LOTO arrangement shall include provision for the following:

a) Provision for hooking lockout devices by multiple lock arrangement to prevent opening of panel door and racking-in of circuit breaker.

b) Provision for attaching tag-out device for warning against energisation and to provide information regarding date of isolation, agency working on the equipment, etc.

c) Provision for Hasp such that the same shall be put-in and closed in the locking arrangement of the breaker/switch and panel door.

5.1.12 All hardware shall be corrosion-resistant. All joints and connections of the panel members shall be made by zinc-passivated high-quality Grade 8.8 or superior steel bolts, nuts and washers, secured against loosening.

5.1.13 Suitable eyebolts/ lifting clamps shall be provided for the lifting of the panel/shipping section. The bolts, when removed shall not leave any opening in the panels.

5.1.14 If specified in job specifications/datasheet/Tender, light/ arc/ pressure based sensors with controller shall be provided to quickly detect internal arc and immediately initiate tripping action.

5.1.15 Thermography window for infrared electrical inspection shall be provided if specified in job specifications/datasheet/Tender . The switchgear with thermo-graphy window shall be type tested and certified for internal arc faults as per IS/IEC 62271-200 requirements. In case IAC test report with thermography window is not available, IAC test report to be submitted for the panel along with internal arc withstand capability report for the material used for thermography window.

5.1.16 MV Switchgear shall be provided with online wireless temperature monitoring facility if specified in job specifications/datasheet/Tender. The passive sensor shall be wireless, battery less, dielectrically safe, robust to high voltage, high electromagnetic field, and harsh environment. It shall take direct measurement of temperature from critical points. This facility shall be interfaced with Substation Automation System/ ECS.

In case online temperature monitoring system (OTMS) for real time monitoring of temperature is being provided for MV switchboards, thermography window is not required.

5.2 Accessibility

5.2.1 All relays, metering, and control components shall be mounted on the panel front only. However, auxiliary contact multiplier relays with auto reset can be mounted inside the panel.

5.2.2 The switchgear shall be considered to be accessible to authorized personnel having access all around and shall be tested for following type of accessibility as per IS/IEC 62271-200:

Type of accessibility where	:	AFLR
Accessibility type A	:	Restricted to authorised personnel only
F	:	for front side
L	:	for lateral side
R	:	for rear side

5.2.3 Checking and removal of components shall be possible without disturbing adjacent equipment. All equipment shall be easily accessible. It shall be possible to set all measuring relays and instruments in-situ without de-energising the switchboard. All mounted equipment shall have identification tags of self-sticking PVC tapes at the rear also. In addition, permanent identification details shall be provided on the panel. Mounting of relays for a particular breaker feeder panel shall be limited to that particular feeder only.

5.2.4 All terminals shall be shrouded with plastic covers to prevent accidental contact.

5.3 Bus Bar

5.3.1 The switchboard shall comprise of 3-phase bus bars which shall extend through all units of the switchgear line-up. The main bus bars shall have uniform cross-section throughout their length and shall be sized to carry continuously the rated current specified in the data sheet.

5.3.2 Bus bars shall be of high conductivity electrolytic aluminium or copper supported on insulators made of non-hygroscopic, non-inflammable material with tracking index equal to or more than that defined in Indian standards. Self supporting busbars can also be accepted provided the same is type tested design.

5.3.3 Bus bars shall be housed in a separate chamber and shall be accessible for inspection. Wire guards /cover shall be provided inside the enclosure to avoid accidental contact when the cover is removed.

5.3.4 Both bus bars and the supports shall be adequately sized and braced to withstand the specified short-circuit current for 1 second. Dynamic stresses shall be calculated on the basis of the specified peak short-circuit current. All bus bars supports shall be of non-carbonising material, resistant to acids and alkalies.

5.3.5 Bus bars shall be insulated by using heat-shrinkable sleeves or glass fibre tubes suitable for withstanding heat under worst operating condition as per type tested design. The sleeves/ tubes shall be rated to withstand the system line-to-line voltage for 1 minute. This shall be verified by a type test in which the line voltage will be applied between the sleeved/ tubed main bus bar and an aluminium foil wrapped closely around the insulation over a length of at least 500mm.

5.3.6 All bus bar joints and all tap-off connections from the main horizontal bus bars shall be provided with removable FRP/PU/PVC/EPDM/Nylon shrouds. The material of the shrouds shall be flame retardant (FR).

5.3.7 Bus bars shall be prominently marked with Red, Yellow and Blue colour rings/ stickers for easy phase identification at regular interval and at every power tap off point.

5.3.8 The thermal design of the bus bars shall be based on installation of the switchgear in poorly ventilated conditions. The cooling air volume shall take into account only the bus bar enclosure.

5.3.9 The hot spot temperature of busbars, including joints, at design ambient temperature shall not exceed 100^0C under normal operating conditions while for silver plated joints, the allowable maximum temperature shall be 115^0C in line with IS/IEC-62271-1.

5.3.10 Only zinc passivated high tensile strength high-quality Grade 8.8 or superior steel bolts, nuts and washers shall be used for all busbar joints and supports. Also, instruction label for torque tightening of busbar coupling shall be provided on switchboard.

5.3.11 The current rating as defined for switchboard and components in data sheet/job specification are for design ambient temperature at site conditions and for being inside the cubicle at fully loaded condition. The vendor shall suitably derate the nominal rating to suit the above condition.

5.4 HV Power Connections

5.4.1 The incoming power connection shall be through XLPE cables / busduct and outgoing power connection shall be through XLPE cables/ busduct, as indicated in the data sheet. Ample space for connection of these cables shall be provided at the rear of the switchboards. In order to avoid accidental contact in the cable compartment while carrying out inspection by opening the rear cover, a removable expanded metal barrier/ wire mesh shall be provided in the cable compartment. In order to facilitate infra-red electrical inspection through thermography window, metal barrier/ wire mesh may not be provided. Non-magnetic cable gland plates shall be provided for feeders wherever single core cables are used.

5.4.2 The switchboard shall be supplied complete with supports for clamping outgoing and incoming cables. The head-room available between cable gland plate and terminal lugs shall not be less than 600 mm for switchgear up to 11 kV, and 900 mm for 22 and 33 kV cables.

5.4.3 In case, the standard panel depth cannot accommodate the specified number of cables, a rear extension panel of full height shall be provided. An earth strip shall also be brought to this extension panel.

5.4.4 Unless otherwise specified, all power cables shall enter the switchboard from the bottom.

5.5 Auxiliary Wiring and Terminals

5.5.1 Inside the cubicles, the wiring for control, signalling, protection and instrument circuits shall be done with BIS approved, PVC/XLPE insulated, flame retardant low smoke (FRLS) type, copper conductor wire. The insulation grade shall be 660 V. FRLS shall be embossed on the inter-panel wires.

The wiring shall preferably be enclosed in FRLS plastic channels or neatly bunched together. Wiring between HV breakers or cable compartments to relay and metering compartments shall be routed through FRLS flexible conduits. FRLS shall also be embossed on the plastic channels/ flexible conduits. However, as an alternative to FRLS embossing, manufacturer compliance for FRLS plastic channels/ flexible conduits in form of certification can also be accepted.

5.5.2 A minimum of 10% spare terminals shall be provided on each terminal block. Conductors shall be terminated with adequately sized compression-type lugs for connection to equipment terminals and strips. Stranded conductors shall be soldered at the ends/ crimped with suitable lugs before connections are made to the terminals. Sufficient terminals shall be provided on each terminal block to ensure that not more than one outgoing wire is connected per terminal. Terminal strips shall preferably be separated from power circuits by metal barriers or enclosures. All spare contacts of auxiliary relays, timers, etc shall be wired up to the terminals.

5.5.3 Each wire shall be identified at both ends by correctly sized PVC ferrules. Shorting links shall be provided for all CT terminals.

5.5.4 XLPE/ PVC insulated copper conductor of cross section 1.5 mm^2 may normally be used provided the control fuse rating is 10A or less. For 16A control fuse circuit 2.5 mm^2 copper conductors shall be used. Each wire shall be terminated at a separate terminal. CT Circuit wiring shall be done with 2.5 mm^2 copper conductors. Shorting links / suitable shorting arrangement for shorting CT secondary shall be provided.

5.5.5 Unless otherwise specified, all control cables shall enter the switchboard from the bottom.

5.5.6 Supporting facilities shall be provided for clamping the control cables.

5.5.7 All inter-panel control wiring within each shipping section shall be by switchgear vendor. The inter-panel wiring shall be taken through PVC sleeves or suitable grommets. For inter-panel wiring between the shipping sections, wires in rolls of the required length, connected at one point, shall be supplied with the panel for connection at site.

5.6 Control and Indication

5.6.1 Breaker tripping, closing and spring charging devices shall be fed with DC control power supply. The rated DC voltage shall be as specified in the data sheet. The power supply for breaker opening, closing and indication devices shall be arranged as follows:

a. One DC feeder shall be provided for each bus section. The bus coupler panel may be fed from any of the two supplies.

b. One separate, single-phase power supply shall be provided for each bus section for feeding space heaters, etc. Supply voltage shall be 240 V AC, unless otherwise specified.

Provision to receive DC and AC control supply shall preferably be provided in bus-coupler panel / bus PT panel.

5.6.2 Breaker positions (CLOSE, OPEN, spring-charged, test position, service position) shall be indicated mechanically. Test & service position viewed through viewing window is also acceptable. Electrical indications, with colours as given below, shall also be provided:

Breaker 'CLOSED'	:	Red lamp
Breaker 'OPEN'	:	Green lamp
Breaker 'Auto-trip'	:	Amber lamp
Trip circuit healthy	:	White lamp
Spring charging	:	Blue lamp

5.6.3 A common DC control supply fail indication shall be provided for each bus section with a blue coloured lamp.

5.7 Earthing Connections

All cubicles shall be connected to an earth bus bar running throughout the length of the switchboard. The minimum earth bus bar size shall be 30 x 6 mm^2 copper up to short-circuit withstand capacity of 31.5 kA and 50 x 6 mm^2 copper for a short-circuit withstand capacity above 31.5 kA and upto 40 kA. All doors and movable parts shall be connected to the earth bus with flexible copper connections. Provision shall be made to connect the earthing bus bar to the plant earthing grid at two ends. All non current-carrying metallic parts of the equipment and components shall be earthed. The earth bus shall be brought back to the cable compartment, and earthing bolts shall be provided to ground cable armour. The mating surfaces of all bolted parts shall be zinc passivated to ensure continuity between them.

5.8 Space Heaters

The panels shall be provided with space heaters to prevent moisture condensation, and maintain cubicle temperature 5°C above the ambient. The space heaters shall be located at the bottom of the panel, and shall be controlled through a double pole MCB and a thermostat with an adjustable setting range of 30 to 70°C. The thermostat shall preferably be located in the metering or relay chamber. Space heaters shall be supplied from 240V AC auxiliary bus for space heater.

5.9 Panel Supporting Frame

The panels shall be suitable for installation on panel supporting frame, to be supplied by others. The panels shall be suitable for tack welding, directly to this frame.

5.10 Nameplates

5.10.1 The switchgear shall be provided with durable and clearly legible nameplate in accordance with Table-1 of IS/IEC 62271-200 requirements.

5.10.2 A nameplate with the switchboard designation shall be fixed at the top of the central panel. A separate nameplate giving details for each feeder compartment of all panels shall be provided. Danger plate (Red) shall be provided at the front and rear for each panel.

5.10.3 The nameplates for feeder compartments shall be in two parts. One part shall have necessary details pertaining to the compartment's number of vertical panel of the switchboards. The other parts shall be removable and shall contain all details regarding the feeder number for drives/equipment controlled by the particular module as per approved single line diagram.

5.10.4 Blank nameplates shall be provided for all spare and vacant modules.

5.10.5 Nameplate or polyester adhesive stickers shall be provided for each equipment mounted inside the switchboard. Special warning plates shall be provided on removable covers or doors giving access to cable terminals and bus bars.

5.10.6 Special warning labels shall be provided inside the switchboards also, wherever considered necessary. Identification tags shall be provided inside the panels matching with those shown on the circuit diagram.

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

5.11 Painting

5.11.1 All metal surfaces shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. Alternately, supplier's standard paint procedure as per their ISO standard is also acceptable. The under surface shall be made free from all imperfections before undertaking the finishing coat.

5.11.2 After preparation of the under surface, the switchboard shall be spray painted with two coats of epoxy based final paint or shall be powder coated.

5.11.3 Colour shade of final paint shall be as RAL 7032 unless specified otherwise.

5.11.4 The finished panels shall be dried in stoving ovens in dust free atmosphere. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint etc. Vendor shall supply final paint (1 litre per switchboard) in non-returnable container for final touch up at site.

5.11.5 All unpainted steel parts shall be Zinc passivated or suitably treated to prevent rust formation. If these parts are moving elements then they shall be greased. Aluzinc/ pre-galvanised sheet, wherever provided, need not be painted.

6.0 SWITCHBOARD COMPONENTS

6.1 Circuit Breakers

6.1.1 Vacuum or SF_6 circuit breakers shall be used in the switchboard. The exact type and rating of breakers shall be as indicated in the data sheet. Breaker transport trolleys required for cassette-mounted breakers shall be provided for each switchboard. Number of trolleys to be provided shall be as per data sheet.

6.1.2 Vacuum circuit breakers shall be designed to have low switching-over voltage levels and with a long switching life. The interrupter shall be leak-free. The VCB shall be type tested with the offered make & model of vacuum interrupter.

6.1.3 In case of SF_6 circuit breaker, each pole shall be provided with a pressure switch to monitor the gas pressure with local indication / lockout, and remote annunciation in the event of SF_6 gas leakage.

6.1.4 The breakers shall have at least 6 normally open (NO) and 6 normally closed (NC) spare auxiliary contacts for purchaser's use. If these are not available, auxiliary relays shall be used to multiply the auxiliary contacts of the breakers.

6.1.5 The breakers shall have a motor-operated, spring-charging mechanism. It shall also be possible to charge the springs manually. The closing spring shall get re-charged (for subsequent closing) soon after a closing shot and prior to breaker tripping. In case the limit switch fails to cut out the spring-charging motor with the springs fully charged, the motor shall be automatically de-coupled or else positive isolation (at both ends) of power supply to spring charging motor shall be ensured. The control circuit shall be suitable for local as well as remote control. Breakers shall be trip-free and shall have an anti-pumping device. The breaker operating duty shall be O-3min.-CO-3min.-CO, unless otherwise agreed.

6.1.6 Operating Mechanism

a) Electric power operating mechanism shall be motor wound spring charged stored energy type. However, manual-operating mechanism may be of the spring charging stored energy type or spring assisted type. For circuit breakers with electrical power operating mechanism, provision shall also be made for manual spring charging. Closing time of circuit breakers with manual operating mechanism shall be independent of the speed of the operating handle.

b) All stored energy operating mechanisms shall be equipped with the following features:

i) Failure of springs, vibrations or shocks shall not cause unintended operation of breaker or prevent intended tripping operation.

ii) Closing of circuit breakers shall be prevented unless the spring is fully charged.

c) All electrical power operating mechanisms shall be suitable for remote operation and shall be equipped with following features:

i) Provided with motors operable on AC or DC control supplies as specified.

ii) Provided with emergency manual charging facility. The motor shall be automatically, decoupled (mechanically) once the manual-charging handle is inserted.

iii) Closing operation of circuit breaker shall automatically initiate charging of the spring for the next closing operation without waiting for tripping of circuit breaker.

iv) Closing operation shall be completed once the closing impulse is given and the first device in the control scheme has responded even though the control switch / Push Button is released, provided no counter trip impulse is present.

