Joints between the heat exchanger and the main body of the motor shall be sealed by weather-proof gaskets.

### 6.6 Rotor

The rotor shall be of squirrel cage type, dynamically balanced to provide a low vibration level and a long service life to the bearings. The accepted values of vibrations for a motor at rated voltage and speed shall not exceed those given in the IS. The shaft ends shall be provided with suitably threaded hole or holes to facilitate the assembly or removal of couplings and bearing races.

### 6.7 Shaft extension

Motors shall be provided with a single, bare shaft extension with key way and key. Motor shaft shall be sized to withstand dynamic torque equal to 10 times the rated design torque.

### 6.8 Lifting hooks

All motors shall be provided with lifting facility (i.e. hooks etc.) of adequate capacity.

For motors provided with heat exchangers, lifting facility shall also be provided for the heat exchanger.

### 6.9 Earth terminals

Two earth terminals shall be provided on the frame of each motor at diametrically opposite points. Minimum size of the stud shall be 12 mm. Necessary nuts and spring washers shall be provided for earth connection. These earth terminals shall be in addition to the earth terminals provided in the terminal box for earthing of the armour.

## 7.0 CONTROL, ALARM AND TRIP DEVICES

All electrical contacts for the devices described below (e.g. at sections 7.3 & 7.4) shall have a current carrying capacity not lower than 5 A and a minimum interrupting capacity of 1 A at 220 V DC or 5 A at 240 V AC.

The contacts shall be located in explosion proof or totally sealed housing according to the type of motor enclosure. The cable ends shall be brought together to the terminal box. Any external connections between the housing containing the relay contacts and the terminal box shall be carried out by insulated copper wires in steel conduits or by PVC insulated, armoured, copper conductor cables with cable entries through double compression type cable glands.

### 7.1 Measurement of winding temperature

Motors with outputs greater than 750 KW or those provided with filters for cooling air irrespective of output shall be provided with platinum resistance temperature measuring devices of 100 ohms resistance at 0°C and a temperature co-efficient of $3.85 \times 10^{-3}$ located in suitable positions to measure the winding temperature. A minimum of three (one per phase) detectors shall be provided between the coil sides to measure the winding temperature and three (one per phase), preferably at the base of the slots, to measure core temperature, each placed 120° apart. If RTD's at the base slot are not possible to be


Copyright EIL – All rights reserved

provided based on motor manufacturer specific design, 12 no's RTD's shall be provided between the coil side, to measure winding temperature. TETV motors may not be provided with core temperature detectors.

A separate terminal box shall be provided for the temperature detectors for hook up with a remote located control / monitoring unit.

### 7.2 Measurement of bearing temperature

Motors with self-lubricated bearing shall be provided with:

a) Two dial type and gas filled capillary type, indicating dial thermometers for checking of bearing temperatures.
b) For motors with output greater than 750 KW, a resistance type of temperature measuring device shall be provided for bearings with connections terminating in the common terminal box for winding temperature detectors.

### 7.3 Measurement of cooling medium for heat exchangers

Motors with forced ventilation and those with air water heat exchangers shall be provided with:

a) An airflow circulation indicator with electrical trip contacts that operate if the flow of cooling air is interrupted or is inadequate. If airflow indicator is not provided based on motor manufacturer specific design constraint, provision for alarm/trip of the motor shall be provided based on RTD.
b) A cooling water flow circulation indicator with electrical trip contacts, which close if the flow of cooling water is interrupted or is inadequate. The indicator shall be located on the discharge piping of the heat exchanger.

### 7.4 Pressurization Control Panel

All pressurized motors (Type Ex p) shall be provided with a control panel for controlling the initial purging and pressurization of the motor. The pressurization control panel shall be mounted on the motor itself and shall be suitable for the hazardous area classification specified in the motor data sheet. Purged control panel shall be powered through external supply to be made available by purchaser. Battery operated purge controller is not acceptable.

The panel shall be complete with but not limited to the following items:

- Timers
- Push buttons for purging/pressurization. (Manual push button shall override the auto selection parameters)
- Solenoid valves/dampers
- Indicating lamps for purging ON, purging OVER, pressurization ON & pressurization OVER etc.
- Claps regulator to compensate the pressure dip.
- Minimum & intermediate pressure sensor
- Pressure switches and flow switches with alarm and trip contacts.
- Low pressure alarm & trip contacts
- Intermediate pressure & pressurization completed contacts
- Purging started & purging completed contacts
- Power interlock/fail contact


Copyright EIL – All rights reserved

## 8.0 MISCELLANEOUS ACCESSORIES

### 8.1 Current transformers

Unless otherwise specified, motors rated 1500 KW and above shall have differential protection and shall be equipped with current transformers suitably designed for installation in the neutral terminal box.

Unless otherwise specified, the CTs shall be supplied along with the motor and mounted in the terminal box, which shall be suitable for housing the CTs and providing the necessary connections. CT terminals shall be brought out to a separate auxiliary terminal box of the same specification and grade of protection as the neutral/main terminal box.
Voltage rating of CT shall be same as voltage rating of motor, however window type CT with voltage rating up to 1100 V can be considered acceptable.

These transformers shall have a secondary current of 1 A, and the characteristics of the CTs ($V_k$, $R_{CT}$ and $I_m$) shall be finalized at detailed engineering stage in consultation with the purchaser. CT ratio shall be as indicated in the motor data sheet.

Differential CTs wherever provided for hazardous area motors shall be Ex protected type.

### 8.2 Anti condensation heaters

All motors shall be provided with 240 V anti-condensation heaters, sized and located so as to prevent condensation of moisture during shut down periods. The heaters shall remain 'ON' when the motor is not in service and shall not cause damage to the windings.

Motors with heaters installed in hazardous atmospheres (Zone-1 or Zone-2), shall conform to the provisions of applicable IS/IEC standards and temperature classification specified in the motor data sheet.

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

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

### 8.3 Special tools and spanners

Motors with special features (e.g. motors with single bearing, explosion proof and increased safety motors etc.) shall be provided with a set of spanners and special tools, required for dismantling and maintenance of the motor.

**8.4** Motors shall be supplied complete with double compression Nickel plated brass (or Aluminum, if specifically required) cable glands, crimp type tinned Cu cable lugs for all power, space heater and auxiliary cables (for the specified cable sizes) and first filling of lube oil for forced lubricated bearings.

**8.5** Auxiliary motors, if any, shall be as per relevant Indian / International standards and shall be suitable for the hazardous classification as specified in the motor data sheet.

### 8.6 Name plates

A stainless-steel name plate manufactured from series 300 stainless steel and having information as per IS shall be provided on each motor. In addition to the motor rating


Copyright EIL – All rights reserved

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

Additional information as stipulated in applicable Standards shall be included in the name plate for motors meant for use in hazardous atmospheres.

## 9.0 NOISE LEVEL

The permissible noise level shall not exceed the stipulations laid down in IS.

## 10.0 MOTOR VIBRATION

Motor vibrations at bearing housing shall be within the limits of IS, unless otherwise specified for the driven equipment. Limits of shaft vibration for motors with sleeve bearings shall be as per IEC-60034-14.

Two and four pole motors having sleeve bearings with forced oil lubrication shall be provided with proximity probes to measure the shaft vibration adjacent and relative to the bearings.

## 11.0 CRITICAL SPEEDS

The first actual critical speed of stiff rotors shall not be lower than 125% of the synchronous speed. For flexible rotors, this shall be between 60% and 80% of the synchronous speed. The second actual synchronous speed shall be above 125% of the synchronous speed.

## 12.0 PAINTING

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

## 13.0 INSPECTION, TESTING AND ACCEPTANCE

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

13.2 Hazardous area type test certificates & corresponding approval letter, BIS license etc. shall be shown to the inspection agency on demand during inspection. The certificates and BIS license must be valid at the time of dispatch.

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

13.4 For VFD fed motors, all tests as specified in VFD specification shall be followed. Combined test for VFD and motor at vendor's works shall be carried out if specified in the Job Specification / datasheet.


Copyright EIL – All rights reserved

13.5 All equipments shall be subjected to various routine / acceptance tests as per Inspection & Test plan no. 6-81-1031.

## 14.0 CERTIFICATION

All hazardous area equipment shall have hazardous area test certificates and approvals as per following:

**For Indigenous manufactured hazardous area equipment:**

For all electrical items manufactured in India, the testing shall be carried out & test report issued by Indian test laboratory recognized by the Chief Controller of Explosives shall be furnished. For Ex protection Electric Apparatus having flameproof type protection, a copy of valid BIS license shall be furnished.

Alternatively, IECEx Certificate of Conformity, valid copy of IECEx Quality Assessment Report (summary) and IECEx Test Report shall be furnished.

**For Imported hazardous area equipment:**

For all electrical items manufactured outside India, test report issued by Indian test laboratory recognized by the Chief Controller of Explosives shall be furnished. For Ex protection Electric Apparatus having flameproof type protection, a copy of valid BIS license shall be furnished.

As an alternative option-1 to this, IECEx Certificate of Conformity, valid copy of IECEx Quality Assessment Report (summary) and IECEx Test Report shall be furnished.

As an alternative option-2 to this, EU Type Examination Certificate, which is applicable for manufacturers having manufacturing locations in countries covered under the European Union, valid copy of Production Quality Assessment / Assurance Notification shall be furnished.

All equipment i.e. 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.
For installations in India, PESO approval letter shall be provided.

## 15.0 PACKING AND DESPATCH

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

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


Copyright EIL – All rights reserved

# 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<br>Approved by | Standards Bureau Chairman |
|---|---|---|---|---|---|---|
| 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 |
| 7 | 01/04/16 | REVISED AND ISSUED AS STANDARD SPECIFICATION | RG | MKS | BRB | RN |
| 6 | 11/04/11 | REVISED AND ISSUED AS STANDARD SPECIFICATION | PS | ANPS | UAP | DM |



Copyright EIL – All rights reserved

**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**

**Convener:** Mr. M.K. Sahu

**Members:**
Mr. Harish Kumar
Ms. Arvind NP Singh
MS. Shalini Verma
Mr. Raman Sood
Mr. Bishan Dass
Mr. Rajiv Kumar Saha
Ms. Shirali Aggarwal
Mr. Ayush Mathur (Projects)
Mr. Rajesh Sinha (Inspection)


Copyright EIL – All rights reserved

## CONTENTS

| | | |
|---|---|---|
| 1.0 | SCOPE | 4 |
| 2.0 | STANDARDS | 4 |
| 3.0 | GENERAL CONSTRUCTION | 5 |
| 4.0 | CABLE ACCESSORIES | 8 |
| 5.0 | INSPECTION, TESTING AND ACCEPANCE | 8 |
| 6.0 | PACKING AND DESPATCH | 10 |



Copyright EIL – All rights reserved

## 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:<br>- Part 41: Mass of zinc coating on steel armour<br>- Part 58: Oxygen index test<br>- Part-61: Flame retardant test<br>- Part-62: Fire resistance test for bunched cables.<br>- 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 |


Copyright EIL – All rights reserved

| | | |
|---|---|---|
| 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.


Copyright EIL – All rights reserved

**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


Copyright EIL – All rights reserved

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


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

## 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.)


Copyright EIL – All rights reserved

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%).


Copyright EIL – All rights reserved

# 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 |



Copyright EIL – All rights reserved

**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 |

**Electrical Standards Committee**

**Convener :** Mr. Parag Gupta

**Members :** Mr. M. K. Sahu
Ms. Arvind NP Singh
Mr. Harish Kumar
Ms. Shalini Verma
Mr. Raman Sood
Mr. V.K. Jain
Ms. Shirali Aggarwal
Mr. Rajesh Sinha (Inspection)
Mr. Ayush Mathur (Projects)


Copyright EIL – All rights reserved

## CONTENTS

1.0 SCOPE ..... 4
2.0 CODES AND STANDARDS ..... 4
3.0 GENERAL CONSTRUCTION ..... 5
4.0 TECHNICAL REQUIREMENTS FOR NON JELLY FILLED CABLES ..... 5
5.0 TECHNICAL REQUIREMENTS FOR JELLY FILLED CABLES ..... 8
6.0 INSPECTION, TESTING AND ACCEPTANCE ..... 10
7.0 PACKING AND DESPATCH ..... 11


Copyright EIL – All rights reserved

## 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:<br>- Part 41: Mass of zinc coating on steel armour.<br>- Part 58: Oxygen index test.<br>- Part-61: Flame retardant test.<br>- Part-62: Fire resistance test for bunched cables.<br>- 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). |


Copyright EIL – All rights reserved

| | | |
|---|---|---|
| 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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

# संकटमय क्षेत्रों में लाइटिंग फिक्सचरों एवं जंक्शन बक्सों के लिए विनिर्देश

# SPECIFICATION FOR HAZARDOUS AREA LIGHT FIXTURES AND JUNCTION BOXES

| Rev. No | Date | Purpose | Prepared by | Checked by | Standards Committee Convenor | Standards Bureau Chairman |
|---|---|---|---|---|---|---|
| | | | | | Approved by | |
| 6 | 23.12.20 | REVISED AND ISSUED AS STANDARD SPECIFICATION | NNB/RKS | ANPS | PG | SM |
| 5 | 24.02.16 | REVISED AND ISSUED AS STANDARD SPECIFICATION | NNB/AK | ANPS | BRB | SC |
| 4 | 11.04.11 | REVISED AND ISSUED AS STANDARD SPECIFICATION | PS | ANPS | UAP | DM |
| 3 | 27.08.07 | REVISED AND ISSUED AS STANDARD SPECIFICATION | ANPS | UAP | JMS | VC |
| 2 | 30.01.02 | REVISED AND ISSUED AS STANDARD SPECIFICATION | UAP | AAN | VPS | GRR |



Copyright EIL – All rights reserved

**Abbreviations:**

| | |
|---|---|
| AC | Alternating Current |
| BIS | Bureau of Indian Standards |
| CEA | Central Electricity Authority |
| CRI | Colour Rendering Index |
| DC | Direct Current |
| DGCA | Director General Civil Aviation |
| EIL | Engineers India Limited |
| FRLS | Flame Retardant Low Smoke |
| IEC | International Electrotechnical Commission |
| IES | Illuminating Engineering Society |
| IP | Ingress Protection |
| IS | Indian Standard |
| LED | Light Emitting Diode |
| MR | Material Requisition |
| NABL | National Accreditation Board for Testing and Calibration Laboratories |
| PESO | Petroleum and Explosives Safety Organisation |
| PO | Purchase Order |
| PVC | Poly Vinyl Chloride |
| SPD | Surge Protection Device |
| SPN | Single Phase Neutral |
| SS | Stainless Steel |
| XLPE | Cross Linked Poly Ethylene |

**Electrical Standards Committee**

**Convenor:** Mr. Parag Gupta

**Members:**
Mr. M. K. Sahu
Ms. Arvind N. P. Singh
Mr. Harish Kumar
Ms. Shalini Verma
Mr. Raman Sood
Mr. V. K. Jain
Ms. Shirali Aggarwal
Mr. Ayush Mathur (Projects)
Mr. Rajesh Sinha (Inspection)


Copyright EIL – All rights reserved

## CONTENTS

1.0 SCOPE ..... 4

2.0 CODES AND STANDARDS ..... 4

3.0 GENERAL REQUIREMENTS ..... 4

4.0 SITE CONDITIONS ..... 4

5.0 POWER SUPPLY ..... 5

6.0 CERTIFICATION/ ..... 5

7.0 TECHNICAL REQUIREMENTS ..... 5

8.0 INSPECTION, TESTING AND ACCEPTANCE ..... 7

9.0 PACKING AND DESPATCH ..... 7



Copyright EIL – All rights reserved

## 1.0 SCOPE

This specification covers the requirements of design, manufacture, testing, packing and supply of LED lighting fixtures, complete with LED lamp and driver, junction boxes and accessories suitable for installation in locations handling flammable liquids and gases/ vapours.

## 2.0 CODES AND STANDARDS

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

| | | |
|---|---|---|
| IS-5 | : | Colours for ready mixed paints and enamels |
| IS-10322 | : | Luminaires |
| IS-13383 | : | Photometry of luminaires - Method of measurement |
| IS 15885 (Part 2/ Sec 13) | : | Safety of lamp control gear-Part-2 Particular requirements-Section 13 d.c. or a.c. supplied electronic control gear for LED modules |
| IS-16101 | : | General lighting – LEDs and LED modules – Terms and Definitions |
| IS-16102 | : | Self-ballasted LED lamps for general lighting services |
| IS-16107 | : | Luminaires performance |
| IS / IEC 60079-0 | : | Electrical apparatus for explosive gas atmospheres (General requirements) |
| IS / IEC 60079-1 | : | Electrical apparatus for explosive gas atmospheres (Equipment Protection by Flameproof Enclosures "d") |
| IS / IEC 60079-7 | : | Electrical apparatus for explosive gas atmospheres (Equipment Protection by Increased Safety "e") |
| IS / IEC 60079-15 | : | Electrical apparatus for explosive gas atmospheres Construction, test & marking of type of protection "n" |
| IS / IEC 60529 | : | Degrees of protection provided by enclosures (IP Code). |

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 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.

## 3.0 GENERAL REQUIREMENTS

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

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

## 4.0 SITE CONDITIONS

The equipment shall be suitable for installation and satisfactory operation in classified hazardous locations in tropical, humid and corrosive atmosphere as prevalent in refineries,


Copyright EIL – All rights reserved

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

## 5.0 POWER SUPPLY

All AC lighting fixtures/ junction boxes shall be suitable for 240V ± 10%, SPN, 50Hz ± 3% power supply and all DC lighting fixtures/ junction boxes shall be suitable for 110/ 220V ± 10% power supply.

## 6.0 CERTIFICATION

The equipment shall have test certificates issued by NABL-approved/ 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.

## 7.0 TECHNICAL REQUIREMENTS

### 7.1 Construction

7.1.1 The enclosures of the lighting fixtures and junction boxes shall be of cast light metal alloy.

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

7.1.3 The enclosures shall be provided with gaskets made of non-inflammable and self-extinguishing material.

7.1.4 All metal surfaces shall undergo manufacturer's standard cleaning/ painting/ powder coating cycle. After surface preparation, the equipment 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 Exd (Gas group IIA/IIB) and AC supply: Dark admiralty grey shade 632 of IS-5/ RAL 7031
- Flameproof Exd (Gas group IIC) and AC Supply : Light yellow shade 355 of IS-5/ RAL 1012
- Non-sparking ExnR/ Increased safety Exec and AC Supply : Dark admiralty grey shade 632 of IS-5/ RAL 7031
- DC lighting fixtures : Bright red shade 538 of IS-5/ RAL 3003

All unpainted parts shall be suitably treated to prevent rust formation/ corrosion. If these parts are moving elements then these shall be greased with non-solidifying grease.

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

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

7.1.7 All equipments on single phase supply shall be provided with an independent earth terminal with lug inside the enclosure for terminating the third (earth) core of the cable and shall have facility for looping.

7.1.8 A nameplate shall be provided to indicate the details of testing agency, name of manufacturer, test certificate number, statutory approval agency (PESO), serial number, BIS license number, applicable gas group etc. and any additional marking required by statutory authority like approval no. etc. The nameplates shall be Al anodized or SS-304 engraved type or laser-


Copyright EIL – All rights reserved

marked and permanently fixed/ fixed with rivets 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 Lighting Fixtures

7.2.1 Glass used for all types of lighting fixtures shall be clear and suitable for use under conditions involving exceptional risk of mechanical damage. Glass shall be toughened type.

