained.

4.7 Coating of field welded joints

Field welded joints shall be coated as per Job/ Standard specification. Field joints of externally 3LPE pre-coated pipes shall be coated as per Job/ Standard specification.

4.8 Back Filling

4.8.1 After testing and inspection of the pipeline to the entire satisfaction of the Engineer-in-Charge, the trench shall be back filled with the serviceable soil excavated earlier. No trench shall be back filled without the approval of the Engineer-in-Charge.

4.8.2 Backfilling with the serviceable soil excavated earlier shall be done in layers of 200 mm, well watered and rammed to avoid any settling afterwards.

4.8.3 The earth cover up to 300 mm above the top of the pipe shall be compacted by manual methods, to protect the pipe from any damage by mechanical compactor.

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4.8.4 If due to exigencies of the work, some portion of the pipeline is backfilled without approval of the Engineer-in-Charge, the Engineer-in-Charge shall have the right to order uncovering of the pipe for examination and the cost of such uncovering shall be borne by the Contractor.

4.8.5 The backfill material shall be free from stone pieces/sharp objects/debris.

4.8.6 When the trench has been dug through roads, all backfill shall be thoroughly compacted. In certain cases, special compaction methods may be required by the Engineer-in-Charge. This shall be done by the contractor at no extra cost to the Owner.

4.8.7 When the trench has been dug across unlined ditches, the backfill shall be thoroughly compacted in 150 mm layers for a distance of 1.5m beyond the outside banks of the ditch on either side. The banks of the ditch shall also be compacted in 150mm layers, at no extra cost to the Owner.

4.8.8 After the roads have been already graded, and if they are trenched or otherwise disturbed by the Contractor during laying of the pipe lines, the contractor shall restore the road to its original level and condition. In the event the Contractor is required to place extra fill, gravel, or other special materials, it shall be done by the contractor without any extra cost to the Owner.

4.8 Clean up of Surroundings

4.9.1 As soon as the backfill is completed, the contractor shall immediately clean up the adjoining area by removing all surplus and defective material and dispose off all refuge such as spurs, sheet-iron and broken skids and surplus excavated earth etc., at his own cost, to the entire satisfaction of the Engineer-in-Charge.

4.9.2 The earth on both sides of the pipeline trench, which has been disturbed during the construction of the pipe line, shall be smoothened and left in a condition to the entire satisfaction of Engineer-in-Charge.

5.0 INSPECTION & FLUSHING

Inspection and flushing of the piping shall be done as per Job/ Standard specification (Specification for inspection, flushing and testing of piping system).
Non-Destructive examination of shop/ field fabricated piping shall be as per Job/ Standard specification (Specification for non-destructive examination requirement of piping).

6.0 TESTING

6.1 Pressure Piping

Pressure testing of pressure piping shall be done as per Job/ Standard specification (Specification for inspection flushing and testing of piping system). Test pressure shall be as per line list/ AFC document.

6.2 Gravity/ Non-pressure Piping

6.2.1 Fabrication yard/ facility

All piping sections fabricated at yard, shall be tested in conformance to Job/ Standard specification (Specification for non-destructive examination requirements of piping). In addition to the above, each fabricated section shall be leak tested at atmospheric pressure for water tightness of the fabricated section. Any repair of coating (internal/ external) at joint location shall be carried out only on

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completion of inspection of leak test and subsequent repair of joint, if any. Care shall be taken during transportation of tested pipes for integrity of tested joints.

6.2.2 In-situ fabrication and erection

All piping including sub headers and headers fabricated/ joined and laid in-situ, shall be tested in conformance to Job/ Standard specification (Specification for non-destructive examination requirements of piping). In addition to the above, each fabricated section: piping upstream of a manhole/ between any two manholes/ sump inlet and upstream manhole shall be considered as a single system and each such system (defined in concurrence with Engineer-In-Charge) shall be leak tested at atmospheric pressure for water tightness of the fabricated section. Any repair of coating (internal/ external) at joint location shall be carried out only on completion of inspection of leak test and subsequent repair of joint, if any.

6.3 Leak Test

6.3.1 Fabrication yard/ facility

The pipe section as fabricated, from the funnel to end of transportable length shall be temporarily blanked and filled with water so that water level is up to the top of the funnel. The entire section shall be kept filled for 4 hours.

The drop in water level of all water and sewage (sanitary, chemical and industrial drainage and other gravity sewers) piping being leak tested shall be recorded at end of 4 hour at the funnel. The value so recorded shall represent a total leak test of the section (Pipe/ group of pipes). The total leak observed shall be limited to the evaporation loss for the open funnel. During test, all funnels but for the observation manhole shall be kept sealed and the observation funnel shall be provided with a temporary cover. During leak test, all exposed pipe, joints, fittings, valves, shall be carefully examined for leakage. Leaking pipes, joints, and fittings shall be replaced/repaired.

The hydrostatic test shall be repeated after the repair of any defects until the system is proved satisfactory. The piping shall be satisfactory if there is no evidence of leakage after the 4 hours.

The contractor shall undertake repairing and testing of the joint without any extra cost to the owner. After completion of the test, all temporary covers shall be removed, the test water shall be drained / pumped out and the line cleaned properly.

6.3.2 In-situ fabrication and erection

The pipe system as defined, upstream of a manhole/ between any two manholes/ sump inlet and upstream manhole shall be filled with water so that water level is up to the top of the manholes. The entire system shall be kept filled for 24 hours.

All water and sewage (sanitary, chemical and industrial drainage and other gravity sewers) piping and retaining structures under atmospheric pressure such as manholes, sumps, catch basins etc. being leak tested shall be topped up with Water to the brim after initial 8 hours and then the drop in water level shall be recorded every 4 hours at the observation manhole. The value so recorded shall represent a total leak test of the system (Pipes and Manhole). The total leak observed shall be limited to the evaporation loss for the open system of Pipes funnels and manholes. During test, all manholes and funnels but for the observation manhole shall be kept sealed and the observation manhole shall be provided with a temporary cover. Site testing shall take place prior to backfill. During hydrotest, all exposed pipe, joints, fittings, valves, shall be carefully examined for leakage. Leaking pipes, joints, and fittings shall be replaced/repaired.

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The hydrostatic test shall be repeated after the repair of any defects until the system is proved satisfactory. The piping shall be satisfactory if there is no evidence of leakage after the 24 hours.

The contractor shall undertake repairing and testing of the joint without any extra cost to the owner. After completion of the test, all temporary covers shall be removed, the test water shall be drained / pumped out and the line cleaned properly.

Before commissioning, the cleanliness of the pipeline shall be checked by following test.

Ring Test (Manhole to Manhole)

In this method of testing, two steel / wooden rings of suitable thickness and design shall be fixed facing each other, at a distance of 2 feet or more. The block of rings shall be inserted from one end of the pipeline, inside manhole and pulled by a rope fixed to the block from the other end of the pipeline, inside the next manhole. The rings shall be of dia. 2" less than the inside dia of pipe under testing. The rope used for pulling the ring block may be inserted in the pipeline by the contractor either during construction or afterwards by suitable means. Any obstruction/ debris/ major misalignment will prevent the ring to pass through the pipeline in which case the pipeline shall again be cleaned / rectified and the test redone. The ring test shall be performed for the complete network of the sewer system, before the same is put in service.

8.0 PAYMENT

8.1 Payment for Piping fabrication and erection shall be made based on respective rates. Payment of piping fabrication shall be based on inch dia. measurement whereas payment for erection of piping shall be based on inch meter measurements, calculated on the basis of the execution drawings. The length shall be measured along the center lines of pipes, center lines of bends and elbows, tees, reducers and flanged joints. All types of valves shall be excluded from this measurement. Branch connections shall be measured from the outer surface of the header.

The payment shall be made on per inch metre basis of piping work laid, measured to the nearest centimeter. The unit rates for the underground piping shall be inclusive of earthwork in excavation, backfilling, compaction, disposal of surplus earth and corrosion protection coating/ coating of field joints of 3L PE pre-coated pipes including supply of materials.

All piping attachments, such as couplings, nipples, thermowells etc., shall be installed by the Contractor as part of piping work and no separate payment shall be made for such work. However, extension on such attachments such as vents and drains will be measured and paid as applicable for the respective size and category of piping / valves.

Fabrication of mitre bends, concentric and eccentric reducers fabricated from pipes supplied by owner & fabrication of flanges from plates supplied by owner, will be paid at respective unit rates. However, erection of these items will be along with piping of the respective size and no separate payment will be made for erection.

The reducers will be measured and paid along with the piping of large diameter.

Payment of Reinforcement pads for branch connections shall be made as per respective SOR rates.

Fabrication, installation and removal of temporary spool pieces etc. to aid contractor's work such as fabrication, erection, flushing and testing etc. will neither be measured nor paid separately. The same is deemed to be included in the unit rates for piping. Payment for carrying out radiographic examination shall be based on inch dia. of joint radiographed. Repeat radiography / additional

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radiography required due to contractor's faults / poor performance of his welders and defective films etc., shall be done at contractor's own cost.

8.2 The payment clause(s) as described in the clause no. 8.1 shall not be referred / applicable for LSTK Jobs

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STANDARD SPECIFICATION FOR PORTABLE FIRE EXTINGUISHER

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved By	
1	24.08.18	REVISED & ISSUED AS STD. SPEC.	GAURAV SINGH	GYAS	RS	RKT
0	19.08.10	ISSUED AS STANDARD SPECIFICATION	AS	RKS	RBB	ND

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Abbreviations:

MS	MILD STEEL
IS	INDIAN STANDARD
PESO	PETROLEUM EXPLOSIVE SAFETY ORGANISATION

Structural Standards Committee

Convenor: Mr. Rajanji Srivastava

Members:
Mr. Anurag Sinha
Mr. VK Panwar
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1.0 SCOPE

This standard lays down requirements regarding material, shape, construction, method of operation, performance and tests of portable fire extinguisher of Carbon Dioxide type, Dry Chemical Powder type Fire Extinguisher.
The extinguisher shall be supplied along with respective extinguishing media duly charged.

2.0 CODES AND STANDARDS

IS: 5	Colours for ready mixed paints and enamels
IS: 2932	Enamel, synthetic, exterior; a) undercoating, b) finishing - specification
IS: 4308	Dry Chemical Powder for Fighting B and C Class Fires
IS: 4947	Specification for gas cartridges for use in fire extinguishers
IS: 14609	Dry Chemical Powder for Fighting A, B, C Class Fires
IS: 15222	Carbon dioxide as the extinguishing media for fire protection - Specification
IS: 15683	Portable Fire Extinguishers, Performance and Construction – Specification

Note: Latest Edition of all standard documents shall be followed

3.0 MATERIAL OF CONSTRUCTION & BASIC REQUIREMENT

3.1 CARBON DIOXIDE TYPE:-

3.1.1 Extinguisher shall be portable high pressure type with capacities 2 / 4.5 Kg as per requirement.
3.1.2 Requirement of performance, construction, and test shall comply with IS: 15683.
3.1.3 Carbon dioxide of 99.5% purity used as extinguishing media shall comply with IS: 15222 with maximum fill density shall not exceed 0.667Kg/l.
3.1.4 Extinguishers shall have concave base, material for extinguisher body shall be either steel conforming to IS: 7285 or aluminum confirming to IS: 4947 and discharge valve shall be of hand wheel / key / lever operated type conforming to IS: 3224

3.2 DRY CHEMICAL POWDER TYPE:

3.2.1 Extinguisher shall be portable low pressure Cartridge type with capacities 1 / 2 / 4 / 6 /per requirement based on fire rating.
3.2.2 Requirement of performance, construction, and test shall comply with IS: 15683.
3.2.3 Dry powder conforming to IS: 14609, I.S. 4308 and ~~or~~ IS: 4861 shall be used for charging the extinguishers.
3.2.4 Material for extinguisher body shall be carbon steel conforming IS: 513 with no vertical joints on the body. Discharge nozzle, valve assembly shall be SS-316 or brass confirming to IS: 6912.
3.2.5 Carbon di oxide gas cartridge shall be ISI marked as per IS: 4947

4.0 APPROVALS

Carbon di oxide extinguisher and valve shall have approval from PESO, Government of India, Nagpur.

5.0 COLOR & MARKING

The color of extinguisher bodies shall be Red conforming to shade no.536 or 538 of IS: 5. Paint shall conform to IS: 2932. Each extinguisher shall be clearly and permanently marked with the information specified in IS: 15683, along with IS certification mark and purchaser's name.

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6.0 ACCESSORIES

Each extinguisher shall be supplied with MS bracket, screws and spanner as may be necessary. The details of the bracket shall be submitted with the offer.

7.0 INSPECTION

Owner's / EIL's authorized representative shall have access at all reasonable times to vendor's works where Extinguishers are being manufactured and/or tested. Vendor shall arrange for all tests and inspection facilities for checking material, design and fabrication, workmanship, finish, performance (operating performance and performance required for test fires), and testing as per IS: 15683.

8.0 INFORMATION REQUIRED FROM VENDOR

8.1 Following information shall be furnished by the vendor along with the supply of extinguisher:

- Instruction book(s) - Instruction book(s) for guidance of the user including both the operating and normal maintenance procedures shall be supplied. The book(s) shall include an itemized and illustrated part list/spare parts list giving reference number of all the wearing parts.
- Approval certificate from PESO as described in clause 4.

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STANDARD SPECIFICATION FOR STAND POST TYPE FIRE HYDRANT WITH NORMAL TYPE LANDING VALVE

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved By	
5	08.08.25	REVISED & ISSUED AS STD. SPEC.	NS	AK	SKN	MN
4	26.06.18	REVISED & ISSUED AS STD. SPEC.	GAURAV SINGH	GYAS	RS	RKT
3	23.05.11	REVISED AND ISSUED AS STD. SPEC.	ALOK	RKS	RBB	DM
2	22.12.05	REVISED & REISSUED AS STD. SPEC.	SKC	NK	VDS	VJN
1	15.02.98	REVISED & ISSUED AS STD. SPEC.	VEDA	SM	MMK	ASONI
0	31.03.82	ISSUED AS STD. SPEC.	RB	-	HVR	RCPC

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Abbreviations:

ANSI	:	American National Standards Institute
IS	:	Indian Standard
PMS	:	Piping Material Specification
ASTM	:	American Society for Testing and Materials
Lpm	:	Liter per minute
NFPA	:	National Fire Protection Association
VMS	:	Valve Material Specification

General Civil Standards Committee

Convenor: Mr. Samir Kumar Naskar

Members:
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Mr. Dinesh Deb Barma
Mr. Gyasuddin
Mr. Raj Kumar Singh
Mr. U.C. Pathak, (Piping)
Mr. Charanjeet Singh (Projects)
Mr. Inrajit Neog (Construction)
Mr. Vikram Gupta (Structural)

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1.0 SCOPE

This standard lays down the requirements of codes and standards, type, shape, dimensions, material and test for vertical stand post type fire hydrant (with or without pumper connection) to be installed on fire water main with Normal Type Landing Valves as per IS 5290. The Hydrant shall normally be supplied without pumper connection unless otherwise specifically mentioned in the Data sheet/ Material Requisition.

2.0 CODES AND STANDARDS

IS: 5290	Specification for Landing Valves
ANSI B16.5	Pipe Flanges and Flanged Fittings
ASTM A-105	Standard Specification for Carbon Steel Forgings for piping applications
NFPA 1963	Standard for Fire Hose Connections
6-52-0006	Standard specification for restriction orifice plates
7-52-0041	Orifice Plates and Flanges Dimensional Details

NOTE: - Latest Edition of all Codes and Standards shall be followed.

3.0 MATERIAL

The MOC of components shall be as the Data Sheet provided along with this specification in the Material Requisition.

4.0 DESCRIPTION

4.1 The hydrant shall be stand-post type which may of the following types (For details, refer Annexure-I)-

a. **Single Headed Hydrant –** The vertical post shall be of 75 mm diameter with one horizontal Landing Valve Single Outlet conforming to Normal Type landing valve as per Fig.1 of IS 5290 having flanged inlet and instantaneous female outlet as per Fig.2 of IS 5290. Refer Fig-A given in the Annexure-I

b. **2-Way Hydrant** - The vertical post shall be of 100 mm diameter with two horizontal hydrant arms, each of 75 mm diameter having independent Landing Valve Single Outlet conforming to Normal Type landing valve as per Fig.1 of IS 5290 having flanged inlet and instantaneous female outlet as per Fig.2 of IS 5290. Refer Fig-B given in the Annexure-I

c. **2-Way Hydrant with pumper connection** - The vertical post shall be of 150 mm diameter with two horizontal hydrant arms, each of 75 mm diameter having independent Landing Valve Single Outlet conforming to Normal Type landing valve as per Fig.1 of IS 5290 having flanged inlet and instantaneous female outlet as per Fig.2 of IS 5290. Also, one pumper connection, 4-inch outlet, non-threaded type fire department connection metal faced, without gasket as per NFPA 1963 with metallic blind cap with SS 304 chain. Refer Fig-C given in the Annexure-I

d. **4-Way Hydrant -** The vertical post shall be of 150 mm diameter with two horizontal hydrant arms, each of 100 mm diameter having 2 numbers of independent Landing Valve Single Outlet (on each am) conforming to Normal Type landing valve as per Fig.1 of IS

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5290 having flanged inlet and instantaneous female outlet as per Fig.2 of IS 5290 on each arm. Refer Fig-D given in the Annexure-I

e. **4-Way Hydrant with pumper connection -** The vertical post shall be of 150 mm diameter with two horizontal hydrant arms, each of 100 mm diameter having 2 numbers of independent Landing Valve Single Outlet conforming to Normal Type landing valve as per Fig.1 of IS 5290 having flanged inlet and instantaneous female outlet as per Fig.2 of IS 5290 on each arm. Also, one pumper connection, 4-inch outlet, non-threaded type fire department connection metal faced, without gasket as per NFPA 1963 with metallic blind cap with SS 304 chain. Refer Fig-E given in the Annexure-I

4.2 Outlet of the landing valve shall be provided with instantaneous female coupling as per Fig.2 of IS 5290 with blind cap as per Fig.5 of IS 5290 along with SS304 chain.

4.3 Landing Valve Single Head Outlet conforming to IS: 5290 shall have rated flow of 900 lpm at 7 kg/cm2g

4.5 All flanges for landing valve connection shall have all dimensions conforming to ANSI.B.16.5, 150 lbs rating, Flat Face, Slip On type. Base flange of stand post shall be as per job specific Piping Material Class as mentioned in datasheet.

4.6 Job specific requirements, if any shall be as per Data Sheet enclosed in Bid/ Requisition document.

4.7 Refer Annexure-I for scope details for supply of Hydrants

5.0 RESTRICTION ORIFICE

5.1 Restriction Orifice (RO) may be provided in the landing valves as per requisition requirement.

5.2 The pressure conditions like Inlet pressure, design pressure and pressure drop in the RO shall be as per the table attached with the data sheet of Hydrant.

5.3 The flow through the RO shall be 900 lpm.

5.4 The MOC of the RO shall be SS 316.

5.5 Refer standard specifications 6-52-0006 and standard 7-52-041 for fabrication of Restriction orifice plate.

5.6 The type of RO plate shall be Concentric Square Edge type with single stage pressure reduction.

5.7 The line ID shall be 3” as per the PMS

6.0 WORKMANSHIP AND FINISH

All parts shall have good workmanship and finish. All warps and sharp edges shall be removed. The waterways shall have smooth finish.

7.0 TESTING

Each hydrant assembly shall be satisfactorily tested for water tightness, hydrostatic test and flow test as per IS 5290.

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Hydrant assembly with Landing valves closed shall be satisfactorily tested and proved water tight, under a hydraulic pressure of 21.0 kg/cm². The pumper connection shall be kept closed during testing in case the same is provided on hydrant assembly.

8.0 PAINTING

The stand post and its arms shall be painted as specified in Job Specific Data Sheet attached with this specification.

9.0 MARKING

Each hydrant shall be clearly and permanently marked with the following:

a) Manufacturers name or trade mark.
b) Year & Month of Manufacture.
c) Batch Number
d) Purchaser name.
e) BIS certification marking on landing valve and couplings.

10.0 INSPECTION

Owner's / EIL's authorized representative or as mentioned in data sheet shall have access at all reasonable times to vendor's works where Stand Post Hydrants and Landing Valves are being manufactured and/or tested. Vendor shall arrange for all tests and inspection facilities for checking material, design and construction, hydraulic performance, workmanship, finish and hydrostatic testing. Any shortcoming pointed out shall be rectified to the satisfaction of the inspectors. All consumables i.e. water etc. shall be arranged by vendor at his own cost.

11.0 VENDOR's DRAWING AND DATA REQUIREMENT

Vendor shall furnish drawings for review, prior to fabrication of Hydrant assembly as per Vendor Data Requirement**.**

12.0 APPROVAL

Vendor shall furnish valid BIS certificate approval letter.