6.1.7 Circuit breaker trip and closing coils, in case of electrically operated breakers, and trip coil in case of mechanically operated breakers and circuit breaker indication shall be suitable for satisfactory operation on a control supply system indicated in data sheets/job specification. Additional second shunt trip coil (operating on different control voltage supply) shall also be provided if specified in job specifications/datasheet/Tender.

6.1.8 All circuit breakers shall be provided with mechanically operated emergency trip device. This device shall be available on the front of the panel. Mechanically operated 'closing' device shall be provided for all breakers. However mechanical closing shall be inhibited for all circuit breakers in service position.

6.1.9 The breakers shall be provided with anti pumping & trip free feature. Each breaker shall be also provided with an operation counter.

6.1.10 For all HV VFD outgoing feeders, breaker shall be provided with one no. shunt trip coil and with undervoltage release. As an alternative, two shunt trip coils can be also provided. One shunt trip coil shall be suitable for switchgear DC control supply while second shunt trip coil shall be suitable for external AC control supply. The control supply voltage level shall be as specified in data sheet.

6.1.11 Metal Oxide surge suppressors shall be provided on all outgoing vacuum circuit breakers to limit the over voltage to a maximum of 2.2 p.u. rated peak line to earth voltage. Sizing calculations for surge suppressor shall be provided post order.

6.1.12 Line PT shall be mounted in a separate drawout carriage having separate arrangement for rack-in/rack-out which will be independent of breaker. For cassette type breaker, line PT can be housed in the same vertical panel housing breaker. In case of truck mounted breaker, line PT

shall be provided in a separate panel. Further, bus PT and line PT shall not be mounted in the same vertical panel.

6.1.13 The complete breaker assembly should have inter-changeability with breakers of identical ratings.

6.1.14 The switchgear shall be supplied in single tier arrangement i.e. one circuit breaker in one vertical panel. For switchgears specified with double tier circuit breaker arrangement, the outgoing feeder breakers shall have double tier arrangement and incomer breakers with Line/bus PT shall be housed in one vertical panel. In double tier arrangement, sheet steel partitions shall be provided for each compartment. Compartmentalization shall be such that maintenance of one breaker is possible without disturbing the adjacent breaker compartment. Suitable trolley(s) shall be supplied for drawing out the breakers in upper tier. The maximum height of the operating handle/switches/reset knobs/pushbuttons shall not exceed 1900 mm and minimum height shall not be below 300 mm.

6.1.15 An integral earthing system, or a separate earthing carriage/truck, shall be provided. In case of a separate earthing carriage, the necessary trolleys for bus-side and cable-side earthing shall be supplied. After withdrawing the circuit breaker, this can be inserted to facilitate earthing of cables and bus bars. Earthing truck shall be complete with the PT and voltmeter giving audio-visual indication and solenoid interlock to prevent closing of bus side earthing truck on live busbars. In case voltmeter cannot be provided suitable voltage detecting system shall be provided. Suitable interlock shall also be provided for Earthing switch. Earthing truck/ earthing switch operation shall be only with door closed.

Integral earthing switch shall be suitable for short time withstand current and peak withstand current rating equal to the corresponding breaker withstand rating.

6.1.16 Number and type of earthing trucks shall be as specified elsewhere.

6.1.17 Circuit breaker electrical endurance shall be class E2 and mechanical endurance shall be class M2 as per IS/IEC-62271-100. Probability of restrike during capacitive current breaking shall be of class C1 as per IS/IEC-62271-100 except for capacitor feeders which shall be of class C2 as per IS/IEC-62271-100.

6.2 Fuse Contactor Units

For outgoing feeders requiring fuse contactor (as specified in job specification/ datasheet), following shall be complied with:

Fuse contactors shall be fully drawable type.

Contactors shall comply with IS/IEC-60470 and shall be suitable for intermittent duty class 0.1 as well as for uninterrupted duties.
The minimum short circuit breaking capacity of the contactor shall be at least 6 kA at rated voltage.

Anti-pumping device (APD) shall be included to prevent "pumping actions" of mechanisms.

Overvoltage surge diverters shall be installed if required to keep high over-voltages during operating conditions within acceptable values.

Contactors for motor starters and capacitor Bank feeders shall be of the latched type. The tripping supply shall be obtained from the DC tripping and closing supply. Motor contactor panels shall be provided with restarting facilities as specified in job specification/ datasheet.

Fuse links shall be in accordance with IEC 60282-1 and shall have high rupturing capacity. They shall be short circuit current limiting type. Fuses shall be provided with striker pin arrangement tripping the contactor.

Fuses for motor starters shall have a time-current characteristic suitable for the method of starting.

Correct discrimination shall be established between fuse characteristics and contactor breaking capacities. This shall ensure that overload and fault currents are safely interrupted by the appropriate devices avoiding any risk of welding or other damage to the contactor.

6.3 Instrument Transformers

Current and voltage transformers shall be cast-resin insulated. The primary and secondary terminals shall be marked indelibly and easily approachable for termination and testing etc.

6.3.1 Current transformer

i) Current transformers shall conform to IS: 2705 Part-1 and IS:16227 Part-1 & 2. The short-time current rating shall be equal to that of the switchboard. They shall be mounted on the stationary part of the switchboard. The CT ratings shall be as shown in the data sheet. Protective CTs shall have an accuracy class of 5P and an accuracy limit factor greater than 10. CTs for instruments shall have an accuracy class of 1.0 and an accuracy limit factor less than 5.0. For numerical relays having protection and metering functions, dual rated CT shall be provided suitable for protection class and metering class. One leg of the CTs shall be earthed. Separate CTs shall be provided for each of Differential protections such as transformer, line, bus, motor, Restricted Earth fault protection, etc. However, common CT having separate cores for any differential and Restricted Earth fault protection is acceptable.

ii) All CTs shall be star connected. Interposing CT (ICT) shall be provided (if required) for differential protection of transformers having star-delta connection.

iii) Proper access to each set of CTs shall be provided for repair / maintenance.

iv) Core Balance Current Transformer shall be provided in motor feeders for sensitive earth fault protection, if specified in job specifications/datasheet/Tender.

6.3.2 Potential transformer

i) The potential transformers shall conform to IS: 16227-1 & 16227-3. The potential transformers shall be of drawout-type, and shall be provided with 4 pole miniature circuit breakers with auxiliary contacts on the secondary side.

ii) The drawout mechanism shall disconnect the PT from the busbars. The primary connection shall be disconnected before the PT becomes accessible. Neutral point of the star connected PTs both on the primary and secondary sides shall be earthed.

iii) The PTs shall have an over-voltage factor of 1.2 continuous and 1.9 for 30 seconds, and an accuracy class of 1.0 from 10% to 120% of normal voltage. PT selected shall be compatible with system grounding. Also precaution shall be provided to mitigate the problem of ferroresonance.

iv) The primary rated voltage shall be equal to the rated voltage V of the system, or $V/\sqrt{3}$, if the PT is connected between phase and neutral.

v) If not otherwise specified, the secondary voltage shall be 110 V, or $110/\sqrt{3}$ V. The burden and class of accuracy shall be as specified in data sheets. For directional relays, either a 3-phase 5-limb PT, or 3 single-phase PTs with secondary windings connected in open delta shall be provided.

6.4 Measuring Instruments

All analogue instruments shall be of square pattern, 96 x 96 mm, flush-mounted type. Measuring instruments shall be provided, as specified in the data sheet. All required auxiliary equipment such as shunts, transducers, CTs, PTs, etc, shall be included in the scope of the switchboard supplier. The accuracy class for all instruments shall be 1.0 as per IS: 1248.

Digital instruments shall also be acceptable, provided specific approval of EIL/Owner for make and model is obtained.

6.4.1 **Ammeters and voltmeters**

Analogue meters shall be of moving-iron type. The range shall be as indicated on the drawings. Ammeters for motor feeders shall have a non-linear compressed scale above rated current to indicate motor starting current.

6.4.2 **kW / kWh meters**

The kW / kWh meters shall be suitable to measure unbalanced loads on a 3-phase, 3-wire system. The kW meters shall operate on a PT secondary voltage of 110 V.

6.4.3 **Frequency meters**

These shall be of direct-reading or digital type and shall operate on a PT secondary voltage of 110V. The standard range shall be 45-50-55 Hz.

6.4.4 **Power factor meters**

Power factor meters shall operate on a PT secondary voltage of 110 V. The CT secondary current shall be as shown on the relevant drawings. The standard range shall be 0.5 lead-1.0-0.5 lag.

6.4.5 Digital meters shall be provided, if specified in job specifications/datasheet/Tender. All digital meters shall be highly reliable, accurate & compact. Digital meter data shall be retained & retrievable even in case of power failure. Field programming from front of the meter shall be possible and shall have RS232/485 port in case specified in the job specification/data sheet.

6.5 Relays

6.5.1 Type of relay i.e. electromechanical, static or numerical shall be as defined in data sheet / job specification.

6.5.2 All electromechanical protective relays shall be back-connected, of drawout type, suitable for flush mounting, and fitted with dust-tight covers. Alternatively, "plug-in" type relays will also be acceptable. Auxiliary relays are acceptable in fixed execution.

6.5.3 The protective relay cases shall have a provision for insertion of a test plug at the front for testing and calibration using an external power supply without disconnecting the permanent wiring. The insertions of the test plug shall automatically short circuit the CTs and permit extension of external power supply to the relay.

6.5.4 All protective relays shall have hand reset facility and clear operating indication, e.g. flags for electro-mechanical type relays or light emitting diodes for static/numerical type relays. It shall be possible to reset the flag without opening the relay case.

6.5.5 All tripping relays (electrical fault trip) shall be of lockout type with hand-reset contacts, and shall be suitable to operate on the specified voltage. These relays shall have self coil cut off contacts, and shall be provided with hand-reset operation indicators. However, for process trip, the lock out relay shall be self reset type Tripping relays will be acceptable in non-drawout cases.

6.5.6 The tripping relay shall be suitable for satisfactory operation from 50% to 110% of the specified control supply voltage.

6.5.7 Motor protection relay provided shall have terminals for CBCT input and feature for detecting sensitive earth fault, if CBCT is provided as specified in datasheet.

6.5.8 Fast Bus Transfer (FBT) relay shall be provided, if specified in job specifications/datasheet/Tender.

6.6 Auxiliary Equipment

6.6.1 Auxiliary relays and contactors:

Auxiliary relays and contactors shall generally be used for inter-locking and multiplying contacts. Auxiliary contacts shall be capable of carrying the maximum anticipated current.

6.6.2 Control Switches:

i) All control switches shall be rotary type, having a cam-operated contact mechanism otherwise stated. Circuit breaker control switches shall be 3-position CNT, spring return to neutral from both Close and Trip positions. They shall have pistol-grip handles and shall be lockable.

ii) Ammeter selector switches shall have a make-before-break feature on its contacts. The selector switch shall generally have four positions, three positions for reading 3-phase currents and the fourth position for OFF. The voltmeter selector switch shall also have four positions, three positions shall be used to measure phase-to-phase voltages and the fourth position shall be for OFF.

6.6.3 Timers:

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

6.6.4 Indicating Lamps:

Clustered LED type indicating light with minimum 8mm diameter size shall be provided for indications. The LED shall have a low glow voltage protection and shall not glow on voltage leakage.

7.0 INSPECTION, TESTING AND ACCEPTANCE

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

7.2 For testing requirements refer Inspection & Test Plan No. 6-81-1001.

8.0 PACKING AND DESPATCH

The switchboard shall be divided into several shipping sections for protection and ease of handling during transportation. All outgoing feeders shall be packed as separate shipping sections. The equipment shall be properly packed for selected mode of transportation i.e. ship/rail or trailer. The panels shall be wrapped in polyethylene sheets before being placed in wooden crates/cases to prevent damage to the finish. Crates/cases shall have skid bottoms for handling. Special notations such as 'Fragile', 'This side up', 'Weight', 'Owner's particulars', 'PO number.' etc., shall be clearly marked on the package together with other details as per purchase order.

The equipment may be stored outdoors for long periods before installation. The packing should also be suitable for outdoor storage in areas with heavy rains and high ambient temperature unless otherwise agreed.

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SPECIFICATION FOR FLAMEPROOF CONTROL STATIONS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	29.9.20	REVISED AND ISSUED AS STANDARD SPECIFICATION	NNB/ RKS	ANPS	SA	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	24.08.07	REVISED AND ISSUED AS STANDARD SPECIFICATION	ANPS	UAP	JMS	VC
2	30.01.02	REVISED AND ISSUED AS STANDARD SPECIFICATION	UAP	AAN	VPS	GRR

Abbreviations:

AC	Alternating Current
BIS	Bureau of Indian Standards
CEA	Central Electricity Authority
CT	Current Transformer
DC	Direct Current
FRLS	Flame Retardant Low Smoke
FRP	Fibre Reinforced Plastic
GI	Galvanised Iron
IEC	International Electro-technical Commission
IP	Ingress Protection
IS	Indian Standards
LED	Light Emitting Diodes
LV	Low Voltage
MR	Material Requisition
NABL	National Accreditation Board for Testing and Calibration Laboratories
PB	Push Button
PESO	Petroleum and Explosives Safety Organisation
PVC	Poly Vinyl Chloride
SMD	Surface Mounted Device
SWG	Standard Wire Gauge
XLPE	Cross Linked Poly Ethylene

Electrical Standards Committee

Convenor: Ms. Sumita Anand

Members:
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Mr. Ayush Mathur (Projects)
Mr. Rajesh Sinha (Inspection)

CONTENTS

1.0 SCOPE

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

2.0 CODES AND STANDARDS

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

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

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

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

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

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

3.0 GENERAL REQUIREMENTS

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

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

4.0 SITE CONDITIONS

The equipment shall be suitable for installation and satisfactory operation in classified hazardous locations in tropical, humid and corrosive atmosphere as prevalent in refineries, petrochemical and fertilizer plants. Unless otherwise specified, a design ambient temperature of 40° C and an altitude not exceeding 1000 m above mean sea level shall be considered.

5.0 CERTIFICATION

The equipment shall have test certificates issued by 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 or IEC 60079 and as required by statutory authorities. All indigenous flameproof equipment shall have valid BIS license.

6.0 TECHNICAL REQUIREMENTS

6.1 Construction

6.1.1 The enclosures of the control stations shall be made of cast light metal alloy, unless otherwise specified. The enclosures of the control stations intended for use in units handling sulphuric acid/ other corrosive materials shall be made of stainless steel grade SS-316L, if specified in MR/ tender.

6.1.2 The control stations shall be suitable for use in outdoor open locations and shall have minimum IP-55 degree of protection. They shall preferably be provided with integral canopy. However, where the enclosure has been certified without integral canopy, a separate canopy can be accepted. The separate canopy shall be made of at least 1.6 mm (16 gauge) galvanised sheet steel/ FRP/ stainless steel minimum SS-304 (as specified in purchase specifications). The canopy shall be suitable for providing protection against rain from top, back and two sides.

6.1.3 The control station enclosure shall be provided with gaskets for IP, if required by equipment certification. Gaskets, wherever provided, shall be made of non-inflammable and self-extinguishing material.

6.1.4 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:

- Flame proof (Gas group IIA/ IIB) : Dark admiralty grey shade 632 of IS-5/ RAL 7031
- Flame proof (Gas group IIC) : Light yellow shade 355 of IS-5/ RAL 1012

All unpainted parts shall be suitably treated to prevent rust formation/ corrosion. If these parts are moving then these shall be greased. Grease, which does not solidify, shall be applied to flamepath. However, in case of Stainless Steel control stations, finish shall be Electropolish/ Buffed/ equivalent finish.

6.1.5 Equipment shall be marked as per IS/IEC 60079.

6.1.6 All accessories like nuts, bolts, washers etc. and operating shaft of push buttons, switches etc. shall be made of stainless steel SS-304. Alternatively, Nickel-plated brass material may be used for the operating shafts of push buttons, switches etc.