7.2.2 All well/ bowl glass fixtures shall be provided with Stainless Steel SS-304 protective wire cage using minimum 5mm welded steel construction and having mesh dimension not exceeding 50mm x 50 mm. The mounting bolts of SS-304 required for physically connecting the hazardous area well/ bowl glass lighting fixtures (bracket/ ceiling mounted type) to the respective mounting bracket shall be supplied by Vendor along with the fixtures.

7.2.3 The fixing parts of the enclosure, which are to be opened for replacement of lamp, shall be so fastened that they can be unfastened only with special tools.

7.2.4 The lighting fixtures in Zone-2 area shall be Ex nR type, unless otherwise specified in the MR/ Tender.

7.2.5 For LED fixture, integral junction box shall be provided with 3 nos. cable entries for loop-in, loop-out and associated wiring to fixture. Alternatively, lighting fixtures shall be provided with 2 nos. threaded entries and 2 nos. hazardous area double compression nickel plated brass cable glands, and internal wiring shall be provided for driver and lamp. The glands shall be suitable for the specified cable size. 20% of the fixtures shall be supplied with 1 no. nickel plated brass plug for sealing the unused entry.

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

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

7.2.8 The aviation warning lighting fixtures shall have cluster LED lamps of Type C, medium intensity (as per DGCA civil aviation statutory regulations) and of red colour, fixed (not flashing), 2000cd, unless otherwise specified.

7.2.9 All lighting fixtures shall be provided with suitable mirror-polished aluminum internal reflector of suitable thickness to ensure adequate mechanical strength.

7.2.10 Lighting fixtures shall be tested for resistance to impact in line with IS/ IEC 60079-0. Impact test certificates shall be furnished by vendor.

7.2.11 All LED fixtures shall be supplied complete with lamp and driver. LED driver shall be suitable for surge protection of minimum 4 kV surge. However, for flood lights, aviation warning lights, and lighting fixtures with wattage higher than 90W, LED driver shall be suitable for surge protection of minimum 10 kV surge. An additional fail safe SPD may be provided, as required, to achieve 10 kV surge protection. LED driver shall comply with the requirement of IS 15885-2-13. Fixture lifetime (L70) shall be greater than 50000 hours at ambient temperature of 40°C.

7.2.12 LED type lighting fixtures shall fulfill the following requirements:

a. Minimum power factor shall be 0.95.

b. LED lighting fixture luminous efficacy shall be minimum 100 lumen per watt.

c. LED lighting fixture beam angle shall be 120°/ 90° depending upon fixture location and mounting height.

d. The CRI for LED lighting fixtures shall be greater than 80 for indoor fixture and greater than 70 for outdoor fixture.


Copyright EIL – All rights reserved

e. The colour temperature of white colour LED shall be from 5700K to 6500K, unless otherwise specified.

f. Polar curves/ photometric drawings shall be submitted by vendor for the offered lighting fixtures.

g. LED lamps and drivers shall be provided with minimum 5 years warranty period, unless specified otherwise in the MR/ Tender. Driver shall have valid BIS certification and the same shall be furnished during drawing review stage.

h. The LED light fixtures, should be tested for luminous lux level as per IES-LM-79. Wherever wire guard is provided, testing shall be done with wire guard. Type test certificates for LM-79 for all fixtures shall be from an NABL-accredited/ IECEx-certified/ equivalent lab.

i. The LEDs used in the lighting fixtures should be tested for the service life as per IES-LM-80. Type test certificates shall be furnished in compliance to same.

### 7.3 Junction Boxes

The junction boxes shall be of flameproof or non-sparking type construction as mentioned in the MR/ Datasheet. All junction boxes for looping of single phase lighting circuits using cables up to 6mm$^2$ shall be minimum 125mm diameter in size. Each junction box shall be complete with requisite number of cable entries and double compression flameproof nickel plated brass cable glands to suit the specified cable size.

### 7.4 Terminals & Wiring

7.4.1 The fixtures and junction boxes shall be provided with sufficient number of terminals. More than 2 wires per terminal shall not be permitted. If required, additional terminal with shorting link may be used. The terminals for external cable termination shall be suitable for 2.5mm$^2$ solid Copper conductor. Tinned copper lugs shall be provided for cable termination wherever applicable.

7.4.2 All internal wiring shall employ 1.5mm$^2$, 660/ 1100 V grade, FRLS type, XLPE/ PVC insulated Copper conductor wires, colour coded for phase, neutral and earth. All termination shall be with suitable lugs.

## 8.0 INSPECTION, TESTING AND ACCEPTANCE

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

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

**8.3** Test certificates of bought out components shall be submitted to the inspection agency, as per Inspection and Test Plan no. 6-81-1061.

**8.4** All equipments shall be subjected to various routine/ acceptance tests as per Inspection and Test Plan no. 6-81-1061.

## 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


Copyright EIL – All rights reserved

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 nos.' 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.


Copyright EIL – All rights reserved

# ऊर्जा दक्ष निम्न वोल्टेज प्रेरण मोटरों के लिए विनिर्देश

# SPECIFICATION FOR ENERGY EFFICIENT LOW VOLTAGE INDUCTION MOTORS

| Rev. No | Date | Purpose | Prepared by | Checked by | Standards Committee Convenor | Standards Bureau Chairman |
|---|---|---|---|---|---|---|
| | | | | | Approved by | |
| 3 | 15.09.25 | REVISED & ISSUED AS STANDARD SPECIFICATION | SS/RKR | ST | HK | MN |
| 2 | 11.10.19 | REVISED & ISSUED AS STANDARD SPECIFICATION | RKR | VKJ | SA | RKT |
| 1 | 12.08.14 | REVISED & ISSUED AS STANDARD SPECIFICATION | SS/SHIRALI | VKJ | BRB | SC |
| 0 | 20.04.09 | ISSUED AS STANDARD SPECIFICATION | SD | BRB | JMS | ND |



Copyright EIL – All rights reserved

**Abbreviations:**

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

**Electrical Standards Committee**

**Convenor:** **Mr. Harish Kumar**

**Members**: Ms. Arvind NP Singh
Mr. Raman Sood
Mr. Rajiv Kumar Saha
Mr. Vijay Kumar
Ms. Shirali Aggarwal
Ms. Rashmi Singh Rathaur
Mr. Supriya Talukder
Mr. Ayush Mathur (Projects)
Mr. Rajesh Sinha (PDD)
Mr. G. Suresh (Inspection)


Copyright EIL – All rights reserved

## CONTENTS


| | | |
|---|---|---|
| 1.0 | SCOPE..... | 4 |
| 2.0 | CODES AND STANDARDS..... | 4 |
| 3.0 | GENERAL REQUIREMENTS..... | 5 |
| 4.0 | OPERATING CONDITIONS..... | 5 |
| 5.0 | PERFORMANCE..... | 6 |
| 6.0 | CONSTRUCTION DETAILS..... | 8 |
| 7.0 | MISCELLANEOUS ACCESSORIES..... | 11 |
| 8.0 | CRITICAL SPEEDS..... | 11 |
| 9.0 | PAINTING..... | 11 |
| 10.0 | INSPECTION AND TESTING..... | 12 |
| 11.0 | CERTIFICATION..... | 12 |
| 12.0 | PACKING AND DESPATCH..... | 13 |



Copyright EIL – All rights reserved

## 1.0 SCOPE

This specification covers the design, manufacture, testing, packing and supply of energy efficient-High efficiency (IE2/IE3/IE4 as specified in data sheet) three phase medium voltage squirrel cage induction motors.

## 2.0 CODES AND STANDARDS

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

| | | |
|---|---|---|
| IS - 5 | : | Colours for ready mixed paints and enamels. |
| IS - 1076 | : | Preferred numbers. |
| IS - 1231 | : | Dimensions and output series of foot mounted induction motors-frame numbers 56 to 315 L. |
| IS - 1271 | : | Electrical insulation- Thermal evaluation and designation. |
| IS - 2223 | : | Dimensions of flange mounted AC Induction motors. |
| IS - 2253 | : | Designation for types of construction and mounting arrangement of rotating electrical machines. |
| IS - 2254 | : | Dimensions of vertical shaft motors for pumps. |
| IS - 4029 | : | Guide for testing three phase induction motors. |
| IS - 6362 | : | Designation of methods of cooling of rotating electrical machines. |
| IS - 8223 | : | Dimensions and output series for rotating electrical machines. |
| IS - 8789 | : | Values of Performance Characteristics for Three-Phase Squirrel Cage Induction Motors with Degree of Protection IP-2X. |
| IS - 9283 | : | Motors for submersible pump sets. |
| IS - 12065 | : | Permissible limits of noise level for rotating electrical machines. |
| IS - 12075 | : | Mechanical vibration of rotating Electrical Machines with shaft heights 56 mm and higher - measurement, evaluation and limits of vibration severity. |
| IS – 12615 | : | Line Operated Three Phase a.c. Motors (IE CODE) "Efficiency Classes and Performance Specification" |
| IS - 13529 | : | Guide on effects of unbalanced voltages on the performance of three phase cage induction motors. |
| IS - 13555 | : | Guide for selection and application of three phase induction motors for different types of driven equipment. |
| IS - 14568 | : | Dimensions and output series for rotating electrical machines, frame numbers 355 to 1000 and flange numbers 1180 to 2360. |
| IS / IEC60079-0: | | Electrical apparatus for explosive gas atmospheres (General requirements) |
| IS/IEC-60079-1: | | Explosive Atmospheres-Equipment protection by flame proof enclosures "d". |
| IS/IEC60079-2 | : | Explosive protection by pressurized enclosure "p". |
| IS/IEC60079-7 | : | Explosive Atmospheres-Equipment protection by increased safety – "e". |
| IS/ IEC: 60529 | : | Degree of protection provided by enclosures (IP Code) |
| IS/IEC-60034/ IS 15999 | : | Rotating Electrical machines |
| IS/IEC 61241: | | Electrical apparatus for use in the presence of combustible dust |
| IS/IEC 60072-1: | | Dimensions and output services for operating electrical machines Part-1 : Frame number 56-400 and flange number 55 to 1080 |

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


Copyright EIL – All rights reserved

**2.3** The motors shall also conform to the provisions of CEA regulations and other statutory regulations currently in force in the country.

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

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

## 3.0 GENERAL REQUIREMENTS

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

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

**3.3** Vendor shall give a notice of at least one year to the end user of equipment and EIL before phasing out the product/spares to ensure the end user for placement of order for spares and services.

## 4.0 OPERATING CONDITIONS

### 4.1 Ambient Conditions

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

### 4.2 Frequency and Voltage Variations

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

a) The terminal voltage differing from its rated value by not more than ± 10 % or
b) The frequency differing from its rated value by not more the ± 5 % or
c) Combined variation — The sum of absolute percent variations of (a) and (b) not exceeding 10 percent.

### 4.3 Starting

a) Motors shall be designed for direct-on-line starting or other method of starting as specified in datasheet.
b) Motors shall be designed for re-acceleration under full load after a momentary loss of voltage with the residual voltage being 100% and is in phase opposition to the applied voltage.
c) Minimum locked rotor thermal withstand time at rated voltage shall be 10 seconds under cold conditions and 8 seconds under hot conditions. In addition, Locked Rotor withstand time under hot conditions at 75% & 100% voltages, shall be minimum 1.4 times the starting time at the corresponding voltage.


Copyright EIL – All rights reserved

d) Unless otherwise specified, all motors shall be suitable for starting under specified load conditions with 75 % of the rated voltage at the motor terminals.

e) Motors shall be designed to allow the minimum number of consecutive starts indicated in Table below:

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

**4.4 Direction of Rotation**

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

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

## 5.0 PERFORMANCE

**5.1** Motors shall be rated for continuous duty ($S_1$), unless otherwise specified.

**5.2** Unless specified, the starting current (as % rated current) shall be as per IS 12615, subject to IS tolerance

**5.3** In particular cases, when the starting current is to be limited, care shall be taken such that the design values of torque meets the load requirement while at the same time complying to clause 4.3 above of this specification. Unless otherwise specified the minimum pull-up torque of motors, at rated voltage & frequency shall be minimum 50% of the rated full load torque.

**5.4** In particular cases, when the starting with reduced voltage is specified, care shall be taken such that the design values of torque meets the load requirement while at the same time complying to clause 4.3 above of this specification.

**5.5** Starting torque and minimum torque of the motor shall be compatible with the speed torque curve of the driven equipment under specified starting and operating conditions.

In case where characteristics of driven equipment are not available while selecting the motor, minimum starting torque shall be 110% of rated value for motors up to 75 kW and shall be 90% of rated value for motors above 75 kW.

**5.6** The breakdown torque at the rated voltage shall be not less than 175% of the rated load torque with no negative tolerance. Unless otherwise agreed, the breakdown torque shall not exceed 350% of the rated load torque.


Copyright EIL – All rights reserved

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

**5.7** Motors fed by variable frequency drive shall additionally meet the following requirements

a) The motor shall be converter grade motor suitable for operation with a solid-state power supply consisting of an adjustable frequency inverter for speed control and shall comply to IS 16724, IEC-60034-25 and relevant part of IS/IEC-60079.

b) The motor shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.

c) The motor shall be designed to operate continuously at any speed over the range (1-100%) of rated speed or as specified in data sheet.

d) Motor shall be provided with thermistor type temperature detector.

e) The motors shall be provided with Class 'F' insulation with temperature rise limited to Class 'B'.

f) Motor shall be designed suitable to deliver the torque required for complete speed torque characteristics of the load considering the voltage available at the motor terminals after taking into account supply voltage tolerances, voltage drop within VFD panel and voltage drop within cable as specified in VFD specification.

g) Motors required to be transferred to DOL by-pass mode shall be rated for specified variations in line voltage, frequency and starting current limitations as specified in data sheet.

h) The motor shall be constructed to withstand torque pulsations resulting from harmonics generated by the solid state power supply.

i) The motor insulation shall be designed to accept the applied voltage wave form, within the Vpeak and dv/dt limits as per IEC-61800-2 and 60034-25.

j) The motor vendor shall also coordinate with driven equipment vendor & VFD vendor and obtain requisite details for motor design.

k) Induced voltage at the shaft end of the motor at no load shall not exceed 250 mV rms for roller and ball bearings and 400 mV for sleeve bearings. The non driving end bearing shall be insulated from the motor frame to avoid circulating current. The insulated bearing end shield or pedestal shall bear a prominent warning. Insulated bearing (Non-Drive End) shall be provided irrespective of motor frame size.

l) Motor for hazardous area application shall have valid type test certificate issued by recognized independent test house certifying that motor is suitable for converter duty application. Corresponding statutory approval (e.g. PESO/DGMS etc.) as applicable for the specified location shall also be furnished for the hazardous area motor.

m) The motors shall be suitable for the current wave forms produced by the power supply including harmonics generated by the drive. The necessary coordination by motor manufacturers with drive manufacturers regarding harmonics generated by VFD shall be taken care and incorporated in motor design suitably.


Copyright EIL – All rights reserved

n) The motors shall be designed to operate continuously at any speed over the range as per process requirement with minimum range as 10–100% of rated speed or as specified in data sheet. The characteristics shall be based on the application – in terms of constant torque / variable torque as per the driven equipment. Additional cooling fan shall be provided if required to limit the temperature rise to specified limits, alternatively option of applying suitable de-rating may be considered.

o) The motors shall withstand torque pulsation resulting from harmonics generated by the solid state power supply.

p) The motors required to be transferred to DOL bypass mode shall be rated for specified variations in line voltage and frequency.

**5.8** The minimum values for performance characteristics of these motors shall be as given in the tables 1, 2 & 3 of IS 12615 for IE2/IE3/IE4 motors, subjected to tolerance as per IS/IEC. Motors operated by frequency converters may have higher losses as compared to line (sinusoidal) power supply due to the harmonic voltage content. These motors must be tested on sinusoidal supply and efficiency must meet the declared efficiency class (which should not be lower than IE 2 class).

## 6.0 CONSTRUCTIONAL DETAILS

### 6.1 Windings

**6.1.1** Unless otherwise specified, motors shall be provided with class `B' insulation as a minimum. In case of motors with class 'F' insulation, the permissible temperature rise above the specified ambient temperature shall be limited to those specified in the applicable Indian standards for class `B' insulation.

**6.1.2** The winding shall be tropicalised. The windings shall preferably be vacuum impregnated. Alternately the windings shall be suitably varnished, baked and treated with epoxy gel for operating satisfactorily in humid and corrosive atmospheres.

**6.1.3** Windings shall be adequately braced to prevent any relative movement during operation. In this respect, particular care shall be taken for the stator windings for direct-on-line starting squirrel cage motors. Insulation shall be provided between coils of different phases that lie together. Core laminations must be capable of withstanding burnout for rewind at 350 ºC without damage or loosening.

**6.1.4** In case of motors driving equipment with pulsating loads, special care shall be taken for the joints of rotor bars and end rings to avoid premature failures due to induced fatigue stresses.

**6.1.5** The windings shall be connected in delta. However, for motors rated 2.2 kW and below, star connection may be accepted. In case of motors with star-delta starting, the motor windings shall be fully insulated for delta connection.

**6.1.6** The ends of the windings shall be brought out into a terminal box. These shall be terminated by means of terminals mounted on an insulating base made of non-hygroscopic and non-flammable material.

**6.1.7** All motors shall be provided with six terminals and suitable links to connect them in star or in delta except for motors rated up to and including 2.2 kW which may be accepted with three terminals.


Copyright EIL – All rights reserved

### 6.2 Terminal Box and Cable Entries

**6.2.1** Unless otherwise agreed, the terminal box shall be located on the right hand side as viewed from the driving (coupling) end. The terminal box shall have side cable entry from non-driving end. However, as a special case, terminal box located on top may also be accepted, particularly for hazardous area motors, in case manufacturer has only top mounted terminal box design which is duly tested/certified & approved by corresponding agency as mentioned in clause 11.0 below for installation in hazardous area. The terminal box design shall allow rotation in steps of 90°C to facilitate cable entry from any direction at site.

**6.2.2** Terminal box cover shall be provided with handles to facilitate easy removal. However, for terminal box covers weighing less than 5 kg., terminal box covers without handles can be accepted.

**6.2.3** The terminal box shall be provided entries for suitable cable glands corresponding to the size of the specified cable. Crimp type tinned Copper lugs and nickel-plated brass (or aluminum if specifically required), double compression type cable glands shall be supplied along with the motors for the specified cable sizes for power and space heater cables.

**6.2.4** For flameproof motors, terminal box can be also provided in increased safety 'Exe' execution.

**6.2.5** The terminals, cable lugs, terminal box, cable entries and cable glands shall be suitable for the minimum cables sizes as specified below for 2 pole, 4 pole or 6 pole motors:

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

**NOTE: - Exact cable size for the motor shall be informed during vendor drawing review. Vendor to provide required size of the terminal box.**

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

### 6.3 Motor Casing and Type of Enclosure

**6.3.1** The minimum degree of motor enclosures including terminal boxes and bearing housing shall be IP-55 as per IS/IEC.


Copyright EIL – All rights reserved

**6.3.2** Motors for outdoor use shall be suitable for installation and satisfactory operation without any protective shelter or canopy. Motor casing shall be provided with a suitable drain for removal of condensed moisture except in case of flameproof motors (Type Ex d/Ex de).

**6.3.3** All internal and external metallic parts, which may come into contact with cooling air, shall be of corrosion resistant material or appropriately treated to resist the corrosive agents, which may be present in the atmosphere. Screws and bolts shall be of rust proof material or protected against corrosion.