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ANNEXURE-I

(SUPPLY SCOPE FOR FIRE HYDRANTS)

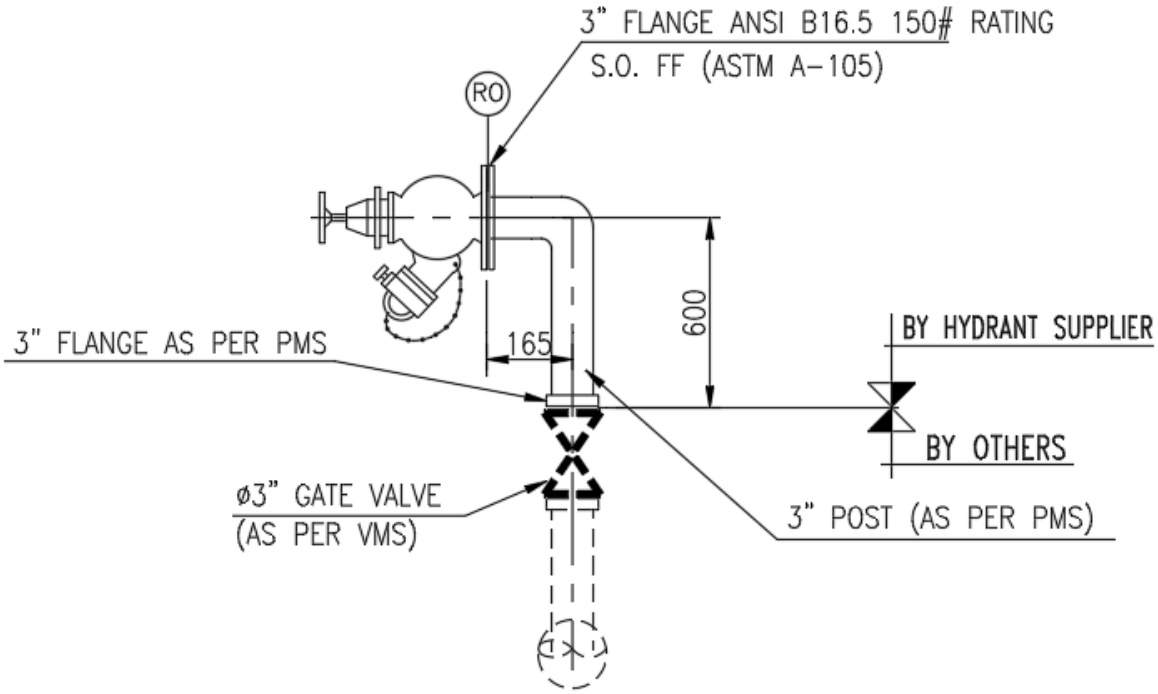


FIG A: SINGLE HEADED HYDRANT

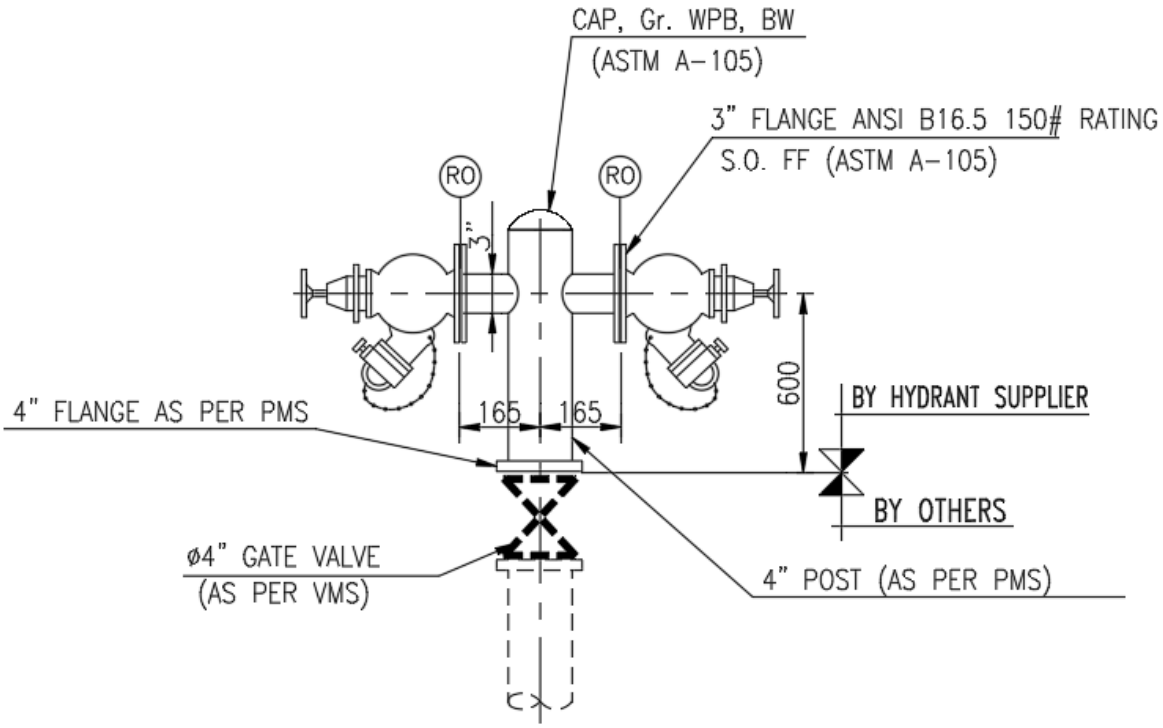


FIG B: 2-WAY HYDRANT

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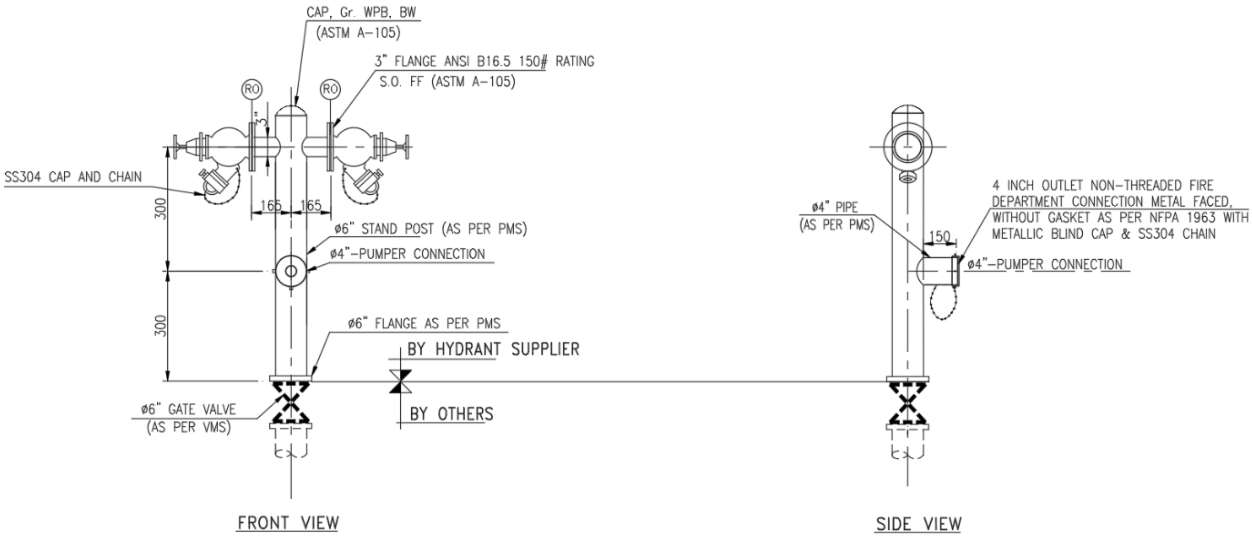


FIG C: 2-WAY HYDRANT WITH PUMPER CONNECTION

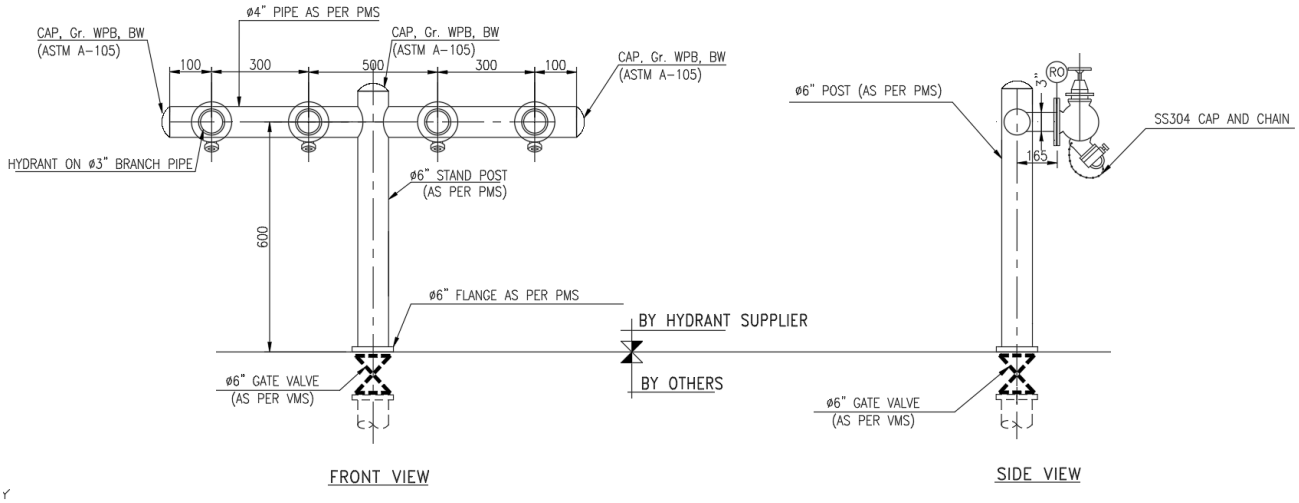


FIG D: 4-WAY HYDRANT

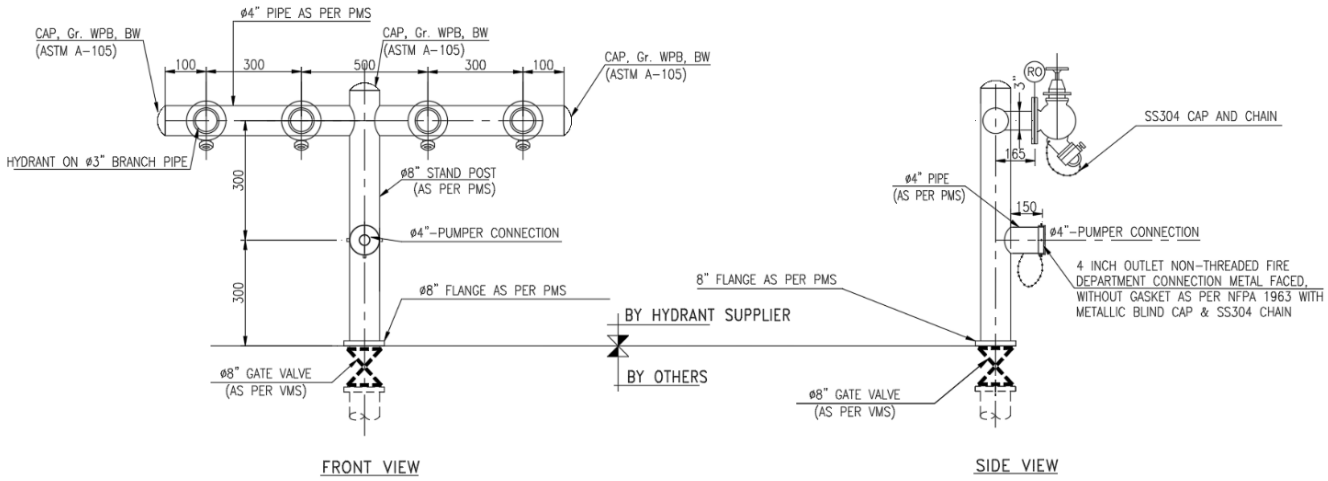


FIG E: 4-WAY HYDRANT WITH PUMPER CONNECTION

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STANDARD SPECIFICATION FOR FIRST AID HOSE REEL

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved By	
5	27.10.25	REVISED & ISSUED AS STD. SPEC.	NKP	GYAS	SK NASKAR	M.NANDI
4	26.06.18	REVISED & ISSUED AS STD. SPEC.	GAURAV SINGH	GYAS	RS	RKT
3	23.05.11	REVISED & REISSUED AS STD. SPEC	ALOK	RKS	RBB	DM
2	12.01.06	REVISED & REISSUED AS STD. SPEC	SKC	NK	VDS	VJN
1	21.11.96	REVISED & ISSUED AS STD. SPEC	NK	PCS	MMK	A SONI
0	31.03.82	ISSUED AS STD. SPEC.	RB	KP	HVR	RCPC

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ABBREVIATIONS:

IS : Indian Standard

General Civil Standards Committee

Convenor : Mr. Samir Kumar Naskar

Members:
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Dinesh Debbarma
Mr. Raj Kumar Singh
Mr. UC Pathak (Piping)
Mr. Charanjit Singh (Proj.)
Mr. Indrajit Neog (Const.)
Mr. Vikram Kumar Gupta (Structural)

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1.0 SCOPE

This specification covers the requirements regarding material, constructional details and test for Floor/Wall mounted First Aid Hose Reel, intended for installation within process units / buildings as emergency firefighting equipment.

Type _A -Wall mounting type to be used for mounting inside buildings on wet and dry riser. This can be directly mounted on the wall or custom-built cabinets for housing the hose -reel.

Type-B – Design shall be horizontal type hose reel-which can be mounted on custom built pedestals or in suitable position on fire engine.

2.0 CODES AND STANDARDS

IS : 884 First-Aid hose reel for fire-fighting.

NOTE: Latest Edition of all Codes and Standards shall be followed.

3.0 MATERIAL, CONSTRUCTION AND TEST

Material, Construction, tests and all other requirements shall conform to IS: 884, Type-A And Type B Hose Reel, except as mentioned in the Data Sheet of Hose Reel attached with Bids / Requisition.

4.0 SIZE

House reel tubing length shall be 30 m with internal bore 25 mm or as specified in data sheet.

5.0 HYDRAULIC PERFORMANCE

5.1 First Aid hose reel shall be capable of discharging not less than 44 lpm at the reel inlet pressure of 7 $kg/cm2_g$ +/- 0.1 $kg/cm2_g$ for 25mm size hose reel.

5.2 The horizontal range of water jet shall not be less than 6.0 m at the reel inlet pressure of 7 kg/cm2g.

6.0 MARKING

Each hose reel shall be clearly and permanently marked with the following information along with Purchaser's name.

a) Manufacturer's name or Trade Mark.
b) Year and month of Manufacture
c) Length and size of tube carried on hose reel.
d) Type of Reel.
e) BIS certification mark on house reel tubing
f) Batch number
g) Type of material.

7.0 INSPECTION AND TESTING

Owner's / EIL's authorized representative as mentioned in data sheet shall have access at all reasonable times to vendor's works where Hose Reels are being manufactured and/or tested. Vendor shall arrange for all tests and inspection facilities for checking material, design and construction, hydraulic performance, workmanship, finish and hydrostatic testing. Any shortcoming pointed out shall be rectified to the satisfaction of the inspectors. All consumables i.e. water etc. shall be arranged by vendor at his own cost.

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8.0 VENDOR's DRAWING AND DATA REQUIREMENT

Vendor shall furnish drawings and data for review, prior to fabrication of Hydrant assembly as per Vendor Data Requirement.

9.0 APPROVAL

Vendor shall furnish valid BIS certificate.

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STANDARD SPECIFICATION FOR STAND POST TYPE WATER MONITOR

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	25.08.18	REVISED & ISSUED AS STD. SPEC	GS	GYAS	RS	RKT
3	24.09.13	REVISED & ISSUED AS STD. SPEC	RBT	RKS	RBB	DM
2	12.01.06	REVISED & ISSUED AS STD. SPEC	SKC	NK	VDS	VJN
1	15.07.98	REVISED & ISSUED AS STD. SPEC	RC	NK	MMK	A SONI
0	09.09.88	ISSUED AS STD. SPEC.	NK	PCS	HVR	RCPC

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Abbreviations:

ANSI	:	American National Standards Institute
BIS	:	Beureau of Indian Standards
IS	:	Indian Standard
NB	:	Nominal Bore

Structural Standards Committee

Convenor: Mr. Rajanji Srivastava

Members:
Mr. Anurag Sinha
Mr. VK Panwar
Mr. Samir Das
Mr. Amitabh Kishore
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Mr. Ravindra Kumar (Const.)

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ANNEXURE –A 6

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1.0 SCOPE

This specification covers the general requirements regarding Material, Design and Construction, Workmanship and Finish, Anticorrosive Treatment, Performance requirements, Tests, Painting, Accessories, Marking and Inspection for Stand Post Type Water Monitor.

2.0 CODES AND STANDARDS

IS: 8442 Functional requirement For Stand Post Type Water Monitor for Fire Fighting.

NOTE: Latest Edition of all Codes and Standards shall be followed.

3.0 DESIGN AND CONSTRUCTION

3.1 Design and Construction of Water Monitor shall conform to IS: 8442, except as mentioned in data sheet for Stand Post Type Water Monitor enclosed with Bid / Requisition document.

3.2 The Monitor shall be Aqua Fog, self-locking type and operated by a single person with the Horizontal range of 360° & vertical range of 135° (i.e. +90° to -45°).

3.3 The monitor shall be mounted on a 100 mm (4") N.B. Raised Face, Slip On type Flange with all dimensions conforming to ANSI B 16.5, 150 lbs rating.

3.4 Water nozzle shall be Non aspirating or aqua foam type with Jet and Fog arrangement.

3.5 The threaded end of the water nozzle shall be hexagonal to facilitate screwing of the nozzle on the water barrel with nozzle spanner.

3.6 Near the base flange a drain connection shall be provided with a 15 mm (½") NB drain valve at the end of pipe.

4.0 HYDRAULIC PERFORMANCE

Minimum Hydraulic performance of the monitor shall be as per clause 9.1 of IS 8442.

5.0 MATERIAL

All material for different parts of Water Monitor shall be per IS: 8442. Except as mentioned in data sheet for Stand Post Type Water Monitor enclosed with Bid/Requisition document.

6.0 WORKMANSHIP AND FINISH

Workmanship and finish, anticorrosive treatment, painting, Hydraulic performance, tests and accessories shall conform to IS: 8442, except as mentioned in data sheet for Stand Post Type Water Monitor enclosed with Bid/Requisition document.

7.0 MARKING

Each monitor shall be clearly and permanently marked with the following:

(a) Manufacturer's name or trademark
(b) Year of manufacture

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(c) Purchaser's name.
(d) Discharge Capacity in liters / minute.
(e) BIS & ISI certification mark.

8.0 INSPECTION

Owner's / EIL's authorized representative shall have access at all reasonable times to vendor's works where Monitors are being manufactured and/or tested. Vendor shall arrange for all tests and inspection facilities for checking material, design and construction, hydraulic performance, workmanship, finish and hydrostatic testing as per IS: 8442. Any shortcoming pointed out shall be rectified to the satisfaction of the inspectors. All consumables i.e. water etc. shall be arranged by vendor at his own cost.

9.0 DRAWINGS

Refer ANNEXURE -A for scope drawing for supply of monitor.

10.0 VENDOR DRAWING AND DATA REQUIREMENT

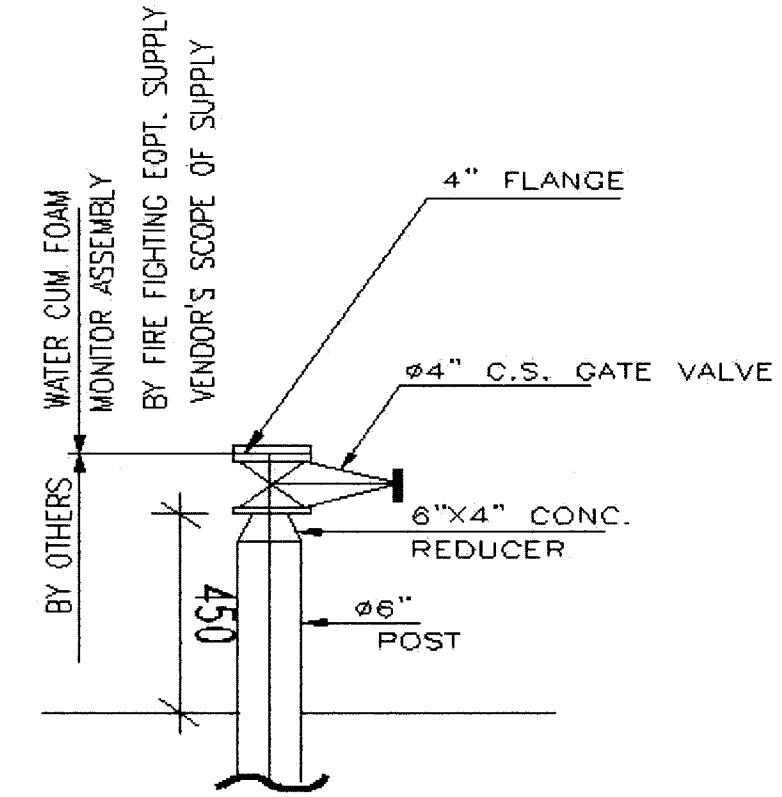
Vendor shall furnish drawings and data as per document for "Vendor drawings and Data Requirements".

11.0 APPROVAL

Vendor shall furnish BIS approval letter along with offer.

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ANNEXURE –A



WATER MONITOR

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जल एवम झाग युक्त मॉनिटर सिंगल बैरल टाइप हेतु मानक विनिर्देश (स्थिर और परिवरतनशील प्रवाह)

STANDARD SPECIFICATION FOR WATER CUM FOAM MONITOR SINGLE BARREL TYPE (FIXED & VARIABLE FLOW)

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved By	
5	26.06.18	REVISED & ISSUED AS STD. SPEC.	GAURAV SINGH	GYAS	RS	RKT
4	21.01.13	REVISED & ISSUED AS STD. SPEC	JAY KUMAR	RC	RBB	DM
3	30.07.07	REVISED & ISSUED AS STD. SPEC	RKS	NK	VDS	VC
2	12.01.06	REVISED & ISSUED AS STD. SPEC	SKC	NK	VDS	VJN
1	15.03.98	REVISED & ISSUED AS STD. SPEC	RB	PCS	MMK	A SONI
0	31.03.82	ISSUED AS STD. SPEC.	RB	KP	HVR	RCPC

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Abbreviations:

ANSI	American National Standards Institute
FM	Factory Mutual
"	Inch
IS	Indian Standard
kg/cm^2	Kilogram per Square Centimeter
lbs	Pounds
m	Meter
MS	Mild Steel
mm	Millimeter
m^3	Cubic Meter
NB	Nominal Bore
PVC	Poly -Vinyl Chloride
SS	Stainless Steel
UL	Underwriters Laboratory
VdS	Verband Der Sachversicherer

Structural Standards Committee

Convenor: Mr. Rajanji Srivastava

Members:
Mr. Anurag Sinha
Mr. VK Panwar
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1.0 SCOPE

This specification covers the general requirements regarding Material, Design and Construction, Workmanship and Finish, Anticorrosive Treatment, Performance requirements, Testing, Painting, Accessories, Marking and Inspection for Single Barrel, Stand Post Type Water cum Foam Monitor.

2.0 CODES AND STANDARDS

IS: 5	Colors For Ready Mix Paints and Enamels.
IS: 291	Machining Purposes- Specification.
IS: 1239-Part 1	MS Tubes, Tubulars and Other Wrought Steel Fittings-MS Tubes.
IS: 1239-Part 2	MS Tubes, Tubulars and Other Wrought Steel Fittings- Tubulars and Other Wrought Steel Fittings.
IS: 3203	Methods of Testing Local Thickness of Electroplated Coatings.
ANSI B16.5-	Pipe Flanges and Flanged Fittings.

NOTE: - Latest Edition of all Codes and Standards shall be followed.

3.0 DESIGN AND CONSTRUCTION

3.1 Design and Construction of Water cum Foam Monitor shall be single barrel type with fixed /variable flow and shall be UL / FM / Vds approved for discharge capacity as specified in data sheet, and shall comply with Data Sheet attached with Bids / Requisition

3.2 The Monitor shall be self-locking type and manually operated by a single person, with Non aspirating type Aqua Fog foam Nozzle.

3.3 Foam induction shall be by aqua powered foam inductor, (Jet Ratio Controller Pump) or self-inducting through pick up tube as specified in data sheet.
The foam induction system by aqua powered foam inductor shall be listed by UL/ FM/ Vds. Water operated foam proportioner shall be suitable for feeding foam concentrate from distance of 60 meters. The inlet and outlet of proportioner shall be provided with 63-mm male and female coupling. Foam induction hose of total 60m length shall be supplied along with end couplings of SS304. Foam solution induction hose shall be Type B delivery hose (Non-Percolating with elastomeric outer coating applied as reinforcement conforming IS 636) of size 63 mm long with ends couplings.
Foam inductor shall be provided behind the air intake chamber of foam maker in Foam Monitor. A flexible pick up tube of 3. length, having strainer at the inlet, shall be provided.
A foam concentrate valve shall be capable of inducing 3% to 6% foam compound.

3.4 Near the base flange a drain connection shall be provided with a 15 mm (½") NB drain valve at the end of pipe. The drain pipe shall be long enough to drain water away from the base flange.

4.0 MATERIAL

All material for different parts of Water cum Foam Monitor shall be as approved for UL / FM / Vds certification and the Water cum Foam Monitor assembly shall be supplied as per data sheet enclosed with Bid / Requisition document. Any conflict between specifications and data sheet, Data Sheet shall govern.

4.1 Pick up tube shall be made from PVC hose reinforced with high tensile steel wire helix manufactured as per ASTM D1785 schedule 80. Pick up tube shall be 3m long with dip Pipe made of SS316. Foam concentrate ball valve shall be of SS316.

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5.0 HYDRAULIC PERFORMANCE

FOAM MONITOR SINGLE BARREL TYPE				
FLOW RATE (US GPM)	**Minimum Horizontal Ranges at** 7 kg/cm^2 pressure for		**Minimum Vertical Ranges at** 7 kg/cm^2 pressure for	
	Water (m)	**Foam (m)**	**Water (m)**	**Foam(m)**
500GPM	50	45	17	15
750 GPM	52	50	17	15
1000GPM	60	55	20	18
2000 at 2000 GPM	80	75	25	22

Table1

Note: The minimum horizontal & vertical ranges for water and foam jets shall be as specified in **Table 1** at 7 kg/cm^2 pressure, with 30° & 45° nozzle angle respectively from horizontal plane in still weather condition except if specifically specified in the data sheet attached with the bid document / purchase document.
Monitor shall be tested for minimum two directions at 0 degrees and second reading at opposite direction i.e. 180 degrees apart as specified above and average reading shall be considered as horizontal throw of the monitor.

Vendor shall furnish the projectile curve for the monitor supplied showing horizontal and vertical throw for foam and water at angles 30, 45, 60, 75 degrees nozzle angle from horizontal plane for records with operational pressure at monitor base flange of 7/8/9/10 kg/ cm^2/.

5.5 Aqueous Film Forming Foam (AFFF) shall be used for testing of foam monitor for horizontal and vertical throws as specified.

6.0 WORKMANSHIP AND FINISH

6.1 All the parts shall have good workmanship and finish. All burrs and sharp edges shall be removed. Particularly Water Way, Foam Way and Nozzle shall have smooth finish.

6.2 None of the joints shall be connected with permanent adhesive. No adhesive shall be used to arrest leaks or locking joint movement in threaded joints.