6.1.7 The control stations shall be provided with two earthing studs (minimum M10 bolt, nut with spring and plain washer) with lugs on the external surface of the enclosures suitable for termination of 8 SWG GI wire. No screw type fixing arrangement shall be allowed.

6.1.8 The control station shall be provided with two cable entries at bottom, and one entry to be blocked with flameproof nickel plated brass sealing plug, unless otherwise specified. Required number of flameproof double compression nickel plated brass cable glands shall be provided. The cable termination chamber of the control station shall be large enough to provide a minimum space of 100mm between top of the cable gland and bottom of the terminal block.

6.1.9 The control stations shall have external fixing lugs for mounting on wall or column. The holes provided on these lugs shall be of oblong type.

6.1.10 A tag plate indicating Tag Number shall be provided on each control station. A nameplate shall be provided to indicate the Name of Manufacturer, test certificate number, serial number, BIS license number, applicable gas group etc. as per IS/IEC 60079 and any additional marking required by statutory authority like approval no. etc. The nameplates shall be engraved type or laser-marked and permanently fixed on the equipment. In case the standard details given above are embossed on the enclosures, the same need not be repeated on the name plate. All

tag plates shall be engraved, 3 ply laminate fixed with screws and name plate shall be Al anodized or SS-304 engraved or laser-marked and fixed with rivets.

6.1.11 All flameproof control stations shall be suitable for 240V AC as well as 110V/ 220V DC control supply.

6.2 Component Specification

6.2.1 Push buttons for START/ OPEN and STOP/ CLOSE shall be of GREEN and RED colour respectively. The STOP push button shall be mushroom type with stay put feature and lockable in pressed position. Refer Sketch 1 for wiring and other details for various types of local control stations.

6.2.2 All selector switches shall have minimum two poles for each position. Each position of switch shall be indelibly marked on the control station. Exact configuration of selector switch (e.g. LOCAL-OFF-REMOTE) shall be as per datasheet/ MR requirement.

6.2.3 All ammeters shall be of moving iron type having an accuracy class of 1.5 and suitable for 1 Ampere CT secondary. Minimum size of ammeter shall be either 72mm x 72 mm or 65 mm diameter. 80% of the scale length shall cover 100% of the CT primary current uniformly and the balance 20% of the scale shall cover 100-800% of the CT primary. A red mark corresponding to the full load current of the motor shall be provided on the ammeter dial. The ammeter front glass shall be toughened.

6.2.4 Indicating lamp(s) wherever provided shall be clustered LED type or SMD chip type LED with colour lens of minimum 25mm diameter.

6.3 Terminals & Wiring

6.3.1 The control stations shall be provided with sufficient number of terminals. More than 2 wires per terminal shall not be permitted. If required, additional terminal with shorting link may be used. Each terminal for external cable connection shall be suitable for termination of 2.5 mm^2 (unless otherwise specified) stranded copper conductor. Tinned copper lugs shall be provided for cable termination wherever applicable.

6.3.2 All internal wiring shall employ 1.5 mm^2, 660V/ 1100V grade, FRLS type, XLPE/ PVC insulated copper conductor wires. All termination shall be with suitable lugs.

7.0 INSPECTION, TESTING AND ACCEPTANCE

7.1 During fabrication, the equipment shall be subjected to inspection by EIL/ Owner or by an agency authorized by the Owner, 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 & expense.

7.2 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.

7.3 Test certificates of bought out components shall be submitted to the inspection agency, as per Inspection and Test Plan no. 6-81-1006.

7.4 All equipments shall be subjected to various routine / acceptance tests as per Inspection and Test Plan no. 6-81-1006.

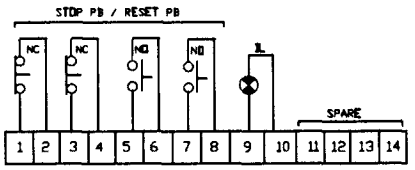
8.0 PACKING AND DESPATCH

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

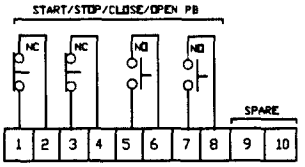
The equipment may be stored outdoors for long periods before installation. The packing should be suitable for outdoor storage in areas with heavy rains and high ambient temperature unless otherwise agreed. A set of instruction manuals for installation, testing and commissioning, a set of operation &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

SKETCH–1

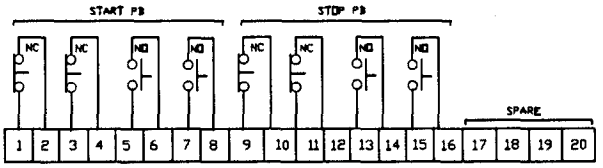
WIRING DETAILS OF LOCAL CONTROL STATIONS



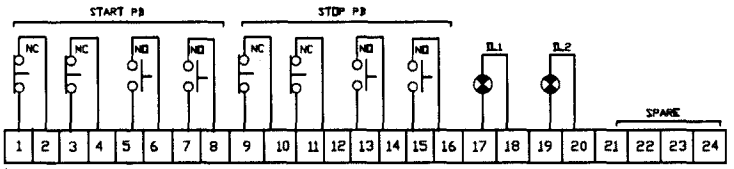
TYPE–A1 (STOP P.B. WITH LAMP)
OR
(RESET P.B. WITH LAMP)
(CABLE SIZE : 4Px2.5 Sq.mm)



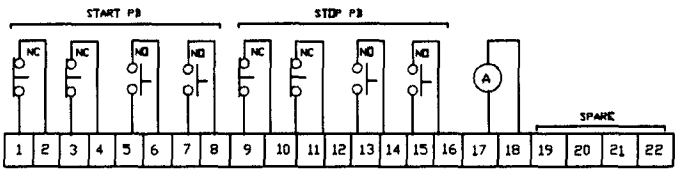
TYPE–A2
(START PB) OR (STOP PB) OR (CLOSE PB) OR (OPEN PB)
(CABLE SIZE : 2Px2.5 Sq.mm)



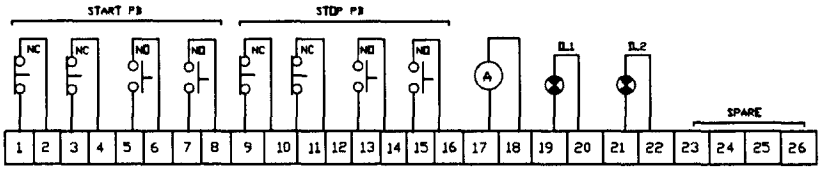
TYPE–B1 (WITH START & STOP PBs) OR (WITH CLOSE & OPEN PBs)
(CABLE SIZE : 4Px2.5 Sq.mm)



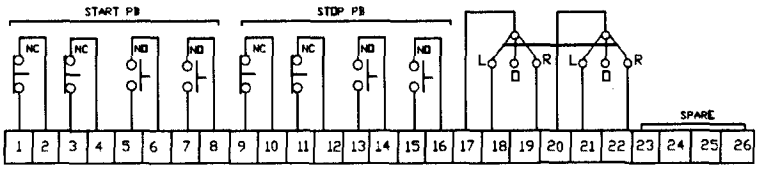
TYPE–B2 (WITH START & STOP PBs & INDICATION LAMPS)
OR
(WITH CLOSE & OPEN PBs & INDICATION LAMPS)
(CABLE SIZE : 6Px2.5 Sq.mm)



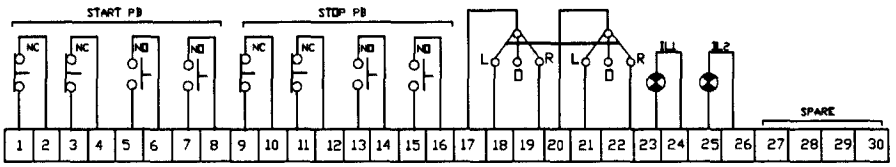
TYPE–C1 (WITH START & STOP PBs & AMMETER)
(CABLE SIZE : 4Px2.5 Sq.mm)



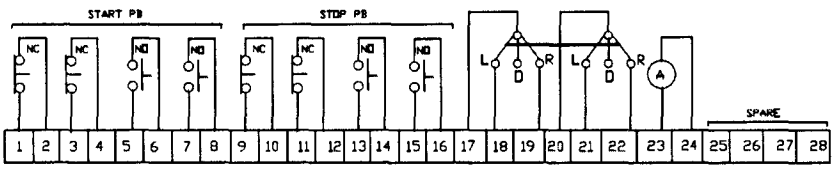
TYPE–C2 (WITH START & STOP PBs, AMMETER & INDICATION LAMPS)
(CABLE SIZE : 6Px2.5 Sq.mm)



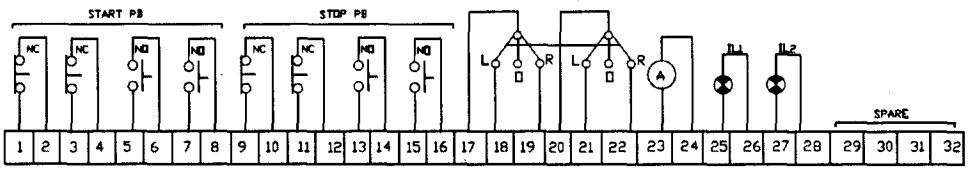
TYPE–D1 (WITH START & STOP PBs & L–O–R SELECTOR SWITCH)
(CABLE SIZE : 6Px2.5 Sq.mm) (REFER NOTE–11)



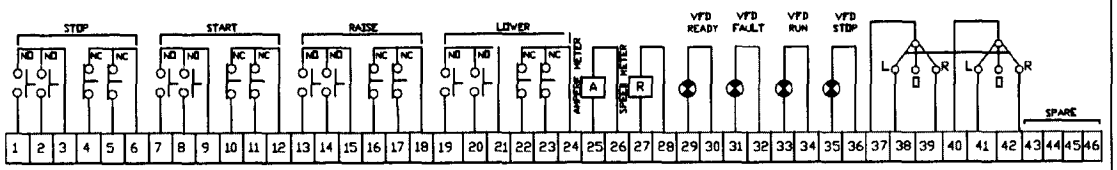
TYPE–D2 (WITH START & STOP PBs, L–O–R SELECTOR SWITCH & INDICATION LAMPS)
(CABLE SIZE : 12Px2.5 Sq.mm) (REFER NOTE–11)



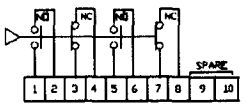
TYPE–E1 (WITH START & STOP PBs, AMMETER & L–O–R SELECTOR SWITCH)
(CABLE SIZE : 6Px2.5 Sq.mm) (REFER NOTE–11)



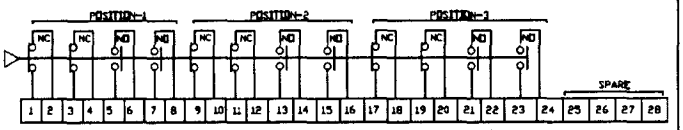
TYPE–E2 (WITH START & STOP PBs, AMMETER, L–O–R SELECTOR SWITCH & INDICATION LAMPS)
(CABLE SIZE : 12Px2.5 Sq.mm) (REFER NOTE–11)



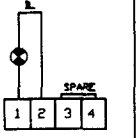
TYPE–F (WITH START & STOP PBs, RAISE & LOWER PBs, L–O–R SWITCH, AMPERE METER, SPEED METER & INDICATING LAMPS) (REFER NOTE–5,6,7)
(CABLE SIZE : 12Px2.5 Sq.mm)



TYPE–11
SEL SWITCH (2POSITION)



TYPE–12 SEL SWITCH (3POSITION)



TYPE–13
(LAMP STATION)

GENERAL NOTES:

1. SHORTING LINKS SHALL BE PROVIDED BY VENDOR. REQUIREMENT SHALL BE INFORMED DURING VENDOR DRAWING REVIEW.
2. WIRING DETAILS SHALL BE READ IN CONJUNCTION WITH MR/TENDER.
3. CABLE SIZES AS INDICATED ABOVE ARE TENTATIVE AND MINIMUM. EXACT CABLE SIZES SHALL BE INFORMED DURING VENDOR DRAWING REVIEW. VENDOR TO PROVIDE REQUIRED SIZE OF CABLE TERMINATION CHAMBER WITH SUITABLE TERMINALS, CABLE ENTRIES, CABLE GLANDS AND LUGS. CROSS SECTIONAL AREA SHALL BE 2.5 SQ.MM, UNLESS OTHERWISE SPECIFIED.
4. AMMETER WHEREVER PROVIDED, SHALL BE ANALOGUE OR 4–20mA TYPE AS DEFINED IN MR/TENDER.
5. FOR VFD LCS, LAMP SUPPLY VOLTAGE SHALL BE SAME AS VFD CONTROL SUPPLY VOLTAGE.
6. FOR VFD LCS, IF EXTERNAL SUPPLY IS REQUIRED FOR METERS, THEN SAME SHALL BE AS VFD CONTROL SUPPLY VOLTAGE.
7. METERS IN VFD LCS SHALL BE SUITABLE FOR 4–20mA TRANSDUCER OUTPUTS AND SHALL BE CALIBRATED FOR THE ACTUAL MOTOR CURRENT. FOR DRIVERS WITH BYPASS FACILITY, METERS SHALL BE CAPABLE OF READING BYPASS MODE FULL LOAD AND STARTING CURRENTS AS WELL AS VFD MODE DRIVE CURRENT.
8. NUMBER AND COLOUR OF INDICATING LAMPS SHALL BE AS PER THE JOB SPECIFATION/TENDER.
9. LCS TYPE "I" ARE TYPICALLY FOR INSTRUMENTATION USE.
10. ALL PUSH BUTTON AND CONTROL SWITCH CONTACTS SHALL BE RATED FOR MINIMUM 5A AT 240V(AC–15) AND 1A AT 110V(DC–13) DUTY. CONTACT RATINGS FOR LCS FOR INSTRUMENTATION USE SHALL BE AS PER INSTRUMENTATION REQUIREMENT.
11. SECOND CONTACT OF L–O–R SWITCH REQUIRED ONLY WHERE DCS INTERFACE IS REQUIRED BY INSTRUMENTATION.
12. THE EXACT DESCRIPTION OF PB'S WHETHER START/STOP OR OPEN/CLOSE SHALL BE INFORMED DURING VENDOR DRAWING REVIEW.
13. ALL L–O–R SELECTOR SWITCHES SHALL BE LOCKABLE IN OFF POSITION.

अग्निरोधक विद्युत वितरण बोर्ड के लिए विनिर्देश

SPECIFICATION FOR FLAMEPROOF POWER DISTRIBUTION BOARDS

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

Abbreviations:

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

Electrical Standards Committee

Convenor: Mr. Manjit Kumar 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)
Ms. Rajesh Sinha (Inspection)

CONTENTS

1.0 SCOPE

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

2.0 CODES AND STANDARDS

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

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

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

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

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

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

3.0 GENERAL REQUIREMENTS

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

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

4.0 SITE CONDITIONS

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

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

5.0 POWER SUPPLY

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

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

6.0 CERTIFICATION

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

7.0 TECHNICAL REQUIREMENTS

7.1 Construction

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

7.2 Equipment/ Component Specification

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

7.2.18 Push button colours shall be as follows:

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

The 'Stop' push button shall be stayput type.