**6.3.4** Unless otherwise agreed, motors shall have standard frame sizes (min.) for various output ratings as stipulated in IS/IEC.

## 6.4 Bearing and Lubrication

**6.4.1** Motors shall have grease lubricated ball or roller bearings. In all cases, the bearings shall be chosen to provide a minimum L-10 rating life of 5 years, (40, 000 hours) at rated operating conditions
(The L-10 rating life is the number of hours at constant speed that 90% of a group of identical bearings will complete or exceed before the first evidence of failure).

**6.4.2** The bearings shall be adequate to absorb axial thrust produced by the motor itself or due to shaft expansion. Motors designed to handle external thrust from the driven equipment shall be supplied with a thrust bearing at the non-driving end.

**6.4.3** In cases such as pumps for hot liquids where the driven equipment operates at high temperatures, bearings shall be cooled by a shaft-mounted fan. This shall ensure efficient ventilation of the bearing and disperse the heat transmitted from the driven equipment by conduction or convection.

**6.4.4** Bearings shall be capable of grease injection from outside without removal of covers with motors in the running conditions. The bearing boxes shall be provided with necessary features to prevent loss of grease or entry of dust / moisture e.g. labyrinth seal/ oil seal/ V seal. Where grease nipples are provided, these shall be associated, where necessary, with appropriately located relief devices, which ensure passage of grease through the bearings.

**6.4.5** Pre-lubricated sealed bearings may be considered provided a full guarantee is given for 4 to 5 years of trouble-free service without the necessity of re-lubrication.

## 6.5 Cooling System

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

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

## 6.6 Rotor

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


Copyright EIL – All rights reserved

### 6.7 Shaft Extension

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

### 6.8 Lifting Hooks

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

### 6.9 Earth Terminals

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

## 7.0 MISCELLANEOUS ACCESSORIES

### 7.1 Anti-Condensation Heaters

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

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

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

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

### 7.2 Name Plates

In addition to the motor rating plate, a separate number plate for motor tag number shall be fixed in a readily visible position. This number shall be as per the motor data sheets. Nameplates and tag plates shall be of stainless steel material. Name plate shall include details as specified in IS 15999 Part 1 / IEC 60034 Part 1.

## 8.0 CRITICAL SPEEDS

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

## 9.0 PAINTING

All metal surfaces shall undergo manufacturer's standard cleaning /painting cycle. After preparation of the under surface, the equipment shall be painted with two coats of epoxy based final paint. Color shade of final paint shall be 632 of IS: 5/ RAL-7031. All unpainted steel parts shall be suitably treated to prevent rust formation. If these parts are moving elements, then these shall be greased.


Copyright EIL – All rights reserved

## 10.0 INSPECTION AND TESTING

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

**10.2** Type test certificates from CIMFR or equivalent test house, applicable PESO/ DGMS approval certificates, BIS license and original drawings referred in type test certificates shall be shown to the inspection agency on demand during inspection. The certificates and BIS license must be valid at the time of dispatch.

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

**10.4** Combined testing of LV motors along with their associated VFDs shall be carried out as a unit. During this testing, temperature rise and harmonics levels shall be measured to ensure they are within the permissible limits as per applicable standards. This test may not be required in case same make / type / rating of motor & VFD as a unit has been already tested and copy of test certificate is available which will be furnished for EIL/Owner's reference.

**10.5** All equipments shall be subjected to various routine / acceptance tests as per Inspection & Test plan no. 6-81-1064.

## 11.0 CERTIFICATION

A copy of valid BIS license shall be furnished for energy efficient motors as per IS 12615.

All hazardous area equipment shall have hazardous area test certificates and approvals as per following:

**For Indigenous manufactured hazardous area equipment:**
For all electrical items manufactured in India, the testing shall be carried out & test report issued by Indian test laboratory recognized by the Chief Controller of Explosives shall be furnished. For Ex protection Electric Apparatus having flameproof type protection, a copy of valid BIS license shall be furnished as per IS/IEC 60079-1.

Alternatively, IECEx Certificate of Conformity, valid copy of IECEx Quality Assessment Report (summary) and IECEx Test Report shall be furnished.

**For Imported hazardous area equipment:**
For all electrical items manufactured outside India, test report issued by Indian test laboratory recognized by the Chief Controller of Explosives shall be furnished. For Ex protection Electric Apparatus having flameproof type protection, a copy of valid BIS license shall be furnished as per IS/IEC 60079-1.

As an alternative option-1 to this, IECEx Certificate of Conformity, valid copy of IECEx Quality Assessment Report (summary) and IECEx Test Report shall be furnished.

As an alternative option-2 to this, EU Type Examination Certificate, which is applicable for manufacturers having manufacturing locations in countries covered under the European Union, valid copy of Production Quality Assessment / Assurance Notification shall be furnished.


Copyright EIL – All rights reserved

All equipment i.e. 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.
For installations in India, PESO approval letter shall be provided.

## 12.0 PACKING AND DESPATCH

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

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


Copyright EIL – All rights reserved

# विद्युत उपकरणों के लिए स्थापना विनिर्देश

# 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 |
| 3 | 25 04 08 | REVISED & ISSUED AS SPECIFICATION | RKS | SSM | JMS | VC |
| 2 | 28 02 03 | REVISED & ISSUED AS SPECIFICATION | HKM | RSG | VPS | SKG |
| 1 | 26 08 97 | REVISED & ISSUED AS STANDARD SPECIFICATION | RR | VPS | SG | AS |



Copyright EIL – All rights reserved

**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 |

**Electrical Standards Committee**

**Convenor:** Ms. Sumita Anand

**Members:** Mr. Parag Gupta
Mr. M.K. Sahu
Ms. ANP Singh
Mr. Harish Kumar
Ms. Shalini Verma
Mr. Raman Sood
Ms. Shirali Aggarwal
Ms. N.P. Guha (Projects)
Mr. Rajesh Sinha (Inspection)


Copyright EIL – All rights reserved

## CONTENTS

1.0 SCOPE..... 4

2.0 CODES AND STANDARDS..... 4

3.0 INSTALLATION OF EQUIPMENT..... 4

4.0 EQUIPMENT COMMISSIONING..... 14

5.0 LIST OF CONSTRUCTION EQUIPMENT..... 15



Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

## 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


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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


Copyright EIL – All rights reserved

# 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 |



Copyright EIL – All rights reserved

**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**

**Convener:** Mr. M.K. Sahu

**Members:**

Ms. Harish Kumar
Ms. Arvind NP Singh
Mr. Raman Sood
Mr. Bishan Dass
Mr. Rajiv Kumar Saha
Mr. Vijay Kumar
Ms. Shirali Aggarwal
Ms. Rashmi Singh Rathaur
Mr. Ayush Mathur (Projects)
Mr. Rajesh Sinha (Inspection)
Ms. Shalini Verma (PEM)


Copyright EIL – All rights reserved

## CONTENTS

1.0 SCOPE ..... 4

2.0 CODES AND STANDARDS ..... 4

3.0 MATERIAL SPECIFICATIONS ..... 4

4.0 CABLE LAYING ..... 6

5.0 TERMINATIONS ..... 10

6.0 TESTING AND COMMISSIONING ..... 11



Copyright EIL – All rights reserved

## 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


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

| | |
|---|---|
| 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.


Copyright EIL – All rights reserved

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


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

## 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


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

**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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

# प्रकाश व्यवस्था के उत्थापन के लिए विनिर्देश

# SPECIFICATION FOR LIGHTING INSTALLATION

| Rev. No | Date | Purpose | Prepared by | Checked by | Standards Committee Convenor | Standards Bureau Chairman |
|---|---|---|---|---|---|---|
| | | | | | Approved by | |
| 6 | 31 12 2019 | REVISED AND ISSUED AS SPECIFICATION | DK/RM | RS | SA | RKT |
| 5 | 10 03 15 | REVISED AND ISSUED AS SPECIFICATION | AKG | SA | BRB | SC |
| 4 | 15 01 14 | REVISED AND ISSUED AS SPECIFICATION | FA | SA | UAP | 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 | 01 09 97 | REVISED and ISSUED AS STANDARD SPECIFICATION | RR | VPS | SG | AS |
| 0 | 31 03 82 | ISSUED AS STANDARD SPECIFICATION | RR | VPS | -- | -- |



Copyright EIL – All rights reserved

**Abbreviations:**

| | | |
|---|---|---|
| AC | : | Alternating Current |
| BIS | : | Bureau of Indian Standards |
| CCoE | : | Chief Controller of Explosives |
| CD | : | Compact Disc |
| CEA | : | Central Electricity Authority |
| CFL | : | Compact Fluorescent Lamps |
| CIMFR | : | Central Institute of Mining and Fuel Research |
| DC | : | Direct Current |
| DG | : | Diesel Generator |
| DGMS | : | Director General Mines and Safety |
| ELCB | : | Earth Leakage Circuit Breaker |
| FFL | : | Finished Floor Level |
| FRP | : | Fibre Reinforced Plastic |
| GI | : | Galvanised Iron |
| HPMV | : | High Pressure Mercury Vapour |
| HPSV | : | High Pressure Sodium Vapour |
| HRC | : | High Rupturing Capacity |
| IP | : | Ingress Protection |
| IS | : | Indian Standards |
| JB | : | Junction Box |
| LED | : | Light Emitting Diode |
| MCB | : | Miniature Circuit Breaker |
| MCCB | : | Moulded Case Circuit Breaker |
| MDB | : | Main Distribution Board |
| MS | : | Mild Steel |
| PE | : | Polyethelene |
| PVC | : | Polyvinyl Chloride |
| TPN | : | Three Phase and Neutral |
| SS | : | Stainless Steel |

**Electrical Standards Committee**

**Convenor:** **Ms. Sumita Anand**

Members: Mr. Parag Gupta
Mr. M.K.Sahu
Ms. ANP Singh
Mr. Harish Kumar
Ms. Shalini Verma
Mr. Raman Sood
Ms. Shirali Aggarwal
Mr. Rajesh Sinha (Inspection)
Ms. N.P. Guha (Projects)


Copyright EIL – All rights reserved

## CONTENTS

1.0 SCOPE ..... 4

2.0 CODES AND STANDARDS ..... 4

3.0 EQUIPMENT SPECIFICATIONS ..... 4

4.0 LIGHTING INSTALLATION ..... 8

5.0 TESTING AND COMMISSIONING ..... 13



Copyright EIL – All rights reserved

## 1.0 SCOPE

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

## 2.0 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:5 | Colours for ready mixed paints and enamels. |
| IS:3854 | Switch for domestic & similar purpose |
| IS/IEC 60947 | L.V. Switch gear and control gear |
| IS: 1293 | Plugs & socket outlets of rated voltage upto and including 250V & rated current upto 16A. |
| IS:9537 | Conduits for electrical installations |
| IS 694 | Polyvinyl Chloride insulated unsheathed & sheathed cables/cords upto & including 450/750V |
| 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 (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 EQUIPMENT SPECIFICATIONS

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

### 3.1 Lighting and Power Panels

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


Copyright EIL – All rights reserved

additional weather protection. The canopy shall be made of 2mm thick galvanized sheet steel, FRP, SS (1mm) where these are separate from the equipment.

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

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

3.1.4 All MCBs shall be of M9 category as per IS 8828 and sensitivity of ELCBs shall be 100 mA-300 mA unless otherwise specified.

3.1.5 Wherever the size of incoming cable to lighting, power panels/MDB is more than 35 sq.mm a suitable cable adapter box shall be provided and attached to the panel. The incoming cable leads shall be connected to terminal block (bolted type terminals) of required size. This terminal block shall be connected to TPN incomer unit through separate PVC insulated copper conductor wires/bus bars. Sufficient space shall be provided (minimum 300mm) between gland plate and the bottom of terminal block for easy termination.

### 3.2 Lighting Fixtures

The types, makes and catalogue numbers of various types of lighting fixtures shall be as given in Fixture schedule, job data sheet. HPMV/HPSV/fluoroscent lighting fixtures shall be complete with ballast, starters and capacitor, as required. Control gears for these fixtures shall be integral or non-integral as specified in lighting layout drawings. LED lighting fixtures shall be complete with its driver. All lighting fixtures should have sufficient number of cable entry for loop in & loop out and also should have sufficient terminals & size for connection of cable/wire. All lighting fixtures to be installed in battery room should be flame proof type, suitable to IIC gas group and should have anticorrosive feature. Unless otherwise specified, all fixtures shall be supplied complete with lamps. Ballast for fixture shall be copper wound or electronic type. The fixtures shall be of high power factor type i.e. at least 0.9 or more.


Copyright EIL – All rights reserved

### 3.3 Switches

Switches, manufactured in accordance with IS: 3854 shall be used for non hazardous areas. Switches in areas where concealed wiring has been adopted, shall be flush mounting Modular type unless otherwise specified. For surface conduit wiring, Modular type switches in surface mounted box shall be provided. Industrial Type switches (Weather protected) shall be used for outdoor areas. Industrial Type switches (Flame proof/Weather proof) shall be provided for tall structures, columns, vessels, walkways etc as shown in lighting layout drawings.

### 3.4 Receptacles

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

3 phase, 5 pin, 40A, 415V sockets shall be provided for tower air conditioners in control rooms. The receptacles and the controlling ON/OFF switch shall be mounted in the same enclosure box but these shall be in separate units to facilitate replacement by parts.

### 3.5 Outlet Boxes

The outlet boxes used as point outlets shall be prefabricated GI sheet steel of 18 gauge thickness and of adequate depth. Outlet boxes custom fabricated for sockets, switches, fixtures and fan regulators etc. shall be made of MS sheet having minimum thickness of 1.6mm.Outlet boxes shall be galvanized/ nickel plated after fabrication. These shall be complete with terminal block suitable for connection of wires up to 4 sq. mm Front cover plate shall be of 3mm thick Bakelite / PE sheet. The colour shall suit the shade of the walls or shall be white if the shade of the walls is not finalised. The sheet shall extend at least 2 cm on all sides of outlet box. Cover plate shall be fixed by cadmium plated brass screws and cup washers. Outlet boxes shall be provided with adequate number of knock outs on all the sides for ease of wiring either with conduits or without conduits.

### 3.6 Conduit and Accessories

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

### 3.7 Lighting Poles

Lighting poles shall be fabricated as per EIL installation standards enclosed with the specification from ERW steel tubular pipes of specified section, with joints, swaged together when hot and beveled on outside edges or hexagonal shape. Poles shall be coated with bituminous preservative solution on the ground portion of the outside surface. Remainder of the outside surface shall be given one coat of redoxide primer and finished with two coats of aluminium paint. The pole shall have a marshalling box near the bottom to contain HRC


Copyright EIL – All rights reserved

fuses, a neutral link, an earth stud and terminal block. FRP/GRP type lighting poles shall be provided in case shown in the layout.

### 3.8 Lighting Mast

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

3.8.2 Unless otherwise specified the flood lighting high masts shall be telescopic type conforming to EIL specification and data sheet.

### 3.9 Wires

Wires shall be PVC insulated and shall be of 660 Volts grade as per IS694. Conductor shall be of stranded copper and size shall be minimum 1.5 Sq. mm for lighting, 2.5 Sq. mm for 15A power socket circuits and 4 sq. mm for split A/C power socket circuits. Red/Yellow/blue wires for phases, black wire for neutral and green wire for earth shall be used (size of earth wire shall be same as for phase and neutral size). Wire size for air conditioning circuit feeders shall be as indicated in the panel schedule.

### 3.10 Ceiling fan/Exhaust fan

Ceiling fans shall be of 1200mm sweep with BEE (Bureau of energy efficiency) rating of minimum 3 star, unless otherwise specified with double ball bearing and regulator. The suspension down rod shall be sturdy mild steel rod of adequate diameter and of minimum length of 300mm with shackles suspension arrangement as per IS. For exhaust fans, the sweep dia. and air CFM shall be as specified in job specification. Exhaust fans for battery room shall be flame proof type, suitable to IIC gas group and with anticorrosive blades suitable for use in acidic fumes. Exhaust fans shall be with BEE rating of minimum 3 star.

### 3.11 Decorative switches and sockets

Decorative lighting switches and sockets where specified, shall be modular in design. All these items shall fit into the same frame with overall standard dimensions. Frames shall be suitable for surface and flush mounting in brick / concrete wall. The frames shall be suitable for conduit entry from all the sides. Switches and sockets shall match colors of the frame and cover plates to obtain a combination which shall match décor of the interiors of Control Room, Administrative buildings, offices rooms etc.


Copyright EIL – All rights reserved

## 4.0 LIGHTING INSTALLATION

### 4.1 General

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

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

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

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

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

4.1.6 Mounting height of equipment shall be as under:-

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

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

4.1.8 The lighting fixtures on various circuits shall be suitably interlaced so that failure of any one circuit does not result in complete darkness.

4.1.9 Circuit cables in a group shall be cleated to structure by using galvanised strip clamps or cable run in cable trays wherever trays are available. Spacers and cleats shall be of required size to


Copyright EIL – All rights reserved

accommodate the cables. All hardware shall be galvanised or zinc passivated. Underground lighting cables (in paved areas) shall be taken in suitable GI sleeves buried at a minimum depth of 300mm from FFL. GI pipe sleeves shall be extended to 300mm above FFL. Exact termination/layout of GI pipes (for protection of cables) shall be decided at site as per site convenience in consultation with Engineer-in-charge.

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

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

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

4.1.13 For location where fan points are shown, fan hooks with junction box shall be provided during concreting.

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

4.1.14 Industrial type plug sockets with 20A MCB or rating as per job specification shall be provided at a height close to window/split AC units so that plugging of power cable coming from AC units can be easily achieved without adding any extensions to it, however, its switch should be installed at a height of 1200 mm from FFL.

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

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

4.1.16 Identification of indoor receptacles shall be done through stickers/paint.

4.1.17 Wherever in process units fire proofing of structural columns has to be done, it would be the responsibility of lighting installation agency to weld adequate size of angles to such structures before its fireproofing which length should be such that it is projected at least 65 mm outside from the finished surface of fireproofing. These welded angles shall be utilized latter to install lighting cable trays, bracket & clamps of lighting fixtures, frame of lighting/power panels, welding/ conveyance receptacles, control gears & other electrical equipments as required. It should be the responsibility of lighting installation agency to coordinate with other agencies which are involved in fireproofing works to complete the all structural/welding works before completion of fire proofing works.

## 4.2 Conduit System

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


Copyright EIL – All rights reserved

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

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

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

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

4.2.5 Conduit pipes shall be fixed by 1.6mm thick GI saddles on 3mm thick GI. saddle bars of required width in an approved manner at intervals of not more than 50cms for straight run. At places near junction boxes, bends, or similar fittings, saddle and bars shall be provided on either side.

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

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

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

**4.3 Hazardous Area Installation**

4.3.1 Wiring in hazardous area shall be done by using minimum 2.5mm$^2$ copper conductor armoured cable.3$^{rd}$ core of the cable shall be used as earth conductor for earthing of lighting fixture. Circuit wiring feeding hazardous areas shall be controlled by two pole switches/MCBs (for phase as well as neutral isolation).Switches for lighting panels installed in hazardous area shall have a pole to break the neutral in addition to poles for phases.

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

4.3.3 The terminations in the junction boxes and the lighting fittings shall be done avoiding possibility of loose connections due to vibrations. After the terminations are made the cover of the junction boxes and the lighting fittings shall be closed properly with all bolts and hard wares in correct position, retaining its explosion and weather protections. In fixtures having


Copyright EIL – All rights reserved

double cable entries, both the entries shall be used for looping in and looping out connection, thus minimising the use of a separate junction box. Wherever separate control gear boxes (CG box) are provided looping in and looping out connections shall be through CG box, thus avoiding the use of an additional junction box. All unused cable entries shall be sealed with suitable plugs.