7.0 ANTICORROSIVE TREATMENT AND PAINTING

7.1 Monitor's steel parts shall be painted with luminous fire red colour, conforming to IS: 5, shade no.536, over 2 coats of Red Oxide Zinc Chromate primer or single coat of Aluminum paint. Nozzle shall be Yellow Epoxy painted. Copper Alloy parts shall be polished.

8.0 TESTING

8.1 Monitor shall be tested to fulfill hydraulic performance requirements as per clause 5.0 above and as per Data Sheet of Water cum Foam monitor attached with Bids / Requisition.

8.2 All the monitors shall be tested as follows:

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The entire assembly shall be subjected to hydraulic pressure of 23 kg/cm^2 and horizontal rotation shall be carried out 5 times and then vertical rotation up and down for 5 cycles for 5 minutes. During the test there shall be no leakage observed in any of the swiveled joints.

9.0 ACCESSORIES

9.1 The accessories shall include nozzle spanner.

10.0 MARKING

10.1 Each Monitor shall be clearly and permanently marked with the following:

(a) Manufacturer's name or trademark
(b) Year of manufacture
(c) Purchaser's name.
(d) Discharge Capacity in liters / minute.
(e) FM/UL/Vds listing marks.

11.0 INSPECTION

11.1 Owner's / EIL's authorized representative shall have access at all reasonable times to vendor's works where Monitors are being manufactured and/or tested. Vendor shall arrange for all tests and inspection facilities for checking material, design and construction, hydraulic performance, workmanship, finish and hydrostatic testing.

11.2 Verification of all the relevant document at shop before dispatch of the monitor.

11.3 Any shortcomings pointed out shall be rectified to the satisfaction of the inspectors. All consumables i.e. water and foam etc. shall be arranged by vendor at his own cost.

12.0 APPROVAL

12.1 Water cum foam monitor & nozzle along with foam induction mechanism shall be UL listed/ FM / Vds approved.

12.2 Vendor shall provide certified approved drawings / documents authenticated by UL / FM / Vds as documentary evidence along with bids.

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सुरक्षा शॉवर एवं आई वॉश हेतु मानक विनिर्देश

STANDARD SPECIFICATION FOR SAFETY SHOWER AND EYE WASH

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved By	
5	17.08.21	REVISED AND ISSUED AS STANDARD SPECIFICATION	GAURAV SINGH	GYAS	Anurag Sinha	SM
4	11.01.19	REVISED AND ISSUED AS STANDARD SPECIFICATION	GAURAV SINGH	GYAS	RS	RKT
3	17.07.12	REAFFIRMED AND ISSUED AS STANDARD SPECIFICATION	JAY KUMAR	RC	RBB	DM
2	11.09.06	REAFFIRMED AND ISSUED AS STANDARD SPECIFICATION.	DCB	UCJ	VDS	VC
1	02.06.97	REAFFIRMED AND ISSUED AS STANDARD SPECIFICATION	AK	PCS	MMK	AS

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Abbreviations:

GI	:	Galvanized Iron
IS	:	Indian Standard
Kg	:	Kilogram
LPM	:	Litre per minute
mm	:	Millimeter

Structural Standards Committee

Convener: Mr. Anurag Sinha

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Mr. Gyasuddin
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1.0 SCOPE

This specification covers the general requirements regarding material, design, fabrication and acceptance tests for safety showers and Eye wash (combine unit).

2.0 CODES AND STANDARDS

IS: 1239	Mild steel tubes, tubular and other wrought steel fittings
IS: 10592	Specification for Industrial Emergency Shower, eye and face fountain and combination units.
Installation drawing	As per Vendor

3.0 DESIGN REQUIREMENT

3.1 It shall be as per IS : 10592.

3.2 The twin fountain head of eye wash unit shall give soft, controlled drenching of eye/face when the foot pedal is pressed.

3.3 Shower head should give uniform shower of water as soon as the chain/ pull rod is pulled.

3.4 Available inlet pressure shall not be less than 2.0 kg/cm^{2}g. In case available pressure is greater than 3.0 kg/cm^{2}g suitable Restriction Orifice shall be provided before safety shower and eye wash unit.

3.5 All steel parts shall be properly painted with 3 coats of anticorrosive paints.

3.6 Water supply pipe size shall be 40mm at inlet of combined equipment. Inlet connection shall generally be from top unless specified otherwise. Inlet connection shall be 1.5" flanged as per ASTM A105 (GALV.), 150FF.

3.7 Emergency shower head shall be capable of delivering a minimum of 76 lpm of water and each eye wash head shall be capable of delivering approximately 12 lpm.

4.0 MATERIAL OF CONSTRUCTION

Pipe	: GI heavy grade conforming to IS: 1239.
Pipe Fittings	: GI heavy grade conforming to IS: 1239 (II)/ CI conforming to IS:1879
Self closing Valve	: Gun Metal / Brass
Bowl for eyewash	: Stainless steel (SS 304)
Atomiser	: SS 304 with Copper head
Shower head	: C.P Brass or stainless steel(SS 304)
Foot Pedal	: M.S. with aluminium top
Spring	: M.S Galvanised
Pull chain	: M.S Galvanised

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5.0 INSPECTION AND TESTING

a) The whole assembly shall be tested for its hydraulic performance as per the requirements of IS 10592

b) EIL/Owner's representative shall have access at all reasonable times to the manufacturer's work in which safety shower/its components are being manufactured and/or tested.

6.0 MARKING

Combined unit shall be marked with ISI certification mark and other marking requirement as per IS 10592

7.0 VENDOR DATA REQUIREMENTS

7.1 Vendor shall furnish drawings and data as per VENDOR drawing and data requirements for approval prior to manufacturing.

7.2 Original transparencies after incorporating the as built information shall be got signed by the inspection engineer before submitting to EIL/OWNER for records.

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STANDARD SPECIFICATION FOR REMOTE OPERATED FOAM/WATER MONITOR TOWER / GRADE MOUNTED

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved By	
3	13.09.18	REVISED & ISSUED AS STD. SPEC.	GAURAV SINGH	GYAS	RS	RKT
2	02.02.10	REVISED & ISSUED AS STD. SPEC.	AK	RKS	RBB	ND
1	15.02.98	REVISED & ISSUED AS STD. SPEC.	RLT	SM	MMK	A SONI
0	14.06.90	ISSUED AS STD. SPEC.	RP	PCS	RPB	RCPC

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Abbreviations:

AFFF	Aqueous Film Forming Foam
API	American Petroleum Institute
ASME	American Society Of Mechanical Engineers
BS	British Standard
FM	Factory Mutual
GPM	Gallon Per Minute
GI	Galvanised Iron
JRCP	Jet Ratio Controller Pump
PFD	Process Flow Diagram
P&ID	Piping and Instrumentation Diagram
PVC	Poly Vinyl Chloride
UL	Underwriters Laboratory
Vds	Verband der sachversicherer

Structural Standards Committee

Convenor: Mr. Rajanji Srivastava

Members:
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Mr. VK Panwar
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1.0 SCOPE

This specification covers the requirements of the material, design, construction, performances and test for Remote operated elevated / Grade mounted Long Range Water cum Foam Monitors, non-aspirating type consisting of UL/FM/ Vds listed Water/ Foam monitor. Foam feeding shall be by aqua powered foam inductor JRCP. The induction system should be evaluated and listed by UL/FM/Vds.

The discharge capacity of remote operated Long Range high Volume water cum foam monitor shall be 1000/ 2000 GPM (US) as specified in data sheet. The monitor shall be capable to give discharge with hollow jet, fog and spray arrangement (aqua fog/ foam type)

Remote operated (Electric operated) elevated long range water cum foam monitors shall be supplied along with control panels and associated piping, valve etc. Field mounted remote control panels (separately for each monitor) shall be provided for operating monitors.
Motor operated isolation valve for operation of remote operated elevated long range monitor with push button on / Off for Open/ Close of isolation valve shall be provided. Foam feeding shall be by aqua powered foam inductor (Jet Ratio Controller Pump). The induction system shall be listed by UL/ FM/ Vds.

2.0 CODES AND STANDARDS

IS: 5	Colors For Ready Mix Paints and Enamels.
IS: 291	Machining Purposes- Specification.
IS: 1239-Part 1	MS Tubes, Tubulars and Other Wrought Steel Fittings-MS Tubes.
IS: 1239-Part 2	MS Tubes, Tubulars and Other Wrought Steel Fittings- Tubulars and other Wrought Steel Fittings.
IS: 3203	Methods of Testing Local Thickness of Electroplated Coatings.
ANSI B16.5-	Pipe Flanges and Flanged Fittings.

NOTE: - Latest Edition of all Codes and Standards shall be followed.

3.0 DESIGN AND CONSTRUCTION

3.1 Design and Construction of Water cum Foam Monitor shall be single barrel type with fixed /variable flow and shall be UL / FM / Vds approved for discharge capacity as specified in data sheet, and shall comply with Data Sheet attached with Bids / Requisition

3.2 The Monitor shall be self-locking type and manually operated by a single person, with Non aspirating type Aqua Fog foam Nozzle.

3.3 Near the base flange a drain connection shall be provided with a 15 mm (½") NB drain valve at the end of pipe. The drain pipe shall be long enough to drain water away from the base flange.

3.4 Electric Remote-Control System

Electric Remote control system shall be provided for horizontal and vertical rotation of the monitor from local panel to be supplied by the contractor. The remote control system shall be electrical as specified in the data sheet. Remote control system may not be UL /FM listed/ approved.

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3.5 Control Panel

All electrical connections shall be provided in a panel for operation such as start, stop, monitor operation in horizontal and vertical plane in desired direction and angle. All electrical accessories shall be minimum Ex-n / Ex-e/ Ex-d type in flameproof enclosure suitable for Zone -2, Gas group –II A/ II B with GI sheet canopy. Control panel shall have IP55 ingress protection as minimum, weather proof canopy. The panel shall be provided in a suitable place as per job specific drg.

Control panel shall have minimum following indication and control functions for each monitor.

- Push Button Control - up, down, right and left
- Nozzle - Full/spray/ Jet.
- Push Button on/ off - Open/ Close Isolation valve
- Power available - Indication lamp

3.6 Foam Induction System

Foam induction shall be by aqua powered foam inductor, (Jet Ratio Controller Pump) or self-inducting through pick up tube as specified in data sheet.
The foam induction system by aqua powered foam inductor shall be listed by UL/ FM/ Vds. Water operated foam proportioner shall be suitable for feeding foam concentrate from distance of 60 meters. The inlet and outlet of proportioner shall be provided with 63-mm male and female coupling. Foam induction hose of total 60m length shall be supplied along with end couplings of SS304. Foam solution induction hose shall be Type B delivery hose (Non-Percolating with elastomeric outer coating applied as reinforcement conforming IS 636) of size 63 mm long with ends couplings.
A flexible pick up tube of 3. length, having strainer at the inlet, shall be provided.
A foam concentrate valve shall be capable of inducing 3% to 6% foam compound
For elevated tower mounted foam cum water monitors, suitable foam pumps and foam tanks as per data sheet and scope of work shall be provided.

4.0 MATERIAL OF CONSTRUCTION

All material for different parts of Remote operated Water cum Foam Monitor shall be as approved for UL / FM / Vds certification and the Water cum Foam Monitor assembly shall be supplied as per data sheet enclosed with Bid / Requisition document. Any conflict between specifications and data sheet, Data Sheet shall govern.
Pick up tube shall be made from PVC hose reinforced with high tensile steel wire helix manufactured as per ASTM D1785 schedule 80. Pick up tube shall be 3m long with dip Pipe made of SS316. Foam concentrate ball valve shall be of SS316.

5.0 HYDRAULIC PERFORMANCE

FOAM MONITOR SINGLE BARREL TYPE				
FLOW RATE (US GPM)	**Minimum Horizontal Ranges at** 7 kg/cm^2 pressure for		**Minimum Vertical Ranges at** 7 kg/cm^2 pressure for	
	Water (m)	**Foam (m)**	**Water (m)**	**Foam(m)**
500GPM	50	45	17	15
750 GPM	52	50	17	15
1000GPM	60	55	20	18
2000 GPM	80	75	25	22

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Note: The minimum horizontal & vertical ranges for water and foam jets shall be as specified in table above at 7 kg/cm^2 pressure, with 30° nozzle angle from horizontal plane in still weather condition except if specifically specified in the data sheet attached with the bid document / purchase document.
Monitor shall be tested for minimum two directions at 0 degrees and second reading at opposite direction i.e. 180 degrees apart as specified above and average reading shall be considered as horizontal throw of the monitor.

Vendor shall furnish the projectile curve for the monitor supplied showing horizontal and vertical throw for foam and water at angles 30, 45, 60, 75 degrees nozzle angle from horizontal plane for records with operational pressure at monitor base flange of 7/8/9/10 kg/ cm^2/ .

Aqueous Film Forming Foam (AFFF) shall be used for testing of foam monitor for horizontal and vertical throws as specified.

6.0 ELECTRICAL WORKS

Local control panel shall be complete with motor starters consisting of required rating AC3 motor duty switch, fuse, contactor & bimetal overload relay to suit motor rating. Motor start/ stop push button, selector switch, ammeter for motor KW>5.5 etc. and suitable for column/ structural mounting.

The panel shall be in flame proof enclosure suitable for Zone-2, Gas group-IIA/ IIB with GI sheet canopy.

Motor shall be minimum Ex-n type suitable for Zone-2, gas group IIA/ IIB, Temp. Class: T3. Starting current shall be limited to 600% and motor shall comply to specification 6-51-0032. Local control panel and motor shall be suitable for cable sizes which shall be informed during review of drawings.

All incoming and outgoing cables from panel to motor are excluded from vendor's scope. Earthing of the equipment shall be arranged by the purchaser.

Minimum conductor size of power cable shall be 4 mm^2 copper and all cables shall be 1100V grade, PVC insulated, PVC inner sheathed, fire retardant PVC outer sheathed and armoured type.

All the cabling from local control panel to the monitor shall be provided by the owner.

All electrical equipment shall be epoxy painted.

7.0 WORKMANSHIP AND FINISH

All the parts shall have good workmanship and finish. All burrs and sharp edges shall be removed. Particularly Water Way, Foam Way and Nozzle shall have smooth finish.

None of the joints shall be connected with permanent adhesive. No adhesive shall be used to arrest leaks or locking joint movement in threaded joints.

8.0 ANTICORROSIVE TREATMENT AND PAINTING

Painting of all piping material shall be as per job specification for painting.
Monitor's steel parts shall be painted with luminous fire red colour, conforming to IS: 5, shade no.536, over 2 coats of Red Oxide Zinc Chromate primer or single coat of

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Aluminum paint. Nozzle shall be Yellow Epoxy painted. Copper Alloy parts shall be polished.

9.0 INSPECTION & TESTING

9.1 Shop Testing

Prior to dispatch from vendor's shop, the following acceptance tests shall be carried out by the vendor to the complete satisfaction of owner's representative/ inspection agency without any extra cost to owner. All consumable (e.g. water, foam compound etc.) shall be arranged by vendor at his own cost. Vendor shall arrange all facilities to carry out inspection & testing.

- Review of material test certificates & welding records
- Hydraulic test of monitor = 23 kg/cm^2. There shall not be any leakage from any part of the equipment's.
- The performance test of minimum 20% monitors system for specified parameters including vertical and horizontal throw with water and foam shall also be carried out. (however minimum 2 monitors shall be subjected to performance test)
- Functional test for horizontal and vertical rotation at a pressure of 10.5 kg/cm2(g)
- Visual and dimensional check.
- The valves shall be hydraulically tested as per pipe material specification.
- The piping manifolds including valves shall be hydraulically tested at 1.5 times of maximum working pressure.

Owner or his representative shall have access at all reasonable times to vendor's works where the appliance or its accessories are being fabricated and tested. Originals/Transparencies after incorporating as built information shall be got signed by EIL inspection Engineers before submitting to Owner/EIL for records.

9.2 Field Testing

The performance test of monitors for remote operation system shall further be carried out at site in presence of vendor's representative for ascertaining all parameters specified.

The piping manifolds including valves shall be hydraulically tested at 1.5 times of maximum working pressure again in presence of the Client as total system testing.
Routine test as per applicable Indian Standards for all the motors.

Vendor's obligation towards their scope shall be considered as complete only after successful demonstration of vertical and horizontal throw at site, which will be conducted by vendor at their cost.

10.0 MARKING

Each unit shall be clearly and permanently marked with the following.

a. Manufacturer's/Supplier's name
b. Year of manufacturer
c. Purchaser's name and order reference
d. Capacity
e. UL/ FM/ Vds marking

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11.0 VENDOR DATA REQUIREMENTS

a. Documents listed in Vendor Data Requirement shall be submitted at various stages as indicated.
b. All drawings shall be in metric units.

12.0 APPROVALS

Vendor shall provide certified approved drawings/ documents authenticated by UL/FM/Vds as documentary evidence along with bids.

13.0 PERFORMANCE GUARANTEE

1 Year / as specified in data sheet.

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होज़ केबिनेट के लिए मानक विनिर्देशन

STANDARD SPECIFICATION FOR HOSE CABINET

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved By	
4	26.06.18	REVISED & ISSUED AS STD. SPEC.	GAURAV SINGH	GYAS	RS	RKT
3	21.01.2013	REAFFIRMED AND ISSUED AS STD. SPEC.	JAY KUMAR	RC	RBB	DM
2	26.12.07	REVISED AND REISSUED AS STD. SPEC.	GAURAV	PPC	NK	VC
1	20.06.97	REVISED AND REISSUED AS STD. SPEC.	NK	PCS	MMK	A.SONI
0	31.03.82	ISSUED AS STD. SPEC. RECOMPOSED IN AUG. 95	RB	-	HVR	-

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Abbreviations:

BIS	Bureau of Indian Standards
GI	Galvanised Iron
IS	Indian Standard
MS	Mild Steel
mm	Millimeter

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Mr. VK Panwar
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9.0 VENDOR's DRAWING AND DATA REQUIREMENT 5

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1.0 SCOPE

1.1 This specification covers the general requirements regarding the Design requirement, Material, Construction, Painting and Marking of Hose cabinet and fire fighting equipments contained in the cabinets.

1.2 The Hose cabinet shall be supplied along with all the fire fighting equipments contained in it.

2.0 CODES AND STANDARDS

IS: 5	Colors for Ready Mix Paints and Enamels
IS: 636	Non-Percolating flexible fire fighting delivery hose
IS: 903	Fire Hose Delivery Couplings, Branch Pipe, Nozzles and Nozzle Spanner
IS: 2871	Branch pipe, universal, for fire fighting purposes

NOTE: Latest Edition of all Codes and Standards shall be followed.

3.0 DESIGN REQUIREMENTS

3.1 Hose cabinet shall be of two types, Type-I and Type-II, to accommodate delivery hose and jet nozzle with branch pipe or universal branch pipe.

3.2 Type I Hose Cabinet

3.2.1 It shall be suitable to accommodate one Type B firefighting delivery hose (Reinforced rubber lined, non-Percolating with elastomeric outer coating applied as reinforcement conforming IS 636) of size 63 mm 15 meter long with ends couplings, one jet nozzle with branch pipe or one universal branch pipe.

3.2.2 It shall be capable of being mounted on wall. Necessary hangers and bracket for hose, nozzle and branch pipe or universal branch pipe shall be provided, with the cabinet.

3.2.3 It shall be provided with single panel glass door

3.3 Type II Hose Cabinet

3.3.1 It shall be suitable to accommodate two Type B firefighting delivery hoses (Reinforced rubber lined, non-Percolating with elastomeric outer coating applied as reinforcement conforming IS 636) of size 63 mm, 15 meter long with end couplings, one jet nozzles with branch pipe and one universal branch pipes.

3.3.2 It shall be of self-supporting type, suitable for outside installation. Necessary hangers and brackets for hose, nozzle and branch pipe or universal branch pipe shall be provided within the cabinet.

3.3.3 It hall be provided with double panel glass door.

3.4 Both the types shall be provided with handle type lock, a small recess to keep cabinet key under glass cover, a small hammer secured to the cabinet with a chain to break key glass cover.

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4.0 MATERIAL

4.1 Cabinet shall be made of 18 gauge MS sheet suitably welded with single/double MS door frame glass covered. 3mm Glass with rubber gomet shall be securely fitted to the door frame in a standard manner.

4.2 Door shall be provided with standard handle Mortise type lock.

4.3 Hammer shall be of MS with GI chain.

4.4 Suitable size angle iron posts shall be provided to support type II cabinet.

4.5 Delivery hose shall be either of the following type

a) Type B Reinforced rubber lined hose to I.S. 636

4.6 End couplings, jet nozzle and branch pipe shall conform to I.S. 903.

4.7 Universal branch pipe shall conform to I.S. 2871.

5.0 PAINTING

The hose cabinet shall be painted with 3 coats of anticorrosive fire red paint conforming to shade no. 536 of IS: 5 from outside and white paint from inside. The paint shall conform to IS: 2932.

6.0 MARKING

6.1 Each cabinet shall be clearly and permanently marked with following.

a) The words Hose Cabinet-Type I or II
b) Instructions for use.

6.2 Each equipment in the cabinet shall be marked with BIS certification mark and purchaser's name.

7.0 TESTING

All equipments being supplied with Hose Cabinet shall be tested as per relevant IS test requirements.

8.0 INSPECTION

Owner's / EIL's authorised representative shall have access at all reasonable times to vendor's works where Hose Cabinets and equipments being supplied with Hose Cabinet, are being manufactured and/or tested. Vendor shall arrange for all tests and inspection facilities for checking material, design and construction, hydraulic performance, workmanship, finish and hydrostatic testing. Any shortcoming pointed out shall be rectified to the satisfaction of the inspectors.

9.0 VENDOR's DRAWING AND DATA REQUIREMENT

Vendor shall furnish drawings and data as per "Vendor's drawings and Data Requirements" for information and records.

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डिल्यूज वाल्व स्किड हेतु मानक विनिर्देश

STANDARD SPECIFICATION FOR DELUGE VALVE SKID

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
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3	21.06.18	REVISED AND ISSUED AS STD. SPEC.	BP	DCB	RS	RK TRIVEDI
2	06.07.10	REVISED AND ISSUED AS STD. SPEC.	AS	RKS	RBB	ND
1	01.07.99	REVISED AND ISSUED AS STD. SPEC.	PKT	PCS	MMK	ASONI
0	18.11.92	ISSUED AS STD. SPECIFICATION	SKC	RB	RPB	AS

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Abbreviations:

FM	:	Factory Mutual
IS	:	Indian Standard
lpm	:	Liters per minute
NFPA	:	National Fire Protection Association
SRR	:	Satellite Rack Room
SS	:	Stainless Steel
TAC	:	Tariff Advisory Committee
UL	:	Underwriters Laboratory
DV	:	Deluge Valve
DGFAP	:	Data Gathering and Fire Alarm Panel
F&G PLC	:	Fire & Gas Programmable Logic controller

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1.0 SCOPE

This specification describes design requirements, material of construction, performance and schematic details for deluge valve skid.

2.0 CODES AND STANDARDS

1. NFPA 13
2. NFPA 15
3. NFPA 72
4. Piping Material Specification
5. Job Specification for surface preparation and protective coating
6. 6-44-0012 Specification for fabrication and erection of piping
7. 6-44-0013 Specification for inspection, flushing and testing of piping systems
8. Job Specification for non-destructive examination requirement of piping
9. Job Specification for instrumentation items attached elsewhere

3.0 DESIGN REQUIREMENTS

3.1 A deluge valve skid shall broadly consist of following:

1. Deluge Valve Diaphragm Type
2. Dry pilot basic trim/ Hydraulic Detection, with test and alarm trim and electric release trim
   a. Restriction check valve
   b. Pressure gauge with gauge valve
   c. Emergency release station
   d. Positive drain actuator
   e. Swing check valve
   f. Solenoid valve
   g. Drip valve
   h. Alarm system
   i. Priming connection
   j. Detector pipe work manifold
   k. PT, PA, PG, switches
   l. Local control panel
   m. All instrumentation and erection material such as impulse tubes, pipes, valves, fittings, manifolds for instrumentation mounted on skid.
3. Piping with Matching flange
4. Inlet valve, outlet valve & Bypass valve
5. Cables, Cable glands and PCP shrouds for cables etc. Cables up to Junction Box shall be provided by vendor.
6. Earthing strips and earthing cables for earthing of all instrumentation
7. Insulation and painting of instruments and impulse lines as applicable
8. Any other installation material required for installation and commissioning of various instruments and system supplied by vendor.
9. Any additional instrument required in the opinion of vendor for meeting functional requirements, safe and efficient operation, which is not listed specifically in this document.