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

8.0 INSPECTION, TESTING AND ACCEPTANCE

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

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

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

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

9.0 PACKING AND DESPATCH

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

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

अग्निरोधक लाइटिंग और पावर पैनलों के लिए विनिर्देश

SPECIFICATION FOR FLAMEPROOF LIGHTING AND POWER PANELS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	22.03.21	REVISED AND ISSUED AS STANDARD SPECIFICATION	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	24.08.07	REVISED AND ISSUED AS STANDARD SPECIFICATION	ANPS	UAP	JMS	VC
2	30.01.02	REVISED AND ISSUED AS STANDARD SPECIFICATION	UAP	AAN	VPS	GRR

Abbreviations:

AC	Alternating Current
BIS	Bureau of Indian Standards
CEA	Central Electricity Authority
DGMS	Directorate General of Mines Safety
EIL	Engineers India Limited
ELCB	Earth Leakage Circuit Breaker
FRLS	Flame Retardant Low Smoke
GI	Galvanized Iron
IEC	International Electro-technical Commission
IP	Ingress Protection
IS	Indian Standards
LV	Low Voltage
MCB	Miniature Circuit Breaker
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
SPN	Single Phase and Neutral
SS	Stainless Steel
TPN	Three Phases and Neutral
XLPE	Cross Linked Poly Ethylene

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Mr. Ayush Mathur (Projects)
Mr. Rajesh Sinha (Inspection)

CONTENTS

1.0 SCOPE

This specification covers the requirements of design, manufacture, testing, packing and supply of flameproof Lighting and Power panels/ accessories suitable for installation in locations handling flammable liquids and gases / 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-12640	:	Residual current operated circuit breakers
IS / IEC 60079-0	:	Electrical apparatus for explosive gas atmospheres (General requirements)
IS / IEC 60079-1	:	Electrical apparatus for explosive gas atmospheres (Equipment Protection by Flameproof Enclosures "d")
IS / IEC 60529	:	Degree of protection provided by enclosures (IP Code)
IS / IEC 60898	:	Electrical Accessories - circuit breakers for over protection for household and similar installations
IS / IEC 60947	:	LV switchgear and control gear.

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

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

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

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

3.0 GENERAL REQUIREMENTS

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

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

4.0 SITE CONDITIONS

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

5.0 POWER SUPPLY

5.1 Lighting and power panels shall be suitable for 415V, 50Hz, TPN incoming power supply and outgoing circuits for 240V, SPN power supply.

5.2 For projects falling under the jurisdiction of DGMS, the following additional requirements shall apply:

5.2.1 The phase-to-phase voltage shall not exceed 125V (where electric lighting is used in underground mine)/ 250V (where electric lighting is used in open cast mine or surface of a mine), with the neutral or the mid-point of the lighting system connected with earth.

5.2.2 The panels shall have three phase, 3-wire system, without neutral.

5.2.3 Outgoing circuits shall be controlled by 2-pole MCBs. Earth leakage protection shall be provided for all outgoing circuits, which shall isolate both poles.

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 and power panels shall be made of cast light metal alloy, unless otherwise specified. The enclosures of the lighting and power panels intended for use in units handling sulphuric acid/ other corrosive materials shall be made of stainless steel grade SS-316L, if specified in MR/ Tender.

7.1.2 The panels shall be suitable for use in outdoor open locations and shall have minimum IP-55 degree of protection. They shall preferably be provided with integral canopy. However, where the enclosure has been certified without integral canopy, a separate canopy can be accepted. The separate canopy shall be made of at least 1.6 mm (16 gauge) galvanized sheet steel/ stainless steel minimum SS-304 (as specified in MR/ Tender). The canopy shall be suitable for providing protection against rain from top, back and two sides.

7.1.3 The lighting and power panels 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 panels shall be painted with two coats of epoxy based final paint or epoxy powder coated with minimum coating thickness of 80 microns, with colour shade as below:

- Flame proof Exd (Gas group IIA/IIB): Dark admiralty grey shade 632 of IS-5/ RAL 7031
- Flame proof Exd (Gas group IIC): Light yellow shade 355 of IS-5/ RAL 1012.

All unpainted steel 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. However, in case of stainless steel lighting and power panels, finish shall be Electropolish/ Buffed/ equivalent finish.

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 the non-current carrying metallic parts of the panel shall be inherently bonded together. Each lighting and power panel shall be provided with two earthing studs (bolt, nut with spring and plain washer) with lugs on the exterior of the panel enclosure suitable for termination of 10 mm dia GI wire rope. No screw type fixing arrangement shall be allowed.

7.1.8 Each outgoing feeder shall be provided with distinct terminals for phase, neutral and earth. The terminal block enclosures shall be adequately sized to properly terminate the cables by taking into account the required bending radii of cable cores and shall have the following minimum gland to terminal distances:

Conductor Size	Up to 2.5 mm^2	Above 2.5 mm^2 & Up to 10 mm^2	Above 10 mm^2 & Up to 35 mm^2	Above 35 mm^2 & Up to 95 mm^2
Gland to terminal distance	40 mm	60 mm	100 mm	150 mm

7.1.9 The panels shall be provided with suitably sized cable entries at the bottom/ sides, for incoming and outgoing cables. Panels shall be complete with double compression type nickel plated brass flameproof cable glands. Flameproof nickel plated brass sealing plugs shall be supplied, for plugging the unused cable entries. The quantity of sealing plugs shall be equal to 20% of the total number of outgoing cable entries.

7.1.10 The panels shall have external fixing lugs for mounting on wall or column. The holes provided on these lugs shall be of oblong type.

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

7.2 Component Specification

7.2.1 Bus bars in the lighting and power panels shall be made of high conductivity copper, and shall be supported by non-hygroscopic insulators. Bus bars shall be colour coded for identification of phases and neutral.

7.2.2 The incomer shall have one no. 4 pole MCB isolator (without overload and short-circuit release) and one no. 4 pole ELCB (if specified in the MR/ Tender). ELCBs shall have a maximum sensitivity of 30mA.

7.2.3 The outgoing feeders shall be provided with double pole MCBs having overload and short-circuit releases. Further, separate 2 pole ELCBs with maximum sensitivity of 30mA shall be provided for outgoing feeders if specified in MR/ Tender.

7.2.4 All MCBs (except isolators) and ELCBs shall be with 10kA interrupting capacity.

7.2.5 The ELCB shall be hand reset type. Door mounted reset push button shall be provided for ELCB.

7.2.6 The operating knobs (ON/ OFF/ RESET) shall be provided with a suitable rack and pinion arrangement or cam type operating mechanism for operating them smoothly from outside.

7.3 Terminals & Wiring

7.3.1 The panels shall be provided with sufficient number of terminals. More than 2 wires per terminal shall not be permitted. If required, additional terminal with shorting link may be

used. Tinned Copper lugs shall be provided for cable termination. Incoming and outgoing terminals shall be suitably segregated.

7.3.2 All internal wiring in lighting and power panels shall employ adequately sized, 660V/ 1100V grade, FRLS type, XLPE/ PVC insulated, Copper conductor wires, colour coded for phase, neutral and earth, with minimum conductor sizes as below:

Incomer : 16 mm²

Outgoing : 2.5 mm²

All terminations 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. 6-81-1008.

8.4 All equipments shall be subjected to various routine/ acceptance tests as per Inspection and Test plan no. 6-81-1008.

9.0 PACKING AND DESPATCH

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

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

पैकेज उपस्कर के निम्न वोल्टेज वाले फ़िक्स किस्म के स्विच बोर्ड के लिए विनिर्देश

SPECIFICATION
FOR
LV SWITCHBOARD FIXED TYPE
FOR PACKAGE EQUIPMENT

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	20.03.2025	REVISED AND REISSUED AS STANDARD SPECIFICATION	CA	SA	HK	MN
5	10.02.2021	REVISED AND REISSUED AS STANDARD SPECIFICATION	CA/RKS	SA	PG	SM
4	01.04.2016	REVISED AND REISSUED AS STANDARD SPECIFICATION	CA/RKS	SA	BRB	RN
3	03.02.2011	REVISED AND REISSUED AS STANDARD SPECIFICATION	DA	SG	UAP	DM
2	07.03.2005	REVISED AND REISSUED AS STANDARD SPECIFICATION	SSM	RR	AAN	SKG
1	19.11.2001	REVISED AND ISSUED AS STANDARD SPECIFICATION	SSM	AAN	VPS	GRR

Abbreviations:

A	Ampere
AC	Alternating Current
BIS	Bureau of Indian Standards
CEA	Central Electricity Authority
CPRI	Central Power Research Institute
CRCA	Cold Rolled Cold Annealed
CT	Current Transformer
CBCT	Core Balance Current Transformer
DC	Direct Current
DMPR	Digital Motor Protection Relay
DOL	Direct On Line
EIL	Engineers India Limited
ELR	Earth Leakage Relay
EPDM	Ethylene Propylene Diene Monomer
FRLS	Flame Retardant Low Smoke
HDPE	High-Density Polyethylene
HRC	High Rupture Capacity
Ics	Rated service short circuit current
Icu	Rated ultimate short circuit current
IEC	International Electrotechnical Commission
IP	Ingress Protection
IS	Indian Standard
kA	kilo Ampere
kW	kilo Watt
kWH	kilo Watt Hour
LED	Light Emitting Diode
MCB	Miniature Circuit Breaker
MCCB	Moulded Case Circuit Breaker
MFM	Multi-Function Meter
LV	Low Voltage
NO	Normally Open
NC	Normally Closed
PVC	Poly Vinyl Chloride
V	Volt
XLPE	Cross-linked polyethylene

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Mr. Rajesh Sinha (PDD)
Mr. G. Suresh (Inspection)

CONTENTS

1.0 SCOPE

This specification covers the requirement of design, fabrication, testing, packing and supply of Low voltage fixed type switchboard in single front execution required for receipt, control and distribution of power to various low voltage consumers of the package equipment such as Air conditioning plant, Pressurisation plant, etc.

2.0 CODES AND STANDARDS

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

IS : 1248	:	Direct Acting Indicating Analogue Electrical Measuring Instruments and their Accessories
IS : 2824	:	Method for determining the proof and the comparative tracking indices of solid insulating materials.
IS : 5082	:	Wrought aluminum and aluminum alloy bars, rods, tubes and sections for electrical purposes.
IS : 5578	:	Guide for marking of insulated conductor.
IS : 11353	:	Guide for uniform system marking and identification of conductors and apparatus terminals.
IS : 13703	:	Low voltage fuses for voltages not exceeding 1000V AC or 1500V DC.
IS : 16227/ IEC: 61869	:	Instrument transformers
IS/IEC: 60255	:	Measuring Relays and Protection Equipment.
IS/IEC: 60269	:	Low-Voltage Fuses
IS/IEC: 60529	:	Degree of protection provided by enclosures (IP Code).
IS/IEC: 60947	:	Low Voltage Switchgear and control gear.
IS/IEC: 61439	:	Low voltage switchgear and control gear assemblies.

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

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

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

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

3.0 GENERAL REQUIREMENTS

3.1 The offered equipment shall be brand new with state of art technology and 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 at least for 10 years from the date of supply.

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

4.0 SITE CONDITIONS

4.1 The switchboards shall be suitable for installation and satisfactory operation in a pressurised room or in room with restricted natural air ventilation in a tropical, humid and corrosive atmosphere.

4.2 The switchboards shall be designed to operate under specified site conditions. If not specifically mentioned, a design ambient temperature of 40° C and altitude not exceeding 1000 metres above mean sea level shall be considered.

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

5.0 DESIGN AND FABRICATION REQUIREMENTS

5.1 The switchboard shall be free standing, suitable for directly flush mounting with the wall, with complete front access for operation and maintenance. The switchboard shall be fixed type, in single front execution, assembled in single line up, metal enclosed, fully compartmentalised, totally segregated compartments for feeders, cables and bus bar, dust and vermin proof suitable for indoor installation with form of internal separation minimum "Form-3b" as per IS/IEC-61439, unless otherwise specified elsewhere. The switchboard shall be completely type tested for the following tests (Short circuit, Temperature rise, Degree of Protection, Impulse withstand etc), as per IS/IEC standards. The switchboard shall also be completely Design Verified as per IS/IEC 61439-1 and Design Verification Report shall be submitted for the same.

5.2 The switchboard enclosure shall be dust and vermin proof and shall provide a degree of protection not less than IP-41.

5.3 The switchgear shall be assembled out of vertical panels of uniform height not exceeding 2450 mm in a single line up. The maximum height of the operating handle/switches shall not exceed 1900 mm and the minimum height not below 300 mm.

5.4 The switchboard shall be designed to ensure maximum safety during operation, inspection, and connection of cables, relocation of outgoing circuits and maintenance with the bus bar system energised and without taking any special precautions. The switchgear shall permit maximum interchangeability. All identical equipments and corresponding parts shall be fully interchangeable.

5.5 It shall be possible to extend the switchboard, in either direction at a later date. End of bus bars shall be suitably drilled for this purpose. Panels at extreme end shall have openings, which shall be covered with plates screwed to the panel.

5.6 Adequate means shall be provided to prevent shorting of power and / or control terminals due to accidental dropping of maintenance tools etc. inside the switchboard. Checking and removal of components shall be possible without disturbing adjacent equipment/modules/feeders.

5.7 The frame, of individual vertical panels shall be fabricated using pressed and cold rolled sheet steel. The sheet steel used for panel shall be of minimum 2mm (14SWG) CRCA except the doors and covers that may be made of 1.6mm (16SWG) CRCA. Wherever required, stiffeners shall be provided to increase mechanical strength of large size doors and covers.

As an alternative to CRCA, Aluzinc/pre-galvanised sheet steel can also be provided for internal inter-panel partitions only as per vendor's standard manufacturing practices. However, all external surfaces shall be of CRCA with specified paint shade.

5.8 The switchboard shall be provided with integral base frame for each vertical panel. The switchboard integral base frame shall be suitable for tack welding.

5.9 All hardware shall be corrosion resistant. All joints and connections of the panel members shall be made of galvanised or zinc passivated cadmium plated high quality steel bolts, nuts and washers, secured against loosening.

5.10 All openings, covers and doors shall be provided with gaskets of Neoprene/HDPE/EPDM or equivalent around the perimeter to make the switchboard dust and vermin proof.

5.11 Suitable removable type eyebolts/ lifting hooks shall be provided for lifting of the panel/shipping section. These eyebolts/ lifting hooks, when removed shall not leave any opening in the panels.

5.12 After preparation of the under surface, the panel shall be spray painted with two coats of epoxy based final paint or shall be powder coated. The colour shade of final paint shall be as RAL-7032, unless specified otherwise. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint, etc.

5.13 All unpainted steel parts shall be zinc passivated, cadmium plated or suitably treated to prevent rust and corrosion. If these parts are moving elements, then these shall be greased.

5.14 The switchboard shall be suitable for top or bottom cable entry as mentioned in datasheet, and shall be provided with removable gland plates. The gland plate thickness shall be minimum 3mm. Non-magnetic cable gland plates shall be provided for termination of single core cables. The switchboard shall have a separate cable alley for each vertical panel with cable tying arrangement. The cable alley width shall be sufficient to accommodate the required number of cables. However, in any case it shall not be less than 200mm width. The cable alley shall be provided with a suitable hinged door. Required number of single compression nickel plated brass cable glands and tinned copper compression type lugs (for bolted terminals) for all power and control cables shall be included in the vendor's scope of supply.

5.15 The switch board shall comprise of incoming load break switch panel or air circuit breaker panel, outgoing switch fuse, switch fuse contactor feeders, MCCB feeders, motor starter feeders, control supply transformers, both power and auxiliary/control bus bars, cable termination compartment etc. All these shall be housed in independent compartments separated from each other by metallic barrier.

5.16 Main horizontal bus bars shall be provided at the bottom in separate compartment for switchboards with top cable entry and at the top for switchboards with bottom cable entry. Vertical bus bars required for connection between main bus bars and outgoing feeders shall be in separate vertical chamber. One set of vertical bus bars can be provided for feeding outgoing feeders in two panels on either side of the vertical bus bar.