4.3.4 Circuit cables shall be firmly cleated in a group along columns/ beam/ladders/side channels/platform using 1.6mm thick GI saddles on 25x3 mm GI saddle bar at intervals of 400mm to 500mm for straight run and on either side close to bending and at both termination ends as per the directions of Engineer-in-charge. Where required 3 or more of cables shall be taken in perforated150mm wide slotted channel cable tray after getting the approval of Engineer-in-charge. Minimum straight run shall be 3000mm.Cables shall not be routed along hand rails.

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

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

**4.4 Building Lighting**

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

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

4.4.3 Wiring in areas above false ceiling shall be done in Surface Conduit (25mm dia GI conduit) suitably clamped to the true ceiling. Vertical drops from true ceiling for panels, switches, receptacles etc. shall be taken in 25mm dia PVC conduit concealed in walls upto switchboards/panels. Lighting fixtures shall be supported from true ceiling. Exact location of fixtures shall be finalised in co-ordination with air-conditioning duct diffuser layout, panel's layout and false ceiling grid layout. To facilitate easy maintenance `Looping back system` of wiring shall be followed throughout. Accordingly supply tapping's and other interconnections including for earthing are made only at fixture connector blocks or at switch boards. Required number of junction boxes shall be used at intervals for wire pulling and inspection.

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

4.4.5 Building conduit lighting system of wiring where measurement is done on point wiring basis generally consists of two parts. The first part is the circuit wiring which includes the work necessary from lighting panel up to switch box and from switch box to another switch box.


Copyright EIL – All rights reserved

The second part is the point wiring which shall include the work necessary from tapping point in the switch box upto various fixtures or fan outlets/ceiling roses.

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

4.4.7 Lighting layouts for non-plant buildings (such as ware house, cement godown, gate house, workshop, service building, rest room, etc.) shall be prepared by installation contractor as defined in the scope of work.

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

i) Architectural drawings
ii) Illumination level required
iii) Type of lighting fixture
iv) Type of wiring (concealed/surface conduit/cable wiring etc.)

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

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

All drawings shall be prepared preferably in A0 and A1 size. Panel schedules shall be in A4 size drawings. Final submission of drawings shall be in soft copies (CD form) and in bound volumes.

**4.5 Street Lighting**

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

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

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

4.5.4 The poles shall be numbered as per the drawings/ directions of Engineer Incharge.

**4.6 Mast Lighting**

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

4.6.2 The main feeder upto the distribution board of lighting mast shall be through PVC insulated armoured cable of size as specified in the respective drawing. Wiring from Distribution Board to each flood-light fixture shall be by means of a 3-core 2.5sqmm, copper conductor PVC


Copyright EIL – All rights reserved

insulated armoured cable. All the cables shall be neatly clamped to the structure at intervals not exceeding 25 cms.

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

**4.7 Telephone Wiring**

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

Conduit installation system shall comply with the requirements given in clause 4.2 `conduit system'. Required number of pull boxes shall be provided at interval for easy drawing of wires. The telephone wiring shall be done with 0.63mm dia annealed copper conductor PVC insulated 660V grade, twin flat wire, unless otherwise specified in job specification. One telephone socket outlet shall be provided for connection to telephone instrument.

## 5.0 TESTING AND COMMISSIONING

5.1 Lighting installation shall be tested and commissioned by installation contractor as per EIL specifications. Precommissioning checks and tests shall include but not be limited to the following:

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

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

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

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

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

(vi) Operation of ELCB's shall be checked.

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

5.2 All lighting layout drawings shall be marked by contractor for 'AS BUILT STATUS' and two sets of hard copies plus 1 set of soft copy in CD, shall be submitted to EIL.


Copyright EIL – All rights reserved

# 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 |



Copyright EIL – All rights reserved

**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**

**Convenor:** Mr. BR Bhogal

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


Copyright EIL – All rights reserved

## CONTENTS

1.0 SCOPE.....4

2.0 CODES AND STANDARDS.....4

3.0 MATERIAL SPECIFICATIONS.....4

4.0 EARTHING NETWORK.....4

5.0 INSTALLATION OF EARTH ELECTRODE.....5

6.0 CONNECTION.....6

7.0 TESTING AND COMMISSIONING.....7



Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

**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.


Copyright EIL – All rights reserved

**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.


Copyright EIL – All rights reserved

**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.


Copyright EIL – All rights reserved

**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.


Copyright EIL – All rights reserved

# 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 |
| 2 | 03 03 09 | REVISED & ISSUED AS STANDARD SPECIFICATION | RKS | NS | JMS | ND |
| 1 | 14 07 03 | REVISED & ISSUED AS STANDARD SPECIFICATION | HKM | RSG | VPS | SKG |
| 0 | 02 08 01 | ISSUED AS STANDARD SPECIFICATION | UAP | RR | VPS | MI |



Copyright EIL – All rights reserved

**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 |

**Electrical Standards Committee**

**Convenor:** Ms. Sumita Anand

**Members:** Mr. Parag Gupta
Mr. M.K. Sahu
Ms. ANP Singh
Mr. Harish Kumar
Ms. Shalini Verma
Mr. Raman Sood
Ms. Shirali Aggarwal
Ms. N.P. Guha (Projects)
Mr. Rajesh Sinha (Inspection)


Copyright EIL – All rights reserved

## CONTENTS

1.0 SCOPE ..... 4

2.0 CODES AND STANDARDS ..... 4

3.0 FIELD INSPECTION, TESTING AND COMMISSIONING ..... 4

4.0 RECORDS ..... 8



Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

**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


Copyright EIL – All rights reserved

**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 |


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

| 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).


Copyright EIL – All rights reserved

# ऑफ साईट पैकेज यूनिटों के लिए विद्युत विनिर्देश

# SPECIFICATION FOR ELECTRICS OF OFFSITE PACKAGE UNITS

| 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 | 26/02/18 | 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 | 12/11/02 | Revised and Issued as standard specification | IKG | AAN | VPS | SKG |



Copyright EIL – All rights reserved

**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 |
| 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 |
| FLP | : | Flame Proof |
| FM | : | Factory Mutual |
| GI | : | Galvanized Iron |
| HRC | : | High Rupturing Capacity |
| HV | : | High Voltage |
| 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 |
| 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 |
| UL | : | Underwriter's Laboratories |
| UPS | : | Uninterrupted Power Supply |
| V | : | Volt |
| VDE | : | Verband Deutscher Elektrotechniker |

**Electrical Standards Committee**

Convenor: Mr. M.K Sahu

Members:
Mr. Harish Kumar
Ms. Arvind NP Singh
Ms. Shalini Verma
Mr. Raman Sood
Mr. Bishan Dass
Mr. Rajiv Kumar Saha
Ms. Shirali Aggarwal
Mr. Ayush Mathur (Projects)
Mr. Rajesh Sinha (Inspection)


Copyright EIL – All rights reserved

## CONTENTS

1.0 SCOPE ..... 4
2.0 STATUTORY REQUIREMENTS ..... 4
3.0 GENERAL REQUIREMENTS ..... 4
4.0 SITE CONDITIONS ..... 5
5.0 AREA CLASSIFICATION AND EQUIPMENT SELECTION ..... 5
6.0 POWER SYSTEM DESIGN ..... 6
7.0 EQUIPMENT SPECIFICATIONS ..... 9
8.0. CABLING SYSTEM ..... 11
9.0 LIGHTING SYSTEM ..... 12
10.0 EARTHING SYSTEM ..... 15
11.0 INSPECTION, TESTING AND COMMISSIONING ..... 16


Copyright EIL – All rights reserved

## 1.0 SCOPE

1.1 This specification along with job specifications (if any) defines the requirements for design, engineering, procurement, installation, testing and commissioning of the electrical facilities for the package unit as indicated in the data sheet.

1.2 It is not intended to cover all aspects of system design but to indicate the basic requirements only. Vendor shall ensure that detailed design and installation is carried out as per good engineering practices, relevant codes and shall meet the requirements of safety, reliability, ease of maintenance and operation, aesthetics, scope for future expansion and maximum interchangeability of the equipment. Vendor shall acquaint himself with EIL standards and specifications as deemed necessary for proper execution of the work.

1.3 Compliance with this specification and /or review of any of the vendor documents shall not relieve the vendor of his responsibility towards his contractual obligation with regard to the completeness and satisfactory operation of the plant.

## 2.0 STATUTORY REQUIREMENTS

All electrical equipment and complete installation shall meet the requirement of this specification and data sheet in addition to the relevant Indian Standards / code of practices, EIL Standards, Statutory regulations and sound engineering practices. Complete system shall also conform to the latest revisions of following:

- 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.

2.1 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.

2.2 Obtaining approvals from statutory authorities for materials, plant design/ drawings and complete installation shall be the responsibility of the vendor.

2.3 Where Indian Standards do not exist, the relevant IEC, British or German (VDE)/ IEEE/NEMA standards shall apply. Any other standard may also be followed provided it is equivalent to or more stringent than the applicable Indian standards.

2.4 In case of any contradiction between various referred standard / specification /datasheet and statutory regulations, most stringent requirement shall prevail. However owner's decision in this regard will be final and binding.

## 3.0 GENERAL REQUIREMENTS\

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


Copyright EIL – All rights reserved

**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 $40^0$C 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 material within the battery limits of the package unit, area classification shall be carried out in line with IS-5572, Petroleum rules and DGMS guidelines as applicable. Area Classification drawing prepared by the vendor shall indicate the zone of hazardous area and the gas group. A hazard source list prepared by the vendor shall include the list of all flammable materials handled along with their properties like flash point, ignition temperature, explosive limits etc.

**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 BIS, 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 NFPA-70, 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/ 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.

**5.4** Electrical equipment for hazardous areas shall generally be suitable for gas group II A, II B and temp. class T3 as applicable to the selected type of explosion protection. In case of hydrogen or hydrocarbon mixtures having more than 30% hydrogen, the gas group to be considered shall be IIC.

**5.5** As additional safety features, the following requirements for electrical equipment shall be followed :

(i) All electric motors for agitators/mixers and metering pumps handling flammable material shall be flameproof type irrespective of the area being classified as zone-2 or zone-1.

(ii) All electric motors for vertical sump pumps handling flammable material shall be flameproof type.

(iii) Irrespective of the area classification (whether zone-1 or zone-2), all lighting fixtures within the storage areas shall be flameproof type.


Copyright EIL – All rights reserved

(iv) Irrespective of the area classification (whether zone-1 or zone-2), all motors and lighting fittings within the pump house near the offsite tank farm and within the loading/unloading gantries shall be of flameproof type.

(v) All emergency/critical lighting fixtures and associated junction boxes in hazardous areas (whether zone-1 and zone-2) shall be flameproof type.

(vi) Ex-n motors shall be without prestart ventilation as permitted by Indian Standard unless any other type is specified by Process Licensor except for following cases as listed below:

- Ex-de motors shall be used in Zone-2 areas for HV motors for centrifugal compressors.
- Ex-de motors shall be used in Zone-2 areas for motors having frequent start/stop requirements e.g. EOT cranes, Elevators, MOV actuators etc.

(vii) Ex-de or Ex-p motors shall be used in Zone-2 areas for application having average starting frequency more than 1 per week, where rating of motor is more than 100KW.

(viii) Ex-p motors shall be used for large rating motors where either Ex-n or Ex-de motors are not available.

(ix) Increase safety (Ex-e) terminal box are also acceptable for flameproof equipments.

**5.6** Irrespective of area classification (i.e. whether zone-1 or zone-2) all power junction boxes shall be flameproof type.

**5.7** All hazardous area equipment (except motors) shall be provided with cast light metal alloy enclosure.

## 6.0 POWER SYSTEM DESIGN

The distribution system shall be designed in accordance with project specifications/data sheets and shall ensure continuity /reliability of supply, flexibility of operation and safety. All the components of electrical system must be sized to suit the maximum load, under the most severe operating conditions.

### 6.1 Capacity of Electrical Plant

All components of the Electrical System shall be sized to suit the maximum load under the most severe operating conditions. Accordingly, the maximum simultaneous consumption of power, required by continuously operating loads shall be considered and additional margin shall be taken into account for intermittent service (30%) / standby (10%) loads, if any.
In addition to above 10% spare capacity shall also be considered for future load growth.

### 6.2 System Voltages and Frequency

Voltage levels and variations for electrical distribution system and equipment utilisation voltages shall be as per Project specifications/Data sheets unless otherwise specified. System frequency shall be 50Hz.

### 6.3 Voltage Drops

6.3.1 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:


Copyright EIL – All rights reserved

| Sl. No | SYSTEM ELEMENT | MAX. PERMISSIBLE VOLTAGE DROP |
|---|---|---|
| a) | Cable between transformer secondary and Switchboards | 0.5% |
| b) | Cable between PCC/PMCC and MCC or auxiliary switchboard<br>i) MCC /Auxiliary Switchboard near PCC/PMCC<br>ii) MCC/Auxiliary Switchboard situated remote from PCC/PMCC | <br><br>0.5% (Note-3b)<br>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) |
| 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.


Copyright EIL – All rights reserved

6.3.2 The maximum voltage drop at various buses during start-up of large motor and/or motor re-acceleration conditions shall be within the limits stated below :

| Sl. 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) |
| 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.

## 6.4 Sub-station/MCC Room

6.4.1 Sub-station or MCC room, wherever required shall be located in a safe area close to load centre. The building shall be sized to take care of present and future needs and to maintain adequate clearances between equipment for ease of maintenance. Clearance around equipment shall be maintained as per CEA regulations & equipment supplier's recommendation whichever is higher.

6.4.2 Battery banks (Ni-cd & Lead acid) 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 upto 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.


Copyright EIL – All rights reserved

6.4.3 Chemical resistant type, wall mounted Light fittings shall be provided inside battery room. Lighting switch / sockets for the battery room shall be provided outside the room. Battery room shall be provided with minimum two exhaust fan with louvers installed in opposite walls. Lighting fixtures and exhaust fans in battery room shall be flameproof type suitable for gas group IIC, Temp class T3.

6.4.4 Adequate safety equipment such as insulating mats, exit signs, shock/fire hazard charts, first aid boxes, portable fire extinguishers etc. shall be provided in the sub-station/MCC room as per statutory regulations.

**6.4.5** 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

## 7.0 EQUIPMENT SPECIFICATIONS

All equipment 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 equipment shall be complete with all necessary weather and anticorrosion protection including tropicalization to prevent damage due to climate, saline atmosphere, dust and corrosive vapours.

Certain minimum requirements for the major equipments shall be as follows.

### 7.1 High Voltage Motors

All high voltage motors shall meet the requirements given in the enclosed data sheets and EIL standard specifications.

### 7.2 Medium Voltage Motors

All medium voltage motors shall meet the requirements given in the enclosed data sheets and EIL standard specifications.

### 7.3 Medium Voltage Switchboards and Busduct

7.3.1 Medium voltage switchboard shall be in fixed/draw out execution as specified in the data sheets and shall conform to EIL standard specification.

7.3.2 Medium voltage bus-duct shall conform to EIL standard specification. Proper Sealing arrangement shall be provided at the wall where busduct enters the switchgear room.

7.3.3 Main bus bars 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 switchboards shall be designed to cater to the complete load including 10% margin for future load growth.

7.3.4 Spare outgoing feeders shall be provided in all switchboards. 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.


Copyright EIL – All rights reserved

7.3.5 Circuit breakers / contactors controlling motor feeders shall have a rating of at least 125% of the maximum continuous rating of the connected motors.

7.3.6 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.

7.3.7 All incomers to same switchboard shall be of equal rating. 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.

7.3.8 Each short circuit interrupting device shall be designated to have breaking capacity equal to or higher than the maximum value of the short circuit current at the point of installation. MCCBs with backup fuses shall not be acceptable.

7.3.9 Air circuit breakers shall be provided in MV switchboards for all feeders rated above 400 A 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.

7.3.10 Transducers shall be provided in various switchboards for providing 4-20mA output to DCS/PLC/ECS, as specified elsewhere.

7.3.11 Circuit breakers/MCCB/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.

7.3.12 The switchboard components viz. circuit breakers, main horizontal and vertical busbars, busbar joints, busbar 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.

7.3.13 Moulded Case Circuit Breakers for power feeders shall have `built in' short circuit and thermal overload releases. The rated service short-circuit breaking capacity (Ics) of MCCBs shall be more than or equal to the specified fault level.

7.3.14 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.

7.3.15 The Power Control Centre (PCC) shall generally include incomers, bus coupler, outgoing breaker feeders, large TPN Switch fuse feeders and motor feeders of rating 75KW & above unless otherwise specified in data sheets.

7.3.16 The Motor Control Centre (MCC) shall generally include motor feeders of rating upto and including 55 KW unless otherwise specified in data sheets. The maximum rating of busbar shall be limited to 1250 A or 40% of the feeding switchgear incomer rating, whichever is lower . In case of MCC having two incomers, necessary tie switch shall be provided for bus sectionalising. Heavy duty type load break switches/ACB shall be used for incoming and tie feeders and these shall have suitable interlocks and shall be designed to withstand the specified short circuit level for minimum 1 sec. All motor starters shall be DOL type unless otherwise specified.


Copyright EIL – All rights reserved

7.3.17 The Auxiliary Service Board (ASB) and/or lighting distribution board containing mainly MCCB/switch fuse units may be in fixed/drawout execution as specified in data sheets. Where required, contactor controlled feeders shall be provided to feed lighting panels.

## 7.4 Local Control Stations

Each motor shall be provided with a local control station in the field near the motor. The local control station shall have die-cast aluminium / sheet steel enclosure with IP - 55 protection for safe area and shall be flameproof type with cast light metal alloy enclosure for installation in hazardous area. The control station shall include START /STOP push buttons, ammeter for motors rated above 5.5KW, local/remote selector switch, breaker control switch, cable glands, Auto/Manual selector switches etc, as required. STOP push button shall have stay put feature except in the case of critical drives such as lube oil pump etc. Each push button shall have one normally open & one normally close contact and shall be complete with necessary inscription plates. Outdoor control stations shall have necessary canopies. Motors installed at elevated platforms (such as cooling tower fan, air fan cooler etc.) shall be provided with a stop push button at ground level in addition to one near motor. Control stations shall conform to EIL standard specification.

## 7.5 Welding Receptacles

The welding receptacles shall be industrial heavy duty type rated for 415 V, 63 Amp, three phase system, complete with scraping earthing facilities, necessary interlocks and associated plugs. The receptacles shall be weatherproof type and additionally flameproof type for hazardous areas. Adequate number of welding receptacles shall be provided at suitable locations to ensure accessibility with a 50 meters length of trailing cable to any point within battery limits of the package unit.

## 7.6 Hazardous Area Lighting Fixtures & Accessories

Lighting Fixtures and accessories for installation in hazardous areas shall be suitable for Zone-1 or Zone-2 area as required, gas group IIA/IIB/IIC and temp. Class `T3' unless specified otherwise. All equipments shall conform to EIL standard specifications.

# 8.0 CABLING SYSTEM

**8.1** All Power and control cables shall meet the requirements of EIL standard specification.

**8.2** The power and control cables shall have the following minimum overall cross sectional areas:

| | | |
|---|---|---|
| a. | Medium voltage power | 2.5mm$^2$ (copper conductor up to 16mm$^2$ and aluminium conductor beyond 16mm2) |
| b. | Control cables | 2.5 mm$^2$ twisted paired (copper) |
| c. | Lighting cables | 2.5mm$^2$ (copper) |

**8.3** Cables shall be sized based on the maximum continuous load current and the voltage drop. The derating due to ambient air temperature, ground temperature, grouping and proximity of cables with each other etc. shall be taken into account.