Schematic details for Deluge valve skid shall be of following types: (Refer Annexure – A,B C and D)

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1. Deluge Valve Scheme-1, Pneumatic Detection
2. Deluge Valve Scheme-2, Hydraulic Detection
3. Deluge Valve Scheme-3, Pneumatic Detection Security P&ID's
4. Deluge Valve Scheme-4, Hydraulic Detection for Transformers etc.

3.2 Size and working pressure of deluge valve shall be as under:

Size in inch (mm)	Working Pressure (kg/cm^2g)
2 (50)	7.0 to 13.5
3(80)	7.0 to 13.5
4(100)	7.0 to 13.5
6(150)	7.0 to 13.5
8(200)	7.0 to 13.5

3.3 The deluge valve shall be provided with solenoid operated release valve for remote operation in addition to automatic operation of deluge valve. The deluge valve and its accessories shall be provided as per the relevant area classification.

4.0 MATERIAL OF CONSTRUCTION

4.1 For non saline water service

Deluge Valve	
Body/ Housing & Cover	Cast Steel (ASTM A 216 WCB) / Ductile Iron (ASTM A 536-77 GRADE 65-45-12) / Cast iron to IS:210 Gr. FG 260
Seat, Clapper, Clamp Ring	Bronze
Diaphragm spindle and Hinged pin	SS 304
All piping, fittings, valves, strainers etc.	PMS CLASS of project
Skid	Carbon steel construction with provision of bolts for securing it firmly to foundation pedestal
Canopy	FRP (Canopy shall be provided over local control panel)

4.2 For saline water service, body shall be aluminum bronze. Test and drain valve, installation stop valve, outlet valve and check valve shall be cast steel with internal epoxy lining.

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5.0 CONSTRUCTION AND PERFORMANCE

Entire Deluge Valve assembly with all fittings and instrument including bypass valve and strainers shall be incorporated into a single self-contained skid, of appropriate size and strength.

5.1 The deluge valve unit shall be provided with a clack to keep the valve close through a diaphragm unit.

5.2 The deluge valve shall also be fitted with an integral test and drain manifold. It shall consist of 50mm test and drain valve and a drip plug.

5.3 The test valve shall allow water to flow through the deluge valve to drain during testing of deluge valve and to drain water from distribution pipe after fire. At open position, the valve clack shall be held against its seating by an internal compression spring of sufficient strength to keep it in closed position till the pressure acting on underside of it does not exceed approximately 0.5 kg/cm^2. The clack will open when pressure exceeds 0.5kg/cm^{2}g.

5.4 The drain valve shall drain all the water from the deluge valve body and the outlet connections during maintenance of the deluge valve. The drain pipe work is to be designed to periodically check the rate of flow available in the system to satisfy the requirements appropriate to the hazard class for which the deluge valve is provided. Flow measurement shall be checked with differential pressure.

Water operated alarm motor gang shall be connected to the test and drain valve so that it gives an alarm as the deluge valve opens.

5.5 In hydraulic detector network, tapping from fire water network shall be taken. Check valve, strainer and restricted orifice shall be provided in the detector network. Piping shall be as per relevant piping material specifications. Refer Annexure A, B, C and D for schematic details for deluge valve skid.

5.6 In addition to above, pressure transmitters on the detection and actuation piping, Solenoid operated valve on priming chamber drain line, push buttons and lamps as per attached schematics shall be provided as a minimum requirement. Alarm set values shall also be provided by vendor.

5.6.1 For schemes-1, 2 & 3 (e.g.. applications other than Transformer fire protection), Alarm values provided by vendor shall be configured in Purchaser's F&G PLC system. When fire occurs and deluge valve opens, the alarm shall be given in local control panel, control room and fire station. Deluge valve shall be operated automatically via detection system as well as through interlock of F&G PLC system. Provision shall also be kept to manually operate the solenoid valve through push buttons provided in the local control panel and from F&G console in the control room / fire station.

5.6.2 For scheme-4 (e.g.. Deluge system for transformer fire protection), Alarm values provided by vendor shall configured within the local control panel. When fire occurs and deluge valve opens, the alarm shall be provided in local control panel, DGFAP and fire station. Deluge valve shall be operated automatically via detection system equipped with QBDs. Provision shall also be kept to manually operate the solenoid valve through push buttons provided on local control panel.

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5.7 Installation of valve, check valve, strainer etc. required as per deluge valve schematic shall be as per the relevant piping material specification. In addition, following provisions shall be made:

Both the valves (u/s and d/s of deluge valve) must be strapped (not chained) and padlocked in open position at all normal times.

5.8 The deluge valve shall be tested for operation/ opening at set pressure and operation of the alarms at set pressures. Restricted orifice provided in QBD line shall be sized such that breakage of one quartzoid bulb will lead to pressure drop in line. Hence, lead to DV actuation.

5.9 For testing and setting of deluge valve, a priming valve and a vent valve shall be provided with deluge valve assembly. At all normal times and when testing the deluge valve according to various tests required, the body of the deluge valve shall remain full of water.

5.10 Pressure gauge shall be fitted immediately above the deluge valve on water supply line. Pressure gauges shall be provided for 1-15 Kg/cm^2 range.

5.11 The complete deluge valve skid assembly shall be of good workmanship and finish, and it shall be free from burrs and sharp edges. All waterways shall have smooth finish.

5.12 The deluge valve , inlet / outlet isolation valve, bypass valve shall be tested for a test pressure of 28.5kg/cm^{2}g.

6.0 APPROVALS

The deluge valve shall be UL/ FM approved.

7.0 INSPECTION AND MARKING

7.1 EIL or its authorised representatives/ third party inspection agency shall have access at all reasonable times, to the manufacturer's works where the deluge valve skid assemblies are being manufactured or being tested.

7.2 Deluge valve assembly shall be clearly and permanently marked with the purchaser's name, design and test pressure, UL/ FM approval.

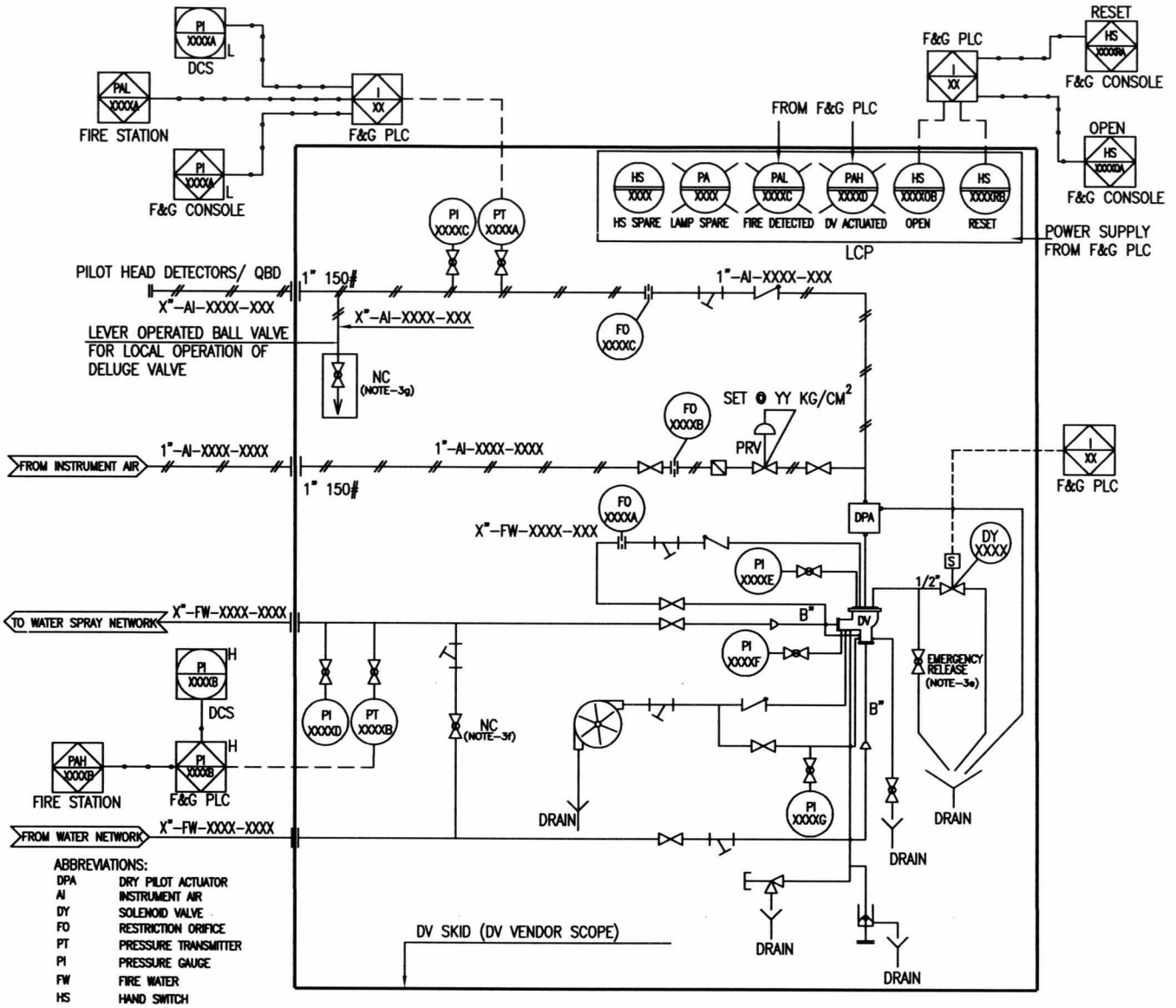
8.0 INFORMATION REQUIRED FROM VENDOR

Vendor Data Requirement shall be as per VDR document attached separately with the tender/MR document.

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Annexure-A : Deluge Valve Scheme-1(Pneumatic Detection)

DV skid nomenclature: A" X B" ([Fire water inlet and outlet size to DV skid] X [DV size])



ABBREVIATIONS:

DPA	DRY PILOT ACTUATOR
AI	INSTRUMENT AIR
DY	SOLENOID VALVE
FO	RESTRICTION ORIFICE
PT	PRESSURE TRANSMITTER
PI	PRESSURE GAUGE
FW	FIRE WATER
HS	HAND SWITCH
F&G PLC	FIRE & GAS PROGRAMMABLE LOGIC CONTROLLER
DV	DELUGE VALVE
PAL	PRESSURE ALARM LOW
PAH	PRESSURE ALARM HIGH
PRV	PRESSURE REGULATOR
NO	NORMALLY OPEN
NC	NORMALLY CLOSED
QBD	QUARTZOID BULB DETECTOR

CAUSE & EFFECT DIAGRAM:

CAUSE \ EFFECT	Action	Description	Tag	No.
	Open	Deluge Valve SOV	DY-XXXX	1
	Reset	Deluge Valve SOV	DY-XXXX	2
	ON	Fire Detected Lamp at LCP	I/AL-XXXXC	3
	ON	DV Actuated Lamp at LCP	I/AH-XXXXD	4

No.	Description	Tag no.	Signal Type	From	Condition	F&G PLC Action			
1	Detection Line Pressure	PT-XXXXA	AI	Field	Low	X		X	
2	DV Actuation Line Pressure	PT-XXXXB	AI	Field	High				X
3	Open Soft hand switch at HMI	HS-XXXXOA	Soft	CR		X			
4	Reset Soft hand switch at HMI	HS-XXXXRA	Soft	CR			X		
5	Open Push Button at LCP	HS-XXXXOB	DI	Field	Close	X			
6	Reset Push Button at LCP	HS-XXXXRB	DI	Field	Close		X		

LEGENDS:

- FRANGIBLE BULB/ QBD
- REDUCER
- DV — DELUGE VALVE
- DRLV — DRIP VALVE
- PRV — PRESSURE REGULATOR
- FILTER
- DY — SOLENOID OPERATED VALVE (AUTO RESET)
- BALL VALVE
- GATE VALVE
- WATER MOTOR GONG (ALARM)
- NON RETURN VALVE
- DRAIN VALVE
- ANGLE VALVE
- STRAINER
- DPA — DRY PILOT ACTUATOR

SIGNALS & INDICATIONS

- PNEUMATIC LINE
- INSTRUMENT SIGNAL
- SOFT SIGNAL
- SOFT INDICATION
- I XX — INTERLOCK
- LCP MOUNTED(LAMP)
- LCP MOUNTED

"YY" BY DELUGE VALVE SUPPLIER

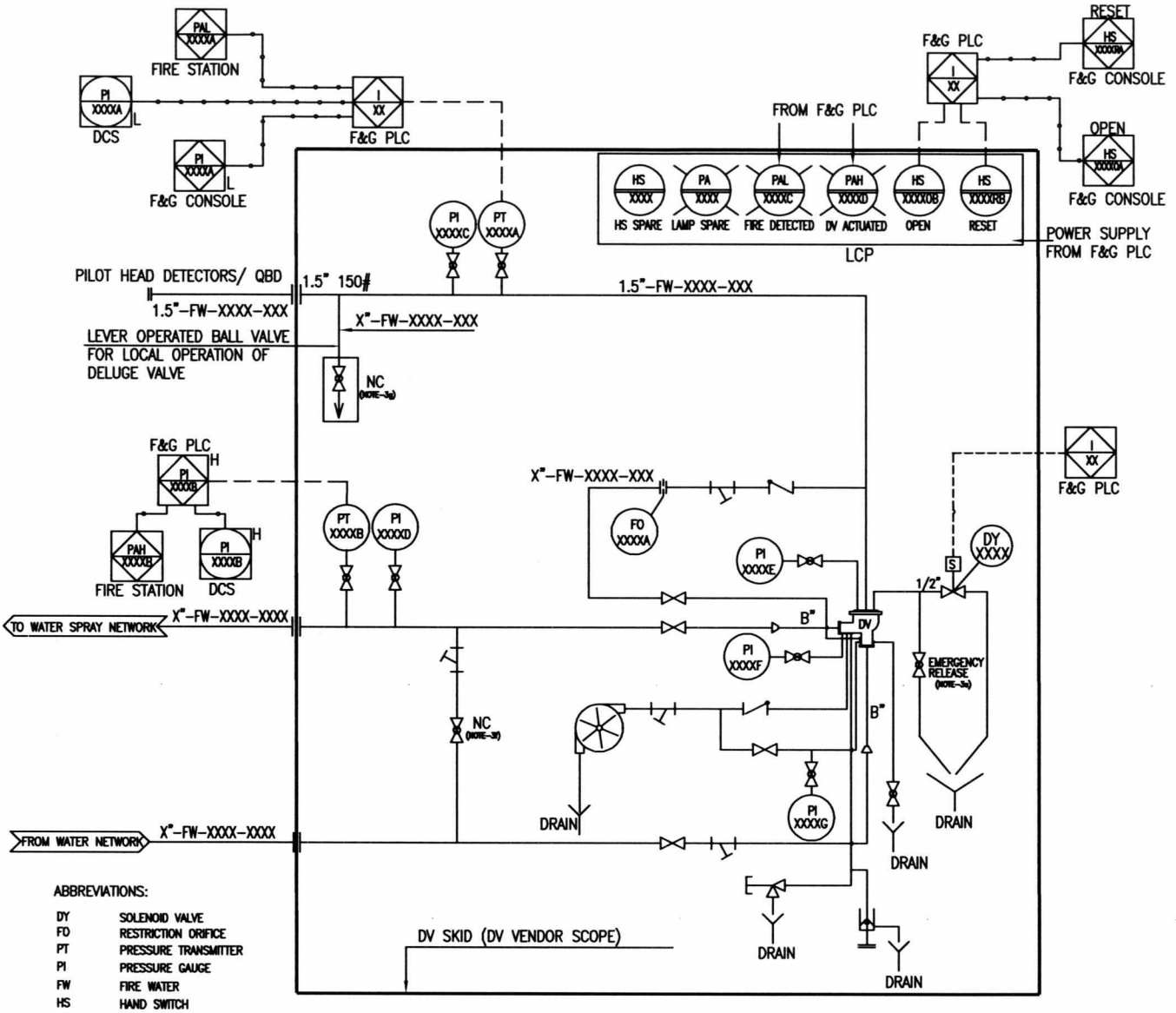
NOTES:

1. DURING NORMAL CONDITION INSTRUMENT AIR SUPPLY SHALL KEEP LINE PRESSURISED TO CLOSE THE DELUGE VALVE.
2. RESTRICTION ORIFICE PROVIDED IN QBD LINE SHALL BE SIZED SUCH THAT BREAKAGE OF ONE QUARTZOID BULB WILL LEAD TO PRESSURE DROP IN LINE CAUSING DV ACTUATION.
3. VARIOUS METHODS OF DV ACTUATION ARE AS UNDER:
   a. AUTOMATIC ACTUATION THROUGH PRESSURE DROP IN DETECTION LINE.
   b. AUTOMATIC ACTUATION THROUGH F&G INTERLOCK.
   c. MANUAL/LOCAL ACTUATION THROUGH HAND SWITCH PROVIDED IN LCP.
   d. REMOTE ACTUATION THROUGH SOFT HANDSWITCH IN F&G PLC CONSOLE.
   e. MANUAL/LOCAL ACTUATION THROUGH EMERGENCY RELEASE.
   f. MANUAL/LOCAL ACTUATION USING BYPASS VALVE.
   g. MANUAL/LOCAL ACTUATION USING DETECTION LINE DRAIN VALVE.

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Annexure-B : Deluge Valve Scheme-2(Hydraulic Detection)

DV skid nomenclature: A" X B" ([Fire water inlet and outlet size to DV skid] X [DV size])



ABBREVIATIONS:

DY	SOLENOID VALVE
FD	RESTRICTION ORIFICE
PT	PRESSURE TRANSMITTER
PI	PRESSURE GAUGE
FW	FIRE WATER
HS	HAND SWITCH
F&G PLC	FIRE & GAS PROGRAMMABLE LOGIC CONTROLLER
DV	DELUGE VALVE
PAL	PRESSURE ALARM LOW
PAH	PRESSURE ALARM HIGH
NO	NORMALLY OPEN
NC	NORMALLY CLOSED
QBD	QUARTZOID BULB DETECTOR

LEGENDS:

- FRANGIBLE BULB/ QBD
- REDUCER
- DV DELUGE VALVE
- DRIP VALVE
- DY SOLENOID OPERATED VALVE (AUTO RESET)
- BALL VALVE
- GATE VALVE
- WATER MOTOR GONG (ALARM)
- NON RETURN VALVE
- DRAIN VALVE
- ANGLE VALVE
- STRAINER

SIGNALS & INDICATIONS

- INSTRUMENT SIGNAL
- SOFT SIGNAL
- SOFT INDICATION
- I XX INTERLOCK
- LCP MOUNTED(LAMP)
- LCP MOUNTED

CAUSE & EFFECT DIAGRAM:

CAUSE \ EFFECT						Action	Open	Reset	ON	ON
						Description	Deluge Valve SOV	Deluge Valve SOV	Fire Detected Lamp at LCP	DV Actuated Lamp at LCP
						Tag	DY-XXXX	DY-XXXX	PAL-XXXXC	PAH-XXXXD
No.	Description	Tag no.	Signal Type	From	Condition	No.	1	2	3	4
							F&G PLC Action			
1	Detection Line Pressure	PT-XXXXA	AI	Field	Low		X		X	
2	DV Actuation Line Pressure	PT-XXXXB	AI	Field	High					X
3	Open Soft hand switch at HMI	HS-XXXXOA	Soft	CR			X			
4	Reset Soft hand switch at HMI	HS-XXXXRA	Soft	CR				X		
5	Open Push Button at LCP	HS-XXXXOB	DI	Field	Close		X			
6	Reset Push Button at LCP	HS-XXXXRB	DI	Field	Close			X		

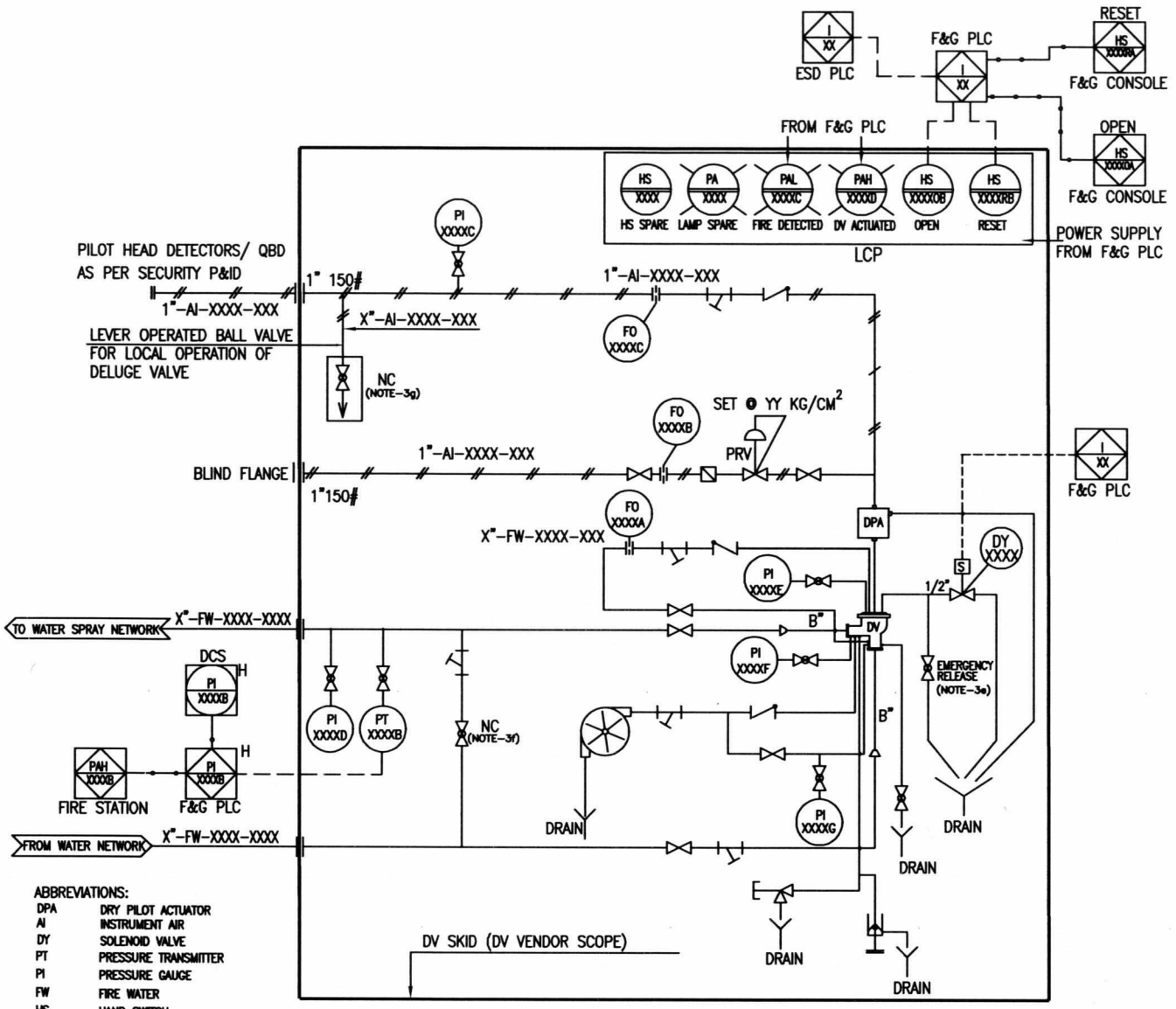
NOTES:

1. DURING NORMAL CONDITION FIRE WATER SUPPLY SHALL KEEP LINE PRESSURISED TO CLOSE THE DELUGE VALVE.
2. RESTRICTION ORIFICE PROVIDED IN QBD LINE SHALL BE SIZED SUCH THAT BREAKAGE OF ONE QUARTZOID BULB WILL LEAD TO PRESSURE DROP IN LINE CAUSING DV ACTUATION.
3. VARIOUS METHODS OF DV ACTUATION ARE AS UNDER:
   a. AUTOMATIC ACTUATION THROUGH PRESSURE DROP IN DETECTION LINE.
   b. AUTOMATIC ACTUATION THROUGH F&G INTERLOCK.
   c. MANUAL/LOCAL ACTUATION THROUGH HAND SWITCH PROVIDED IN LCP.
   d. REMOTE ACTUATION THROUGH SOFT HANDSWITCH IN F&G PLC CONSOLE.
   e. MANUAL/LOCAL ACTUATION THROUGH EMERGENCY RELEASE.
   f. MANUAL/LOCAL ACTUATION USING BYPASS VALVE.
   g. MANUAL/LOCAL ACTUATION USING DETECTION LINE DRAIN VALVE.