5.17 All components including bus bars and cable termination shall be accessible only from the front side for repair and maintenance.

5.18 Each outgoing feeder shall be in multitier arrangement having minimum height of individual module as defined in switchboard data sheet. All feeders shall be of modular design with height in multiples of standard unit size.

5.19 All auxiliary devices for control, reset, indication, measurement and protection except the bimetallic relays shall be mounted on the front side of the respective compartment. Components requiring frequent inspection during operation shall be easily accessible. The design shall be such that all power ON/OFF or START / STOP and relay reset operations shall be performed without opening the panel door.

5.20 Each vertical panel shall be provided with space heater to prevent moisture condensation rated for 240V AC supply, provided with a switch, fuse or double pole MCB and thermostat having variable setting range of 30-70 °C. The panels shall be provided with suitable illuminating LED lamp with switch and fuse or MCB. Further, one number 240V AC, 6/ 16A, 5 Pin socket for owner's use shall be provided inside panels.

5.21 Main bus bars shall be of high conductivity electrolytic aluminium/ copper having uniform current rating throughout their length. Horizontal and vertical bus bars shall be sized depending upon the maximum expected current and to limit the specified maximum operating temperature at specified design ambient temperature.

5.22 The hot spot temperature of busbars, conductors including joints at design ambient temperature shall not exceed 130°C for Copper busbar and 120°C for Aluminium busbar. Temperature rise at all other locations shall be maintained in line with IS/IEC 61439.

5.23 Minimum clearance & creepage distances between live parts, between live parts/neutral to earth shall be as per IS/IEC 61439 for the selected material group and specified pollution degree.

5.24 Adequately sized auxiliary copper bus bars running horizontally in a separate enclosure / compartment shall be provided for space heaters, control supply and metering requirements. Necessary tee-off connections shall be used for distributing auxiliary supply to each vertical panel.

5.25 All horizontal and vertical bus bars shall be insulated with heat shrink PVC sleeves of 1100 V grade and removable shrouds shall be provided for joints. All bus bars shall be prominently marked with red, yellow and blue colour rings for easy phase identification at regular interval and at every power tap off point and designed to withstand specified short circuit currents for one second. The sleeves shall be rated to withstand the system line-to-line voltage for 1 minute.

5.26 Copper earth bus of minimum 30x6 mm^2 size for fault level upto 31.5 kA and minimum 50x6 mm^2 size for fault level upto and including 65 kA shall be provided throughout the length of the switchboard with provision for interconnection to earthing grid at two ends. All non-current carrying metallic parts of the mounted equipment shall be earthed. Doors and movable parts shall be earthed using flexible copper connections.

5.27 Inside the switchboards, the wiring for power, control, signalling, protection and instrument circuits shall be done with FRLS, PVC/XLPE insulated copper conductors & BIS approved having 660/1100 V grade insulation.

5.28 For modules rated above 100 A, preferably copper strip connections shall be used. The controls connections shall be done with 660V grade PVC/XLPE insulated FRLS wires having stranded copper conductors. Minimum size of control wire shall be 1.5 mm^2 copper for circuits having fuse rating 10 A or less. For higher fuse rating control circuits, minimum 2.5 mm^2 copper conductor shall be used. Each wire shall be identified at both ends by self-sticking wire marker tapes or PVC ferrules. Transparent shrouds shall be used on outgoing power terminals.

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

5.30 Components of similar modules of same sizes shall be identically located and wired. Control supply change over switch shall be provided in case the switchboard is with two bus-sections.

5.31 In open doors condition of compartment, all live parts or terminals of all door-mounted, internal components and bus contact openings shall be IP-2X protected.

5.32 Unless otherwise specified elsewhere, the switchboard assembly and components shall be suitable for use in pollution degree 3 environment as per IS/IEC.

6.0 EQUIPMENT / COMPONENTS SPECIFICATION

6.1 All circuit breaker shall be air break type. All switches shall be load break, heavy duty/motor duty, air break type with the operating handle mounted on the compartment door, complete with necessary interlock and defeat mechanism. All switches drives other than rotary switches shall be lockable in OFF position. Rating of switches for starter module shall meet the requirements of AC-23 duty as per IS/ IEC 60947 and minimum rating shall be as specified in job specification/data sheets.

6.2 The incomers & buscoupler shall be provided with 4 pole load break switch/breaker.

6.3 All contactor-controlled starter feeders shall meet the requirements of type-2 co-ordination as per IS/IEC: 60947. However, contactor-controlled motor feeders shall meet the requirements of type-2 co-ordination as per IS/IEC: 60947 considering energy efficient motors of IE-3/IE-4 type (as per job specification), unless otherwise specified elsewhere.

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

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

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

6.7 MCCBs shall be provided with spring assisted quick make/ break manually operated trip free mechanism. `ON' and `OFF' position of the operating handle of MCCB shall be displayed and the operating handle shall be mounted on the door of the compartment. MCCB's as part of motor starter module shall be current limiting type and type tested for type-2 co-ordination as per IS/ IEC-60947 considering energy efficient motors of IE-3/ IE-4 type (as per job specification) unless otherwise specified elsewhere. MCCB shall be suitable for Ics=Icu=100%.

6.8 For MCCB feeders other than those provided with DMPR or any other numerical relay, MCCBs shall be provided with a tripping device with inverse time characteristic for over load protection and instantaneous characteristics for short circuit protection and earth fault protection.

6.9 Current transformers for metering shall have an accuracy class 1.0 and instrument security factor not greater than 5. Protective current transformers shall have an accuracy class 5P and an accuracy limit factor greater than 20.

6.10 All measuring AC instruments shall be moving iron, flush mounting type and of 72 x 72 mm square pattern instruments for incomer and outgoing feeders. The accuracy class for all instruments shall be 1.0 as per IS-1248. Ammeters for motor feeders shall have a non-linear compressed scale at the end to indicate motor starting current and red mark for the full load current. The KW/KWH meters shall be suitable to measure unbalanced loads on 3 phases 4-wire system. Test terminal block shall be provided for KWH meters.

6.11 Multifunction meters/ Digital meters shall be provided, if specified in job specifications/datasheets. All MFM/ digital meters shall be highly reliable, accurate and compact. MFM/ Digital meter data shall be saved in case of power failure. Communicable type MFM/ Digital meter shall be provided if specified in datasheet/ job specification.

6.12 Digital motor protection relay shall be provided, if specified in job specifications/datasheets. All DMPR relay shall have Multi-Protection features like Motor protection (Overload, Overcurrent, Earth leakage Protection, Ground fault, Stalled Rotor, Loss of load, Phase unbalance, Negative phase sequence, Reverse connection), overcurrent, undercurrent & under voltage protection.

6.13 DMPR shall also have display and following features shall be provided in display like type of fault, three phase current, power, voltage, power factor and motor load (%) etc.

6.14 CT ratio shall be settable in Digital MPR and communicable type DMPR shall be provided if specified in datasheet/ job specification.

6.15 CBCT with Earth Leakage Relay shall be provided if specified in job specifications/datasheets. ELR shall be manually hand reset type. In case hand reset feature is not available in the offered relay model, vendor to provide external hardware logic for manual hand resetting of the earth leakage relay.

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

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

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

6.19 Indicating lamps shall be cluster LED type of minimum 8mm-diameter size. The following indicating colours shall be used.

Closed/on	:	Red
Open/off	:	Green
Fault trip	:	Amber
Control supply on	:	White

6.20 Push button colours shall be as follows:

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

The 'Stop' push button shall be stayput type.

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

6.21 A centrally located engraved nameplate shall be provided for the switchboard. Each module shall have engraved nameplate bearing data as per approved drawings. Nameplate or polyester adhesive stickers shall be provided for each equipment mounted on & inside the switchboard. Identification tags shall be provided inside the panels matching with those shown on the circuit diagram. Special warning labels shall be provided on removable covers or doors giving access to cable terminals and bus bars.

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

7.0 INSPECTION, TESTING AND ACCEPTANCE

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

7.2 For testing requirements refer Inspection & Test Plan No. 6-81-1012. Prior notice of minimum 4 weeks shall be given to EIL/owner for witnessing the final testing of the complete assembly to ensure satisfactory operation of all components. Tests shall be carried out at manufacturer's works under his care and expense.

7.3 Test certificates of bought out components shall be submitted to the inspection agency, as per Inspection and Test Plan no. 6-81-1012.

8.0 PACKING AND DESPATCH

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

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

औद्योगिक किस्म के नियंत्रण स्टेशन के लिए विनिर्देश

SPECIFICATION FOR INDUSTRIAL TYPE CONTROL STATIONS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	18.01.21	REVISED AND ISSUED AS STANDARD SPECIFICATION	PS	RSR	PG	SM
5	11.03.16	REVISED AND ISSUED AS STANDARD SPECIFICATION	SV	ANPS	BRB	SC
4	11.04.11	REVISED AND ISSUED AS STANDARD SPECIFICATION	JM	ANPS	UAP	DM
3	24.08.07	REVISED AND ISSUED AS STANDARD SPECIFICATION	ANPS	UAP	JMS	VC
2	30.01.02	REVISED AND ISSUED AS STANDARD SPECIFICATION	UAP	AAN	VPS	GRR

Abbreviations:

AC	Alternating Current
BIS	Bureau of Indian standards
CEA	Central Electricity Authority
CT	Current Transformer
DC	Direct Current
EIL	Engineers India Limited
FRLS	Flame Retardant Low Smoke
GI	Galvanised Iron
IEC	International Electrotechnical Commission
IP	Ingress Protection
IS	Indian Standards
LED	Light Emitting Diode
LV	Low Voltage
NC	Normally Closed
NO	Normally Open
PB	Push Button
PO	Purchase Order
PVC	Poly Vinyl Chloride
SMD	Surface Mount Device
SS	Stainless Steel
SWG	Standard Wire Gauge
VFD	Variable Frequency Drive
XLPE	Cross Linked Poly Ethylene

Electrical Standards Committee

Convenor: 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. Ayush Mathur (Projects)
Mr. Rajesh Sinha (Inspection)

CONTENTS

1.0 SCOPE

This specification covers the requirements of design, manufacture, testing, packing and supply of industrial type control stations and accessories suitable for installation in non-hazardous/ safe outdoor areas.

2.0 CODES AND STANDARDS

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

IS: 5	:	Colours for ready mixed paints and enamels.
IS: 1248	:	Direct acting indicating analogue measuring instruments and their accessories.
IS / IEC: 60529	:	Degrees of protection provided by enclosures (IP code).
IS / IEC: 60947	:	LV switchgear and control gear.

2.2 In case of imported equipment, IEC standards or equivalent standards shall be applicable, if these standards are equivalent or more stringent than the applicable Indian Standards.

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

2.4 In case Indian standards are not available for any equipment, standards issued by IEC 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 tropical, humid and corrosive atmosphere as prevalent in refineries, petrochemical and fertilizer plants. Unless otherwise specified, a design ambient temperature of 40° C and an altitude not exceeding 1000 m above mean sea level shall be considered.

5.0 TECHNICAL REQUIREMENTS

5.1 Construction

5.1.1 The enclosures of the control stations shall be made of either sheet steel or cast light metal alloy, unless otherwise specified.

5.1.2 The control stations shall be suitable for use in outdoor open locations and shall have minimum IP-55 degree of protection. Suitable canopy shall be provided for protection against rain from top, back and two sides. The separate canopy shall be made of at least 1.6 mm (16 gauge) galvanized sheet steel/ stainless steel minimum SS-304 (as specified in purchase specifications).

5.1.3 All control stations shall be suitable for 240V AC as well as for 110V/220V DC control supply.

5.1.4 The control stations shall be provided with gaskets made of non-inflammable and self-extinguishing material.

5.1.5 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 dark admiralty grey, shade 632 of IS-5/ RAL 7031. All unpainted parts shall be suitably treated to prevent rust formation/ corrosion. If these parts are moving, then these shall be greased with grease which does not solidify.

5.1.6 All accessories like nuts, bolts, washers etc. and operating shaft of push buttons, switches etc. shall be made of stainless steel SS-304. Alternatively, nickel-plated brass material may be used for the operating shafts of push buttons, switches etc.

5.1.7 The control stations shall be provided with two earthing studs (minimum M10 bolt, nut with spring and plain washer) with lugs on the external surface of the enclosures suitable for termination of 8 SWG GI wire. No screw type fixing arrangement shall be allowed.

5.1.8 The control stations shall be provided with undrilled gland plate. However, double compression nickel-plated brass cable glands shall be supplied loose to suit the specified cable sizes. The cable termination chamber of the control station shall be large enough to provide a minimum space of 100 mm between top of the cable gland and bottom of the terminal block.

5.1.9 The control stations shall have external fixing lugs for mounting on wall or column. The holes provided on these lugs shall be of oblong type.

5.1.10 A tag plate indicating Tag Number shall be provided on each control station. The tag plate shall be engraved, 3 ply laminate fixed with screws.

5.2 Component Specification

5.2.1 Push buttons for START/ OPEN and STOP/ CLOSE shall be of GREEN and RED colour respectively. Each push button shall have two NO and two NC contacts. The STOP push button shall be mushroom type with stay put feature and lockable in pressed position. Refer Sketch 1 for wiring and other details for various types of control stations

5.2.2 All selector switches shall have minimum two poles for each position. Each position of switch shall be indelibly marked on the control station. The configuration of selector switch shall be LOCAL-OFF-REMOTE.

5.2.3 All ammeters shall be of moving iron type having an accuracy class of 1.5 and suitable for 1 Ampere CT secondary. Minimum size of ammeter shall be either 72 mm x 72 mm or 65 mm diameter. 80% of the scale length shall cover 100% of the CT primary current uniformly and the balance 20% of the scale shall cover 100-800% of the CT primary. A red mark corresponding to the full load current of the motor shall be provided on the ammeter dial. The ammeter front glass shall be toughened.

5.2.4 Indicating lamp(s), wherever provided, shall be clustered LED type or SMD chip type LED with colour lens of minimum 25 mm diameter.

5.3 Terminals & Wiring

5.3.1 The control stations shall be provided with sufficient number of terminals. More than 2 wires per terminal shall not be permitted. If required, additional terminal with shorting link may be used. Each terminal for external cable connection shall be suitable for termination of 2.5 mm^2 (unless otherwise specified) stranded copper conductor. Tinned copper lugs shall be provided for cable termination wherever applicable.

5.3.2 All internal wiring shall employ 1.5 mm^2, 660V/ 1100V grade, FRLS type, XLPE/ PVC insulated copper conductor wires. All termination shall be with suitable lugs.

6.0 INSPECTION, TESTING AND ACCEPTANCE

6.1 During fabrication, the equipment shall be subjected to inspection by EIL/ Owner or by an agency authorised by the Owner, 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.

6.2 Test certificates of bought out components shall be submitted to the inspection agency, as per Inspection and Test Plan no. 6-81-1014.

6.3 All equipment shall be subjected to various routine / acceptance tests as per Inspection and Test Plan no. 6-81-1014.