Copyright EIL – All rights reserved

**8.4** Cables shall be laid above or below grade as indicated in the data sheets. Cables for firewater pumps up to the pump house shall be taken through underground sand filled trench.

**8.5** 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. Above ground cables shall preferably be laid in overhead cable trays along the pipe rack/pipe sleepers wherever available. Wherever pipe rack/pipe sleepers are not available, cables shall be laid in above ground cable trays on separate sleepers/rack.

**8.6** Below grade cables in paved areas shall be in concrete lined trenches with concrete covers having proper slope and suitable drainage arrangement to avoid water collection. In unpaved areas, cables shall be in lined trenches or directly buried in ground as specified elsewhere. In hazardous areas and transformer bays, trenches shall be completely filled up with sand. Concrete lined cable trenches shall be sealed against ingress of liquid and gases wherever the trenches leave a hazardous area or enter control room or substation. The cable trenches shall be sized depending upon the number and voltage grade of cables. Where underground cables cross roadways, pipe sleepers at grade etc., they shall be protected by being drawn through PVC sleeves/ducts to provide a permanent crossing. Pipes laid for mechanical protection shall be sealed at both ends.

**8.7** High voltage, medium voltage, control and signal cables shall be separated from each other by adequate spacing or running through independent pipes, trenches or cable trays as applicable. Cable trays, racks and trenches shall be sized to allow for 20% future cables. Cable installation shall provide minimum cable bending radii as recommended by cable manufacturer.

**8.8** Cable route markers shall be installed at every 30m interval all along the routes of directly buried cable trench and also at locations where the direction of cable trench changes.

**8.9** All cable trays and accessories shall be prefabricated and hot dip galvanized as per standard specification unless otherwise specified. 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.

**8.10** All power and control cables shall be of Fire retardant low smoke type and shall be in continuous lengths without intermediate joints. Where joints are unavoidable, these shall be provided with the permission of Engineer-in-charge. In any case joints shall not be located in classified areas All cables shall carry tag number for easy identification. In case of control cables, all cores shall be identified at both ends by their terminal numbers using PVC ferrules as per interconnection diagrams.

**8.11** All cables shall be terminated by means of single / double compression type cable glands and tinned copper crimping type lugs. All cable entries shall be through bottom/side only unless otherwise specified.

**8.12** Unless otherwise specified, cable glands shall be of nickel plated brass/aluminium for multi core/single core cables respectively. The single compression type cable glands shall be used for indoor panels/equipment. 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 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 conform to the requirements of latest IS/IEC-60079-0.


Copyright EIL – All rights reserved

**8.13** Fire proofing paint on cables shall be provided near end terminations of cables upto 1 meter.

## 9.0 LIGHTING SYSTEM

**9.1** Lighting system shall consist of lighting transformer ( if specified ), lighting distribution board, lighting panels/power panels, fixtures, junction boxes, 3 pin 5 A / 15A convenience socket outlets, cable glands etc. all conforming to the required area classification and environmental conditions.

**9.2** 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, cooling tower, columns, pig launching/ receiving loading area, flare etc. | 60 |
| 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) | Switchyard | |
| | Operating area | 100 |
| | Other areas | 50 |
| p) | Warehouse | 100 |
| q) | Office, Operator Room | 300 |
| r) | Compressor operating area | 200 |
| s) | Watch room | 100 |
| t) | Stairs | 50 |
| u) | Corridors/ lifts | 70 |
| v) | Tube well, Gate & watchman booth | 100 |
| w) | 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.

**9.3** 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 It shall be contractor's responsibility to demonstrate the illumination levels as indicated above using luxmeter. If the illumination levels are found to be below the specified values, the contractor


Copyright EIL – All rights reserved

shall provide additional lighting fixtures and install them in uniformity to achieve the illumination level. Dark patches and uneven illumination shall be avoided.

**9.4** Light fixtures with LED lamps shall be used for all areas- indoor lighting for non-process buildings, control room, outdoor plant, pump house/ Compressor house lighting. Safe area street lighting shall employ LED lamps. All chemical handling facilities shall be provided with chemical resistant fixtures. Tall structures shall have aviation obstruction lighting as per statutory requirements. All lighting fixtures shall be supplied complete with control gear, driver and lamps. Special fixtures, wherever required to meet operational requirements, aesthetics etc. shall also be provided by the vendor. Make of lighting fixture shall be embossed on each lighting fixture.

**9.5** Lighting wiring between panels and lighting fixtures shall be done by XLPE insulated, 3 core (phase, neutral and earth) armoured cables except for non-plant buildings which shall be through concealed conduit. All lighting cables shall be 3x2.5 $mm^2$, 660 / 1100 V grade, copper conductor, XLPE insulated, armoured FRLS type. Conduit wiring shall be done in 25 mm dia minimum 16 gauge black enamelled steel surface conduit or PVC concealed conduit, with 660 V grade PVC insulated FRLS copper wire of min, size 2.5 $mm^2$ for fixtures / 5A receptacles and 4 $mm^2$ for power sockets. Not more than seven wires shall be accommodated in each conduit. All lighting fittings/ convenience outlets shall be earthed through the third wire / separate core in conduit /cable. All cable / wire shall be BIS approved.

**9.6** On walkway, platforms and other outdoor areas, lighting fixtures shall be nearer to landing of stairs or ladders, gauges, flow meters, panel boards and other equipment requiring good illumination. In pump and compressor areas and other locations at ground level, lighting fixtures shall be mounted preferably 4 meters above floor level. Where this is impracticable, the minimum height of any lighting fixture shall not be less than 2.5 meters. Socket outlets in process plant areas shall be approximately 1200 mm above grade and 300 mm above grade in office area. Lighting /power panels shall be mounted such that the top of the panel is 1800 mm above finished grade.

**9.7** In addition to the normal lighting system, emergency lighting shall be provided to allow for personnel safety, plant operation and safe shutdown during normal lighting system failure.

Emergency lighting system shall be fed from a separate emergency lighting panel. Generally 20-25% of total lighting fixtures shall be fed from AC emergency supply.

**9.8** Critical lighting shall be provided for emergency escape routes, such as substation, control rooms etc. and strategic locations where specific safety/shutdown operation are to be carried out. Where DC supply is not available, emergency lighting units fed by a self-contained battery and charger operating on 240V AC supply shall be provided.

**9.9** All lighting circuits and convenience receptacles shall be fed from lighting/power panels. Where large numbers of lighting/power panels are required, independent Main/lighting distribution board (MDB/LDB) with energy metering facility shall be provided. MDB/LDB shall be dust and vermin proof and shall be provided with switch fuse units (HRC)/ MCCB as incomer and outgoing feeders where fault level is more than 9 KA. It shall be fabricated out of 14 SWG sheet steel. MDB/LDBs shall have sufficient space between gland plate and terminals for easy termination and dressing of cables. Lighting and power panels shall be fed from LDB/MDB through 415/415V, dry type lighting transformer wherever included in the scope of work. In case of oil mine installations secondary side voltage shall be 240V between phases.

**9.10** Lighting and power panels shall be provided with MCB and ELCB as incomer and Miniature Circuit Breakers (MCBs) for outgoing feeder to control and protection of lighting circuits.


Copyright EIL – All rights reserved

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% MCB in each panel shall be kept as spares. Two pole MCBs shall be used for controlling lighting circuits in hazardous areas. Power and lighting panels for safe area shall be of 14 gauge sheet steel construction and shall be suitable for surface or flush mounting. A hinged door to cover the operations knobs shall be provided. These panels shall be flush mounting in the buildings with operating Knobs projecting out. Outdoor panels shall be housed in outdoor weather protected KIOSK with IP55 protection. Flameproof lighting and power panels shall conform to EIL standard specification.

**9.11** All outdoor lighting shall be automatically controlled by means of photoelectric cell or synchronous timers as specified in enclosed data sheets with manual overriding control. If not specifically mentioned therein, synchronous timers shall be used for control of outdoor lighting. In general, the load on each circuit shall be limited to 1.5 kW and MCB rating shall not be more than 16A. Lighting feeders requiring automatic control shall be provided with contactors of suitable rating.

**9.12** Sufficient number of 5A and 15 A receptacles shall be provided within the Sub-station, MCC room, and other rooms /buildings as required. 24V, 5A Flameproof sockets with built in 240V/24V transformers shall be provided near the manholes of vessels inside the process units. Adequate no. (at least 20% of the sockets provided) of 24V, 5A Flameproof sockets connected with extension cord & a hand lamp with LED lamp having minimum 1250 lumens output shall be supplied loose. The flameproof plugs, sockets and hand lamps shall confirm to enclosed EIL standard Specifications.

**9.13** Adequate number of ceiling fans shall be provided in offices and rooms allocated for operating and maintenance personnel etc. In places where ceiling fans are provided, lighting fixtures shall be suspended below fan level with the help of conduits/chains to avoid shadows on the floor.

**9.14** Switches for control of lighting/exhaust fan in battery room shall be provided outside the battery room. Minimum of two exhaust fans shall be provided in the battery room and lighting fittings shall be mounted on the walls.

## 10.0 EARTHING SYSTEM

**10.1** Earthing system design and installation shall generally be as per CEA regulations & IS: 3043. All metallic non current carrying parts of electrical apparatus, current and potential transformer secondaries, columns, vessels, towers, stacks, storage tanks, loading racks etc. shall be earthed at least by two distinct separate earth conductors from the earth plate connected to the main earthing loop.

**10.2** The main grid conductor shall be hot dip galvanized MS flat unless otherwise specified. The amount of galvanising shall be min. 610 g/m$^2$. The main earth loop shall be laid at a depth of 500 mm below grade level.

**10.3** Earthing conductor shall be laid around the package unit area. Horizontal conductors shall be laid in both longitudinal and transverse direction to facilitate the earthing of various equipment in most economical and reliable manner.


Copyright EIL – All rights reserved

**10.4** The cable trays in offsite/utility/process areas shall be earthed at an interval of approx. 30 m with the help of risers emerging from main earthing conductors laid below/adjacent to structures carrying cable trays.

**10.5** Joints and tappings in the main 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 suitably protected by giving two coats of bitumen and covered with hessian tape.

**10.6** Adequate number of 65 mm dia. 3 m long GI pipe earth electrodes with test/earth pit shall be provided. All earth electrodes shall preferably be driven to a sufficient depth to reach permanently moist soil. Package unit earth grid shall have provisions for interconnection to owner's main plant earth grid.

**10.7** Multiple earth connection shall be taken from suitably located earth plates connected to earth loop. All hardware used for earthing installation shall be hot dip galvanized or zinc passivated. Spring washers shall be used for all earthing connections of equipment. Unless otherwise specified, earth connections to individual equipment shall be done in accordance with standard equipment earthing schedule. Earthing connections to equipments shall be made by means of specially provided bolts and lugs.

**10.8** Lightning protection shall be provided for Equipment, structures & buildings as per IS/IEC-62305. Self conducting structures may not be provided with aerial rod and down conductors but shall be connected to the earthing grid at minimum two points of the base. An independent earthing network shall be provided for lightning protection and this shall be bonded with the main earthing network minimum at two points at the buried electrodes.

**10.9** All utility, process pipelines shall be bonded and earthed on entering/leaving any hazardous area. In addition, steel pipe racks shall be earthed at every 24 meters.

**10.10** The resistance value of an earthing system to the general mass of earth shall be as follows:

- 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.
- 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.

## 11.0 INSPECTION, TESTING AND COMMISSIONING

**11.1** All the equipment shall be tested and inspected at vendor works before despatch to ensure compliance with the enclosed EIL specifications and applicable codes and standard and agreed quality assurance/testing plan.

**11.2** The owner or his authorised 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


Copyright EIL – All rights reserved

inspection. Owner's representative shall be given minimum two weeks advance notice for witnessing the final testing.

**11.3** Field tests as per the approved procedures/procedures available with engineer-in-charge or his authorised representative shall be performed on the electrical system/ equipment before its being put into service. All test equipment shall be arranged by the vendor. Test reports shall be approved by the Engineer-in-charge before acceptance of the complete plant and equipment.


Copyright EIL – All rights reserved

# वैद्युत सुविधाओं के लिए डिजाइन फिलोसोफी

# 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 |



Copyright EIL – All rights reserved

**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 |


Copyright EIL – All rights reserved

**Electrical Standards Committee**

**Convener :** Ms. Sumita Anand

**Members :** Mr. Parag Gupta
Mr. M.K. Sahu
Ms. ANP Singh
Mr. Harish Kumar
Ms. Shalini Verma
Mr. Raman Sood
Ms. Shirali Aggarwal
Ms. N.P. Guha (Projects)
Mr. Rajesh Sinha (Inspection)


Copyright EIL – All rights reserved

# CONTENTS

1.0 SCOPE ..... 5

2.0 CODES AND STANDARDS ..... 5

3.0 STATUTORY REQUIREMENTS ..... 6

4.0 SYSTEM DESIGN PHILOSOPHY ..... 6

5.0 EQUIPMENT DESIGN PHILOSOPHY ..... 14

6.0 SUBSTATION / MCC ROOM DESIGN PHILOSOPHY ..... 22

7.0 INSTALLATION DESIGN PHILOSOPHY ..... 25


Copyright EIL – All rights reserved

## 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 |


Copyright EIL – All rights reserved

| | | |
|---|---|---|
| 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.


Copyright EIL – All rights reserved

- 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.


Copyright EIL – All rights reserved

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<br><br>i) MCC /Auxiliary Switchboard near PCC/PMCC<br>ii) MCC/Auxiliary Switchboard situated remote from PCC/PMCC | <br><br>0.5% (Note-3b)<br>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) |


Copyright EIL – All rights reserved

| | | |
|---|---|---|
| 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) |


Copyright EIL – All rights reserved

| | | | |
|---|---|---|---|
| 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.


Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

## 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


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

## 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:


Copyright EIL – All rights reserved

- 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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

**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:


Copyright EIL – All rights reserved

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<br>- Single row, single/double tier<br>- Double row, single tier<br>- Double row, double tier<br>- Multistep racks | <br>100 mm<br>100 mm<br>750 mm<br>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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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


Copyright EIL – All rights reserved

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 |


Copyright EIL – All rights reserved

| | | |
|---|---|---|
| | 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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

# विध्युत उत्तोलक के लिए मानक विनिर्देश

# STANDARD SPECIFICATION FOR ELECTRIC WIRE ROPE HOIST

| Rev. No | Date | Purpose | Prepared by | Checked by | Standards Committee Convenor | Standards Bureau Chairman |
|---|---|---|---|---|---|---|
| | | | | | Approved by | |
| 6 | 17.12.25 | REAFFIRMED AND REISSUED | NJ | SPC | NK | MN |
| 5 | 03.02.21 | REVISED AND REISSUED | NJ/SPC | PPP | NK | SM |
| 4 | 01.04.16 | REVISED AND REISSUED | MS | SPC | PB/RKT | RN |
| 3 | 29.06.10 | REVISED AND REISSUED | SPC | PB | MK/DM | ND |
| 2 | 31.07.06 | REVISED AND REISSUED | PPP | AK | SMA | VJN |



Copyright EIL – All rights reserved

**Abbreviations:**

| | | |
|---|---|---|
| BHN | : | Brinell Hardness Number |
| HTB | : | High Tensile Brass |
| IS | : | Indian Standard |
| QA | : | Quality Assurance. |

**Packaged Equipment Standards Committee**

| | | |
|---|---|---|
| **Convenor** | : | Mr. Nalin Kumar |
| **Co-Convenor** | : | Mr. Tarun Kumar |
| **Members:** | : | Mr. Shishupal Choudhary |
| | | Mr. R.R. Shrivastava |
| | | Mr. A. Natarajan |
| | | Mr. K.C. Paikar |
| | | Mr. Plaban Dan |
| | | Mr. Mayank Sharma |
| | | Mr. Venkitesh M.G. |
| | | Mr. Ajeet Kumar |
| | | Mr. Aasheesh Handa (Projects) |



Copyright EIL – All rights reserved

## CONTENTS

1.0 GENERAL ..... 4

2.0 CODES AND STANDARDS ..... 4

3.0 TECHNICAL REQUIREMENTS ..... 4

4.0 INSPECTION AND TESTING ..... 7

5.0 PROTECTION AND PAINTING ..... 7

6.0 PACKAGING AND IDENTIFICATION ..... 8

7.0 SPARE PARTS ..... 8



Copyright EIL – All rights reserved

## 1.0 GENERAL

This specification outlines the minimum requirements for design, engineering, manufacture and assembly at shop, painting, inspection, testing, supply and performance testing at site of Electric Wire Rope Hoist(s) with electric drives, complete with all accessories.

A Bullet (●) at the beginning of a clause indicates that the exact requirement is to be firmed up by Purchaser / Supplier.

## 2.0 CODES AND STANDARDS

**2.1** This standard is based on following Indian Standards, and the standards referred therein, which shall be deemed to be part of this standard.

| | | |
|---|---|---|
| IS-304 | : | Specification for High Tensile Brass Ingots and Castings |
| IS 305 | : | Specification for Aluminium Bronze Ingots and Castings |
| IS - 2266 | : | Specification for Steel Wire Ropes for General Engineering Purpose |
| IS - 3938 | : | Specification for Electric wire rope hoists |
| IS - 3973 | : | Code of Practice for selection, installation and maintenance of wire ropes |
| IS - 15560 | : | Specification for Point hooks with shank up to 160 Tonne |
| EIL Std.- 7-76-0103 | : | Instructions to Vendor for Site Performance guarantee Requirements for Package units. |

Latest revision of the above-mentioned standards 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.

**2.4** National Laws and statutory provisions together with any local bylaws for the state wherein package is required to be installed shall be complied with.

## 3.0 TECHNICAL REQUIREMENTS

Technical requirements of Electric Wire Rope Hoist shall be as per Codes and Standards referred in clause 2.1 above, subject to the following additions, deletions and modifications:

### 3. 1 Addition / Deletion / Modification to IS- 3938: 1983 (Reaffirmed 2018)

● i) Clause no. 1 (Addition): The type of electric wire rope hoist shall be trolley suspended, unless otherwise specified in data sheet.

● ii) Clause no. 3 (Addition): The capacity and height of lift of electric wire rope hoist shall be as specified in data sheet.



Copyright EIL – All rights reserved

iii) Clause no. 4 (Addition): The duty class of electric wire rope hoist shall be as specified in data sheet.

iv) Clause no. 5.7 (Addition): Creep speed, if specified in data sheets shall be provided with one of the following means:

a) Pole changing motors

b) Epicyclic gear train

c) Additional gear box and clutch system.

d) VFD (For safe area hoist only)

v) Clause no. 6.1.3 (Modification): Cast iron drums shall not be used. Drums shall be fabricated type / Seamless tube and stress relieved. In case multilayer rope arrangement, rope drum shall be provided with flange at both end.

vi) Clause no. 6.1.7 (Addition): Extra flexible plough steel wire rope as per IS:2266 with 180 kg/mm² (minimum) strength shall be used. Rope guides shall be made of Aluminum base alloy/Brass.

vii) Clause no. 6.1.7.1 (Modification): The minimum factor of safety of wire rope shall not be less than 6. For hoists handling hot metal, factor of safety of wire rope shall not be less than 8.

viii) Clause no. 6.2.1.7 (Modification): Rope sheaves and equaliser sheaves shall be either cast steel or fabricated. Cast iron is not acceptable. Sheaves (except for equalizer) shall be mounted on antifriction bearings.

ix) Clause no. 6.3.1 (Modification): Lifting hooks shall be as per IS: 15560. Hooks shall be proof load tested, marked and duly certified by competent authority.

x) Clause no. 6.3.3 (Modification): Hook shall be provided with safety latch to prevent accidental removal of slings from the hook.

xi) Clause no. 6.3.1(Addition): Suspension fittings if any other than hooks shall be of sufficient strength to afford a static factor of safety of not less than '4'.

xii) Clause no. 7.3.2 (Modification): Gears shall be made of alloy steel. Cast iron is not acceptable. Gears shall be machined in metric module. Suitable heat treatment shall be done to achieve hardness. However, case carburising of gear teeth is not permissible.