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Annexure-C : Deluge Valve Scheme-3(Pneumatic Detection Security P&ID's)

DV skid nomenclature: A" X B" ([Fire water inlet and outlet size to DV skid] X [DV size])



ABBREVIATIONS:

DPA	DRY PILOT ACTUATOR
AI	INSTRUMENT AIR
DY	SOLENOID VALVE
PT	PRESSURE TRANSMITTER
PI	PRESSURE GAUGE
FW	FIRE WATER
HS	HAND SWITCH
F&G PLC	FIRE & GAS PROGRAMMABLE LOGIC CONTROLLER
DV	DELUGE VALVE
PAL	PRESSURE ALARM LOW
PAH	PRESSURE ALARM HIGH
PRV	PRESSURE REGULATOR
QBD	QUARTZOID BULB DETECTOR

CAUSE & EFFECT DIAGRAM:

No.	Description	Tag no.	Signal Type	From	Condition	Type	Action	Open	Reset	ON	ON
							Description	Deluge Valve SOV	Deluge Valve SOV	Fire Detected Lamp at LCP	DV Actuated Lamp at LCP
							Tag	DY-XXXX	DY-XXXX	PAL-XXXXC	PAH-XXXXD
							No.	1	2	3	4
								F&G PLC Action			
1	Detection line Pressure transmitter(s)	##	AI	CR	Low	1ooN		x		x	
2	Trip from ESD on Manual Interlock actuation	XS-XXXX	DI	CR	Close			x			
3	DV Actuation Line Pressure	PT-XXXXB	AI	Field	High						x
4	Open Soft hand switch at HMI	HS-XXXXOA	Soft	CR				x			
5	Reset Soft hand switch at HMI	HS-XXXXRA	Soft	CR					x		
6	Open Push Button at LCP	HS-XXXXOB	DI	Field	Close			x			
6	Reset Push Button at LCP	HS-XXXXRB	DI	Field	Close				x		

Refer C&E of Security System P&ID.

LEGENDS:

- REDUCER
- DV — DELUGE VALVE
- DRIP VALVE
- DY — SOLENOID OPERATED VALVE (AUTO RESET)
- BALL VALVE
- GATE VALVE
- WATER MOTOR GONG (ALARM)
- ANGLE VALVE
- STRAINER
- DPA — DRY PILOT ACTUATOR
- NON RETURN VALVE
- PRV — PRESSURE REGULATOR
- FILTER

SIGNALS & INDICATIONS

- PNEUMATIC LINE
- INSTRUMENT SIGNAL
- SOFT SIGNAL
- SOFT INDICATION
- XX — INTERLOCK
- LCP MOUNTED(LAMP)
- LCP MOUNTED

"YY" BY DELUGE VALVE SUPPLIER

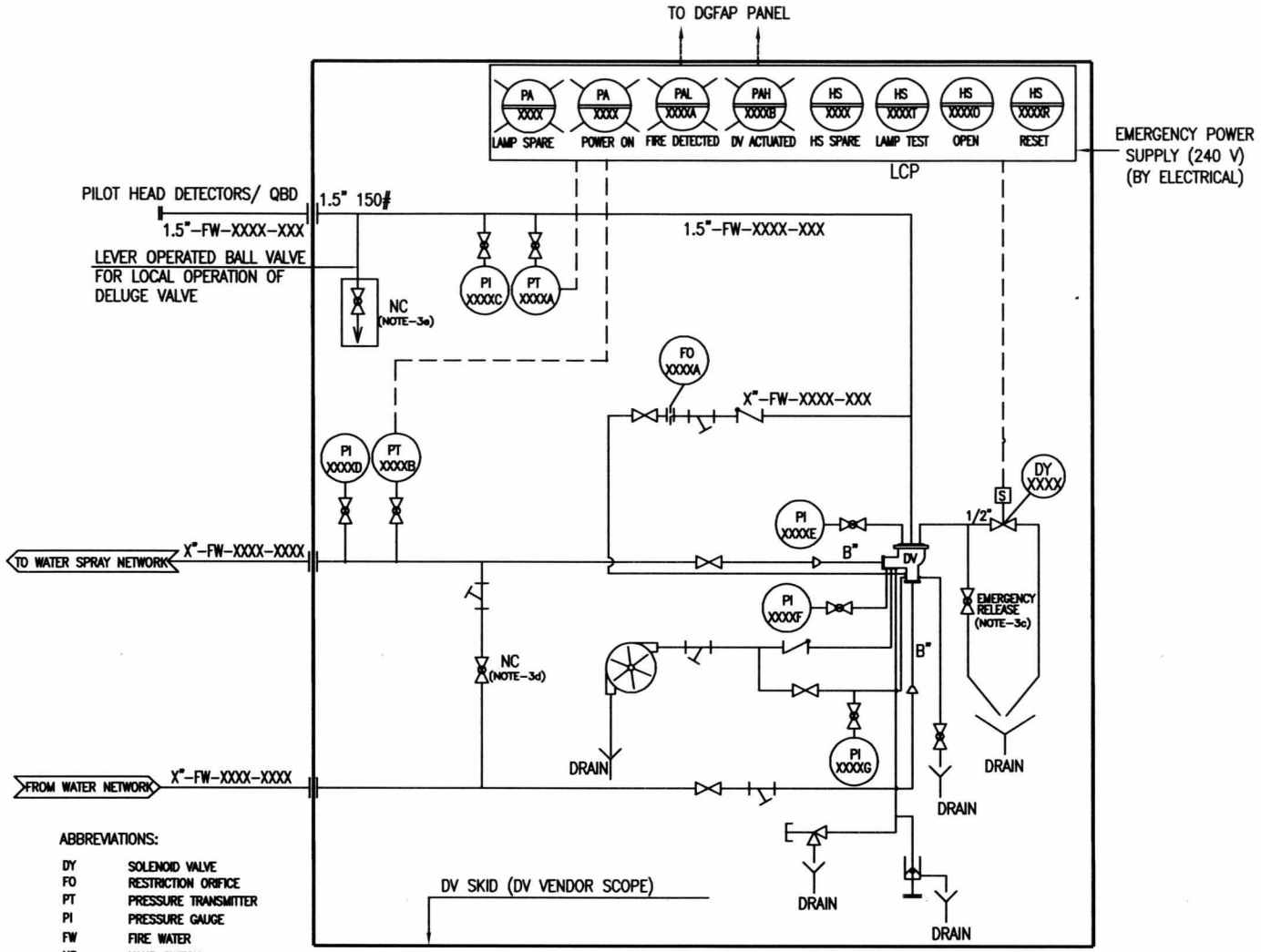
NOTES:

1. DURING NORMAL CONDITION INSTRUMENT AIR SUPPLY SHALL KEEP LINE PRESSURISED TO CLOSE THE DELUGE VALVE.
2. RESTRICTION ORIFICE PROVIDED IN QBD LINE SHALL BE SIZED SUCH THAT BREAKAGE OF ONE QUARTZOID BULB WILL LEAD TO PRESSURE DROP IN LINE CAUSING DV ACTUATION.
3. VARIOUS METHODS OF DV ACTUATION ARE AS UNDER:
   a. AUTOMATIC ACTUATION THROUGH PRESSURE DROP IN DETECTION LINE.
   b. AUTOMATIC ACTUATION THROUGH F&G INTERLOCK.
   c. MANUAL/LOCAL ACTUATION THROUGH HAND SWITCH PROVIDED IN LCP.
   d. REMOTE ACTUATION THROUGH SOFT HANDSWITCH IN F&G PLC CONSOLE.
   e. MANUAL/LOCAL ACTUATION THROUGH EMERGENCY RELEASE.
   f. MANUAL/LOCAL ACTUATION USING BYPASS VALVE.
   g. MANUAL/LOCAL ACTUATION USING DETECTION LINE DRAIN VALVE.
4. PRESSURE TRANSMITTER(S) ON THE DETECTION LINE ARE LOCATED OUTSIDE THE SCHEME. SAME SHALL BE CONNECTED TO ESD PLC AND FURTHER CONNECTED TO F&G PLC.
5. "OPEN DV" HAND SWITCH SHALL ACTUATE THE DELUGE VALVE ONLY.
6. "RESET DV" HAND SWITCH SHALL RESET THE DELUGE VALVE ONLY.

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Annexure-D: Deluge Valve Scheme-4(Hydraulic Detection for Transformers etc.)

DV skid nomenclature: A" X B" ([Fire water inlet and outlet size to DV skid] X [DV size])



ABBREVIATIONS:

DY	SOLENOID VALVE
FO	RESTRICTION ORIFICE
PT	PRESSURE TRANSMITTER
PI	PRESSURE GAUGE
FW	FIRE WATER
HS	HAND SWITCH
DGFAP	DATA GATHERING & FIRE ALARM PANEL
DV	DELUGE VALVE
PAL	PRESSURE ALARM LOW
PAH	PRESSURE ALARM HIGH
QBD	QUARTZOID BULB DETECTOR

CAUSE & EFFECT DIAGRAM:

No.	Description	Tag no.	Signal Type	From	Condition
1	Detection Line Pressure	PT-XXXXA	AI	Field	Low
2	DV Actuation Line Pressure	PT-XXXXB	AI	Field	High
3	Open Push Button at LCP	HS-XXXXO	DI	Field	Close
4	Reset Push Button at LCP	HS-XXXXR	DI	Field	Close
5	Test Push Button at LCP	HS-XXXXT	DI	Field	Close

EFFECT / CAUSE	Description	Tag	Action
	Deluge Valve SOV	DY-XXXX	Open
	Deluge Valve SOV	DY-XXXX	Reset
	Fire Detected Lamp at LCP	PAL-XXXXA	ON
	DV Actuated Lamp at LCP	PAH-XXXXB	ON
	Fire Detected to DGFAP	PAL-XXXXC	Contact Close
	DV Actuated to DGFAP	PAH-XXXXD	Contact Close
Relay Logic Action	No.	1	2	3	4	5	6
1				X		X	
2					X		X
3		X					
4			X				
5				X	X		

LEGENDS:

- FRANGIBLE BULB/ QBD
- REDUCER
- DELUGE VALVE
- DRIP VALVE
- SOLENOID OPERATED VALVE (AUTO RESET)
- BALL VALVE
- GATE VALVE
- WATER MOTOR GONG (ALARM)
- NON RETURN VALVE
- DRAIN VALVE
- ANGLE VALVE
- STRAINER

SIGNALS & INDICATIONS

- INSTRUMENT SIGNAL
- LCP MOUNTED(LAMP)
- LCP MOUNTED

NOTES:

1. DURING NORMAL CONDITION FIRE WATER SUPPLY SHALL KEEP LINE PRESSURISED TO CLOSE THE DELUGE VALVE.
2. RESTRICTION ORIFICE PROVIDED IN QBD LINE SHALL BE SIZED SUCH THAT BREAKAGE OF ONE QUARTZOID BULB WILL LEAD TO PRESSURE DROP IN LINE CAUSING DV ACTUATION.
3. VARIOUS METHODS OF DV ACTUATION ARE AS UNDER:
   a. AUTOMATIC ACTUATION THROUGH PRESSURE DROP IN DETECTION LINE.
   b. MANUAL/LOCAL ACTUATION THROUGH HAND SWITCH PROVIDED IN LCP.
   c. MANUAL/LOCAL ACTUATION THROUGH EMERGENCY RELEASE.
   d. MANUAL/LOCAL ACTUATION USING BYPASS VALVE.
   e. MANUAL/LOCAL ACTUATION USING DETECTION LINE DRAIN VALVE.
4. OPEN & RESET SHALL BE SEPARATE CONTACTS & LATCHING SHALL BE DONE AT LCP.
5. PRESSING OF "LAMP TEST" HAND SWITCH SHALL ACTIVATE ALL LAMPS IN THE LCP.

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50 के०जी० तथा 75 के०जी० क्षमता के सूखा रसायन पाउडर अग्निशामक हेतु मानक विनिर्देश

STANDARD SPECIFICATION FOR 50 KG. & 75 KG. CAPACITY DRY CHEMICAL POWDER EXTINGUISHER

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved By	
4	24.08.18	REVISED & ISSUED AS STD. SPEC.	GAURAV SINGH	GYAS	RS	RKT
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1	25.6.99	REVISED AND ISSUED AS STD. SPEC.	RC	PCS	MMK	AS
0	18.1.93	ISSUED AS STANDARD SPECIFICATION	RB	MMK	RPB	RNS

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Abbreviations:

DCP	DRY CHEMICAL POWDER
IS	INDIAN STANDARD
OISD	OIL INDUSTRY SAFETY DIRECTORATE
PESO	PETROLEUM EXPLOSIVE SAFETY ORGANISATION (Formerly known as CCOE)

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1.0 SCOPE

This specification lays down the requirements regarding material, shape, construction, chemical charges, anticorrosive treatment, painting, test, safety, reliability and performance for trolley mounted dry powder fire extinguishers of capacities 50 kg and 75 kg.

2.0 CODES AND STANDARDS

IS: 16018	Specification for performance and construction of wheeled fire Extinguisher
OISD-GDN-115	Guidelines on Fire Fighting, Equipment and Appliances in Petroleum Industry

Note: - Latest Edition of all standard documents shall be followed.

3.0 DESIGN REQUIREMENTS

3.1 Fire extinguisher shall be as per IS: 16018.

3.2 The method of expulsion of dry powder shall be by means of pressure produced from compressed or liquefied gas from gas cylinder attached to the body and suitably mounted on trolley.

3.3 Propellant for cartridge operated wheeled fire extinguisher shall be CO_2 gas type and having maximum dew point of -55°C.Gas cartridge shall conform to IS 4947 in all aspects.

3.4 Chemical content for Dry chemical powder used as extinguishing media shall cover more than 50% of Mono ammonium phosphates of total composition of the extinguishing powder, and shall comply with IS 14609, with maximum fill density as specified in IS: 16018.

3.5 The recommended capacity with filling tolerance/ Nominal charge of the dry powder extinguisher when filled for the various capacities shall be as under:

Nominal Size (Kg)	Dry Powder content (Kg. minimum.)
50	50 ±2% by mass
75	75±2% by mass

4.0 MATERIAL OF CONSTRUCTION

4.1 The material ~~of~~ for construction of various parts of Fire Extinguisher shall be as per IS: 16018.

4.2 The body shall be cylindrical made up of welded Low carbon steel (Mild steel) / stainless Steel. The welding of cylinder shall conforming to requirements of IS 9595.

4.3 All internal and external surface of the body shall be completely coated with an anti corrosive Material. Thickness of the coating shall be measured as per IS: 3203. Testing of anti-corrosive Treatment shall be complying with IS: 10658.

5.0 SAFETY CLIP

Safety Clip should be provided to prevent accidental actuation of piercing mechanism.

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6.0 COLOUR AND MARKING

Each extinguisher shall be painted fire red confirming to shade No. 536 of IS 5. Each extinguisher shall be clearly and permanently marked with the information specified in IS: 16018 along with the BIS certification mark, operating instruction and purchaser's name.

7.0 TESTING INSPECTION AND APPROVALS

Each fire extinguisher shall be complying with test requirement specified in IS: 16018
Wheeled fire extinguishers intended for use on class ABC fires shall be tested for 6A and 144B fire rating system as specified in IS 15683.

A clearance/approval certificate from the PESO, Nagpur shall be submitted for each gas cartridge supplied with the DCP extinguishers.

EIL or its authorised representatives shall have access at all reasonable times to the manufacturer's works where the extinguishers are being manufactured or being tested.

8.0 INFORMATION REQUIRED FROM VENDOR

8.1 The vendor shall furnish the following information along with the offer and for approval prior to fabrication.

- General arrangement of trolley mounted extinguisher showing plan and elevation.
- Fabrication details and plate thickness calculation for pressure vessel.
- Catalogues for all bought out items with Model No. If any.

8.2 Following information shall be furnished by the vendor along with the supply of extinguisher:

- Instruction book(s) - Instruction book(s) for guidance of the user including both the operating and normal maintenance procedures shall be supplied. The book(s) shall include an itemized and illustrated part list/spare parts list giving reference number of all the wearing parts.
- Duly approved final drawings listed in clause 8.1.
- A clearance/approval certificate from PESO as described in clause 7.

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मानक विनिर्देशन
सिविल एवं संरचनात्मक कार्य

STANDARD SPECIFICATION
CIVIL AND STRUCTURAL WORKS

सामान्य परिधि
GENERAL SCOPE

Rev No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	28.02.2025	REVISED AND REISSUED AS SPECIFICATION	RGA	VIKRAM	AS	MN
5	04.07.2019	REAFFIRMED AND REISSUED AS SPECIFICATION	AVM	AJS	RS	RKT
4	28.03.2013	REAFFIRMED AND REISSUED AS SPECIFICATION	AJS	RS	PKM	DM
3	26.02.2008	REAFFIRMED AND REISSUED AS SPECIFICATION	PKB	PKM	VK	VC
2	08.06.2001	REAFFIRMED AND REISSUED AS SPECIFICATION	DPN	RPM	SCJ	MI
1	02.03.1994	ISSUED AS STD. SPECIFICATION		HM	GPL	AS

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Abbreviations:

IS : Indian Standards

Structural Standards Committee:

Convenor: Mr. Anurag Sinha

Members:
Mr. Virender Goel
Mr. Deepak Agrawal
Ms. Alpana Srivastava
Dr. Sudip Paul
Mr. Charanjit Singh (Projects)
Mr. Indrajit Neog (Construction)
Ms. Papia Mandal
Mr. Vikram Kumar Gupta

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1. These specifications establish and define the material and constructional requirements for CIVIL and STRUCTURAL WORKS.

2. Methods of measurements are indicated in these specifications; however, if not specified, latest revision of IS 1200 shall be applicable.

3. Providing and operating all necessary measuring and testing devices/ equipments including all materials and consumables are included in the scope of work. No separate measurement or payment for testing the quality of work and materials shall be made; rates quoted for various items shall be deemed to include the cost of such tests which are required to ensure achievement of specified quality.

4. All materials shall be of standard quality, manufactured by renowned concerns conforming to Indian Standards or equivalent, and shall have IS mark as far as possible unless otherwise approved by the Engineer-in-Charge. Wherever Vendor List is attached in the Tender document, the same shall be followed. The Contractor shall get all materials approved by the Engineer-in-Charge prior to procurement and use. The Contractor shall furnish manufacturer's certificates for the materials supplied by him when asked for. Further to that he shall get the materials tested from an approved test house if asked for by the Engineer-in- Charge. The cost for all the tests and test certificates for the material procured by the Contractor shall be borne by the Contractor. No separate payment shall be made for the testing. The Engineer-in-Charge shall have the right to determine whether all or any of the materials are suitable. Any materials procured or brought to site and not conforming to specifications and satisfaction of the Engineer-in-Charge shall be rejected and the Contractor shall have to remove the same immediately from site at his own expense and without any claim for compensation due to such rejection.

5. Wherever referred to in the tender document, only the latest version of BIS Specifications, Codes of Practice, etc. shall be applicable.

6. Wherever the Contractor executes civil and structural works involving buildings, equipment foundations, supporting structures, pipe racks, etc., the following works are deemed to have been included in the quoted rates for various works.

   - Marking of centre lines of foundations etc.
   - Establishing layout and levels of foundations and superstructure etc., including establishment of reference lines, bench marks on various floors, platforms etc.
   - General upkeep of the construction site, till completion of works and handing over.
   - Preparation of BBS.
   - Preparation of Fabrication drawings and getting approval from Engineer-in-Charge after incorporating all the comments.
   - Preparation of "As-Built" scheme of civil-structural drawings indicating constructed details including levels, centre lines, layouts, member sizes, MTO etc. complete.

7. The provisions of Schedule of Rates, specifications and drawings shall be read in conjunction with each other and in case of conflict amongst them, clarification shall be obtained from the Engineer-in-Charge whose decision shall be final and binding. However, the following procedure may generally be followed:

   - Description of items in schedule of rates shall be followed when provisions therein are different from those in specifications.

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- Where the description of item does not call for some specific requirement but the same is given in specifications, the specifications shall be followed in addition to the requirement given in description of item.

- Where drawings call for requirements different from or additional to those given in item description and specifications, the decision of the Engineer-in-Charge shall be obtained as to what shall be followed.

- All relevant General notes and Safety notes shall be followed

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सिविल एवं संरचनात्मक कार्य

STANDARD SPECIFICATION
CIVIL & STRUCTURAL WORKS

सामग्री
MATERIALS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
7	13.03.25	UPDATED & REISSUED	MI	AJS	ANURAG SINHA	M. NANDI
6	25.02.21	UPDATED & REISSUED	TK	AJS	AS	S.MAZUMDAR
5	16.05.16	UPDATED & REISSUED	MK	AJS	RS	R.NANDA
4	21.08.14	UPDATED & REISSUED	ASR	AS	PKM	S.CHANDA
3	19.06.09	REAFFIRMED & REISSUED	AS	SCH	VINAY KUMAR	N. DUARI
2	18.02.00	UPDATED & REISSUED	DPN	SKP	SC JAIN	A. SONI

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Abbreviations:

API	:	American Petroleum Institute
ASTM	:	American Society for Testing & Materials
BIS	:	Bureau of Indian Standards
BS	:	British Standard
C&D Waste	:	Construction and Demolition Waste
DIN	:	Deutsches Institut' für Normung
EC	:	Emulsifiable Concentrate
IS	:	Indian Standards
PCC	:	Plain Cement Concrete
PVC	:	Poly Vinyl Chloride
RA	:	Recycled Aggregates
RCA	:	Recycled Concrete Aggregates
RCC	:	Reinforced Cement Concrete

Structural Standards Committee

Convenor: **Mr. Anurag Sinha**

Members:
Mr. Virender Goel
Mr. Deepak Agrawal
Ms. Alpana Srivastava
Dr. Sudip Paul
Ms. Papia Mandal
Mr. Vikram Kumar Gupta
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1.0 SCOPE

1.1 This specification establishes and defines the requirements of various materials to be used in Civil and Structural works.

1.2 Whenever any reference to BIS Codes is made, the same shall be taken as the latest revision (with all amendments issued thereto) as on the date of submission of the bid.

1.3 Apart from the BIS Codes mentioned in particular in the various clauses of this specification, all other relevant codes related to specific job under consideration regarding quality, tests, testing and/ or inspection procedures shall be applicable. Reference to some of the Codes in the various clauses of this specification does not limit or restrict the scope of applicability of other referred or relevant codes.

1.4 In case of any variation/contradiction between the provision of BIS Codes and this specification, the provision given in this specification shall be followed.

1.5 All materials shall be of standard quality and shall be procured from renowned sources/ manufacturers approved by the Engineer-in-Charge. It shall be the responsibility of the Contractor, to get all materials/ manufacturers approved by the Engineer-in-Charge prior to procurement and placement of order.

1.6 Whenever called for by the Engineer-in-Charge all tests of the materials as specified by the relevant BIS Codes shall be carried out by the Contractor in an approved laboratory and test reports duly authenticated by the laboratory, shall be submitted to the Engineer-in-Charge for his approval. If so desired by the Engineer-in-Charge, tests shall be conducted in the presence of the Engineer-in-Charge or his authorized nominee.

1.7 Quality and acceptability of materials not covered under this specification shall be governed by the relevant BIS Codes. In case BIS code is not available for the particular material, other codes e.g. BS or DIN or API/ ASTM shall be considered. The decision of Engineer-in-Charge, in this regard, shall be final and binding on the Contractor.

1.8 Whenever asked for, the Contractor shall submit representative samples of materials to the Engineer-in-Charge for his inspection and approval. Approval of any sample does not necessarily exempt the Contractor from submitting necessary test reports for the approved material, as per the specification/relevant BIS Codes.