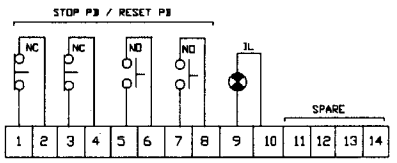
7.0 PACKING AND DESPATCH

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

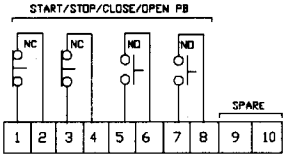
The equipment may be stored outdoors for long periods before installation. The packing shall be suitable for outdoor storage in areas with heavy rains and high ambient temperature unless otherwise agreed. A set of instruction manuals for installation, testing and commissioning, a set of operation & maintenance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

SKETCH–1

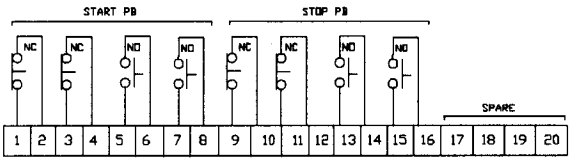
WIRING DETAILS OF CONTROL STATIONS



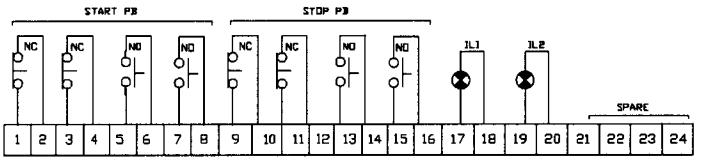
TYPE–A1 (STOP P.B. WITH LAMP)
OR
(RESET P.B. WITH LAMP)
(CABLE SIZE : 4Px2.5 Sq.mm)



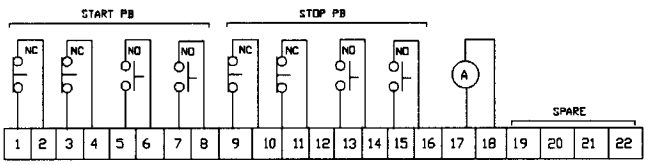
TYPE–A2
(START PB) OR (STOP PB) OR (CLOSE PB) OR (OPEN PB)
(CABLE SIZE : 2Px2.5 Sq.mm)



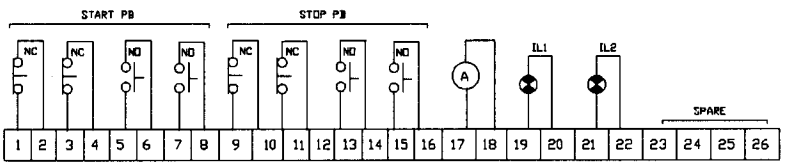
TYPE–B1 (WITH START & STOP PBs) OR (WITH CLOSE & OPEN PBs)
(CABLE SIZE : 4Px2.5 Sq.mm)



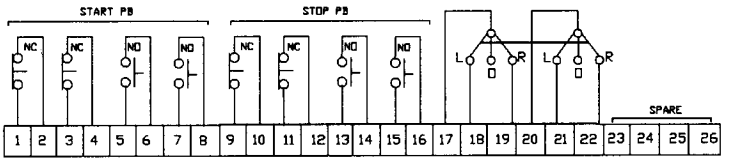
TYPE–B2 (WITH START & STOP PBs & INDICATION LAMPS)
OR
(WITH CLOSE & OPEN PBs & INDICATION LAMPS)
(CABLE SIZE : 6Px2.5 Sq.mm)



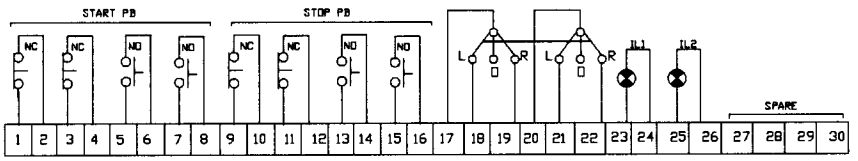
TYPE–C1 (WITH START & STOP PBs & AMMETER)
(CABLE SIZE : 4Px2.5 Sq.mm)



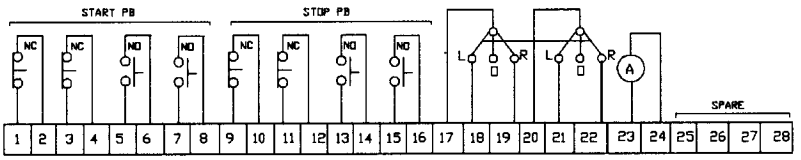
TYPE–C2 (WITH START & STOP PBs, AMMETER & INDICATION LAMPS)
(CABLE SIZE : 6Px2.5 Sq.mm)



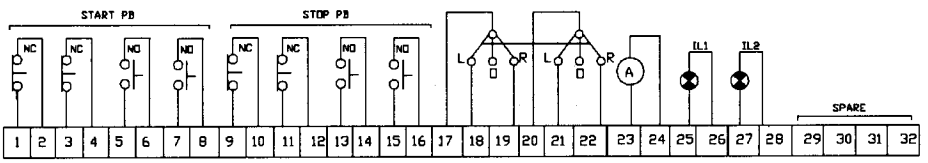
TYPE–D1 (WITH START & STOP PBs & L–O–R SELECTOR SWITCH)
(CABLE SIZE : 6Px2.5 Sq.mm)



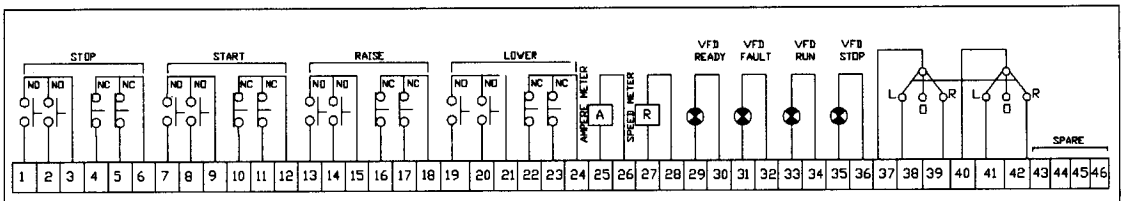
TYPE–D2 (WITH START & STOP PBs, L–O–R SELECTOR SWITCH & INDICATION LAMPS)
(CABLE SIZE : 12Px2.5 Sq.mm)



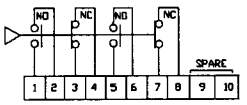
TYPE–E1 (WITH START & STOP PBs, AMMETER & L–O–R SELECTOR SWITCH)
(CABLE SIZE : 6Px2.5 Sq.mm)



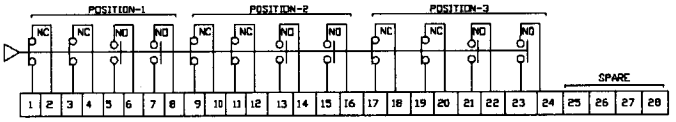
TYPE–E2 (WITH START & STOP PBs, AMMETER, L–O–R SELECTOR SWITCH & INDICATION LAMPS)
(CABLE SIZE : 12Px2.5 Sq.mm)



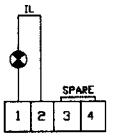
TYPE–F (WITH START & STOP PBs, RAISE & LOWER PBs, L–O–R SWITCH, AMPERE METER, SPEED METER & INDICATING LAMPS) (REFER NOTE–5,6,7)
(CABLE SIZE : 12Px2.5 Sq.mm)



TYPE–I1
SEL SWITCH (2POSITION)



TYPE–I2 SEL SWITCH (3POSITION)



TYPE–I3
(LAMP STATION)

GENERAL NOTES:

1. SHORTING LINKS SHALL BE PROVIDED BY VENDOR. REQUIREMENT SHALL BE INFORMED DURING VENDOR DRAWING REVIEW.
2. WIRING DETAILS SHALL BE READ IN CONJUNCTION WITH MR/TENDER.
3. CABLE SIZES AS INDICATED ABOVE ARE TENTATIVE AND MINIMUM. EXACT CABLE SIZES SHALL BE INFORMED DURING VENDOR DRAWING REVIEW. VENDOR TO PROVIDE REQUIRED SIZE OF CABLE TERMINATION CHAMBER WITH SUITABLE TERMINALS, CABLE ENTRIES, CABLE GLANDS AND LUGS. CONDUCTOR SIZE SHALL BE 2.5 SQ.MM, UNLESS OTHERWISE SPECIFIED.
4. AMMETER WHEREVER PROVIDED, SHALL BE ANALOGUE TYPE UNLESS OTHERWISE SPECIFIED. 4–20 MA TYPE SHALL BE PROVIDED IF DEFINED IN MR/TENDER.
5. FOR VFD CONTROL STATIONS, LAMP SUPPLY VOLTAGE SHALL BE SAME AS VFD CONTROL SUPPLY VOLTAGE.
6. FOR VFD CONTROL STATIONS, IF EXTERNAL SUPPLY IS REQUIRED FOR METERS, THEN SAME SHALL BE AS VFD CONTROL SUPPLY VOLTAGE.
7. METERS IN VFD CONTROL STATIONS SHALL BE SUITABLE FOR 4–20mA TRANSDUCER OUTPUTS AND SHALL BE CALIBRATED FOR THE ACTUAL MOTOR CURRENT. FOR VFD HAVING BYPASS FACILITY, METERS SHALL BE CAPABLE OF READING BYPASS MODE FULL LOAD AND STARTING CURRENTS AS WELL AS VFD MODE DRIVE CURRENT.
8. NUMBER AND COLOUR OF INDICATING LAMPS SHALL BE AS PER THE JOB SPECIFATION/TENDER.
9. CONTROL STATIONS TYPE "I" ARE TYPICALLY FOR INSTRUMENTATION USE.
10. ALL PUSH BUTTON AND CONTROL SWITCH CONTACTS SHALL BE RATED FOR MINIMUM 5A AT 240V(AC–15) AND 1A AT 220V/110V(DC–13) DUTY. CONTACT RATINGS FOR CONTROL STATIONS FOR INSTRUMENTATION USE SHALL BE AS PER INSTRUMENTATION REQUIREMENT.
11. THE EXACT DESCRIPTION OF PB'S WHETHER START/STOP OR OPEN/CLOSE SHALL BE INFORMED DURING VENDOR DRAWING REVIEW.
12. ALL L–O–R SELECTOR SWITCHES SHALL BE LOCKABLE IN OFF POSITION.

निम्न वोल्टेज स्विच बोर्ड के लिए विनिर्देश

SPECIFICATION
FOR
LOW VOLTAGE SWITCHBOARD

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
7	20.03.2025	REVISED AND ISSUED AS STANDARD SPECIFICATION	CA	SA	HK	MN
6	08.12.2021	REVISED AND ISSUED AS STANDARD SPECIFICATION	CA/RKS	SA	PG	SM
5	21.12.2016	REVISED AND ISSUED AS STANDARD SPECIFICATION	CA/RKS	SA	BRB	RN
4	23.03.2011	REVISED AND ISSUED AS STANDARD SPECIFICATION	DA	SG	UAP	DM
3	01.03.2005	REVISED AND ISSUED AS STANDARD SPECIFICATION	SSM	RR	AAN	SKG
2	19.11.2001	REVISED AND ISSUED AS STANDARD SPECIFICATION	SSM	AAN	VPS	GRR

Abbreviations:

A	:	Ampere	Icw	:	Rated short time withstand current
AC	:	Alternating Current	kA	:	kilo Amperes
ACB	:	Air Circuit Breaker	kVA	:	kilo Volt Ampere
ASB	:	Auxiliary Service Board	kW	:	kilo Watt
BIS	:	Bureau of Indian Standard	LDB	:	Lighting Distribution Board
CBCT	:	Core Balance Current Transformer	LED	:	Light Emitting Diode
			LOTO	:	Lock Out Tag Out
CEA	:	Central Electricity Authority	LV	:	Low Voltage
CPRI	:	Central Power Research Institute	mA	:	milli Ampere
			MCB	:	Miniature Circuit Breaker
CRCA	:	Cold Rolled Cold Annealed	MCC	:	Motor Control Center
CT	:	Current Transformer	MCCB	:	Moulded Case Circuit Breaker
DC	:	Direct Current	MFM	:	Multi-Function Meter
DMPR		Digital Motor Protection Relay	NC	:	Normally Closed
EIL	:	Engineers India Limited	NO	:	Normally Open
EPDM	:	Ethylene Propylene Diene Monomer	OTMS	:	Online Temperature Monitoring System
ELR	:	Earth Leakage Relay	PCC	:	Power Control Center
FRLS	:	Flame Retardant Low Smoke	PMCC	:	Power cum Motor Control Center
HDPE	:	High Density Poly Ethylene	PT	:	Potential Transformer
HRC	:	High Rupture Capacity	PVC	:	Poly Vinyl Chloride
IEC	:	International Electrotechnical Commission	R-C	:	Resistor-Capacitor
			SWG	:	Standard Wire Gauge
iMCC	:	Intelligent Motor Control Center	V	:	Volt
IP	:	Ingress Protection	VA	:	Volt Ampere
IS	:	Indian Standard	XLPE	:	Cross Linked Poly Ethylene
Ics	:	Rated service short circuit current			
Icu	:	Rated ultimate short circuit current			

Electrical Standards Committee

Convenor: **Mr. Harish Kumar**

Members:
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Mr. Raman Sood
Mr. Bishan Dass
Mr. Rajiv Kumar Saha
Mr. Vijay Kumar
Ms. Shirali Aggarwal
Ms. Rashmi Singh Rathur
Mr. Ayush Mathur (Projects)
Mr. Rajesh Sinha (PDD)
Mr. G. Suresh (Inspection)

CONTENTS

1.0 SCOPE

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

2.0 CODES AND STANDARDS

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

IS : 1248	:	Direct Acting Indicating Analogue Electrical Measuring Instruments and their Accessories.
IS: 2705, Part 1	:	Current transformers - General requirements
IS : 2824	:	Method for determining the proof and the comparative tracking indices of solid insulating materials.
IS : 3618	:	Phosphate treatment of iron and steel for protection against corrosion.
IS : 5082	:	Wrought aluminum and aluminum alloy bars, rods, tubes and sections for electrical purposes.
IS : 5578	:	Guide for marking of insulated conductor.
IS : 11353	:	Guide for uniform system marking and identification of conductors and apparatus terminals.
IS : 13703	:	Low voltage fuses for voltages not exceeding 1000 V AC or 1500 V DC.
IS : 16227 / IEC: 61869	:	Instrument transformers.
IS/IEC: 60255	:	Measuring Relays and Protection Equipment.
IS/IEC: 60269	:	Low voltage fuses.
IS/IEC: 60529	:	Degree of protection provided by enclosures (IP Code).
IS/IEC: 60947	:	LV Switchgear and control gear.
IS/IEC: 61439	:	Low voltage switchgear and control gear assemblies.
IEC TR 61641	:	Enclosed low-voltage switchgear and control gear assemblies - Guide for testing under conditions of arcing due to internal fault.

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

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

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

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

3.0 GENERAL REQUIREMENTS

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

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

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

4.0 SITE CONDITIONS

4.1 The switchboards shall be suitable for installation and satisfactory operation in an air-conditioned/pressurised substation or in a covered shed/enclosed electrical room (e-room) or in a substation with restricted natural air ventilation in a tropical, humid and corrosive atmosphere.

4.2 The switchboards shall be designed to operate under specified site conditions. If not specifically mentioned, a design ambient temperature of 40° C and altitude not exceeding 1000 metres above mean sea level shall be considered.

4.3 All the equipment described in this specification shall be suitable for continuous duty with the specified ratings under the mentioned ambient conditions unless indicated otherwise.

5.0 DESIGN AND FABRICATION REQUIREMENTS

5.1 Low voltage switchboard shall be metal enclosed fully draw out or fixed, as specified in datasheet/ job specification, free standing, floor mounting, compartmentalized, modular type suitable for indoor installation. Draw out type switchboards shall be with form of internal separation "Form-4b" whereas Fixed type switchboards shall be with form of internal separation minimum "Form-3b" as per IS/IEC 61439 unless otherwise specified elsewhere. The switchboard shall be completely type tested for the following tests (Short circuit, Temperature rise, Degree of Protection, Internal Arc, Impulse withstand and breaker duty cycle etc), as per IS/IEC standards. The switchboard shall also be completely Design Verified as per IS/IEC 61439-1 and Design Verification Report shall be submitted for the same.