The gear box covers shall be made of cast steel or fabricated from plate. Stress relieving shall be done in case of fabricated gear boxes.

xiii) Clause no. 7.3.5 (Modification): All gears shall be totally enclosed in oil bath type gear boxes.

xiv) New Clause no. 7.4.1 (Addition): Couplings shall be geared type on all power output shafts. On power input shafts, flexible couplings (pin bush or any other suitable couplings) shall be provided. In case of geared motor, coupling between motor and gear is not required.

xv) Clause no. 7.5.1.1 (Modification): Brake shall be fail safe type. DC Electromagnetic or AC Electro-hydraulic thrustor type brake (with anti drop circuitry for hoist motion) shall be provided for each drive power shaft.


Copyright EIL – All rights reserved

xvi) Clause no. 8 (Addition): The trolley shall be of fabricated construction with carbon steel plates.

● xvii) Clause no. 8.1 (Modification): The trolley shall be motor-driven type unless otherwise specified in data sheet. For travel, at least half of the total wheels shall be power driven. The travel shall be motorised as per the requirements of data sheets. Refer electrical specifications for motor and other electricals.

xviii) Clause no. 8.4.2 (Modification): Cast iron track wheels shall not be used. The trolley wheels shall be of forged steel, mounted on antifriction bearings and shall be single piece type (without tyre).The contact surface of wheels shall be heat treated to a hardness of 250 BHN upto 10 mm depth minimum.

xix) Clause no. 9 (Addition): In case of any conflict between Electrical specifications of Material Requisition/Tender and electrical requirements specified in the above referred Indian Standard, the former shall prevail.

● xx) Clause no. 10 (Addition): The motor shall be reversible crane duty type. Unless specified otherwise in electrical data sheet, the cycle duration factor for the motors shall be 40% and motors shall be suitable for minimum 240 start-stop operations per hour for creep speed and minimum 150 start-stop operations per hour for main speed. The motors shall have class F insulation.

● Dual drives shall be provided for trolley motion wherever part of monorail is not accessible, if specified in the job specification/ data sheet. The spare drive shall be used to bring the trolley to accessible portion of monorail for repairs in case of failure of one drive.

xxi) Clause no. 11.1 (Modification): Hoist shall be provided with push button pendant switch. Hand rope and chain as a remote control is not acceptable. Pendant height shall be 1200 mm maximum from the operating floor level.

xxii) Clause no. 15.2 (Addition): A back up gravity type limit switch for over hoisting shall be provided for class-4 duty hoist.

xxiii) New Clause no. 15.5 (Addition): Limit switches shall also be provided for over traversing (both sides).

**3. 2 Special Requirements for Hazardous Area Hoists**

i) MOC of wheel shall be solid construction in High Tensile Brass / Aluminium Bronze /SS or all Wheels shall be provided with High Tensile Brass/Aluminium bronze /SS tyres on core wheel of forged C55Mn75 or superior MOC. The minimum thickness of tyres shall be 10mm at the tread.

ii) Wheel hardness value as specified in this specification is not applicable for Hoist having tyres/solid wheels of HTB/Aluminium bronze/SS.

iii) Hook material shall be of forged stainless steel / bronze coated forged steel.

iv) Any mechanism where two non-lubricated parts mate, one of them shall be of non-ferrous material like HTB as per IS 304 or Aluminium Bronze as per IS 305.

v) Coupling guards (if applicable) shall be non-ferrous/non-metallic type.

vi) All electrical components/equipments shall meet the requirements of respective area classification.


Copyright EIL – All rights reserved

## 4.0 INSPECTION AND TESTING

**4.1** Equipment shall be subjected to stagewise expediting, inspection and testing at vendor's/sub-vendor's works by purchaser/its authorised inspection agency. Vendor shall submit Quality Assurance (QA) plan before commencement of fabrication. Approved QA plan shall form the basis for equipment inspection.

**4.2 Testing at Works**

**4.2.1** Vendor shall perform tests and inspection necessary to ensure that the material and workmanship conform to the requirement of Clause 20 of IS-3938.

**4.2.2** Any or all the tests, at purchaser's option, shall be witnessed by purchaser/its authorised inspection agency. However, such inspection shall be regarded as check-up and shall in no way absolve the vendor of his responsibility.

**4.3 Performance Testing and Guarantees**

**4.3.1** A field performance test shall be conducted by the vendor to demonstrate the performance of the equipment after commissioning in accordance with test procedure prepared as per EIL Standard 7-76-0103.

**4.3.2** A field performance test shall be conducted by the vendor to demonstrate the performance of the Hoists after commissioning as per clause 21 of IS-3938. Following parameters shall be guaranteed.

i) SWL of Hoist

ii) Hoisting/Lowering Speed.

**4.3.3** All parts of the hoist shall operate satisfactorily with no undue friction, noise or display of any other unfavourable characteristics during the performance test.

**4.3.4** All equipment and component parts shall be guaranteed by the vendor against defective material and design for a period as specified in Purchaser’s general purchase conditions.

**4.3.5** If any defect occurs during the guaranteed period the Vendor shall make all necessary alterations, repairs and replacement at their own cost.

**4.3.6** Necessary instruments for the performance testing shall be arranged by the vendor, and shall be tested and calibrated before undertaking the performance test. Only test load shall be provided by purchaser near test site.

## 5.0 PROTECTION AND PAINTING

**5.1** All exposed carbon steel parts to be painted shall be thoroughly cleaned from inside and outside to remove scale rust, dirt and other foreign materials by wire brushing and shot/grit blasting as applicable.

**5.2** Painting shall be done as per manufacturer’s standard painting suitable for corrosive industrial/ marine environment (whichever is applicable) unless otherwise specified in the Job Specification.

**5.3** Stainless steel surfaces, both inside and outside, shall be pickled and passivated.

**5.4** Machined and bearing surfaces shall be protected with varnish or thick coat of grease.


Copyright EIL – All rights reserved

## 6.0 PACKAGING AND IDENTIFICATION

**6.1** All packaging shall be done in such a manner as to reduce the volume. The equipment may be dismantled into major components, suitable for shipment and 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.

**6.5** Vendor shall furnish procedure for prolonged storage of supplied equipment/ material at site.

## 7.0 SPARE PARTS

**7.1** Vendor shall submit 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 should 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.

**7.3** Vendor shall supply adequate quantity of commissioning spares. The commissioning spares shall be sufficient for trouble free commissioning of the system at site. Any commissioning spares required during commissioning, over and above, the commissioning spares supplied, shall be made available by the vendor without any cost and time implication to purchaser. If for any reason, during commissioning, vendor needs to utilise spares from 2 years' operation spares (if already available at site), the same shall be replenished by vendor within a reasonable time without any cost implication to purchaser. Any unused commissioning spares shall be handed over to owner.


Copyright EIL – All rights reserved

# 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 |



Copyright EIL – All rights reserved

**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)


Copyright EIL – All rights reserved

## CONTENTS

1.0 GENERAL ..... 4

2.0 CODES AND STANDARDS ..... 4

3.0 TECHNICAL REQUIREMENTS ..... 4

4.0 INSPECTION AND TESTING ..... 6

5.0 PROTECTION AND PAINTING ..... 6

6.0 PACKAGING AND IDENTIFICATION ..... 6

7.0 SPARE PARTS ..... 6



Copyright EIL – All rights reserved

## 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.



Copyright EIL – All rights reserved

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 |


Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

# भूमिगत पाइपिंग हेतु भूमि कार्य के लिए मानक विनिर्देश

# 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 |



Copyright EIL – All rights reserved

**Abbreviations:**

| | | |
|---|---|---|
| IS | : | India Standard |
| RCC | : | Reinforced Cement Concrete |
| U/G | : | Underground |

**Structural Standards Committee**

**Convener:** Mr. Rajanji Srivastava

**Members:**
Mr. Anurag Sinha
Mr. VK Panwar
Mr. Samir Das
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)


Copyright EIL – All rights reserved

## CONTENTS

1.0 SCOPE ..... 4
2.0 CODES & STANDARDS ..... 4
3.0 MATERIAL ..... 4
4.0 EARTHWORK IN EXCAVATION FOR TRENCHES / PITS FOR PIPELINES ..... 4
5.0 BACKFILLING AND COMPACTION ..... 6
6.0 TRANSPORTATION OF SURPLUS EARTH ..... 7
7.0 PAYMENT ..... 7


Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

**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.


Copyright EIL – All rights reserved

**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.


Copyright EIL – All rights reserved

# कंक्रीट पेवमेंट हेतु मानक विनिर्देश

# 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 |
| 2 | 20 01 05 | REVISED AND ISSUED AS STD SPEC | GG | SKC | VDS | SKG |
| 1 | 15 7 98 | REVISED AND ISSUED AS STD SPEC | PCS | RJAIN | MMK | ASONI |
| 0 | 31 3 82 | ISSUED AS STANDARD SPECIFICATION | RP | RPB | HVR | RCPC |


Copyright EIL – All rights reserved

**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 |

**Structural Standards Committee**

**Convenor:** Mr. Rajanji Srivastava

**Members:**
Mr. Anurag Sinha
Mr. VK Panwar
Mr. Samir Das
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Charanjit Singh (Proj.)
Mr. Ravindra Kumar (Const.)


Copyright EIL – All rights reserved

## CONTENTS

1.0 SCOPE ..... 4
2.0 REFERENCE CODES AND SPECIFICATIONS ..... 4
3.0 MATERIALS ..... 4
4.0 GRADES, TYPE OF CONCRETE MIX, PROPORTIONING AND BATCHING ..... 4
5.0 EQUIPMENTS ..... 5
6.0 PREPARATION OF SUB GRADE ..... 5
7.0 PREPARATION OF SUB BASE ..... 5
8.0 FORMS ..... 6
9.0 REINFORCEMENT, MIXING & PLACING OF CONCRETE ..... 6
10.0 JOINTS ..... 8
11.0 OPENING TO TRAFFIC ..... 8
12.0 METHOD AND BASIS FOR PAYMENT ..... 9


Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

**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


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

# पाइप पुलिया तथा ई आर सी/ आई आर सी क्रासिंग हेतू मानक विनिर्देश

# STANDARD SPECIFICATION FOR PIPE CULVERTS & ERC/ IRC CROSSING

| 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 & ISSUED AS STD SPEC | AS | RKS | RBB | DM |



Copyright EIL – All rights reserved

**Abbreviations:**

| | | |
|---|---|---|
| ERC | : | Electrical Road Crossings |
| IRC | : | Instrumentation Road Crossings |
| IS | : | Indian Standard |
| PVC | : | Poly Vinyl Chloride |
| RCC | : | Reinforced Cement Concrete |

**Structural Standards Committee**

**Convener:** Mr. Rajanji Srivastava

**Members:**
Mr. Anurag Sinha
Mr. VK Panwar
Mr. Samir Das
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)


Copyright EIL – All rights reserved

## CONTENTS

1.0 SCOPE ..... 4

2.0 CODES & STANDARDS ..... 4

3.0 MATERIALS ..... 4

4.0 TRANSPORTATION AND STACKING ..... 4

5.0 LOWERING AND LAYING OF RCC PIPES ..... 4

6.0 LOWERING AND LAYING OF PVC PIPES ..... 5



Copyright EIL – All rights reserved

## 1.0 SCOPE

The scope of this specification covers RCC pipe culverts and ERC/ IRC crossings with RCC or PVC pipes.

## 2.0 CODES & STANDARDS

| | |
|---|---|
| IS: 458 | Precast Concrete Pipes (with and without reinforcement) |
| IS: 783 | Code of practice for laying of RCC pipes |
| IS: 4985 | Unplasticised PVC pipes for potable water supplies |
| NOTE: - | Latest Edition of all Codes and Standards shall be followed. |

## 3.0 MATERIALS

3.1 All pipes must be new and perfectly sound, free from cracks, cylindrically straight and of standard nominal diameter and length, with even texture. PVC Pipes shall be Class-I as per IS: 4985.

For pipe culverts, class of RCC pipe shall be NP3 / NP4 or as mentioned in the drawings.

3.2 The Contractor shall submit manufacturer's test certificate for acceptance of RCC/PVC pipes.

3.3 Spun yarn for pipe joints shall be of best quality. It shall be free from dust etc.

## 4.0 TRANSPORTATION AND STACKING

4.1 The transportation of materials to the worksite and stacking shall be done in a manner to cause minimum inconvenience to the traffic and other construction work.

4.2 The pipe shall be protected during handling against impact, shocks and free fall to avoid cracks and damage.

4.3 The Contractor shall be fully responsible for the safety and security of materials transported and stacked in the field.

### 4.4 Earthwork

Refer standard specification No.6-68-0003 for earthwork.

## 5.0 LOWERING AND LAYING OF RCC PIPES

### 5.1 General

The laying and jointing of RCC pipes shall confirm to IS: 783.

The trench shall be checked for proper level, grade and alignment before lowering the pipes.



Copyright EIL – All rights reserved

**5.2 Lowering**

The RCC pipe shall be lowered cautiously to prevent disturbance to the bed and sides of the trench. The heavy RCC pipes shall be lowered by means of proper tripods, chain pulley blocks or as directed by Engineer-in-charge. Great care should be taken to prevent sand etc. from entering the pipes.

**5.3 Laying**

5.3.1 Laying of RCC pipes shall proceed up grade of slopes.

5.3.2 The error of grade shall not be rectified by packing up earth underneath the pipe. If required, concrete shall be used for packing.

5.3.3 The end of RCC pipes shall be kept closed to keep dirt, mud and foreign materials out. Adequate provision shall be made to prevent floating of pipes in the event of flooding of trenches.

The body of RCC pipe, for its entire length, shall rest on an even bed in the trench.

**5.4 Jointing of RCC pipes.**

5.4.1 Cement mortar 1:2 (1 cement: 2 sand) shall be slightly moistened and must on no account be soft or sloppy and shall be carefully inserted by hand into the joint. The mortar shall than be punched and caulked into the joint and more cement mortar added until the space of the joint has been filled completely with tightly caulked mortar.

5.4.2 Any surplus mortar projecting inside the joint is to be removed and guarded against any damage. Sack or gunny bags shall be drawn past each joint after completion.

**5.5 Curing.**

The Cement mortar joints in RCC pipes shall be cured at least for seven days.

**5.6 Testing.**

All joints in culvert pipelines shall be tested to a head of 1.5 m of water above the top of the highest pipe, if required, by Engineer-in-Charge.

**5.7 Payment**

Payment shall be made on running meter basis, which includes supplying, transporting, lowering, laying, jointing and curing, concreting around RCC pipes etc., all complete.

**6.0 LOWERING AND LAYING OF PVC PIPES**

**6.1** Lowering and laying of PVC pipes shall be done as per IS: 4985. The jointing of the pipes shall be done by expanding one end after heating and using solvent cement.

**6.2 Payment**

Payment shall be made on running meter basis of PVC pipes, which includes supplying, transporting, lowering, laying and jointing, concreting around PVC pipes etc., all complete.



Copyright EIL – All rights reserved

# 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 |
| 5 | 06.07.18 | REAFFIRMED & ISSUED AS STD. SPEC. | LP | VG | RAJANJI SRIVASTAVA | R K TRIVEDI |
| 4 | 20.05.13 | REAFFIRMED & ISSUED AS STD. SPEC. | RBT | RKS | RBB | DM |



Copyright EIL – All rights reserved

**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
Mr. Raj Kumar Singh
Mr. U.C. Pathak (Piping)
Mr. Charanjeet Singh (Projects)
Mr. Indrajit Neog (Construction)
Mr. Vikram Kumar Gupta (Structural)



Copyright EIL – All rights reserved

## CONTENTS

1.0 SCOPE ..... 4

2.0 CODES & STANDARDS ..... 4

3.0 FABRICATION ..... 5

4.0 COATING & LAYING OF UNDERGROUND PIPING ..... 5

5.0 INSPECTION & FLUSHING ..... 8

6.0 TESTING ..... 8

8.0 PAYMENT ..... 10



Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

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.



Copyright EIL – All rights reserved

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 $29^0$C 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.


Copyright EIL – All rights reserved

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


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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


Copyright EIL – All rights reserved

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


Copyright EIL – All rights reserved

# भूमिगत सीवर प्रणाली के लिए

# मानक विनिर्देश (एच.डी.पी.ई. पाइप)

# STANDARD SPECIFICATION FOR UNDERGROUND SEWER SYSTEM (H.D.P.E. PIPES)

| Rev. No | Date | Purpose | Prepared by | Checked by | Standards Committee Convenor | Standards Bureau Chairman |
|---|---|---|---|---|---|---|
| | | | | | | Approved by |
| 5 | 22.01.24 | REVISED & ISSUED AS STD. SPEC | PREETI | RKS | SKN | MAINAK NANDI |
| 4 | 06.07.18 | REAFFIRMED & ISSUED AS STD. SPEC. | LP | VG | RAJANJI SRIVASTAVA | R K TRIVEDI |
| 3 | 24.08.12 | REVISED & ISSUED AS STD. SPEC. | JAY KUMAR | RC | RBB | DM |


Copyright EIL – All rights reserved

**Abbreviations:**

| | | |
|---|---|---|
| ANSI | : | American National Standard Institute |
| BIS | : | Bureau of Indian Standards |
| $cm^2$ | : | Square Centimeter |
| HDPE | : | High Density Polyethylene |
| IS | : | Indian Standards |
| mm | : | Millimeter |
| m | : | meter |
| Litres/km/hr/cm | : | Liters/ Kilometer/ Hours/ Centimeter |
| PTFE | : | Poly tetra flouro ethylene |

**General Civil Standards Committee:**

**Convenor:** Mr. Samir Kumar Naskar

**Members:**
Mr. C. Damodaran
Mr. Amitabh Kishore
Mr. Dinesh Deb Barma
Mr. Gyasuddin
Mr. U.C. Pathak (Piping)
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)
Mr. S.C. Maity (Structural)


Copyright EIL – All rights reserved

## CONTENTS

1.0 SCOPE ..... 4
2.0 REFERENCES ..... 4
3.0 MATERIALS ..... 4
4.0 EARTHWORK IN EXCAVATION, BACKFILLING AND TRANSPORTATION ..... 4
5.0 LAYING AND JOINTING ..... 4
6.0 BEDDING AND SIDE FILLING ..... 5
7.0 TESTING ..... 5
8.0 RESTORATION OF DAMAGED SURFACES AND CLEARING THE SITE ..... 6
9.0 PAYMENT ..... 6


Copyright EIL – All rights reserved

## 1.0 SCOPE

This specification covers supplying, laying, cutting, jointing and testing of underground HDPE gravity pipelines and related works.