1.9 The Contractor shall submit manufacturer's test reports on quality and suitability of any material procured from them and their recommendation on storage, application, workmanship etc. for the intended use. Submission of manufacturer's test reports does not restrict the Engineer-in-Charge from asking fresh test results from an approved laboratory of the actual material supplied from an approved manufacturer/ source at any stage of execution of work.

1.10 All costs relating to or arising out of carrying out the tests and submission of test reports and or samples to the Engineer-in-Charge for his approval during the entire tenure of the work shall be borne by the contractor and included in the quoted rates.

1.11 Materials for approval shall be separately stored and marked, as directed by the Engineer-in-Charge and shall not be used in the works till these are approved.

1.12 All rejected materials shall be immediately removed from the site by the Contractor at his own cost.

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2.0 REFERENCES

As mentioned in the respective clauses.

3.0 WATER

3.1 Water used in construction for all civil & structural works shall be clean and free from injurious amount of oil, acids, alkalies, organic matters or other harmful substances which may be deleterious to concrete, masonry or steel. The pH value of water sample shall be not less than 6. Potable water shall be considered satisfactory. Underground water can also be used with the prior approval of Engineer-in-Charge, if it meets all the requirements of IS 456.

3.2 Tests on water samples shall be carried out in accordance with IS 3025 and they shall fulfill all the guidelines and requirements given in IS 456.

3.3 The Engineer-in-Charge may require the Contractor to prove, that the concrete prepared with water, proposed to be used, shall have average 28 days compressive strength not lower than 90% of the strength of concrete prepared with distilled water.

3.4 The Engineer-in-Charge may require the Contractor to get the water tested from an approved laboratory before starting the construction work and in case the water contains any oil/ organic matter or an excess of acid, alkalies or any injurious amount of salts etc., beyond the permissible maximum limits given in IS 456, the Engineer-in-Charge may refuse to permit its use. In case the water is supplied by the owner, contractor shall get himself satisfied regarding its quality before using the same in his works at his own expense. In case there is any change in source of water, water samples shall be tested again to meet the specified requirements.

3.5 Water shall be stored in tin barrels, steel tanks or water-tight reservoirs made with bricks / stone or reinforced concrete. Brick/ stone masonry reservoirs shall have RCC base slab and shall be plastered inside, with 1 part of cement and 4 parts of sand and finished with neat cement punning. These reservoirs shall be of sufficient capacity to meet the water requirement, at any stage of construction.

3.6 Water for curing shall be of the same quality as used for concreting and masonry works. Sea water shall not be used for preparation of cement mortar, concrete as well as for curing of plain/reinforced concrete and masonry works. Sea water shall not be used for hydrotesting and checking the leakage of liquid retaining structures also.

4.0 AGGREGATE

4.1 General

4.1.1 Coarse and fine aggregates for Civil and Structural Works shall conform in all respects to IS 383 (Specification for coarse and fine aggregate for concrete). Aggregates shall consist of naturally occurring (crushed or uncrushed) stones, gravel and sand or a combination thereof or manufactured aggregates produced from other than natural sources. These shall be chemically inert, hard, strong, dense durable, clear and free from veins, adherent coatings, injurious amount of disintegrated pieces, alkalies, free lime, vegetable matter and other deleterious substances such as iron pyrites, coal, lignite, mica, shale, sea shells etc. Naturally occurring aggregates shall be obtained from an approved source known to produce the same satisfactorily.

Manufactured aggregates shall consist of Iron and Steel slag aggregates, Copper slag aggregates or aggregates made from Construction & Demolition (C&D) waste such as Recycled Aggregates (RA) and Recycled Concrete Aggregates (RCA). RA shall comprise of waste from concrete, brick, tiles, stone, etc. and RCA shall be derived from concrete after requisite processing. Extent of utilization of manufactured aggregates in RCC and PCC works shall be as per Table-1 of IS 383.

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4.1.2 Source and type of aggregates shall be got approved by the Engineer-in-Charge prior to procurement. Change in source and type of aggregates, at later stage, shall not be generally permitted; but under specific circumstances, Engineer-in-Charge can allow a change in source and type of aggregate. Contractor shall produce necessary test certificates from approved laboratories regarding the quality and suitability of the proposed aggregates and submit fresh mix design for approval of the Engineer-in-Charge. Any such change, if permitted by the Engineer-in-Charge, shall be without any time and cost implication to the owner.

4.1.3 Aggregates which may chemically react with alkalies of cement or might cause corrosion of the reinforcement, shall not be used. If so desired by the Engineer-in-Charge, the Contractor shall carry out alkali reactivity tests and submit the results to him for approval.

4.1.4 The maximum quantities of deleterious materials in the aggregates as determined in accordance with IS 2386 - Part II (Methods of Test for aggregates for concrete), shall not exceed the limits defined in IS 383. No special test is required to prove the absence of such deleterious matters if the aggregates are from a known source with satisfactory prior data on the properties of concrete made with them. In case of newly developed quarry sites, the contractor shall submit necessary test results as per IS 383 and IS 2386 to the Engineer-in-Charge prior to his acceptance and approval. The method of Sampling shall be in accordance with the requirements given in IS 2430.

4.1.5 Coarse and fine aggregates shall be batched separately. All-in-aggregate shall be used only where specifically permitted by the Engineer-in-Charge.

Separate sieve analysis and grading curves shall be prepared by the Contractor for any/ all batches of coarse and fine aggregates, and submitted to the Engineer-in- Charge, whenever asked for, to ensure conformity with those submitted along with the mix design.

4.1.6 Whenever required by Engineer-in-Charge, the aggregates (coarse/ fine) shall be washed and/ or sieved by the contractor before use in the works to obtain clean and graded aggregate at no extra cost to the owner.

4.1.7 Aggregates not in conformity with the specifications shall be rejected and the Contractor shall immediately remove them from the site of work.

4.2 Coarse Aggregates

4.2.1 Coarse aggregates are the aggregates, which are retained on 4.75 mm BIS Sieve. It shall have a specific gravity not less than 2.6 (saturated surface dry basis).

The grading of the aggregates shall be as per IS 383 or as required by the mix design, to obtain densest possible concrete. For this purpose, the contractor shall submit to the Engineer-in-Charge at least three sets of mix design and test results, each with different gradings of coarse aggregates, proposed to be used. The Engineer-in-Charge may allow "All-in-aggregates" to be used provided they satisfy the requirements of IS 383.

4.2.2 Coarse aggregates may be obtained from

a) Uncrushed gravel or stone which results from natural disintegration of rock

b) Crushed gravel or stone which results from crushing of gravel or hard stone

c) Partially crushed gravel or stone which results from blending of (a) and (b) above

d) Manufactured from other than natural sources, by processing materials, using thermal or other processes such as separation, washing, crushing and scrubbing. Manufactured coarse

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aggregate may be RCA or RA processed from C&D waste and may be supplied as single sized or graded.

4.3 Fine Aggregates

4.3.1 Fine aggregates are the aggregates which pass through 4.75 mm BIS sieve but not more than ten percent (10%) pass through 150 micron BIS sieve. These shall comply with the requirements of grading zones I, II and III of IS 383. Fine aggregates conforming to grade zone IV shall not be used for reinforced concrete works.

Sand from sea shores, creeks or river banks affected by tides, shall not be used for filling or concrete works.

4.3.2 Fine aggregates shall consist of

a) Natural Sand : Fine aggregate resulting from natural disintegration of rock and which has been deposited by streams or glacial agencies. This may also be called as uncrushed sand.

b) Crushed Sand –
   i) Crushed Stone Sand : Fine aggregate produced by crushing hard stone
   ii) Crushed Gravel Sand : Fine aggregate produced by crushing natural gravel

c) Mixed Sand : Fine aggregate produced by blending natural sand and crushed stone sand or crushed gravel sand in suitable proportions.

d) Manufactured Fine Aggregate : Fine aggregate manufactured from other than natural sources, by processing materials, using thermal or other processes such as separation, washing, crushing and scrubbing. Manufactured fine aggregate may be RCA processed from C&D waste.

4.4 Sampling and Testing

The Contractor shall carry out all tests including mix designs of concrete, at his own expense, at the start of work as well as during any stage of construction as required by the Engineer-in-Charge. Test shall be carried out in accordance with IS 516 - Methods of test for strength of concrete and IS 2386 - Methods of test for aggregates for concrete. Testing shall be carried out from laboratories approved by the Engineer- in-Charge. The method of sampling shall be in accordance with the requirements given in IS 2430.

4.5 Storage of Aggregates

4.5.1 Storage of all types of aggregates at site of work shall be at contractor's expense and risk and shall be stored as specified in IS 4082. Aggregates shall in no case be stored near to the excavated earth or directly over ground surface.

4.5.2 The Contractor shall maintain sufficient quantities of aggregates, near to the place of work, required for the continuity of the work. Each type and grade of aggregate shall be stored separately on hard, firm surface having adequate slope for drainage of water.

4.5.3 Aggregates delivered at site in wet condition or becoming wet due to rain or any other means, shall not be used for atleast 24 hours. The Contractor shall obtain prior approval of the Engineer-in-charge for the use of such aggregates and shall adjust the water content in accordance with IS 2386 to achieve the desired mix. In the absence of test results, and to allow variation in mass of aggregates and water content on account of moisture content, the

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Contractor can make suitable adjustment in the masses as per IS 456, for preparation of nominal mix concrete only.

5.0 SAND

5.1 Sand for Masonry Mortars

5.1.1 The sand shall consist of natural sand, crushed stone sand or crushed gravel sand or a combination of any of these. The sand shall be hard, durable, clean and free from adherent coatings and organic matter and shall not contain the amount of clay, silt and fine dust more than specified in IS 2116.

5.1.2 The sand shall not contain any harmful impurities such as iron pyrites, alkalis, salts, coal or other organic impurities, mica, shale or similar laminated materials, soft fragments, sea shells in such form or in such quantities as to affect adversely the hardening, strength or durability of the mortar.

5.1.3 Unless found satisfactory as a result of further tests as may be specified by the Engineer-in-Charge, or unless evidence of such performance is offered which is satisfactory to him, the maximum quantities of clay, fine silt, fine dust and organic impurities in the sand, when tested in accordance with IS 2386, shall not be more than 5% by mass in natural sand, or crushed gravel sand or crushed stone sand. For organic impurities, when determined in accordance with IS 2386, colour of the liquid shall be lighter than that indicated by the standard solution specified in IS 2386.

5.1.4 **Grading of Sand**

The particle size grading of sand for use in mortars shall be within the limits as specified below:

GRADING OF SAND FOR USE IN MASONRY MORTARS

IS SIEVE DESIGNATION IS 460 (PART I)	PERCENTAGE PASSING BY MASS	REF. TO METHOD OF
4.75 mm	100	IS 2386 (Part I)
2.36 mm	90 to 100	
1.18 mm	70 to 100	
600 micron	40 to 100	
300 micron	5 to 70	
150 micron	0 to 15	

In case of a sand whose grading falls outside the specified limits due to excess or deficiency of coarse or fine particles, this shall be processed to comply with the standard by screening through a suitably sized sieve and/or blending with required quantities of suitable sizes of natural sand particles or crushed stone screenings which are by themselves unsuitable. Based on test results and in the light of practical experience with the use of local materials, deviation in grading of sand may be considered by the Engineer-in-Charge. The various sizes of particles of which the sand is composed shall be uniformly distributed throughout the mass.

5.1.5 **Sampling and Testing**

The method of sampling shall be in accordance with IS 2430. The amount of material required for each test shall be as specified in relevant parts of IS 2386. Any test which the engineer-in-charge may require in connection with this, shall be carried out in accordance with the relevant parts of IS 2386.

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If further confirmation as to the satisfactory nature of the material is required, compressive test on cement mortar cubes (1:6) may be made in accordance with IS 2250 using the supplied material in place of standard sand and the strength value so obtained shall be compared with that of another mortar made with a sand of acceptable and comparable quality.

5.2 Sand for Filling

Sand for filling shall meet the requirements of IS 383 and shall be natural sand, hard, strong, free from any organic and deleterious materials. Any sand proposed for filling, shall be used only after it is approved by the Engineer-in-Charge. Sand obtained from sea shores, creeks or river banks affected by tides, shall not be used for filling. Fine aggregates suitable for concreting works shall be suitable for filling also. No sand below grading zone-III as per IS 383 shall be allowed for filling.

6.0 CEMENT

Cement to be used for civil and structural works shall be one of the following. Specific requirement for the type of cement to be used shall be as shown in the drawings or as specified in the contract or as directed by the Engineer-in-Charge.

- Specification for 33/43/53 grade ordinary portland cement — IS 269
- Specification for portland slag cement — IS 455
- Specification for Portland pozzolana cement (fly ash based) — IS 1489 Pt.1
- Specification for Portland pozzolana cement (calcined clay based) — IS 1489 Pt.2
- Specification for Masonry Cement — IS 3466
- Specification for high alumina cement for structural use — IS 6452
- Specification for rapid hardening portland cement — IS 8041
- Specification for Sulphate Resisting Portland cement — IS 12330

6.1 Storage at Site

6.1.1 The storage of cement (lifted from the Owner's godown or procured by the Contractor himself) at the site of work shall be at contractor's expense and risk and shall meet the requirements of IS 4082. The cement shall be stored above ground in a suitable weather tight building or godown and in such a manner as to permit easy access for proper inspection and also to prevent deterioration due to moisture. In the event of any damage occurring to the quality of cement due to faulty storage or on account of negligence on the part of the contractor, such damages shall be borne by the contractor himself.

6.1.2 All approved cement shall be arranged in batches with type, brand and date of receipt flagged on them. A maximum of eight bags shall be stacked one over the other. Cement bags shall be used in the same order as received from the manufacturer/ owner. The contractor shall maintain a register, on day-to-day basis, giving the details of the receipt/ consumption, source of supply and type of cement etc. The register shall always be accessible to the Engineer-in-Charge for verification.

6.2 Tests after Delivery

Each consignment of cement supplied by Owner or contractor, shall, after delivery at site and at the discretion of the Engineer-in-Charge, be subjected to any or all of the tests and analyses, required by the relevant Indian Standard Codes. In case the cement is supplied by the owner, the contractor shall get himself satisfied regarding its quality before using the same in his works at his own expense. The contractor shall carry out and bear the cost of all tests and

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analyses required to ensure quality of cement before using in actual works, irrespective of the fact whether the cement is supplied by the Owner or procured by him.

6.3 Rejection

The Engineer-in-Charge may reject at his discretion any cement, notwithstanding the manufacturer's certificate or failing to meet the requirements of relevant BIS Codes for testing of cement. He may similarly reject any cement which has deteriorated owing to inadequate protection from moisture or due to intrusion of foreign matter or any other cause. Any cement which is considered defective, shall not be used and shall be promptly removed from the site by the contractor.

7.0 STEEL

7.1 General

All steel bars, sections, plates, and other miscellaneous steel materials, etc shall be free from loose mill scales, rust as well as oil, mud, paint or other coatings. The materials, construction specifications such as dimensions, shape, weight, tolerances, testing etc, for all materials covered under this section, shall conform to respective BIS Codes. Steel sections shall be conforming to IS 808 or IS 12778.

7.2 Reinforcement Bars

Reinforcement bars, to be used for civil and structural works shall be one of the following or in combination thereof.

- Mild Steel and Medium Tensile Steel Bars and Hard-Drawn Steel Wire for Concrete Reinforcement — IS 432
- Specification for hard drawn steel wire fabric for concrete reinforcement — IS 1566
- Specification for plain hard-drawn steel wire for prestressed concrete. — IS 1785
- Specification for High strength deformed steel bars and wires for concrete reinforcement. — IS 1786
- Specification for indented wire for prestressed concrete. — IS 6003
- Specification for fusion bonded epoxy coated reinforcing bars — IS 13620

7.3 Structural Steel

Structural steel to be used for general structural purposes shall be one of the following or in combination thereof.

Structural steel sections shall conform to following BIS Codes:

- Steel tubes for structural purposes. — IS 1161
- Mild Steel Tubes, tubulars and other wrought steel fittings. — IS 1239
- Steel for general structural purposes (Grade A/BR/B0). — IS 2062
- Hollow steel sections for structural use. — IS 4923

7.4 Miscellaneous Steel Materials

Miscellaneous steel materials shall be conforming to the following BIS Codes.

- Expanded Metal Steel Sheets for General purposes. — IS 412
- Mild steel bars of anchor bolts, rungs, metal inserts, grating etc.) — IS 2062
- Hexagonal head bolts, screws & nuts of product grade C. — IS 1363

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- Cold formed light gauge structural steel sections. IS 811
- Technical supply conditions for threaded steel fasteners. IS 1367
- Plain washers IS 2016
- Steel wire ropes for general engineering purposes IS 2266
- Thimbles for wire ropes. IS 2315
- Bulldog grips. IS 2361
- Mild Steel Tubes, tubulars and other wrought steel fillings. (For Hand rail tubular sections). IS 1239
- Drop forged sockets for wire ropes for general engineering purposes. IS 2485
- Steel chequered plates. IS 3502
- Hexagonal bolts and nuts (M42 to M150). IS 3138
- High Strength Structural Bolts IS 3757
- High Strength Bolts IS 4000

7.4.1 Anchor Bolts

Material for Anchor Bolts such as MS bars, washers, nuts, pipe sleeves and plates etc. shall be as per relevant BIS Codes mentioned above.

7.5 Storage

The storage of all materials at site of work shall be at the contractor's expense and risk and shall be done as per the requirements given in IS 4082. The contractor shall maintain the proper records of receipt/consumption. The records shall always be accessible to the Engineer-in-Charge for verification.

The reinforcement bars, structural steel sections and other miscellaneous steel materials etc, shall be stored in such a way as to avoid and prevent deterioration, corrosion, bending, twisting and wrapping. In case of any damage occurring to the material on account of faulty storage or negligence by the contractor, same shall be borne by the contractor himself.

7.6 Tests after Delivery

Materials supplied by the Owner or Contractor, shall, after delivery at site and at the discretion of Engineer-in-Charge, be subjected to any or all of the tests, required by the relevant BIS Codes. The Contractor shall carry out and bear the cost of such tests irrespective of the fact whether the material is procured by the Owner or the contractor. In case steel is supplied by the Owner, the Contractor shall get himself satisfied regarding its quality before using the same in his works at his own expense.

7.7 Rejection

The Engineer-in-charge may reject at his discretion any material, not withstanding the manufacturer's certificate or failing to meet the requirements of relevant BIS Codes for testing of materials. He may similarly reject any material, which has deteriorated or corroded etc., due to improper storage, handling or transport. Defective materials shall not be used and removed from the site by the contractor at his own expense.

8.0 BRICK

8.1 General

All Bricks used for masonry works shall conform to the requirements of following BIS Codes:

- Common Burnt Clay Bricks- Specifications IS 1077

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- Pulverized Fuel Ash Cement Bricks- Specifications IS 16720
- Pulverized Fuel Lime Ash Bricks- Specifications IS 12894
- Burnt Clay Fly Ash Bricks- Specifications IS 13757

8.1.1 Common Burnt Clay Bricks

Bricks for masonry works shall conform to IS 1077 - Specification for common burnt clay building bricks and shall be of class 5.0 (with minimum compressive strength of 5.0 N/mm^2). Specific requirement for any other class of bricks shall be as shown in drawings or as described in the contract for a particular site or type of work. Physical requirements, quality, dimensions, tolerances etc. of common burnt clay building bricks shall conform to the requirements of IS 1077.

Bricks shall be hand - moulded or machine moulded and shall be made from suitable soils. The bricks shall have smooth rectangular faces with sharp corners and shall be well burnt, sound, hard, tough and uniform in colour. These shall be free from cracks, chips, flaws, stone or humps of any kind.

8.1.2 Pulverized Fuel Ash Cement Bricks

Pulverized fuel ash-cement bricks shall conform to IS 16720. The bricks shall be sound, free from visible cracks and uniform in shape and colour. The brick shall have total pulverized fuel ash content not less than 35 percent of the mass of bricks. Pulverized fuel ash shall conform to IS 3812 (Part 1) or IS 3812 (Part 2).

8.1.3 Fly Ash Lime Bricks (FALG Bricks)

The Fly Ash Lime Bricks (FALG Bricks) shall conform to IS 12894. Visually the bricks shall be sound, compact and uniform in shape free from visible cracks, warpage, flaws and organic matter. Fly ash shall conform to IS 3812.

8.1.4 Burnt Clay Fly Ash Bricks

The burnt clay fly ash bricks shall conform to IS 13757. The bricks shall be sound, compact and uniform in shape and colour. Bricks shall have smooth rectangular faces with sharp and square corners. The bricks shall be free from visible cracks, flaws, warpage, nodules of free lime and organic matter, the bricks shall be hand or machine moulded. The bricks shall have frog of 100 mm in length 40 mm width and 10 to 20 mm deep on one of its flat sides. If made by extrusion process may not be provided with frogs. Fly Ash shall conform to grade I or grade II of IS 3812.

8.1.5 Mechanized Autoclave Fly Ash Lime Brick

These bricks shall be machine moulded and prepared in plant by appropriate proportion of fly ash and lime. The autoclave fly ash bricks shall conform to IS 12894. Visually, the bricks shall be sound, compact and uniform shape, free from visible cracks, warpage and organic matters. The brick shall be solid with or without frog, and of 100/80 mm in length, 40 mm width and 10 to 20 mm deep one of its flat side as per IS 12894. The brick shall have smooth rectangular faces with sharp corners and shall be uniform in shape and colour. Fly ash shall conform to IS 3812 and lime shall conform to class 'C' hydrated lime of IS 712.

8.2 Tests after Delivery

The Contractor shall take samples of each type of brick as directed by the Engineer-in-Charge as per the requirements of IS 5454 and tests shall be carried out as per IS 3495. The cost for carrying out any or all the tests, shall be borne by the Contractor. The bricks, when tested, as

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per IS 3495 shall have a minimum average compressive strength, as given in the Code, for a particular class of brick. Water absorption shall not be more than 20% by its dry weight, when soaked in cold water for 24 hours.

Brick samples so approved, shall be deposited with the Engineer-in-Charge. All subsequent deliveries shall be upto the standards of the approved samples.

8.3 Stacking of Bricks

Bricks shall be stored at site as per the requirements given in IS 4082 and shall not be dumped at site. They shall be unloaded from trucks to a place on a levelled surface near to the work site. They shall be stacked in regular tiers even as they are unloaded, to minimise breakages and defacement of bricks. The supply of bricks shall be so arranged that as far as possible, at least two days' requirements of bricks are available at site at any time. Bricks, of different class & types, shall be stacked separately.

8.4 Local Bricks/ Class 3.5 Bricks.

Where shown on drawings, locally available bricks of non modular size (230 mm x 110 mm x 70 mm) in place of bricks of modular size (190 mm x 90 mm x 90 mm) can be used in case the bricks satisfy the other requirements of respective BIS codes. Minimum compressive strength of these bricks shall not be less than 3.5 N/mm^2.

8.5 Concrete Block Masonry

Concrete Block Masonry shall be as per EIL Specification No. 6-68-0016.

9.0 STONE

9.1 General

All Stones used for masonry works shall conform to the requirements of following BIS Codes.

- Method of identification of natural building stones. IS 1123
- Recommendations for dimensions and workmanship of natural building stones for masonry work. IS 1127
- Recommendations for dressing of natural building stones. IS 1129

9.2 Quality of Stones

Stones shall be of approved quality, hard, dense, strong, sound, durable, clean and uniform in colour. They shall also be free from veins, adherent coatings, injurious amount of alkalies, vegetable matters and other deleterious substances such as iron pyrites, coal, lignite, mica, sea shells etc. Unless otherwise approved, stones from one single quarry shall be used for any one work. The strength of stones should be adequate to carry the imposed load and shall meet all the requirements of IS 1905, taking into account the appropriate crushing strength of stone and type of the mortar used. The percentage of water absorption, when tested in accordance with IS 1124, shall not exceed 5 percent.

Stones normally used, shall be small enough to be lifted and placed by hand. The length of the stone shall not exceed 3 times the height. Width of stone on base shall not be less than 150 mm and in no case exceed $3/4^{th}$ thickness of the wall. Height of the stone shall not be more than 300 mm.

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9.3 Unloading/Stacking

The stones shall be unloaded from the trucks to a site near to the place of work as defined in IS 4082 and shall be stacked on a firm ground having adequate stope for drainage. The supply of stones shall be so arranged that as far as possible, at least two days' requirements of stone are available at site at any time.