5.2 The switchboard enclosure shall be dust and vermin proof and shall provide a degree of protection not less than IP-41 as per IS/IEC 60529.

5.3 The switchboard shall be assembled out of vertical panels of uniform height, not exceeding 2450 mm in a single line up.

5.4 It shall be possible to extend the switchboard, in either direction at a later date. End of bus bars shall be suitably drilled for this purpose. Panels at extreme end shall have openings, which shall be covered with plates screwed to the panel.

5.5 The switchboard shall be designed to ensure maximum safety during operation, inspection, connection of cables, relocation of outgoing circuits and maintenance, with the bus bar system energised and without taking any special precautions.

5.6 Adequate means shall be provided to prevent shorting of power and / or control terminals due to accidental dropping of maintenance tools etc. inside the switchboard. Checking and removal of components shall be possible without disturbing adjacent equipment/ modules/ feeders.

5.7 All identical equipments and corresponding parts shall be fully interchangeable.

5.8 The frame, of individual vertical panels shall be fabricated using pressed and cold rolled sheet steel. The sheet steel used for panel shall be of minimum 2 mm (14SWG) CRCA except the doors and covers that may be made of 1.6 mm (16SWG) CRCA. Wherever required, stiffeners shall be provided to increase mechanical strength of large size doors and covers.

As an alternative to CRCA, Aluzinc/ pre-galvanised sheet steel can also be provided for internal inter-panel partitions only as per vendor's standard manufacturing practices. However, all external surfaces shall be of CRCA with specified paint shade.

5.9 The switchboard shall be provided with integral base frame for each vertical panel. The switchboard integral base frame shall be suitable for tack welding.

5.10 All openings, covers and doors shall be provided with gaskets of Neoprene/HDPE/EPDM or equivalent around the perimeter to make the switchboard dust and vermin proof.

5.11 All hardware shall be corrosion resistant. All joints and connections of the panel members shall be made of galvanized or zinc passivated or chromium plated high quality steel bolts, nuts and washers, secured against loosening.

5.12 Suitable removable type eyebolts/ lifting hooks shall be provided for lifting of the panel/shipping section. These eyebolts/ lifting hooks, when removed shall not leave any opening in the panels.

5.13 Non-magnetic cable gland plates (min. 3 mm thick) shall be provided for termination of single core cables.

5.14 The switchboard shall be formed using distinct vertical panels each comprising of the following compartments.

5.14.1 A metal enclosed horizontal bus bar compartment running at the top or rear, unless otherwise specified.

5.14.2 Individual feeder modules in multitier mode.

5.14.3 Vertical bus bars serving all feeder modules in the vertical panel.

5.14.4 Cable termination compartment.

5.14.5 Perforated sheet steel / insulating material enclosed, horizontal auxiliary bus bars for control, interlock, indication and metering running horizontally.

5.15 Metal sheets shall be provided between two adjacent vertical panels running upto the full useful height of the switchboard.

5.16 MCC/ MCC part of PMCC shall be of single/double front execution as specified in data sheet/job specification. However circuit breaker panels shall be in single front execution only.

5.17 Motor starter and MCCB/switch-fuse modules shall not be accommodated at front and rear of ACB Incomer and bus coupler panels.

5.18 The MCC/ASB/LDB switchboards shall be provided with castle-key interlock between incomers and bus-coupler switches for manual changeover of supplies unless otherwise specified elsewhere.

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

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

5.21 Unless otherwise specified elsewhere, the switchboard assembly and components shall be suitable for use in pollution degree 3 environment as per IS/IEC.

5.22 In open doors condition of compartment, all live parts or terminals of all door-mounted, internal components and bus contact openings shall be IP-2X protected.

5.23 LOTO arrangement

5.23.1 Pad locking arrangement shall be provided for rack in operation of breaker as well as for the panel door meeting LOTO requirements.

5.23.2 LOTO arrangement shall be provided be provided for each module of draw-out switchboard PCC/PMCC/MCC etc. and shall include provision for the following:

a) Provision for hooking lockout devices by multiple lock arrangement to prevent opening of panel door and racking-in of circuit breaker.

b) Provision for attaching tag-out device for warning against energisation and to provide information regarding date of isolation, agency working on the equipment, etc.

c) Provision for Hasp such that the same shall be put-in and closed in the locking arrangement of the breaker/switch and panel door.

5.24 The panel shall be internal arc tested as per IEC TR 61641 requirements for full short circuit current for a duration of 0.1 second (minimum) unless specified otherwise in job specification/ datasheet and shall be qualified to comply with all the 7 criteria as per IEC TR 61641. However where the circuit is protected by a current limiting device, then duration shall be 0.2 second (minimum) as per IEC TR 61641. In addition to this, internal arc protection system shall also be provided if specified in job specification/ datasheet. Internal arc protection system shall be supplied complete along with requisite quantity of arc sensors and associated arc flash protection relay.

5.25 The Depth of MCC/ASB/LDB panels in double front execution shall be preferably limited to 1000 mm and in no case depth shall exceed 1200 mm.

5.26 For switchboards rated upto and including 5000A, forced cooling for any of the equipments and components i.e. bus bars, circuit breakers etc. shall not be provided.

5.27 The switchboard shall be supplied complete with supports for clamping outgoing and incoming cables.

5.28 The Bus PT shall be provided in the respective bus section of switchboard.

5.29 All breakers/ load break switches of incomers and bus coupler(s) shall be with 4 poles unless otherwise specified elsewhere.

5.30 Switchboard shall be provided with online wired/ wireless temperature monitoring facility if specified in job specifications/datasheet. The passive sensor shall be battery less, dielectrically safe, robust to suitable voltage, high electromagnetic field, and harsh environment. It shall take direct measurement of temperature from critical points. This facility shall be interfaced with Substation Automation System/ ECS.

5.31 If specified in job specification/ datasheet, all drawout modules shall be suitable for closed door operation i.e. Module racking operation should be possible with module door closed. The design shall be such that the degree of protection (IP) remains the same in all three positions of the feeder i.e. service, test and isolated.

5.32 Space Heaters & Panel Illumination

The switchboard panels shall be provided with space heaters to prevent moisture condensation. The space heater shall be located in the bottom part of each panel and shall be supplied from 240 V AC auxiliary buses for space heater. The space heater shall be provided with a switch, fuse or double pole MCB and thermostat having adjustable setting range of 30-70° C. Further, one number 240V AC, 6/16A, 5 Pin socket for owner's use shall be provided inside panels. The panels shall be provided with LED light of required wattage with switch and fuse or MCB.

5.33 Auxiliary Bus Bars

5.33.1 Auxiliary bus bars (solid – rectangular or circular), each of minimum size 16-mm^2 copper, shall be provided for the following applications.

a) Panel space heater supply and motor space heater supply.

b) AC Control supply.

c) DC Control supply.

d) AC PT supply for energy meters, voltage operated relays etc.

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

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

5.34 Bus Bar

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

5.34.2 The main bus bars shall have uniform current ratings throughout their length as specified in data sheet/job specification. The current rating of the neutral shall be half that of the phase bus bars. Removable neutral links shall be provided on feeders to permit isolation of the neutral bus bar. The neutral bus bar shall be provided alongside of the phase bus bars.

5.34.3 Both horizontal and vertical bus bars, bus joints, risers, connecting bus bar links/ terminals to equipment and supports shall be capable of withstanding dynamic and thermal stresses of the specified short circuit currents.

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

5.34.5 The hot spot temperature of busbars, conductors including joints at design ambient temperature shall not exceed 130°C for Copper busbar and 120°C for Aluminium busbar. Temperature rise at all other locations shall be maintained in line with IS/IEC 61439.

5.34.6 The current rating as defined for switchboard, bus bar and components in data sheet/enquiry document are for design ambient temperature at site conditions and for being inside the panel/ cubicle at fully loaded condition. The vendor shall suitably derate the nominal rating to suit the above condition considering ambient temperature inside panel/ cubicle.

5.34.7 All bus bars shall be insulated with heat shrunk PVC sleeves of 1100 V grade. Red, yellow and blue colour shall be used for phase bus bars and black colour shall be used for neutral bus bars. Alternatively, colour bands at suitable intervals along PVC sleeved bus bars may be provided. The sleeves shall be rated to withstand the system line-to-line voltage for 1 minute. Removable type shrouds shall be provided for joints & tap off points.

5.34.8 Minimum clearance & creepage distances between live parts, between live parts/neutral to earth shall be as per IS/IEC 61439 for the selected material group and specified pollution degree.

5.34.9 Vertical bus bars for circuit breaker panels shall be sized depending upon the rating and number of breakers per vertical panel. However vertical bus bars of all other panels shall be of uniform cross section.

5.35 Wiring and Terminals

5.35.1 Inside the switchboards, the wiring for power, control, signalling protection and instrument circuits shall be done with BIS approved FRLS, PVC/XLPE insulated copper conductor wires having 660/1100 V grade insulation. The wiring shall preferably be enclosed in flame retardant plastic channels or neatly bunched together.

5.35.2 PVC/ XLPE insulated copper conductor of cross section 1.5 mm^2 may normally be used provided the control fuse rating is 10 A or less. For higher fuse ratings minimum 2.5 mm^2 copper conductor shall be used. Each wire shall be terminated at a separate terminal. CT circuit wiring shall be done with 2.5mm^2 copper conductor.

5.35.3 Shorting links/suitable arrangement for shorting CT secondary shall be provided.

5.35.4 Each wire shall be identified at both ends by PVC ferrules.

5.35.5 Inter panel wiring within each shipping section shall be switchboard vendor's responsibility. For wiring between shipping sections, vendor shall provide terminal blocks on adjoining shipping sections and supply suitable jumpering wires. Inter-panel wiring shall be taken thorough PVC sleeves or rubber grommets.

5.35.6 A minimum of 10% spare terminals shall be provided on each terminal block.

5.35.7 Conductors shall be terminated with adequately sized compression-type lugs for connection to equipment terminals and strips. Stranded conductors shall be soldered at the ends/ crimped with suitable lugs before connections are made to the terminals. Sufficient terminals shall be provided on each terminal block to ensure that not more than one outgoing wire is connected per terminal.

5.35.8 Terminal strips shall preferably be separated from power circuits by metal barriers or enclosures. All spare input and output contacts of numerical relays, auxiliary relays, contactors, timers, etc shall be wired up to the terminal strips/block (ensuring that two terminals are provided for each contact).

5.36 Earthing

5.36.1 All panels shall be connected to a tinned copper earth bus bar running throughout the length of the switchboard at the bottom of the panels.

5.36.2 The minimum earth bus size shall be 30x6 mm^2 copper for fault level up to 31.5kA and 50x6 mm^2 copper for fault level for fault level upto and including 65 kA.

5.36.3 All doors and movable parts shall be earthed, using flexible copper connections, to the fixed frame of the switchboard. Provision shall be made at the end panels of each switchboard to connect the earthing bus bar to the plant earthing grid at two ends.

5.36.4 All non-current carrying metallic parts of the mounted equipment shall be earthed. Minimum 4 nos. 10 mm diameter bolts with nuts shall be provided on the earth bus for termination of fourth core of cable per vertical panel.

5.37 Nameplate

5.37.1 A nameplate with the switchboard designation shall be fixed at the top of the central panel. A separate nameplate giving details for each feeder compartment of all panels shall be provided. Danger nameplate shall be provided at the front and rear of each panel.

5.37.2 The nameplates for feeder compartments shall be in two parts. One part shall have necessary details pertaining to the compartments number of vertical panel of the switchboards. The other parts shall be removable and shall contain all details regarding the feeder number for drives/equipment controlled by the particular module as per approved single line diagram.

5.37.3 Blank nameplates shall be provided for all spare and vacant modules.

5.37.4 Nameplate or polyester adhesive stickers shall be provided for each equipment mounted inside the switchboard. Special warning plates shall be provided on removable covers or doors giving access to cable terminals and bus bars.

5.37.5 Special warning labels shall be provided inside the switchboards also, wherever considered necessary. Identification tags shall be provided inside the panels matching with those shown on the circuit diagram.

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

5.38 Painting

5.38.1 After preparation of the under surface, the panel shall be spray painted with two coats of epoxy based final paint or shall be powder coated. The colour shade of final paint shall be as RAL-7032, unless specified otherwise. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint, etc.

5.38.2 All unpainted steel parts shall be zinc passivated, chromium plated or suitably treated to prevent rust and corrosion. If these parts are moving elements, then these shall be greased.

6.0 SPECIFIC REQUIREMENTS OF AIR CIRCUIT BREAKER PANELS

6.1 The breaker panels shall have distinct bus bar, breaker and cable compartments.

6.2 The design of each compartment shall be such as to prevent movement of vermin from a particular compartment to any other compartment of the panel when the breaker is withdrawn and compartment door is closed.

6.3 In order to minimise accidental access and avoid accidents due to falling tools, all the outgoing links shall be shrouded.

6.4 Outgoing air circuit breaker can be mounted in a maximum of two-tier execution while the incoming/bus coupler air circuit breaker shall be in single tier execution only.

6.5 Cable Compartment

6.5.1 Separate compartment, totally enclosed from all sides, shall be provided for cable termination, on the rear/front side. Access to cables shall be from the rear/front side after opening the cabling compartment cover.

6.5.2 The incoming / outgoing cable termination shall be staggered for each circuit and barriers of sheet steel or insulating material shall be provided between terminations of two circuits such that maintenance on one circuit could be carried out while the other circuit is live. Suitable clamping arrangements shall be provided for cables and cable termination. Terminal blocks shall not be used for supporting the cables.

6.5.3 The incoming supply for PCC/ PMCC panels shall be through top entry bus ducts or through bottom entry cables unless specified otherwise. The outgoing cables shall have bottom entry unless specified otherwise.

6.5.4 The cable terminations shall be suitably sized for receiving specified number of cables per termination and provision shall be made for terminating each outgoing cable with a separate bolted connection. In case the total number of cables entering a particular panel cannot be accommodated in the cabling compartment of the panel, an extension panel of full height shall be added to the cabling compartment for accommodating extra cables. Alternatively, in view of extra cables, provision for back to back connections of cables may be offered.

6.6 Circuit Breaker Compartment

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

6.6.2 The current transformers for the ammeter/protection circuits shall be mounted on the fixed portion of the compartment. However, current transformers associated with built-in releases may be mounted on the breaker trolley.

6.6.3 All terminals except wiping/sliding type control terminals shall be shrouded with plastic covers to prevent accidental contact. For direct termination, clip-on shrouded type terminals shall be provided.

6.6.4 There shall be three positions for the draw out trolley viz:

- "Service" position - In this position both power and control circuits shall be connected. This shall be the normal operating position of the circuit breaker.
- "Test" position - The power contacts shall be disconnected in this position but the control connections shall not be disturbed, testing provision for the entire control circuitry shall be available in test mode including close and trip of breakers.
- "Isolated" Position - both power and control circuits shall be disconnected in this position.

6.6.5 The circuit breaker shall be lockable in "service" and "test" positions. Safety shutters shall be provided when the breaker is in Isolated position.

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

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

6.7 Interlocks

Following interlocks shall be provided:

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

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

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

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

7.0 SPECIFIC REQUIREMENTS OF FEEDERS OTHER THAN ACB FEEDERS

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

7.2 All identical feeder modules shall be interchangeable.

7.3 Each vertical panel shall have a separate cable alley. The width of this cable alley shall be sufficient to accommodate all the cables and shall have free access for cable terminations and in any case shall not be less than 250 mm minimum. The cable alley width more than 250 mm shall be provided in case of requirement of termination of large number of outgoing cables as required. Cable alleys shall be provided with suitable doors.

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

7.5 Maintenance and connection of cables to any modules shall be possible without having to take out the modules from its position from the panel.