## 2.0 REFERENCES

### 2.1 Codes & Standards

IS 14333 : Polyethylene pipes for sewerage and industrial chemicals and effluent- Specification

IS: 7634 (Part 2) : Plastic pipes selection, handling, storage and installation for potable water supplies (Laying and jointing of polyethylene (PE) pipes)

### 2.2 Specifications

6-65-0006 : Standard Specification for earthwork for underground piping

NOTE: -Latest Edition of all Codes and Standards shall be followed.

## 3.0 MATERIALS

### 3.1 Pipes

All pipes shall strictly conform to the requirements of IS: 14333. The pipes shall be of minimum PN 2.5 pressure rating and of material grade PE 80. The pipes shall be supplied in suitable lengths convenient for handling, transportation and laying. Whenever possible it should be supplied in coils. The minimum internal diameter of the coil shall not be less than $18d_n$ ($d_n$= nominal outside diameter) of the pipe ensuring that buckling, kinking of the pipe is prevented. Manufacturer's name, trademark, pipe designation, lot number/ batch number containing date of manufacture and BIS certification marking shall be clearly stamped, on each pipe at intervals not more than 1.0m.

## 4.0 EARTHWORK IN EXCAVATION, BACKFILLING AND TRANSPORTATION

All earthwork involved in laying of H.D.P.E. pipes and related works is deemed to have been included in the quoted rates for the laying of H.D.P.E. Pipes.

All earthwork shall be carried out as per specification No. 6-65-0006 (Standard specification for earthwork for underground piping.)

## 5.0 LAYING AND JOINTING

### 5.1 Laying of HDPE Pipes Below Ground

The underground HDPE piping shall be laid, welded, aligned, flushed and tested as per the specifications given below, to the satisfaction of Engineer-in-Charge and also as per relevant clauses mentioned elsewhere:

(a) The contractor shall dig the pipeline trenches as per drawings, true to the line and gradient and as directed by Engineer-in-Charge.

(b) The contractor shall be responsible for correct layout and gradient of the pipe lines. Errors, if any, shall be rectified by the contractor at his own cost.


Copyright EIL – All rights reserved

**5.2** The underground HDPE pipelines shall be buried in excavated trenches over a cushion of 200mm sand padding. No extra payment is admissible to the Contractor for excavation in trenches of required dimensions, sand padding under the pipe, compacting, backfilling after testing to the satisfaction of the Engineer-in-Charge and removal of surplus earth to a place designated by the Engineer-in-Charge within a limit of 0.5 km. All the above activities are deemed to have been included in the cost of pipe laying per meter length.

**5.3** Contractor shall provide casing pipe of suitable sizes under the road as sleeves. The casing pipe will take care of vehicular traffic load. The contractor shall include the cost for taking in the pipe through the sleeve, cost of extra field joints and cost of providing jute or outer face hemp packing throughout the circumference of the outer face of HDPE pipe and inner face of the sleeve pipe in per meter cost of pipe laying. The specification of the packing material, shall be got approved from the Engineer-in-Charge in advance before the execution of the job.

**5.4 Jointing**

The pipes shall be butt jointed by heating the pipe using non- stick PTFE coated electrical heating plate (temperature range 200° C- 230° C) . Electrical power will be given to the contractor at the available locations on the site and power charges shall be as per General Conditions of the contract. The pipe end shall be butted accurately on hydraulic jack platform leaving the gap for insertion of hot plate and heated till a uniform rim of melted material is formed. Immediately the hydraulic jack shall be released and the pipe ends butted together such that a good butt joint shall be formed in between the pipes. Manufacturer's recommendations shall be strictly followed for jointing of pipes. Jointing shall be carried out by skilled fitters with past experience in doing such type of jobs. Care shall be taken that there is no displacement of the centre line of the pipe.

**5.5** Maximum number of jointing shall be done on ground to minimise number of field joints to be made inside the trench. Jointed pipe on the ground in suitable lengths shall be lowered inside the trench, supporting it very carefully, without inducing any secondary stresses on the pipe and laid true to alignment and elevations as shown in the working drawings and as directed by Engineer-in-Charge.

## 6.0 BEDDING AND SIDE FILLING

**6.1** After laying of the pipe on 200mm sand bed and testing to the satisfaction of Engineer-in-Charge, additional material free from all Kankars, clods, or any other foreign material which may damage the HDPE pipe should be placed around the pipe and compacted in 75mm layers up to a level of at least 100mm above the top of pipe.

## 7.0 TESTING

**7.1** The pipeline shall be tested for water tightness of joints. The test shall be carried out from manhole to manhole. Pipe ends shall be closed and filled with water so that water level is upto the top of the manholes.

**7.2** The line shall be kept full for 24 hours. Observations shall be taken after one hour interval and if leakage is within 2.5 litres/km/hr/cm of dia. of pipelines, it shall be deemed to have passed the test.

**7.3** Engineer-in-Charge may at his own discretion ask the contractor to test the laid pipe line in section, in which case the contractor will do the same as per the procedure to be decided by the Engineer-in-Charge without any extra cost to owner. The procedure adopted in such cases, however, will be to test the pipeline according to the criteria mentioned in 7.2 above.

**7.4** In case joints are found to leak, they shall be repaired or redone and test shall be repeated until the joints are approved by Engineer-in-Charge.


Copyright EIL – All rights reserved

**7.5** After completion of the test all temporary seals will be removed the test water shall be drained out/pumped out and the line cleaned properly.

**7.6** Before commissioning the cleanliness of the pipeline will be checked by:

7.6.1 **Torch & Mirror Test**

In this method of testing, a torch will be held at one end of the pipeline inside the manhole and its image through the pipeline will be reflected and seen on a mirror held at the opposite end of the pipeline, inside the next manhole. Any obstruction/debris/major misalignment will not give a clear image in which case the pipeline will again be cleaned/ rectified and the test re-done.

7.6.2 **Ring Test**

In this method of testing two steel/wooden rings of suitable thickness and design shall be fixed facing each other at a distance of 600mm 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"(inches) 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 will again be cleaned/ rectified and the test redone. The ring test shall be performed for the complete net work of the pipe system before the same is put in commission.

## 8.0 RESTORATION OF DAMAGED SURFACES AND CLEARING THE SITE

**8.1** All pavements, structures, pipelines, cables, etc. removed, damaged or disturbed during the pipe laying work shall be restored to original conditions.

**8.2** Surplus excavated soil or rubbish material shall be removed to a place as directed by the Engineer-in-Charge.

## 9.0 PAYMENT

### 9.1 Laying of Pipes

The payment shall be made on running meter basis of the actual job executed. Pipeline shall be measured along the centreline. The rate quoted shall be inclusive of excavation, sand bedding, lowering, laying, jointing, testing, cleaning of pipelines, back filling, removal of surplus earth to a place designated by the Engineer- in- Charge within a limit of 0.5 Km and any other work(s) involved in the pipeline work.

**9.2** The payment clause 9.1 is not applicable in case of LSTK Jobs.


Copyright EIL – All rights reserved

# बिटुमिन मास्टिक सहित तेजाब/क्षार प्रूफ लाइनिंग के लिए मानक विनिर्देशन

# STANDARD SPECIFICATION FOR ACID/ALKALI PROOF LINING WITH BITUMEN MASTIC

| Rev. No | Date | Purpose | Prepared by | Checked by | Standards Committee Convenor | Standards Bureau Chairman |
|---|---|---|---|---|---|---|
| | | | | | Approved by | |
| 4 | 06.07.18 | REAFFIRMED & ISSUED AS STD. SPEC. | LP | VG | RAJANJI SRIVASTAVA | R K TRIVEDI |
| 3 | 20.05.13 | REAFFIRMED & ISSUED AS STD. SPEC | RBT | RKS | RBB | DM |



Copyright EIL – All rights reserved

**Abbreviations:**

| | |
|---|---|
| IS | INDIAN STANDARD |
| mm | MILLIMETER |
| BIS | BUREAU OF INDIAN STANDARDS |
| ASTM | AMERICAN ASSOCIATION FOR TESTING AND MATERIAL |

**Structural Standards Committee:**

**Convenor:** Mr. Rajanji Srivastava

**Members:**
Mr. Anurag Sinha
Mr. VK Panwar
Mr. Samir Das
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)


Copyright EIL – All rights reserved

## CONTENTS

1.0 SCOPE ..... 4

2.0 REFERENCES ..... 4

3.0 MATERIAL ..... 4

4.0 LAYING ..... 4

5.0 GUARANTEE ..... 5

6.0 PAYMENT ..... 5



Copyright EIL – All rights reserved

## 1.0 SCOPE

1.1 This specification covers the supply and application of acid/alkali proof treatment to foundations and superstructure. All material required for the completion of the work shall be supplied by the contractor as per specifications and sound engineering practice.

1.2 The acid/alkali proof treatment as a whole shall be strictly as per these specifications.

1.3 All materials used for the anti-corrosive treatment shall be of best available quality. All work shall be carried out by agencies specialised in the field.

## 2.0 REFERENCES

### 2.1 Codes and standards

| | |
|---|---|
| IS: 9510 | Indian Standard Specification for Bitumen Mastic, Acid – Resisting Grade |

### 2.2 Specifications

| | |
|---|---|
| ASTM D-41 | Standard Specification for Asphalt Primer used in Roofing, Dampproofing, and Waterproofing |

Note: - Latest Edition of IS shall be followed

## 3.0 MATERIAL

### 3.1 Bitumen Primer

3.1.1 A bitumen primer is an asphalt based material thinned with petroleum solvent (conforming to ASTM D-41) should be applied over the surface. Primers from standard manufacturers only shall be used. It should be allowed to dry before applying the bitumen mastic.

### 3.2 Bitumen Mastic

3.2.1 The bitumen mastic shall consist of a mixture of asphalt cement mineral filler, and mineral aggregate, which are acid alkali proof. The mastic shall be sufficiently plastic at a temperature of approximately 400° F (205° C) to enable its placement and compression with a wooden trowel or by other suitable means into a compact, water tight sheet of the thickness desired.

3.2.2 The composition, preparation and properties of the bitumen mastic shall be as per IS: 9510 for resisting acid. The bitumen mastic shall be insoluble in Benzol and the matter soluble in diluted hydrochloric acid should not be more than five percent. "Prodorphalte" by Coromandal Prodorite or equivalent may be used.

3.2.3 Bitumen mastic used for application on floor and foundations shall be a hard finished surface capable of withstanding the expected loads. The thickness of the mastic layer shall be to suit the acid concentration and expected load or as specified by the Engineer-in-charge.

## 4.0 LAYING

4.1 The concrete surface of the foundation, etc. shall be well cleaned to ensure that it is free from all dirt, dust, girt etc. A bitumen primer shall be applied over this surface at the rate of 0.75 $Kg/m^2$ by spraying or painting with a heavy brush. The primer shall be allowed to set for 24 hours and should be entirely absorbed. Any excess of the primer which has collected in surface depression should be blotted up the application of clean blinding material e.g. coarse sand. Prior to laying the next course all lose or excess sand should be swept from the base.



Copyright EIL – All rights reserved

**4.2** Over the priming coat of bitumen, bitumen mastic of thickness (as specified in the drawing), mixed in mechanical hot mix plant, shall be laid in two layers. The bonding surfaces shall be heated by blow lamps to ensure proper adhesion between the primer and the mastic layer and adjacent joints. If blows occur they should be stabbed and the areas affected shall be carefully made good.

All materials used are to conform to the specification and to relevant IS codes. The entire job shall be done by a specialist firm in the field and to the satisfaction of the Engineer-in-Charge

## 5.0 GUARANTEE

The Vendor shall give material and performance guarantee for a period of minimum one year from the date of commissioning of the plant.

## 6.0 PAYMENT

**6.1** Payment shall be on square meter basis of area covered.

**6.2** The payment clause(s) as described in the clause no. 6.1 shall not be referred / applicable for LSTK Jobs


Copyright EIL – All rights reserved

# अम्ल अवरोधी ब्रिक / टाइल लाइनिंग

# के लिए मानक विनिर्देश

# STANDARD SPECIFICATION FOR

# ACID RESISTING BRICK / TILE LINING

| Rev. No | Date | Purpose | Prepared by | Checked by | Standards Committee Convenor | Standards Bureau Chairman |
|---|---|---|---|---|---|---|
| | | | | | Approved by | |
| 6 | 16.08.21 | REVISED & ISSUED AS STD. SPEC. | ADP | GYAS | ANURAG SINHA | SANJAY MAZUMDAR |
| 5 | 06.07.18 | REAFFIRMED & ISSUED AS STD. SPEC. | LP | VG | RAJANJI SRIVASTAVA | R K TRIVEDI |
| 4 | 27.09.13 | REVISED AND ISSUED AS STD. SPEC. | RB | RKS | RBB | DM |



Copyright EIL – All rights reserved

**Abbreviations:**

| | | |
|---|---|---|
| ASTM | : | American Society for Testing and Materials |
| BIS | : | Bureau of Indian Standards |
| IS | : | Indian Standard |
| LSTK | : | Lump Sum Trunkey |
| mm | : | Millimeter |

**Structural Standards Committee:**

**Convenor:** Mr. Anurag Sinha

**Members:**
Mr. C. Damodaran
Mr. VK Panwar
Mr. Samir Das
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)


Copyright EIL – All rights reserved

## CONTENTS

1.0 SCOPE ..... 4

2.0 REFERENCES ..... 4

3.0 MATERIAL ..... 4

4.0 LAYING ..... 5

5.0 GUARANTEE ..... 6

6.0 PAYMENT ..... 6



Copyright EIL – All rights reserved

## 1.0 SCOPE

This specification covers the requirement of material and laying of Acid Resisting Brick/ tile lining for flooring on acid storage areas.

## 2.0 REFERENCES

### 2.1 Codes & Standards

IS 4457 Specification for ceramic unglazed vitreous acid resisting tile.
IS 4832 (Part-I) Chemical resistant mortar silicate type
IS 4832 (Part-II) Chemical resistant mortar Resin type
IS 4860 Acid resistant bricks
IS 9510 Specification for Bitumen Mastic, Acid resistant grade.

### 2.2 Specifications

ASTM D41-94 Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and waterproofing

Note: - Latest Edition of IS / codes and standards shall be followed

## 3.0 MATERIAL

### 3.1 Acid Resisting Bricks / Tiles

The Bricks shall conform to IS: 4860 – Class I quality. All bricks shall be dense, homogeneous and manufactured out of special raw material which shall have low lime, flint, sand and iron contents. These shall be specially fired and vitrified at high temperature to have qualities of low absorption. The size of the bricks shall normally be 230mm x 114mm x 64 mm or as per IS 4860. Ceramic unglazed Acid resisting tiles shall confirm to IS 4457. The size of Acid resisting tile shall be as per IS: 4457 or as defined in SOR.

### 3.2 Chemical Resistant Mortar

3.2.1 Silicate Mortar

It shall consist of selected potassium silicate solution and inert filter powder. Both mixed well to enable to set at ambient temperature. The mortar shall conform to IS 4832 (Part – I). The mixing proportion and other instructions for use shall be as specified standard manufacturers. Silicate mortar from standard manufacturers only shall be used. Contractor shall obtain approval from Engineer – in – charge prior to order and supply of the material. This type of Mortar is resistant to most acids except hydro-fluoric acid and concentrated ortho-phosphoric acid; they are not resistant to alkalies of any concentration or to boiling water or stream.

3.2.2 Resin Mortar

The furane and phenolic mortar for jointing consist of inert powder synthetic resin syrup. No water shall be used during mixing. This mortar shall conform to IS 4832 (Part – II). The mixing proportion and other instructions shall be as specified by standard manufacturers. Resin mortar from standard manufacturers only shall be used. Contractor shall obtain approval from Engineer – in – charge prior to order and supply of the material. This type of Mortar has a good resistance to non-oxidising mineral acids, and poor resistance to oxidising mineral acids. They are fairly resistant to inorganic alkalies and water.


Copyright EIL – All rights reserved

### 3.3 Bitumen Primer

A bitumen primer is an asphalt based material thinned with petroleum solvent (conforming to ASTM D-41) should be applied over the surface. Primers from standard manufacturers only shall be used.

### 3.4 Bitumen Mastic

The bitumen mastic shall consist of a mixture of asphalt cement mineral filler, and mineral aggregate, which are acid alkali resistant. The composition, preparation and properties of the bitumen mastic shall be as per IS 9510 for resisting acid. The bitumen mastic shall be insoluble in Benzol and the matter soluble in diluted hydrochloric acid should not be more than five percent. "Prodorphalte" by Coromandal Prodorite or equivalent may be used.

## 4.0 LAYING

### 4.1 Surface Preparation

a) All damaged or questionable areas should be chipped out and replaced.
b) Adequate floor slope for good drainage is important.
c) Low spot should be avoided because finished floor will follow contour or sub floor.
d) Concrete should be dry, clean and well cured before application of membrane is started.

### 4.2 Primer Application

A bitumen primer should be applied over the prepared surface. It should be allowed to dry before applying the membrane material.

### 4.3 Membrane Application

Bitumen mastic is used to build up the membrane. It is heated to 120-205° C and applied to the primed surfaces. Multiple coat application should be made to thickness requirements. The thickness of the mastic layer shall be to suit the acid concentration and expected load or as specified by the Engineer-in-charge. Each coat should be inspected for blisters and pinholes. If present, they should be broken and before applying subsequent coats. Bitumen mastic should not be used as the membrane material where solvents are involved.

### 4.4 Reinforcement Application

Bitumen coated glass cloth can be used for membrane reinforcements at the corners, edges, walls, etc. depending on the requirements.

### 4.5 Application of Mortar and Bricks/Tile

There are two ways of lining Acid resisting linings:

4.5.1 When Bedding and Jointing Material are the same

A thin layer of about 3mm suitable resinous mortar is spread on the back of the acid resisting tiles and the tiles are pressed down on the bed. Suitable joint thickness of about 3mm should be maintained. Jointing is done with suitable resin mortar.

4.5.2 When Bedding and jointing material are different

A thin layer of about 6mm suitable silicate type mortar is spread on the back of the acid resisting tiles and the tiles are pressed down on the bed. Proper joint thickness of about 3mm


Copyright EIL – All rights reserved

should be maintained and filled up with suitable resin type mortar. In case of pointing the joint thickness should be 6mm and depth of the pointing should be 19mm.

In this case, joints with silicate mortar should be acid cured with 20 to 25 percent hydrochloric acid or with 30 to 40 percent sulphuric acid before applying the resin type mortar. After acid curing, the free acid in the joints shall be cleaned with water and sufficient time should be allowed should be allowed for thorough drying. After curing resin mortar is used for filling up the joints.

## 5.0 GUARANTEE

The Vendor shall give material and performance guarantee for a period of minimum one year from the date of commissioning of the plant.