10.0 ADMIXTURES

10.1 General Requirements for Admixtures

10.1.1 All concrete admixtures shall in general comply with the following BIS Codes unless otherwise stipulated in this specification.

- Specification for integral cement water proofing compounds. IS 2645
- Specification for other admixtures for concrete. IS 9103

10.1.2 Generally, admixtures shall have ISI certification marks. However, even in case of BIS certified admixtures, Engineer-in-Charge may require the Contractor to carry out and submit any or all the tests (as specified in relevant BIS Codes), from BIS approved laboratories, over and above the manufacturer's test certificate, before giving his final approval.

In case, admixtures certified by BIS are not available, the contractor shall submit to the Engineer-in-Charge the type and/or proprietary brand of the admixture from only reputed manufacturers along with necessary test certificates from BIS recognized/ BIS approved laboratories or any other document directed by Engineer-in-Charge for the latter's final approval. In such cases, names of at least two manufacturers shall be submitted to the Engineer-in-Charge for his selection. In case, both the names are rejected, the contractor shall submit a fresh list of two manufacturers for approval by the Engineer-in-Charge.

The Engineer-in-Charge may direct the contractor to submit test results as required by IS 2645 or IS 9103 for any admixture proposed to be used in the concrete in any approved laboratory at his discretion at any stage of the work. The cost of any/all tests required to satisfy compliance with this specification shall be borne by the Contractor.

In case of non-availability of any BIS code for testing and acceptability criteria, relevant American, British or German Code shall be applicable.

10.1.3 Prior approval of the Engineer-in-Charge shall be obtained while using water reducing admixtures in the concrete (PCC/ RCC) or mortar. Other type of admixtures such as accelerating admixtures, retarding admixtures or air entraining admixtures, shall not be used unless specified on the design drawings or prior approval taken from the design approving authority. Once approved, utmost care shall be exercised at site by the Contractor to maintain the consistency in the quality of admixture and the concrete/ mortar so produced.

10.1.4 The suitability and effectiveness of any admixture shall be verified by trial with the designed concrete mixes using cement, aggregates together with any other materials to be actually used in the works as per the direction of Engineer-in-Charge. If two or more admixtures are to be used simultaneously in the same concrete mix, the Contractor must submit necessary test results from an approved laboratory to show their interaction and compatibility. Any/all tests specified in BIS Codes shall be carried out only with the type of material and mix design, to be actually used in the work site.

10.1.5 No admixture shall impair the durability of the concrete nor combine with the ingredients to form harmful compounds nor increase the risk of corrosion of reinforcement. Use of admixtures shall not reduce the dry density of concrete. Once the proportion of admixture has

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been established, strict check shall be maintained not to alter the proportions of ingredients and water-cement ratio of the Design Mix during execution.

10.1.6 The chloride contents in admixtures shall not exceed 2% by mass of the admixture or 0.03% by mass of the cement.

10.1.7 Admixtures which do not meet the requirements stipulated in this specification shall be rejected and shall not be used.

10.2 Water Proofing Compounds

10.2.1 Water proofing compounds shall be mixed with cement only.

10.2.2 The permeability of the specimen with the admixture shall be less than half of the permeability with similar specimen without the use of these compounds. These compounds shall be used in such proportion as recommended by manufacturer but in no case it shall exceed 3% by weight of cement.

10.2.3 The initial setting time of the cement with the use of these compounds shall not be less than 30 minutes and final setting time shall not be more than 10 hours. Test shall be carried out in accordance with IS 4031.

10.2.4 Compressive strength of specimen at 3 days shall not be less than 160 kg/sq.cm nor 80% of the 3 days compressive strength of mortar cubes prepared with same cement and sand only, whichever is higher. Similarly compressive strength at 7 days shall not be less than 220 kg/sq.cm nor less than 80% of the 7 days compressive strength prepared with the same cement and sand only, whichever is higher. The test to determine the compressive strength shall conform to IS 4031.

10.3 Concrete Penetrating Corrosion Inhibiting Admixture shall be as per EIL Specification No. 6-68-0017.

11.0 WATER BARS (WATER STOPS)

11.1 PVC water bars shall be used in reinforced concrete construction of liquid retaining structures or any other structure to safeguard them from hydrostatic pressure and water leakage and any relative movement between two parts of the structure due to thermal loading shrinkage or differential movement of foundations. Wherever desired or shown in the drawings, they shall be used at expansion/contraction/construction joints. These shall be pre-formed and shall provide a permanent water tight seal along the entire joint in the poured concrete structures. These shall also be flexible enough to withstand deflection/displacements at joints arising due to variation of temperatures or settlement of foundations. The minimum thickness of water bar shall be as shown on drawings or described in the schedule of rates and unless otherwise mentioned, these shall be able to withstand a water head of at least 12 meters.

11.2 Performance requirements of PVC water bars shall meet the requirements of IS 12200. These shall be of approved make and of ribbed/ serrated/ plane type with a bulb at the centre. The thickness and width of water bars shall be as per schedule of rates/ drawings but in no case the thickness shall be less than 5 mm and width less than 150 mm. The joining of the water bars shall be carried out by vulcanising strictly as per the manufacturer's specifications. Lapped joints shall not be allowed under any circumstances.

12.0 BITUMEN/BITUMINOUS MATERIALS

Bitumen to be used for various types of work shall meet all the requirements of relevant BIS Codes as given below:

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- Specification of Paving Bitumen IS 73
- Specification for bitumen mastic for flooring IS 1195
- Specification for Bitumen felts for water proofing and damp proofing IS 1322
- Specification for Bituminous compounds for water proofing and caulking purposes IS 1834
- Specification for preformed fillers for expansion joint in concrete pavements and structures IS 1838
- Specification for bitumen mastic for use in water proofing of roofs IS 3037
- Specification for bitumen primer for use in water proofing and damp proofing IS 3384
- Specification for Bitumen Mastic for Tanking and Damp proofing IS 5871
- Specification for Glass fibre base coal tar pitch & bitumen felts IS 7193
- Code of practice for damp proofing using bitumen mastic IS 7198
- Specification for bitumen Mastic, Anti-Static and electrically conducting grade IS 8374

The type and grade shall be as shown on the drawings or as indicated in schedule of quantities or as directed by Engineer-in-Charge. Tests and acceptable criteria shall be as per relevant BIS Codes.

13.0 PVC PIPES

PVC Pipes shall conform to the requirements of IS 4985.

14.0 WOOD/ TIMBER

14.1 Wood recommended for platforms of cold vessels or below cold vessels/ exchangers shall be hard and shall be of group A, grade I, and shall have safe permissible stress of 7 N/mm^2 in compression, perpendicular to grains on outside location as per IS 883. General characteristics like durability, treatability etc. shall conform to IS 883 and IS 3629.

14.2 Timber required to be used for formwork shall be fairly dry before use. It should maintain its shape during the use and even when it comes into contact with moisture from the concrete. Storage of Wood/Timber shall be as per the requirements of IS 4082.

For proper identification and selection of suitable timber for formwork, following codes shall be referred.

- Classification of commercial timbers and their zonal distribution IS 399
- Specification for ballies for general purposes. IS 3337
- Specification for Ply wood for concrete shuttering work. IS 4990

15.0 EPOXY COMPOUNDS

Refer EIL Specification No. 6-68-0056.

16.0 PAINT

16.1 Refer EIL Specification No. 6-79-0020 or the job specification whichever applicable.

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17.0 ANTITERMITE COMPOUNDS

17.1 Following chemicals as per IS 6313 (Part 2 & 3) shall be used for treatment of soil for protection of buildings against attack by subterranean termites:

S.No.	Chemical	Relevant Standard	Dosage* (Chemical Emulsion)
1	Chlorpyrifos 20% Emulsifiable Concentrate (EC)	IS 8944	250ml in 5 litre water 50ml in 1 litre water
2	Imidacloprid 30.5% Suspension Concentrate (SC)	IS 16131	10.5ml in 5 litre water 2.1ml in 1 litre water
3	Bifenthrin 2.5% Emulsifiable Concentrate (EC)	IS 15936	100ml in 5 litre water 20ml in 1 litre water

(*Dosage as specified above or as per Manufacturer's recommendation, whichever is stringent)

18.0 POLYSULPHIDE SEALANTS

Polysulphide Sealants shall conform to IS 12118 and be of approved make. Test conditions and requirements shall be as given in the above referred BIS code.

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मानक विनिर्देशन
सिविल एवं संरचनात्मक कार्य

STANDARD SPECIFICATION
CIVIL & STRUCTURAL WORKS

मिट्टी का कार्य

EARTHWORK

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	18.03.21	REVISED & REISSUED	TK	AJS	AS	SM
5	21.08.14	REVISED & REISSUED	AJS	AS	PKM	SC
4	19.06.09	REVISED & REISSUED	AS	SCH	VINAY KUMAR	N. DUARI
3	22.01.02	UPDATED & REISSUED	R SOOD	R SOOD	H MATHUR	GRR
2	AUG'94	UPDATED & REISSUED	-	H MATHUR	GP LAHIRI	A. SONI

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Abbreviations:

CNS : Cohesive Non Swelling

Structural Standards Committee

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1.0 SCOPE

This specification deals with earth work in excavation and filling.

2.0 CLASSIFICATION OF SOIL

2.1 Ordinary Soil

2.1.1 Soft Soil/ Loose Soil

Generally any soil which yields to the ordinary application of pick and shovel, or to phawra, rake or other ordinary digging implements such as:

a) Sand, gravel, loam, clay, mud, black cotton soil
b) Vegetables or organic soil, turf, peats, soft shale or loose murrum
c) Mud concrete below ground level
d) Any mixture of soil mentioned above.

2.1.2 Hard/ Dense Soil

Generally any soil, which requires close application of picks or jumpers or scarifier and rippers to loosen the same, such as:

i) Stiff heavy clay, hard shale or compact murrum requiring grafting tool and/ or pick and shovel
ii) Shingle and river or nallah bed boulders
iii) Soling of roads, paths etc. and hard core
iv) Macadam surface of any description (water bound, grouted tarmac etc.)
v) Lime concrete, stone masonry in lime or cement mortar below ground level
vi) Soft conglomerate when the stone can be detached from the matrix with picks and shovels

2.2 Soft Rock

This is fissured/ disintegrated rocky strata, boulders (volume more than 0.028 m^3 and less than 0.400 m^3) and also which cannot be quarried/ excavated by using above manual tools but can be quarried/ excavated manually by using crow bars is classified as soft rock. Soft rock shall include all kinds of stiff and stratified rock, such as shales, thinly bedded phillites, laterite hard conglomerate, lime stone, sand stone and unreinforced cement concrete below ground level. Soft rock may be quarried or split with crow bar or picks and can also be excavated by rippers, dozers and other mechanical equipment, but without the aid of blasting. If required and permitted, light blasting may be restored to, for loosening the materials, but this will not, in any way entitle the material to be classified as "Hard Rock".

2.3 Hard Rock

2.3.1 Hard Rock (Not Requiring Blasting)

This shall include all types of hard and compact rock, having closely spaced fissures or joints, on account of which blasting is not considered necessary and shall not be resorted unless permitted by the Engineer-in charge.

2.3.2 Hard Rock (Requiring General Blasting)

This shall include all types of hard and compact rock occurring in unfissured masses or similar foundations, boulders (volume more than 0.4 m^3) for excavation in which blasting is

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considered necessary such as quartzite, granite, basalt stones, reinforced cement concrete (reinforcement to be cut through but not separated from concrete) below ground level and the like.

2.3.3 **Hard Rock (Requiring Controlled Blasting (Explosive/ Non-explosive)**

This type of excavation becomes necessary when excavation is done in formations, mentioned in Clause 2.3.2, in the vicinity of existing foundations/ structures. Mode of blasting shall be decided by Engineer-in-Charge, keeping in view the sensitivity of structures.

2.3.4 **Hard Rock (Blasting Prohibited)**

Hard rock requiring blasting as described in clause 2.3.2 above, but where blasting is prohibited for any reason and excavation has to be carried out by chiseling, wedging, pneumatic/ hydraulic/ electro-mechanical breaking by using splitter or by chemical means or any other agreed method.

The use of excavation shall not be considered as a reason for classification under hard rock requiring blasting unless clearly found necessary in the opinion of Engineer-in-Charge.

3.0 BACKFILLING MATERIAL

3.1 Suitable Materials:

3.1.1 Back filling suitable material shall be approved by the Engineer-in-charge. Additionally, they shall be free from refuse, large stones or rocks or other material which might prevent proper compaction or cause the compacted fill or embankment to perform inadequately or to have insufficient stability or bearing capacity for the superimposed loads to which it is likely to be subjected.

3.1.2 Back filling of excavation in trenches, foundations and elsewhere shall consist of one of the following materials as shown on drawing, or directed by the Engineer-in-charge.

i) Soil
ii) Selected earth from heaps or brought from borrow areas.

In case i) or ii) are not available, the Engineer-in-charge may approve use of any of the following:

iii) Stone/ Gravel
iv) Sand
v) CNS material.

3.1.3 The material shall be free from refuse, debris, roots, hard lumps and any other foreign organic material.

3.2 Unsuitable Materials

Unsuitable material shall include particles in excess of 75 mm size and that which is:

a) Organic material, logs, stumps and perishable materials.
b) Material susceptible to spontaneous combustion
c) Materials with undefined properties
d) Materials having a moisture content greater than the maximum specified
e) Building rubble and domestic and industrial wastes
f) Soils and rock susceptible to deterioration/ change of their properties.

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g) Clay, silt and other loose or soft soils not in accordance with compaction criteria.
h) Dredged material
i) Material containing gypsum or other soluble salts.

4.0 SETTING OUT

4.1 The Contractor shall be responsible for the true and proper setting out of the work in relation to original points, ***lines**** and ***levels**** of reference and for the correctness of the levels, dimensions and alignment of all parts of the work. If at any time during progress of the work any error appears or arises in the position of level, dimension, or alignment of part of the work, the Contractor at his own expense shall rectify such errors to the satisfaction of the Engineer-in-Charge. The checking of any line or level by the Engineer-in-Charge shall not in any way relieve the Contractor of his responsibilities.

4.1.1 Tolerances*

The grade shall be properly shaped to the required elevations and parallel to the required surface. The elevation of any point and the line of any edge or center of the earthworks shall conform to that shown on the drawings within the tolerances stated below:

	Tolerances from True Level	Tolerances from True Line
Basic Grading	- 25 mm	- 75 mm
Embankments	+75 mm - 0	+75 mm - 75 mm

4.2 The Contractor shall lay out and construct one or more permanent bench marks in some central place before the start of the work, from which all important levels for the excavations will be set.

These permanent bench marks shall consist of masonry pillars with top neatly plastered and leveled as per the directions of the Engineer-in-Charge. Bench marks shall be well connected with triangular grid system or any other bench mark approved by the Engineer-in-Charge.

5.0 EARTHWORK IN EXCAVATION

5.1 Excavation shall be carried out in any material met on the site to the lines, levels and contours shown on the detailed drawings and the Contractor shall remove all excavated materials to spoil heaps on site or transport for use in filling on the site or stack them for reuse as directed.

5.2 Excavated material shall not be deposited within 1.5 m from the top edge of the excavation.

5.3 The sides of the excavation may be cut sloping, or shored and strutted to hold the face of earth as per site requirements and as directed by the Engineer-in- Charge.

5.4 Foundation pits/ trenches shall not be excavated to the full depth unless construction is imminent. The last 15 cm depth of the excavation shall not be done until concreting work is imminent. The full depth may at the discretion of the Engineer-in-Charge be excavated and the bed covered with a 50 mm (minimum) thick (or as indicated on drawing) layer of lean concrete 1:5:10 mix (1 cement : 5 coarse sand : 10 crushed stone aggregate) or as specified in schedule of rates/ shown on drawing, after watering if required, and consolidating the bed.

5.5 If the bottom of any excavation has been left exposed by the Contractor and in the opinion of the Engineer-in-Charge, that has become badly affected by the atmosphere or by water, then the Contractor shall remove such portions of the deteriorated material as the Engineer-

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in-Charge may direct and shall make good with lean concrete 1:5:10 mix (1 cement : 5 coarse sand : 10 crushed stone aggregate). All expenses for such additional concrete and excavation shall be borne by the Contractor.

5.6 Where excavation is made in excess of the depth required, the Contractor shall, at his own expense, fill upto required level with lean concrete 1:5:10 mix (1 cement : 5 coarse Sand : 10 crushed stone aggregates) or as decided by Engineer-in-Charge.

5.7 The Contractor shall provide suitable drainage arrangement to prevent surface water from any source entering the foundation pits at his own cost.

5.8 The Contractor shall make all arrangements for dewatering during excavation and subsequent works, the accumulated water from any source (including subsoil water) in the excavated pits/trenches and keeping the excavated pits/ trenches dry for subsequent works.

5.9 The Contractor shall make necessary arrangements for lighting, fencing and other suitable measures for protection against risk of accidents due to open excavation.

5.10 Where the excavation is to be carried out below the foundation level of an adjacent structure, the precaution to be taken such as under pinning, shoring and strutting etc. shall be determined by the Engineer- in-Charge. No excavation shall be done unless such precautionary measures are carried out as per directions of the Engineer-in-Charge. The payment for such precautionary measures shall, however, be made separately.

5.11 Loose or soft bed ground encountered in excavation at the required depth shall on the Engineers-in-Charge's instructions be excavated to a firm bed and difference made up to the required level with lean concrete 1:5:10 mix (1 cement : 5 coarse Sand : 10 crushed stone aggregates).

5.12 In those cases where during excavation, side slips occur for reasons not attributable to the Contractor (e.g. side slips which take place on their own but not due to surcharge of earth kept near the edge of excavation and cracking of excavation top strata due to clay drying out leading to collapse of excavation sides), the Engineer-in-Charge shall admit payment at his discretion.

5.13 Any obstacle encountered during excavation shall be reported immediately to the Engineer-in-Charge and shall be dealt with as instructed by him. Removal of buried pipes or cables shall not be done without prior permission of the Engineer-in-Charge and the Contractor shall provide all measures to protect the same. Cost of such protective measures are deemed to be included in the rates for various items of excavation.

5.14 The Contractor shall not undertake any concreting in foundation until the excavation pit/trench is approved by the Engineer-in-Charge.

5.15 The specification for earth work shall also apply to excavation in rock in general.

5.16 In case of hard rock requiring blasting, the provisions mentioned below shall be strictly followed.

5.16.1 **General**

Where hard rock is met with and blasting operations are considered necessary, the Contractor shall intimate about the same to the Engineer-in-Charge, and obtain his approval in writing for resorting to blasting operation.

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The Contractor shall obtain license from the district authorities for undertaking blasting work as well as for obtaining and storing the explosive as per the Explosive Rules 2008, corrected upto date. He shall purchase the explosives, fuses, detonators etc. only from a licensed dealer. He shall be responsible for the safe custody and proper accounting of the explosive materials. The Engineer-in-Charge or his authorised representative shall have the access to check the Contractor's store of explosive and his accounts.

In case where explosives are required to be transported and stored at site, relevant clauses of the Explosive Rules, 2008 as amended subsequently, shall apply.

The Contractor shall be responsible for any accident to workmen, public or property, due to blasting operations.

5.16.2 **Precautions**

Blasting operations shall be carried out under the careful supervision of a responsible authorised and licensed blaster of the Contractor (referred subsequently as "blaster" only) during specified hours, as approved in writing by the Engineer-in-Charge. The blaster shall be fully conversant with the rules of blasting.

Proper precautions for safety of persons shall be taken. Red flags shall be prominently displayed around the area to be blasted and all the people on the work except those who actually light the fuses, shall withdraw to a safe distance of not less than 200 m from the blast. Precautions as per Explosive Rules 2008 with amendment shall be followed.

5.16.3 **Fuses**

All fuses shall be cut to the lengths required before being inserted into the holes. Joints in fuses shall be avoided. Where these are unavoidable, a semicircular niche shall be cut in one piece of fuse about 2 cm. deep from the end and the end of other piece inserted into this niche, and the two pieces then wrapped together with a string. All joints exposed to dampness shall be wrapped with rubber tape. Fuse and detonators shall be kept separated from the explosives.

5.16.4 **Blasting with Gun Powder**

Blasting shall normally be done with gun powder. Dynamite, gelatine or any other high explosive shall only be used in special cases with the written permission of the Engineer-in-Charge.

In case of blasting with gun powder, the position of all bore holes to be drilled shall be marked out in circles with white paint. The bore holes shall be jumped or drilled in the rock face. The depth of bore hole shall be about the same as that of the line of least resistance and its size shall be such that the cartridges can easily pass down to the bottom. The bore holes must be dried before being charged and these shall be inspected by the Contractor's agent.

Gun powder may be used in the form of pellet blasting cartridges or as powder or granules. Cartridges are provided with tapered central hole. One end of fuse is passed through the narrow end of the hole and a sufficient length of the fuse is doubled back so that when the fuse is pulled, it is held tight in the tapered hole of the cartridge. Other cartridges are then inserted in the fuse to make up the required charge. The cartridge along with the fuse is lowered down in the bore hole, placed in position and gently filled and pressed home with dry hay or turf. The rest of the bore shall then be filled with dry clay, which shall be tamped with copper or brass rod until it becomes compact. Care shall be taken to avoid any possibility of an air space around the fuse. The safety fuses shall be taken to the required distance so as to allow the blasting to take place after the person lighting the fuse has withdrawn to a safe distance.

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Where gun powder is used in the form of powder or granules it shall be introduced in the bore hole by means of funnel or copper tube. The bore holes shall be loaded with two thirds of the quantity of charge required, and safety fuse then directly introduced over the charge. Remaining one third charge shall then be introduced, and gently filled and pressed home with dry hay or turf. The rest of the bore hole shall be filled with dry clay in the same way as for cartridges, and the safety fuse taken to the required distance.

The charges shall be fired by igniting the fuse. The number of charges to be fired and the actual number of shots heard, shall be compared, and the Contractor's blaster shall satisfy himself by examination that all the charges have exploded, before workmen are permitted to approach the site. The charge which has not exploded, shall not be permitted to be withdrawn. The tamping and charge shall be flooded with water and the holes marked with a red cross (X) over it. Another hole shall be jumped at a distance of about 45 cm from the old hole and fired in the usual way. This operation shall be continued, till the original and any subsequent unfired charges are exploded.

5.16.5 **Blasting with Dynamite or any other High Explosive**

In case of blasting with dynamite or any other high explosive the position of all bore holes to be drilled shall be marked out in circle with white paint. These shall be inspected by the Contractor's blaster. Bore holes shall be of a size that the cartridge can easily pass down. After the drilling operation, the blaster shall re-inspect the holes to see that the holes marked out by him have been drilled. The Blaster shall then prepare all charges necessary for the bore holes. The bore holes shall be thoroughly cleaned before a cartridge is inserted. Wooden tamping rods (not pointed but cylindrical throughout) shall be used, in charging holes. Metal rods shall never be used for tamping. One cartridge shall be first placed in the bore hole, gently pressed and not rammed down. Other cartridges shall then be added as may be required to make up the necessary charge for the bore hole. The top most cartridge shall be connected to the detonator which shall in turn be connected to the safety fuse of required length.

The maximum of eight (8) bore holes shall be loaded and fired on each occasion. The charges shall be fired successively and not simultaneously.

Immediately before firing a blast, due warning shall be given and the blaster shall see that all persons have retired to a place of safety. The safety fuses of the charged holes shall be ignited in the presence of the blaster, who shall see that all the fuses are properly ignited.

Careful count shall be kept by him and others of each blast as it explodes. After the blast the blaster shall inspect the work and ascertain that all the charged holes have been exploded. In case of misfired holes, the Blaster shall inspect the same after half an hour and mark red crosses (X) over the holes. During this interval of half an hour, no body shall approach the misfired holes. None of the drillers shall work near such holes, until one of the two following operations has been done by the blaster.

a) Either the Contractor's blaster shall very carefully (when the tamping is of damp clay) extract the tamping with a wooden scraper and withdraw the fuse, primer and detonator, after which a fresh detonator, primer and fuse shall be placed in the misfired holes and fired.