## 6.0 PAYMENT

**6.1** Payment shall be on square meter basis of area covered.

**6.2** The payment clause 6.1 is not applicable for LSTK Jobs.


Copyright EIL – All rights reserved

# रबड़ विस्तार जोड़ के लिए मानक विनिर्देश

# STANDARD SPECIFICATION FOR RUBBER EXPANSION JOINT

| Rev. No | Date | Purpose | Prepared by | Checked by | Standards Committee Convener | Standards Bureau Chairman |
|---|---|---|---|---|---|---|
| | | | | | Approved by | |
| 5 | 05.02.2021 | REVISED AND ISSUED AS STD. SPEC. | GS | GYAS/AK | A SINHA | SM |
| 4 | 06.07.18 | REAFFIRMED & ISSUED AS STD. SPEC. | LP | VG | RAJANJI SRIVASTAVA | R K TRIVEDI |
| 3 | 28.05.12 | REVISED AND ISSUED AS STD. SPEC. | JKU | RKS | RBB | DM |



Copyright EIL – All rights reserved

**Abbreviations:**

| | | |
|---|---|---|
| ANSI | : | American National Standards Institute |
| IS | : | Indian Standard |
| PMS | : | Piping Material Specification |
| psig | : | Pounds per square inch gauge |

**Structural Standards Committee:**

**Convenor:** Mr. Anurag Sinha

**Members:**
Mr. C. Damodaran
Mr. VK Panwar
Mr. Samir Das
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)


Copyright EIL – All rights reserved

CONTENTS

1.0 GENERAL ..... 4
2.0 CODES AND STANDARDS ..... 4
3.0 DESIGN REQUIREMENTS ..... 4
4.0 MATERIAL OF CONSTRUCTION ..... 4
5.0 INSPECTION AND TESTING ..... 5
6.0 SPARES ..... 5
7.0 TECHNICAL DATA SHEET ..... 5
ANNEXURE – I ..... 6
ANNEXURE - II ..... 7


Copyright EIL – All rights reserved

## 1.0 GENERAL

This specification covers the purchaser's technical requirements for design, supply of material, construction, inspection and testing of Rubber Expansion Joints for using in the low pressure/ambient temperature piping at pump suction lines or any other place as desired for any of the following utilities

a) Fire water
b) Cooling water
c) Raw water

## 2.0 CODES AND STANDARDS

The rubber expansion joint shall be designed and manufactured as per the relevant Indian and International Standards and sound engineering practice.

## 3.0 DESIGN REQUIREMENTS

a) Expansion joint shall be normally provided on the suction lines of pumps in the piping manifolds of pump stations, etc. especially when suction pipelines are embedded in sump concrete walls or when no load or vibrations are to be transferred to the piping on the other side of the expansion bellow.

b) The expansion joint shall be provided with control units with steel limiting rods. No thrust shall be transmitted by expansion joint to rotating equipment.

c) The retaining rings shall be provided and shall be of split type with min. four segments.

d) The dimensional specifications operating conditions, number, etc shall be as per Annexure-I.

e) The expansion joint, which is also subjected to vibration and shock during operation, shall be capable of withstanding the following:

- Axial compression : 25 mm min.
- Lateral movement : 12 mm min.
- Axial elongation : 12 mm min.

## 4.0 MATERIAL OF CONSTRUCTION

a) The rubber expansion joint, corrugated bellow type shall be made of high grade abrasive resistant natural rubber compound reinforced with adequate number of piles heavy cotton duck, rayon cord, impregnated with rubber compound and further reinforced with square metal ring embedded in the carcass. The outer exposed surface of the rubber expansion joint shall be given a thin coating of synthetic neoprene rubber and further painted with chlorinated rubber based paint.

b) Rubber expansion joint shall be complete with galvanised steel retaining ring (Material to IS: 2062 and thickness 12mm) and drilled suitably to match the particular size of rubber expansion joint.


Copyright EIL – All rights reserved

## 5.0 INSPECTION AND TESTING

a) Stage wise Inspection and testing shall be carried out at vendor's works by Owner/Owner's representative prior to despatch. Inspection plan shall be submitted by contractor.

b) All expansion joints shall be successfully hydrostatically tested as noted below, under normal as well as extreme displacement conditions.

- Hydrostatic pressure of as per PMS class
- Vacuum test to be conducted at 650 mm of Mercury.

c) Owner/Owner's representative shall have access at all reasonable time to vendor's works where the expansion joints are being fabricated and tested. Vendor shall arrange all the facilities to carry out such inspection/testing.

## 6.0 SPARES

The vendor shall furnish list of recommended spares for two years trouble free operation.

## 7.0 TECHNICAL DATA SHEET

Vendor shall furnish the "Technical Data Sheet" (Blank Technical Data Sheet enclosed with the specification – Refer Annexure - II) duly filled up with required information / indicating compliance, etc. along with the offer. **Filled up Technical Data Sheet must accompany the offer failing which the offer can be liable for rejection.**


Copyright EIL – All rights reserved

## ANNEXURE – I

(To be filled up by Job Engineer)

## SPECIFICATIONS AND OPERATING CONDITIONS

### SPECIFICATIONS

| | | |
|---|---|---|
| i) | Face to face dimension Including integral flange | |
| | Upto dia 16" | : 300mm |
| | Dia 16" and above | : 500mm |
| ii) | Drilling of Flanges | : As per PMS class |
| iii) | Job Piping Material Specification No. (to be attached) | : _____ |
| iv) | Hydraulic test pressure | : as per PMS class or as specified by Engineer |
| v) | Vacuum test pressure | : 650 mm of Mercury |

### OPERATING CONDITIONS

| | | |
|---|---|---|
| i) | Fluid to be Handled | : Fresh water / Sea water |
| ii) | Location | : Suction side of pump / any other location |
| iii) | Design Temperature | : 65 degree C. |


Copyright EIL – All rights reserved

## ANNEXURE - II

## TECHNICAL DATA SHEET
(DETAILS TO BE FURNISHED BY THE BIDDER ALONG WITH THE OFFER)

'C' means vendor to furnish data / details

**1.0 GENERAL**

| | | |
|---|---|---|
| a) | Supplier's name | (C) |

**2.0 CODES AND STANDARDS**

| | | |
|---|---|---|
| | Codes and standard practices followed (Specify Code Number) | (C) |

**3.0 DESIGN REQUIREMENTS**

| | | |
|---|---|---|
| a) | No. of Rubber Expansion joints | (C) |
| b) | Nominal dia. of Rubber Expansion Joint | (C) |
| c) | Face to face dimension including integral flange | (C) |

**4.0 MATERIAL OF CONSTRUCTION**

| | | |
|---|---|---|
| | Vendor to give part-wise material list in line with specification | (C) |

**5.0 VENDOR DATA REQUIREMENTS**

**5.1 Along with the Bid**

| | | |
|---|---|---|
| i) | Detailed dimensional and cross sectional drawings. | (C) |
| ii) | Manufacturer's literature / catalogues etc., | (C) |
| iii) | List of deviations if any | (C) |

**5.2 After Award of Contract**

| | | |
|---|---|---|
| i) | Originals transparencies after incorporating as built information signed by the Inspection Engineer | (C) |
| ii) | Final drawings as described in Clause 5.1 (6 sets). | (C) |

**6.0 SPARES**

| | | |
|---|---|---|
| a) | List of recommended spare | (C) |


Copyright EIL – All rights reserved

# पोर्टेबल प्रकार के अग्निशामक का मानक विनिर्देश

# STANDARD SPECIFICATION FOR PORTABLE FIRE EXTINGUISHER

| Rev. No | Date | Purpose | Prepared by | Checked by | Approved By: Standards Committee Convenor | Approved By: Standards Bureau Chairman |
|---|---|---|---|---|---|---|
| 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 |



Copyright EIL – All rights reserved

**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
Mr. Samir Das
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Charanjit Singh (Proj.)
Mr. Ravindra Kumar (Const.)


Copyright EIL – All rights reserved

## CONTENTS

1.0 SCOPE ..... 4
2.0 CODES AND STANDARDS ..... 4
3.0 MATERIAL OF CONSTRUCTION & BASIC REQUIREMENT ..... 4
4.0 APPROVALS ..... 4
5.0 COLOR & MARKING ..... 4
6.0 ACCESSORIES ..... 5
7.0 INSPECTION ..... 5



Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

# 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 |



Copyright EIL – All rights reserved

**Abbreviations:**

| | | |
|---|---|---|
| GI | : | Galvanized Iron |
| IS | : | Indian Standard |
| Kg | : | Kilogram |
| LPM | : | Litre per minute |
| mm | : | Millimeter |

**Structural Standards Committee**

**Convener:** Mr. Anurag Sinha

**Members:**
Mr. C. Damodaran
Mr. VK Panwar
Mr. Samir Das
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar(Construction)


Copyright EIL – All rights reserved

## CONTENTS

1.0 SCOPE ....4

2.0 CODES AND STANDARDS ....4

3.0 DESIGN REQUIREMENT ....4

4.0 MATERIAL OF CONSTRUCTION ....4

5.0 INSPECTION AND TESTING ....5

6.0 MARKING ....5

7.0 VENDOR DATA REQUIREMENTS ....5


Copyright EIL – All rights reserved

## 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 |


Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

# 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 |


Copyright EIL - All rights reserved

**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


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

- 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


Copyright EIL – All rights reserved

# मानक विनिर्देशन
# 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 |



Copyright EIL – All rights reserved

**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**
**Mr. Charanjit Singh (Projects)**
**Mr. Indrajit Neog (Construction)**


Copyright EIL – All rights reserved

## CONTENTS

1.0 SCOPE ..... 4
2.0 REFERENCES ..... 5
3.0 WATER ..... 5
4.0 AGGREGATE ..... 5
5.0 SAND ..... 8
6.0 CEMENT ..... 9
7.0 STEEL ..... 10
8.0 BRICK ..... 11
9.0 STONE ..... 13
10.0 ADMIXTURES ..... 14
11.0 WATER BARS (WATER STOPS) ..... 15
12.0 BITUMEN/BITUMINOUS MATERIALS ..... 15
13.0 PVC PIPES ..... 16
14.0 WOOD/TIMBER ..... 16
15.0 EPOXY COMPOUNDS ..... 16
16.0 PAINT ..... 16
17.0 ANTITERMITE COMPOUNDS ..... 17
18.0 POLYSULPHIDE SEALANTS ..... 17


Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

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


Copyright EIL – All rights reserved

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


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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


Copyright EIL – All rights reserved

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


Copyright EIL – All rights reserved

- 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


Copyright EIL – All rights reserved

- 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


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

### 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


Copyright EIL – All rights reserved

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:


Copyright EIL – All rights reserved

- 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.


Copyright EIL – All rights reserved

## 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<br>50ml in 1 litre water |
| 2 | Imidacloprid 30.5% Suspension Concentrate (SC) | IS 16131 | 10.5ml in 5 litre water<br>2.1ml in 1 litre water |
| 3 | Bifenthrin 2.5% Emulsifiable Concentrate (EC) | IS 15936 | 100ml in 5 litre water<br>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.


Copyright EIL – All rights reserved

# 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 |



Copyright EIL – All rights reserved

**Abbreviations:**

CNS : Cohesive Non Swelling

**Structural Standards Committee**

**Convenor :** Mr. Anurag Sinha

**Members:**
Mr. C Damodaran
Mr. V.K.Panwar
Mr. Samir Das
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Charanjit Singh (Projects)
Mr. Ravindra Kumar (Constn.)


Copyright EIL – All rights reserved

## CONTENTS

1.0 SCOPE ..... 4
2.0 CLASSIFICATION OF SOIL ..... 4
3.0 BACKFILLING MATERIAL ..... 5
4.0 SETTING OUT ..... 6
5.0 EARTHWORK IN EXCAVATION ..... 6
6.0 SHORING AND STRUTTING ..... 12
7.0 BACK FILLING AROUND FOUNDATIONS AND IN PLINTH ..... 13
8.0 TRANSPORTATION OF SURPLUS EARTH ..... 13
9.0 PROTECTION OF PROPERTY AND PERSONNEL ..... 14
10.0 CLEAN UP ..... 14


Copyright EIL – All rights reserved

## 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


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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<br>- 0 | +75 mm<br>- 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-


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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


Copyright EIL – All rights reserved

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).


Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

## 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.


Copyright EIL – All rights reserved

# 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 |



Copyright EIL – All rights reserved

**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**

**Convenor:** Mr. Anurag Sinha

**Members :** Mr. V. Goel
Mr. S. C. Maity
Mr. Deepak Agrawal
Ms. Alpana Srivastava
Dr. Sudip Paul
Mr. Prasenjit Saha (SMMS)*
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)

*For Fireproofing Specifications


Copyright EIL – All rights reserved

## CONTENTS

1.0 SCOPE ..... 4
2.0 MATERIALS ..... 4
3.0 GRADES OF CONCRETE ..... 4
4.0 TYPE OF CONCRETE MIX ..... 5
5.0 CONCRETE MIX PROPORTIONING ..... 5
6.0 BATCHING ..... 7
7.0 CONCRETE MIXING ..... 7
8.0 TRANSPORTATION, PLACING AND COMPACTION ..... 8
9.0 CONSTRUCTION JOINTS ..... 11
10.0 SEPARATION JOINT ..... 12
11.0 EXPANSION JOINTS/ISOLATION JOINT ..... 12
12.0 WATER STOPS ..... 12
13.0 PROTECTION OF FRESHLY LAID CONCRETE ..... 12
14.0 CURING ..... 13
15.0 FIELD TESTS ..... 13
16.0 INSPECTION AND TESTING OF STRUCTURES ..... 199
17.0 FINISHING OF CONCRETE ..... 19
18.0 WATERPROOF CEMENT PAINT ..... 21
19.0 FORM WORK ..... 211
20.0 EXPOSED/ARCHITECTURAL CONCRETE WORK ..... 25
21.0 REINFORCEMENT ..... 266
22.0 PAYMENT ..... 29


Copyright EIL – All rights reserved

## 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<br>M 15<br>M 20 | 10<br>15<br>20 |


Copyright EIL – All rights reserved

**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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

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.


Copyright EIL – All rights reserved

**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 hardened concrete by thoroughly flushing them with water after each run; water used for flushing shall be discharged clear of the structure.


Copyright EIL – All rights reserved

8.1.2 Vibrators

8.1.2.1 Concrete shall be compacted with mechanical vibrating equipment supplemented, if necessary to obtain consolidation, by hand spreading, rodding and tamping. The vibrators shall be of immersion type with operational frequency ranging between 8,000 to 12,000 vibrations per minute. All vibrators shall comply with IS 2505. Screed board concrete vibrators or concreting vibrating tables or form vibrators conforming to IS 2506, 2514 and 4656 respectively shall be used where specifically required and directed by Engineer-in-Charge.

8.1.2.2 Immersion type vibrators shall be inserted in a vertical position at intervals of about 600 mm, depending upon the mix, the equipment used, and experience on work. The vibrators shall be withdrawn slowly. The spacing shall provide some overlapping of the area vibrated at each insertion. In no case shall vibrators be used to transport concrete inside the forms. Over vibration or under vibration shall not be permitted as both are harmful. Hand tamping in some cases may be allowed subject to the approval of the Engineer-in-Charge.

8.1.2.3 In placing concrete in layers which are advancing horizontally as the work progresses, great care shall be exercised to ensure adequate vibration, bonding and moulding of the concrete between the succeeding batches.

8.1.2.4 The vibrator shall penetrate the layer being placed and also penetrate the layer below while the under layer is still plastic to ensure good bond and homogeneity between the two layers and prevent the formation of cold joints.

8.1.2.5 Care shall be taken to prevent contact of vibrators against all embedded reinforcing steel or inserts. Vibrators shall not be allowed to come in contact with forms.

8.1.2.6 The use of form vibrators shall not be permitted for compaction of in-situ concrete without specific authorization of the Engineer-in-Charge.

8.1.2.7 The use of surface vibrators of screed board type shall not be permitted for consolidation of concrete under ordinary conditions. However, for thin slabs (of thickness less than 200 mm) surface vibration by such vibrators may be permitted, upon approval of the Engineer-in-Charge.

8.1.2.8 Whenever vibration has to be applied externally, the design of formwork and the disposition of vibrators shall be carefully planned to ensure efficient compaction and to avoid surface blemishes.

**8.2 Transportation**

8.2.1 All concrete shall be conveyed from the mixer to the place of final deposit such as formwork as rapidly as possible using suitable buckets, dumpers, pumps, transit mixers containers or conveyors which shall be mortar leak tight. Care shall be taken to prevent the segregation or loss of the ingredients and maintaining the required workability. For structural concrete produced from Ready Mixed Concrete/ Batching Plants, concrete shall be transported from the plants to the sites only by transit mixers and Delivery Ticket for each delivery of concrete shall be maintained by the contractor.

8.2.2 During hot or cold weather, concrete shall be transported in deep containers. Other suitable methods to reduce the loss of water by evaporation in hot weather and heat loss in cold weather may also be adopted. All equipment used for transporting and placing of concrete shall be maintained in clean condition. All buckets, hoppers, chutes, dumpers and other equipment shall be thoroughly cleaned after each use.


Copyright EIL – All rights reserved

## 8.3 Placing and Compaction

8.3.1 Before placing concrete, all soil surfaces upon which or against which concrete is to be placed shall be well compacted and free from standing water, mud or debris. Soft or yielding soil shall be removed and replaced, with lean concrete or with selected soils/sand and compacted to the density as directed by Engineer-in-Charge. The surface of absorptive soil (against which concrete is to be placed) shall be moistened thoroughly so that moisture is not drawn from the freshly placed concrete. Similarly, for concrete to be placed on formworks, all chippings, shavings and sawdust etc. shall be removed from the interior of the forms before the concrete is placed.

8.3.2 Concrete shall not be placed until the formwork, the placement of reinforcing steel, embedded parts; pockets etc. have been inspected and approved by the Engineer- in-Charge. Any accumulated water on the surface of the bedding layer shall be removed by suitable means before start of placement. No concrete shall be placed on a water covered surface.

8.3.3 Concrete shall be discharged by vertical drop only and the drop height shall not normally exceed 1.5 metre throughout all stages of delivery until the concrete comes to rest in forms. However, drop height can be relaxed by the Engineer-in-Charge as per the provisions given under Cl. 8.1.1. For continuous concreting operation windows of suitable size shall be kept in the formwork or chutes shall be used to avoid segregation of concrete.

8.3.4 Concrete shall be deposited as near as practicable in its final position to avoid rehandling. Concrete shall be placed in successive horizontal layers. The bucket loads, or other units of deposit, shall be placed progressively along the face of the layer with such over-lap as will facilitate spreading the layer of uniform depth and texture with a minimum of hand shoveling. Any tendency to segregation shall be corrected by shovelling coarse aggregates into mortar rather than mortar on the coarse aggregates. Such a tendency for segregation shall be corrected by redesign of mix, change in process or other means, as directed by the Engineer-in-Charge.

8.3.5 All struts, stays and braces (serving temporarily to hold the forms in correct shape and alignment pending the placing of concrete at their locations) shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. These shall not be buried in the concrete. Concrete shall be thoroughly compacted with vibrators and fully worked around the reinforcement, embedded fixtures and into corners of formwork before setting commences and shall not be subsequently disturbed. Methods of placing shall be such as to preclude segregation and avoid displacement of reinforcement or formwork. The formation of stone-pockets or mortar bondage in corners and against face forms shall not be permitted. Should these occur, they shall be dug out, reformed and refilled to sufficient depth and shape for thorough bonding as directed by the Engineer-in-Charge. Care shall be taken to avoid displacement of reinforcement and embedded inserts or movement of formwork.

8.3.6 Unless otherwise approved, concrete shall be placed in single operation to the full thickness of foundation rafts, slabs, beams and similar members. Concrete shall be placed continuously until completion of the part of the work between approved construction joints or as directed by the Engineer-in-Charge.

8.3.7 The method of placing and compaction employed in any particular section of the work shall be to the entire satisfaction of the Engineer-in-Charge.

8.3.8 During hot weather (atmospheric temperature above 40 degree Celsius) or cold weather (atmospheric temperature below 5 degree Celsius, the concreting shall be done as per the procedure set out in IS 7861).

8.3.9 Concrete that has set standing and becomes stiffened shall not be used in the work.

Signature Not Verified
Digitally signed by MD MAZHER ALI
Date: 2026.04.09 18:02:13 IST
Location: eProcure-EPROC


Copyright EIL - rights reserved