OR

b) The hole shall be cleaned for 30 cm of tamping and its direction ascertained by placing a stick in the hole. Another hole shall then be drilled 15 cm away and parallel to it. This hole shall be charged and fired. The misfired hole should also explode along with the new one.

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Before leaving the work, the blaster of one shift shall inform another blaster relieving him for the next shift, of any cases of misfire, and shall point out their positions denoted by red crosses and also state the action, if any, to be taken in the matter.

The Engineer-in-Charge shall also be informed by the blaster of all cases of misfire, their causes and steps taken in that connection.

5.16.6 **Controlled Blasting (Explosive/ Non-explosive)**

Whenever required by the Engineer-in-Charge, rock blasting shall be carefully controlled so that vibrations generated during the blasting do not cause damage to the buildings and installation around. Similarly, the rock pieces should not fly off and endanger the buildings and installations around. Apart from the general precautions mentioned in the preceding paragraphs, following protective measures and limits for use of explosive are suggested as guidelines. Bidders are requested to carefully check the site conditions and submit details of the scheme they propose to adopt for controlling the blast.

Following protective measures shall be adopted while carrying out blasting operations.

The hole shall be covered with mild steel plate of minimum 12 mm thickness.

Reinforcement rod mesh not less than 20 mm dia. at 150 mm centre in both directions shall be placed over the steel plates.

Steel plate and reinforcement shall be inspected after every blasting operation and all twists shall be removed before reuse to the satisfaction of the Engineer-in-Charge.

Sand filled bags of 6 to 8 layers shall be placed over the mesh suitably covering the whole region under blasting operation.

The thickness of covering plate and the kind of dead weight is to be duly approved by the Engineer-in-Charge.

5.16.7 Hard rock requiring blasting as described under Clause 2.3.2 above, but where blasting is prohibited for any reason(s), breaking up of rock can be done by using Splitter and/or chemical substances of approved manufacturer mixed in an appropriate proportion. The method involves drilling holes into rock and then inserting Splitter (hydraulic/ pneumatic/ electro-mechanical) or injecting Chemical solvents into the holes. The breaking-up of rock takes place in a controlled fashion without much noise and spark. Any other method as agreed with Engineer-in-Charge may also be used.

5.17 Excavation in areas where existing under ground cables are envisaged, to be carried out carefully by manual means taking proper safety precautions.

The earth work machinery be deployed after ensuring from the trial pits that no cable is crossing the proposed area of excavation.

5.18 Payment (applicable for item rate tenders only)

5.18.1 The payment clause shall be operated only if the earthwork is to be measured separately as per relevant tender item.

5.18.2 Payment for earth work in excavation shall be made on cubic meter (m^3) basis on the measurement of volume of pit/ trench of excavation with working space as per relevant Indian Standards (IS:1200) and slopes/ steppings as permitted by the Engineer-in-Charge. The rate shall include cost of all the operations of blasting with explosives & accessories, making of all

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arrangements for dewatering the accumulated water from any source in the excavated pit or trench, removal and disposal of surplus excavated soil within a lead of 100 m from construction areas. The rate shall also include setting out and line out work required for the excavation.

5.18.3 The following works shall not be measured separately and allowance for the same shall be deemed to have been made in the description of main item:

a) Setting out works, profiles, etc.;
b) Site clearance, such as cleaning grass and vegetation;
c) Unauthorized battering or benching of excavation;
d) Forming (or leaving 'dead men' or 'tell-tales' in borrow pits and their removal after measurements;
e) Forming (or leaving) steps in sides of deep excavation and their removal after measurements;
f) Excavation for insertion of planking and strutting;
g) Unless otherwise specified, removing slips or falls in excavations;
h) Bailing out or pumping of water in excavation from rains;
i) Bailing out or pumping of water in excavation from sub-soil water, and
j) Slinging or supporting pipes, electric cables, etc, met during excavation.

5.18.4 Special pumping other than what is included in 5.18.3 (h and i) and well point dewatering where resorted to, shall each be measured separately, unless otherwise stated, in Kilo Watt Hour against separate specific provision(s) made for the purpose.

5.18.5 The Contractor shall intimate to the Engineer-in-Charge as soon as different classification of soils are met with. The measurements of various soil classifications then shall be worked out by either of the following alternatives in the order of their decreasing importance.

a) Joint levels shall be taken as to the levels of different soil classifications and volume worked out on the basis of levels only.

b) Where levels of different strata cannot be clearly marked and defined, the Contractor shall stack different soils of various classifications separately for measurement purpose and then dispose it off.

c) If the quantum of work involved in (b) above is extensively large & time consuming, then the total area may be divided into various zones and reasonably representative samples as in (b) above may be taken and quantities of soils of various classifications finalized for the entire zone based on the representative.

If soil of any classification other than that specified in the Schedule of Rates is met with during excavation, the decision of the Engineer-in-Charge as to the classification of soil, levels of the strata of different classifications and their location shall be binding.

In above case, the total quantity of excavation shall be computed from the measurement of the pit/ trench excavated. The hard rock and soft rock shall be measured separately from the relevant stacks and each shall be reduced by fifty percent for voids, and paid under the relevant items. The balance, that is the total quantity of excavation minus the reduced (for voids) quantity of excavation for rocks shall be paid as soft/ hard soil as per the direction of the Engineer-in-Charge (However, the maximum payment shall be limited to the volume of the excavated pit/ trench as approved by Engineer-in-Charge).

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6.0 SHORING AND STRUTTING

6.1 The shoring and strutting of the sides to withhold the face of excavation pits/trenches shall be done when approved or directed by the Engineer-in-Charge.

6.2 The shoring shall be of close or open timbering type or by Sheet Piling, Soldier Piling, etc. depending upon the site requirements and as directed by the Engineer-in-Charge whose decision shall be final and binding as to the type of shoring to be used.

6.3 The arrangement of the shoring and strutting shall be sound and safe and shall be got approved from the Engineer-in-Charge before installation. The approval shall not absolve the Contractor of his responsibilities of safety and any other requirements of the contract.

6.4 The shoring and strutting shall be kept in position till all the relevant work in the excavated area is completed and approved. It shall be dismantled and removed only after the permission to do so is obtained from the Engineer-in-Charge.

6.5 Sheet Piling

The contractor shall design, supply and install hot rolled steel sheet piles including all associated structural steel members viz. waler & runner beams, strut, cross ties, vertical members, guide frames, suitable interlocks, suitable corner sections, splicing & cutting of sheet piling. The contractor shall also apply recommended sealant for complete water tightness (as required) and ensure pre-drilling for installation into bedrock (as necessary), etc. as per site conditions.

The contractor shall mobilize/ demobilize all necessary tools & tackles, hammer (vibratory/ impact), crane(s) etc., shifting plant/ machinery and carryout all ancillary works (as required) and ensure subsequent removal of entire arrangement after completion of works.

6.6 Payment (applicable for item rate tenders only)

Payment for shoring and strutting by close and open timbering shall be made on square meter (m^2) basis as separate items. In both the cases, the measurement shall be done on the basis of the surface area of the sides of the excavation actually shored and strutted.

The rate shall include all labour, materials, erection of the poling boards, wales, struts, ballies etc., fixing and keeping the same in position as required, dismantling and removing the same after the work is over as directed.

Payment for shoring and strutting by sheet piling shall be made on the basis of shoring area of sheet pile exposed after complete excavation.

The rate shall include all labour, design, supply and installation of hot rolled steel sheet piles including all associated structural steel members, application of recommended sealant, pre-drilling for installation into bedrock etc., mobilization/ demobilization of all necessary tools & tackles, hammer, crane(s) etc., shifting plant/ machinery & all ancillary works, fixing and keeping the sheet piling in position, dismantling and removing the same after the work is over, etc. all complete as directed by the Engineer-in-Charge.

No extra payment shall be made for cost of extraction and replacement for installing of sheet pile deviating the specification or rejected by Engineer-in-charge. Extracted sheet piles shall be contractor's property and contractor shall remove the same from site without any extra cost to client.

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7.0 BACK FILLING AROUND FOUNDATIONS AND IN PLINTH

7.1 Back filling around completed foundations, structures, trenches and in plinth shall be done to the lines and levels shown on the drawings including any trimming of the surfaces, as may be necessary. This shall be done with selected and approved earth from excavation or otherwise with suitable materials described under Clause 3.1 as directed by the Engineer-in-Charge. Where sufficient suitable material is not available from the excavation, the Engineer-in-Charge may direct to import suitable earth from other sources. The filling shall be done in layers of thickness not exceeding 15 cm with watering, rolling and ramming by manual methods/ mechanical compactors to grade and level as shown on drawings to obtain 90% laboratory maximum dry density.

7.2 The Contractor shall not commence filling in and around any work until it has been permitted by the Engineer-in-Charge.

7.3 Backfilling around liquid retaining structures and pipes shall be done only after approval of the Engineer-in-Charge is obtained.

7.4 **Payment (applicable for item rate tenders only)**

Payment for backfilling with earth shall be based on volume in cubic meters (m^3) of consolidated fill. This volume shall be derived from the difference between the volume of excavation and the structure or trenches as the case may be. The rate shall include cost of extracting suitable approved earth from available excavated soil from spoil heaps within a lead of 100 m, placing, watering, rolling, ramming compacting in layers, trimming and dressing finished surface and disposal of surplus material upto a lead of 100 m.

However, backfilling done with materials other than earth shall be paid separately under relevant items.

8.0 TRANSPORTATION OF SURPLUS EARTH

8.1 Surplus earth and soil from excavation shall be removed from construction area to the area demarcated by the Engineer-in-Charge.

8.2 **Payment (applicable for item rate tenders only)**

8.2.1 Payment shall be made only for the lead beyond initial 100 m from construction area. Rate shall include re-excavation, loading, transportation, dumping, stacking or spreading (as per directions of the Engineer-in-Charge) the surplus earth and the soil in the area demarcated by the Engineer-in-Charge. Payment shall be made on cubic metre (m^3) basis on the difference of measurements of the volume of the excavated pits and the measurement of the back filling. Quantity generated due to voids in back filled volume of earth shall also be removed by the Contractor at no extra cost and this disposal of earth shall not be measured and paid under any item.

8.2.2 In exceptional circumstances the Engineer-in-Charge may direct the Contractor to remove surplus earth, concrete debris or any other waste material from site to the areas of disposal on the basis of truck measurement. In such cases volume of material shall be calculated on the basis of truck volume reduced by 30% for voids in case of soft/hard soils and 50% for soft/ hard rock. All other provisions of disposal such as spreading, levelling, grading shall apply in this case also.

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9.0 PROTECTION OF PROPERTY AND PERSONNEL

9.1 The Contractor shall protect all active utility lines shown on the drawings or encountered during the excavation. If he damages those lines, the Contractor shall repair or replace them. If existing utilities interfere with his work, the Contractor shall inform to the Engineer-in-charge and secure written instructions for further action.

9.2 The Contractor shall barricade open holes and depressions which he creates or exposes as part of this, and he shall post warning signs and lights on property adjacent to or with public access. He shall operate warning lights during hours from dusk to dawn each day and as otherwise required for safety.

9.3 The Contractor shall protect structures, utilities, pavements, and other facilities from damage caused by settlement, lateral movement, washout, and other hazards created by his operations.

9.4 The Contractor shall plan and execute all aspects of the earthwork so that the safety of personnel, the work and adjacent property is guaranteed and such that a minimum of inconvenience is caused.

10.0 CLEAN UP

Upon completion of work, the Contractor shall leave the project site clear of debris and surplus materials off plant limits in a manner meeting all location authority requirements.

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मानक विनिर्देशन
सिविल एवं संरचनात्मक कार्य

STANDARD SPECIFICATION
CIVIL & STRUCTURAL WORKS

सादा एवं प्रबलित सीमेंट कंक्रीट

PLAIN AND REINFORCED CEMENT CONCRETE

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
8	07 DEC 22	UPDATED & REVISED	DK	DA	AS	SM
7	29h JAN 16	UPDATED & REISSUED	AJS	AS	RS	SC
6	15th DEC 14	UPDATED & REISSUED	SP	AS	PKM	SC
5	28th DEC 12	UPDATED & REISSUED	CDS	AJS	PKM SC	DM
4	23rd NOV 07	UPDATED & REISSUED	YPC	PKM	VK	VC
3	APR,01	UPDATED & REISSUED	RPM7097	SCS	SCJ1151	MI

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Abbreviations:

ACI	:	American Concrete Institute
ASTM	:	American Society for Testing and Materials
BS	:	British Standards
GI	:	Galvanized Iron
IS	:	Indian Standard
ISO	:	International Organization for Standardization
PVC	:	PolyVinyl Chloride
RCC	:	Reinforced Cement Concrete
SCC	:	Self Compacting Concrete
SWG	:	Standard Wire Gauge

Structural Standards Committee

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1.0 SCOPE

This specification is applicable for Concrete Grade up to M60 and establishes the requirements of materials, mix proportioning, placing, curing, etc. of all types of cast-in-situ and precast concrete (ref. section 1.6) used in foundations, underground and above ground structures, floors, pavements etc. Any special requirements as shown or noted on the drawings shall supersede the provisions of this specification.

1.1 Reference Codes and Specifications

Apart from this specification, construction of plain and reinforced concrete works shall be in accordance with the Indian Standard Code of Practice for "Plain and Reinforced Concrete" IS 456 along with all amendments till date and other relevant codes mentioned therein.

1.2 For Liquid Retaining Structures, EIL Specification No. 6-68-0005 shall be applicable.

1.3 For Structural Steel works, EIL Specification No. 6-68-0006 & 0008 shall be applicable.

1.4 For Bipolar Concrete Penetrating Corrosion Inhibiting Admixture, EIL Specification No. 6-68-0017 shall be applicable.

1.5 For Self Compacting Concrete, EIL Specification No. 6-68-0019 shall be applicable.

1.6 For precast concrete manufacturing refer EIL Specification No. 6-68-0014.

1.7 In case of conflict between the clauses mentioned in this specification and those in the Bureau of Indian Standards (BIS), this specification shall govern.

2.0 MATERIALS

2.1 Materials for concrete viz cement, Pozzolanas, Fly Ash, Ground Granulated Blast Furnace Slag, Sand, Coarse aggregate, Water, etc. shall be as described in EIL Specification No.6-68-0002.

2.2 Materials for all reinforcements, embedment, inserts, water bars etc. shall conform to EIL Specification 6-68-0002.

2.3 Materials to be used as additive to concrete shall conform to EIL specification 6-68-0002 & 6-68-0017.

3.0 GRADES OF CONCRETE

Characteristic Compressive strength for different grades of concrete shall be as per Table-1.

TABLE – 1
GRADES OF CONCRETE

Group	Grade Designation	Specified Characteristic Compressive Strength of 150 mm cube at 28 days (N/mm^2)
Ordinary Concrete	M10 M 15 M 20	10 15 20

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TABLE – 1 (CONT.)
GRADES OF CONCRETE

Group	Grade Designation	Specified Characteristic Compressive Strength of 150 mm cube at 28 days (N/mm^2)
Standard Concrete	M 25	25
	M 30	30
	M 35	35
	M 40	40
	M 45	45
	M 50	50
	M 55	55
High Strength Concrete	M 60	60

Note: The characteristic strength is defined as the strength of material below which not more than five (5) percent of the test results are expected to fall.

4.0 TYPE OF CONCRETE MIX

4.1 Unless otherwise noted on drawings, all lean/plain concrete shall be of Nominal Mix type and reinforced concrete shall be of Design Mix type.

4.2 Nominal Mix Concrete

This concrete shall be made (without preliminary tests) by adopting nominal concrete mix with proportions of materials as specified in Table 9 of IS 456.

4.3 Design Mix Concrete

The mix shall be designed as per IS: 10262 in an approved laboratory to produce the grade of concrete having the required workability and characteristic strength not less than appropriate values given in Table-1. The target mean strength of concrete mix shall be equal to the characteristic strength plus 1.65 times the standard deviation.

As long as the quality of materials does not change, a mix design done earlier but not prior to one year may be considered adequate for later work. However, in case the source & quality of materials changes or there is a break in the continuity of construction, the Engineer-In-Charge shall ask for a new design mix.

Irrespective of the grade of concrete required to be produced as per characteristic strength criteria, the minimum cement content and maximum water cement ratio in the design concrete shall be strictly maintained as stipulated in Table 5 of IS 456.

5.0 CONCRETE MIX PROPORTIONING

Proportioning, as used in this specification, shall mean the process of determining the proportions of the various ingredients to be used to produce concrete of the required workability when fresh/green and strength, durability & surface finish, when hardened. The following information shall be collected prior to design of the concrete mix:

a) Grade designation.
b) Type of cement.
c) Maximum nominal size of aggregate.
d) Minimum cement content.
e) Maximum water cement ratio
f) Workability requirements.

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g) Exposure condition as per Table 3 & Table 4 of IS 456
h) Maximum temperature of concrete at the time of placing.
i) Method of Placing.

The Engineer-in-Charge shall verify the strength of the concrete mix, before giving his sanction of its use. However, this does not absolve the Contractor of his responsibility as regards achieving the prescribed strength of the mix. If during the execution of the work, cube tests show lower strengths than required, the Engineer-in-Charge shall order fresh trial mixes to be made by the Contractor. No claim to alter the rates of concrete work shall be entertained due to such changes in mix variations. Any variation in cement consumption shall be taken into consideration for material reconciliation. Preliminary mix designs shall be established well ahead of start of work.

5.1 Maximum Density

Suitable proportions of sand and the different sizes of coarse aggregates for each grade of concrete shall be selected to give as nearly as practicable the maximum density as per clause 10.2.3 of IS 456. This shall be determined by mathematical means, laboratory tests, field trials and suitable changes in aggregate gradation. The contractor shall ensure the same to the satisfaction of Engineer-in-Charge.

5.2 Consistency

The concrete shall have a consistency such that it shall be workable in the required position and when properly vibrated it flows around reinforcing steel, all embedded fixtures, etc.

5.3 Workability

"Workability of Concrete" shall be as per clause 7 of IS 456.

5.4 Durability

For achieving sufficiently durable concrete, strong, dense aggregates, low water-cement ratio and adequate cement content shall always be used. Workability of concrete shall be such that concrete can be completely compacted with the means available. Leak-proof formwork shall be used so as to ensure no loss of cement-slurry during pouring and compaction. Cover to reinforcement shall be uniform. Concrete mix design shall always take into account the type of cement, minimum cement content irrespective of the type of cement and maximum water cement ratio and minimum grade of concrete conforming to environmental exposure conditions (refer Table 3 of IS 456) as given in Table 5 of IS: 456.

Generally, following types of cement shall be used for Plain and Reinforced concrete works:

a) 43/ 53 Grade Ordinary Portland Cement conforming to IS 269.
b) Rapid hardening Portland Cement conforming to IS 8041.
c) Portland Slag Cement conforming to IS 455.
d) Portland Pozzolana Cement(fly ash based) conforming to IS 1489(Part 1)
e) Portland Pozzolana Cement (calcined clay based) conforming to IS 1489(Part-2).
f) Sulphate Resisting Portland Cement conforming to IS 12330

Sulphate Resisting Portland Cement shall be used only for specific requirements depending on environmental and process exposure conditions to which the structures may be subjected to like high Sulphate concentrations, processes involving Sulphur handling etc.

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5.4.1 Water Cement Ratio

Once a mix, including its water cement ratio, has been determined and approved for use by the Engineer-in-Charge, that water cement ratio shall be maintained. The Contractor shall determine the water content of the aggregates frequently as the work progresses, and the amount of mixing water shall be adjusted so as to maintain the approved water cement ratio. Maximum water-cement ratio shall be as per Table 5 of IS 456 for different exposure condition.

The minimum cement content as mentioned in Table 5 of IS 456 shall be adjusted for aggregates other than 20 mm nominal maximum size as defined in Table 6 of IS 456.

For maximum cement content refer Cl.8.2.4.2 of IS 456.

5.4.2 Where specified, Bipolar concrete penetrating corrosion inhibiting Admixture in reinforced concrete as per EIL specification No. 6-68-0017 shall be used for protecting the reinforcement from corrosion.

5.5 Limits to Deleterious Constituents

Careful selection of the mix and the constituent materials shall be made to limit the presence of deleterious constituents in concrete. The total acid soluble chloride content calculated from the mix proportion and the measured chloride content of each of the constituents shall not exceed 0.6 kg/m^3 at the time of placing of concrete. The total water soluble Sulphate content of the concrete mix shall not exceed 4 percent by mass of the cement in the mix.

6.0 BATCHING

Refer clause 10.2 of IS 456.

7.0 CONCRETE MIXING

7.1 Ready Mixed Concrete supplied by Ready Mixed Concrete Plants or from on/off-site batching plants (IS 4926) shall be used for structural concrete.

All records and charts for the batching and mixing operations shall be prepared and maintained by the contractor in accordance with IS 4926 or as per the instructions of Engineer-in-Charge.

In case Ready Mixed Concrete is not available, the mixing of concrete shall be strictly carried out in an approved type of mechanical concrete mixer. The mixer shall be fitted with water measuring devices. The mixing shall be continued until there is a uniform distribution of the material and the mass is uniform in colour and consistency. If there is segregation after unloading from the mixer, the concrete shall be remixed.

7.2 Mixer

7.2.1 Mechanical Mixers shall comply with IS 1791 and 12119 and shall be maintained in satisfactory operating condition. These shall be used only for producing lean/ plain concrete and/ or nominal mix concrete wherever permitted.

7.2.2 Mixing Time

Mixing time shall be as indicated in the following Table-2. Excessive mixing requiring additions of water shall not be permitted. Time shall start when all solid materials are poured in the revolving mixer drum, provided that all of the mixing water shall be introduced before one-fourth of the mixing time has elapsed. The Engineer-in-Charge may, however, direct a change in the mixing time, if he considers such a change necessary.

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TABLE-2

MINIMUM MIXING TIME FOR MIXERS

Capacity of mixer	Minimum mixing time
2 m^3 or less	2 minutes
Above 2 m^3	3 minutes or as recommended by the mixer manufacturer.

7.3 Hand Mixing

Hand mixing of concrete shall not be permitted. However, for non-critical applications namely foundations for crossovers, isolated operating platforms etc., using concrete upto grade M20 and located at far away isolated places, this may be permitted by the Engineer-in-charge as a special case. Mixing shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. No extra payment shall be made to the Contractor for mixing by hand or for using extra cement due to hand mixing.

7.4 Additives

Additive in concrete shall be used only with the prior approval of the Engineer-in-Charge and shall comply with Cl. 5.5 of IS 456. Any additive used for obtaining proper workability or leak proofness of concrete or repair/rendering works of concrete due to non-conformance to the specifications, shall not be measured and paid for. All costs relating to such usage shall be borne by the Contractor.

8.0 TRANSPORTATION, PLACING AND COMPACTION

8.1 General

The entire concrete placing programme including transportation arrangements, deployment of equipment, layout, proposed procedures and methods, shall be submitted to the Engineer-in-Charge 24 hours prior to concreting for approval. No concreting shall be placed until his approval has been received. Approval of the Engineer-in-Charge for pouring concrete shall be taken as 'conveyed', when the concrete pour card is signed by him.

8.1.1 Chuting

The use of long troughs, chutes and pipes for conveying concrete from the mixer to the forms shall be permitted only on written authorization from the Engineer-in-Charge. In case an inferior quality of concrete is produced by the use of such conveyors, the Engineer-in-Charge may order discontinuance of their use and the substitution of a satisfactory method of placing the concrete. Open troughs and chutes shall be equipped with baffles and be in short lengths to avoid segregation. Chutes shall be designed so that the concrete is, to some extent, remixed at the lower end by passing down through a funnel shaped pipe or drop chute. Alternatively, they shall discharge into a storage hopper from which the concrete shall be transported to the point of placing by wheel barrows or other means. Where drop chutes are used, a sufficient number of these must be provided, so that the concrete discharged from the chute is not required to flow laterally more than 1.0 metre. Where a drop chute is swung from the vertical, the bottom two sections must be maintained in a vertical position to avoid segregation. The addition of water at any point in the system of transportation, to facilitate the movement of concrete shall not be permitted. All chutes, troughs and pipes, shall be kept clean and free from coatings of hard concrete by thoroughly flushing them with water after each run; water used for this shall be discharged clear of the structure.

Signature Not Verified
Digitally signed by ARITRA DE
Date: 2026.05.18 16:50:55 IST
Location: eProcure-EPROC

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