7.6 The outgoing feeder trolleys for drawout type switchboard shall be fully drawout and shall have the following features.

7.6.1 It shall be possible to withdraw the trolley without having to unbolt or unscrew any power and control connections to the equipment mounted on the withdrawable trolley.

7.6.2 Both power and control connections shall be drawout type. All line and bus PTs shall be in drawout execution only. However, outgoing modules having size more than half of the useful vertical height of the panel may be in mixed combination of drawout /fixed type.

7.6.3 Control supply transformer modules may be provided in fixed execution.

7.6.4 The trolley withdrawal shall be by means of crank and screw arrangement. Alternatively movement on guided rollers or swivelling guide levers for self guided movement may also be acceptable. Plug in operation shall be independent of manual force. An insulating handle for racking in/ out modules shall be provided, as required.

7.6.5 For drawout type feeders of size equal to or greater than half the useful vertical height of panel, positive clamping arrangement shall be provided on the top portion of the trolley in addition to clamping arrangement at the bottom, to ensure all round positive pressure on the power drawout contacts once the trolley is plugged in. Alternatively fixed execution can be

accepted for feeder with higher rating, equal to or greater than 400A in case of vendor's standard design, subject to Owner's approval.

7.6.6 Power drawout contacts shall preferably be located towards the bottom portion of each trolley. The trolley shall be lockable in fully plugged in position and devices shall be provided to ensure positive plugging in. In test position, power contacts shall be totally isolated and a device shall be provided for indication of test position. In test position, testing provision for the entire control circuitry shall be available.

7.7 The incomer and bus tie feeders with load break switches rated 800A and above may be in fixed execution

7.8 Various compartment sizes in a vertical panel shall be multiples of a basic dimension. However the minimum module size for switch fuse/MCCB feeder and motor starter/contactor feeder shall not be less than that defined in data sheet/job specification. Vertical bus bars shall be pre-drilled at regular intervals for complete flexibility for changes in size of modules.

7.9 All switch drives other than rotary control switches, shall be lockable in 'OFF' position.

7.10 The switches/Moulded case circuit breakers shall be interlocked with the compartment door to prevent opening of the door when the switch/ moulded case circuit breaker is in 'ON' position and to prevent switching on when the door is open. A defeat mechanism for this interlock shall also be provided.

7.11 The maximum height of the operating handle and switches shall not exceed 1900 mm and the minimum height shall not be below 250 mm.

7.12 Unused modules in the panel shall be fully equipped with hinged door & vertical bus bars and shall be suitable for mounting power and control terminals for starter modules and cradle for future use.

7.13 The power contactor in starter/ feeder modules of PMCC/ MCC shall be provided with R-C circuit across the AC supply contactor coil and surge suppressor/ diode in case of DC supply contactor coil. Further, low burden auxiliary contactors shall be provided in each contactor controlled motor starter modules for receiving start and stop command from remote. The requirement shall be complied for all feeders with remote start/ stop provision. In addition to that, resistor shall be provided in series of contactor to dissipate the residual capacitive voltage

8.0 SWITCHGEAR MODULES

8.1 Switchboard shall be completely lined up in one straight row with the type and quantities of feeders as defined in switchboard data sheet. Generally the feeders of three main categories are identified as circuit breaker, motor starters and MCCB or switch fuse.

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

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

8.2.2 FVR Full Voltage Reversing starter with minimum 24 control terminals.

8.2.3 FVNR - HD Full Voltage Non -Reversing Heavy Duty starter with long starting time such as for compressors and fans etc. with minimum 18 control terminals.

8.3 Switch fuse/MCCB /contactor feeder modules shall be of following types and internal control wiring of all modules of each type shall be identical for all ratings.

8.3.1 SFU/MCCB Switch Fuse Unit or MCCB modules with no control terminals.

8.3.2 SFC/MCCB+C Switch Fuse Contactor or MCCB with contactor modules with 18 control terminals.

8.4 Control transformer shall be provided for each FVR/FVNR/SFC starter/MCCB+C starter/feeder modules or bus section of the PMCC/MCC switchboard having contactor control feeders as specified in the datasheet/job specification or elsewhere. Each control transformer of starter/feeder module shall be sized for taking control supply load of all

components of starter module. In case control transformer is provided in bus section, same shall be sized for control supply load of entire switchboard. Switchboard having two bus sections and coupled by bus tie shall have manual changeover switch for the control transformers. The control transformer shall have at least 10% spare capacity. The control transformer secondary shall be earthed at one end.

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

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

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

8.6 Heavy duty starters shall be provided with saturable type, current transformer operated; overload relays only, which shall be suitable for motor starting time of 15-60 seconds.

8.7 All contactor controlled starter feeders shall meet the requirements of type-2 co-ordination as per IS/IEC: 60947. However, contactor controlled motor feeders shall meet the requirements of type-2 co-ordination as per IS/IEC: 60947 considering energy efficient motors of IE-3/IE4 (as per job specification) type, unless otherwise specified elsewhere.

9.0 SWITCHBOARD COMPONENTS

9.1 Circuit Breakers

9.1.1 Circuit breakers shall be air break, draw-out type and 3/4 poles as specified in the datasheet/job specifications and in this specification above. Circuit breaker shall be suitable for Ics=Icu=Icw=100% for 1sec.

9.1.2 The circuit breakers shall be provided with mechanically operated emergency tripping device. This device shall be available on the front of the panel. Mechanically operated 'closing' device shall be provided for all breakers. However mechanical closing shall be inhibited for all breakers in service position.

9.1.3 The circuit breakers shall be provided with minimum 4 NO + 4 NC contacts, wired and available for owner's use. In case contacts are directly not available in breaker, auxiliary latching type relays shall be used to multiply the auxiliary contacts of the breakers.

9.1.4 Circuit breaker's Open and closed positions; Service and test locations and spring charged condition shall also be indicated mechanically in addition to electrical indications.

9.1.5 Unless otherwise specified, all circuit breakers in the switchboard shall be provided with electrical power operating mechanism. Wherever circuit breakers are provided in place of Isolators, Breaker can be manually operated type.

9.1.6 **Operating Mechanism**

a) Electric power operating mechanism shall be motor wound spring charged stored energy type. However, manual-operating mechanism may be of the spring charging stored energy type or spring assisted type. For circuit breakers with electrical power operating mechanism, provision shall also be made for manual spring charging. Closing time of circuit breakers with manual operating mechanism shall be independent of the speed of the operating handle.

b) All stored energy operating mechanisms shall be equipped with the following features:

i) Failure of springs, vibrations or shocks shall not cause unintended operation of breaker or prevent intended tripping operation.

ii) Closing of circuit breakers shall be prevented unless the spring is fully charged.

c) All electrical power operating mechanisms shall be suitable for remote operation and shall be equipped with the following features:

i) Provided with universal motor operable on AC or DC control supplies.

ii) Provided with emergency manual charging facility. The motor shall be automatically, decoupled (mechanically) once the manual-charging handle is inserted.

iii) Closing operation of circuit breaker shall automatically initiate charging of the spring for the next closing operation without waiting for tripping of circuit breaker.

iv) Closing operation shall be completed once the closing impulse is given and the first device in the control scheme has responded even though the control switch / Push Button is released, provided no counter trip impulse is present.

9.1.7 Circuit breaker trip and closing coils, in case of electrically operated breakers and trip coil in case of mechanically operated breakers and circuit breaker indication shall be suitable for satisfactory operation on a control supply system indicated in data sheets/job specification.

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

9.1.9 Circuit breakers shall be provided with operation counters.

9.1.10 Releases are not required to be provided with breakers where relays are used. However breaker-having AC control supply voltage shall be provided with under voltage release unless specified otherwise.

9.2 Switches

9.2.1 All switches or fuse switches shall be load break, heavy duty/motor duty, air break type provided with quick make/break manual operating mechanism. The operating handle shall be mounted on the door of the compartment having the switch.

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

9.3 Fuses

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

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

9.3.3 It shall be possible to handle fuses during off load conditions with full voltage available on the terminals. Wherever required fuse pullers shall be provided. The fuse base shall be so located in the modules to permit insertion of fuse pullers and removal of fuse links without any problem.

9.4 Contactors

9.4.1 The contactors shall be air break type, equipped with three main contacts and minimum 1NO+1NC auxiliary contacts. The main contacts of a particular contactor for motor starter module shall have AC-3 or AC4 ratings, as specified in data sheet

9.4.2 Unless specified otherwise, the coil of the contactor shall be suitable for operation on 240 V, 1 Phase, AC supply.

9.5 Thermal Overload Relay

9.5.1 Bimetal relays shall be provided for protecting the motor from thermal overload.

9.5.2 Bimetal relays shall be manually reset type with the reset push button brought out on the front of the panel. The reset push button shall be capable of being operated without opening the compartment door.

9.5.3 Bimetal relays shall be three elements positive acting ambient temperature compensated type with adjustable setting range.

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

9.5.5 The rating of Bimetal relay shall be selected by vendor based on type-2 coordination and full load current of IE-3/IE-4 motor as per job specification/ datasheet.

9.6 Moulded Case Circuit Breakers

9.6.1 MCCBs shall be provided with spring assisted quick make/ break manually operated trip free mechanism. Wherever specified, MCCB shall be suitable for remote tripping operation and the tripping device shall be suitable for the specified control supply voltage. MCCB shall be suitable for Ics=Icu=100%.

9.6.2 For MCCB feeders other than those provided with DMPR or any other numerical relay, MCCBs shall be provided with a tripping device with inverse time characteristic for over load protection and instantaneous characteristics for short circuit protection and earth fault protection.

9.6.3 `ON' and `OFF' position of the operating handle of MCCB shall be displayed and the operating handle shall be mounted on the door of the compartment housing MCCB.

9.6.4 Each MCCB shall be provided with minimum 1 NO + 1 NC auxiliary contact and 1NO contact for tripping indication/alarm for owner's use.

9.6.5 MCCBs shall be provided with solenoid/ motorised closing mechanism to make them suitable for remote closing operation if specified. The closing solenoid/motor shall be suitable for specified control supply voltage.

9.6.6 MCCB's as part of motor starter module shall be current limiting motor duty type and type tested for type-2 co-ordination as per IS/ IEC 60947 considering energy efficient motors of IE-3/IE4 type (as per job specification) unless otherwise specified elsewhere.

9.7 Relays

9.7.1 Type of relay shall be numerical, communicable, static or electro-mechanical type as specified in the data sheet /job specification.

9.7.2 All electro-mechanical protective relays shall be back connected, of drawout type, suitable for flush mounting, and fitted with dust-tight covers. Alternatively, "plug-in" type relays will also be acceptable. Auxiliary relays and lock out relays are acceptable in fixed execution.

9.7.3 The protective (static or electro-mechanical type) relay cases shall have a provision for insertion of a test plug at the front for testing and calibration purpose using an external power supply. It shall be possible to test the relays without disconnecting the wiring and without withdrawing the relays. The insertion of the test plug shall automatically short circuit the CTs and permits extension of external power supply to the relay.

9.7.4 Each protective relay shall be provided with minimum 2 numbers potential free contacts of required configuration.

9.7.5 Each tripping relay shall be of lockout type with hand reset coil cut-off contact.

9.7.6 Protective relays shall be preferably mounted on the front side and upper part of the panel and mounting of relays on the lower portion shall be avoided.

9.7.7 CBCT with Earth Leakage Relay shall be provided if specified in job specifications/datasheets. Earth Leakage Relay shall be manually hand reset type. In case hand reset feature is not available in the offered relay model, vendor to provide external hardware logic for manual hand resetting of the earth leakage relay.

9.7.8 Stabilizing resistor shall be provided along with the relays including numerical relays as required to avoid spurious tripping.

9.7.9 Digital motor protection relay (DMPR) shall be provided, if specified in job specifications/datasheets. All DMPR relay shall have Multi-Protection features like Motor protection (Overload, Overcurrent, Earth leakage Protection, Ground fault, Stalled Rotor, Loss of load, Phase unbalance, Negative phase sequence, Reverse connection), overcurrent, undercurrent & under voltage protection.

9.7.10 DMPR shall also have display and following features shall be provided in display like type of fault, three phase current, power, voltage and motor load (%), power factor etc.

9.7.11 CT ratio shall be settable in Digital MPR and communicable type DMPR shall be provided if specified in datasheet/ job specification.

9.8 Instrument Transformers (CTs/PTs)

9.8.1 Current transformers shall generally conform to IS:16227 and any special requirement with respect to numerical relay shall be taken care by the vendor.

9.8.2 For general guidance the vendor shall note that the protective current transformers shall have an accuracy class "5 P" and an accuracy limit factor of minimum "20". However, CTs for restricted earth fault shall be of class "PS"/"PX". Vendor shall co-ordinate the knee point voltage, magnetising current for PS class CTs to avoid saturation and mismatching of CTs provided at other end by other vendor.

9.8.3 Current transformers for metering shall have an accuracy class 1.0 and instrument security factor not greater than 5.0.

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

9.8.5 For numerical relays having protection and metering functions, dual rated CT shall be provided suitable for protection class and metering class. One leg of the CTs shall be earthed.

9.8.6 The voltage transformers shall be cast resin type transformers and PT shall generally conform to IS:16227. PT shall be provided with HRC fuses on primary side and Miniature circuit breakers with auxiliary contact on the secondary side.

9.9 Measuring Instruments

9.9.1 All measuring instruments shall be of 72 x 72 mm square pattern, flush mounting type for incomer and outgoing feeders in the switchboard. The accuracy class for all instruments shall be 1.0 as per IS: 1248.

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

9.9.3 All AC ammeters and voltmeters shall be of moving iron type. Ammeters for motor feeders shall have a non-linear compressed scale at the end to indicate motor starting current and red mark for the full load current.

9.9.3 The KW/KWH meters shall be suitable to measure unbalanced loads on 3 phases 4-wire system. Test terminal block shall be provided for KWH meters.

9.9.4 Multifunction meters/ Digital meters shall be provided, if specified in job specifications/datasheets. All MFM/ digital meters shall be highly reliable, accurate and compact. MFM/ Digital meter data shall be saved in case of power failure. Communicable type MFM/ Digital meter shall be provided if specified in datasheet/ job specification.

9.10 Control/ Selector Switches

9.10.1 All control/ selector switches shall be rotary type, having a cam-operated contact mechanism. Circuit breaker control switches shall be 3-position CNT, spring return to neutral from both Close and Trip positions. They shall have pistol-grip handles and shall be lockable type. Knob type handle shall be provided for other control/ selector switches.

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

position for off. The voltmeter selector switch shall also have 4 positions. Three positions shall be used to measure phase-to-phase voltage and fourth shall be OFF position.

9.11 Push Buttons

Push button colours shall be as follows:

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

The stop push button shall be stay put type & shall have protective hood to avoid accidental operation.

9.12 Indication

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

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

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

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

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

9.13 Auxiliary Relays/Contactors

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

9.14 Timers

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

9.15 Miniature Circuit Breaker

MCB shall provide high mechanical and electrical life, reliable protection of circuits against overload and short circuit and shall have minimum breaking capacity of 9 kA unless otherwise specified. Positive ON/OFF indication shall be provided.

10.0 INTELLIGENT MOTOR CONTROL CENTRE (iMCC)

10.1 In case iMCC is required as per job specification/ datasheet, in addition to requirements specified above, iMCC switchboard shall be intelligent type with microprocessor-based device (intelligent motor controller) with integrated control (feature shall be available but usage shall be as per Job specification), monitoring and protection functions and communication facility in each single motor starter draw-out modules.

10.2 The iMCC and network shall possess all intelligent functionalities but not limited to following: -

i) The intelligent motor controllers shall have Multi-Protection features like Motor protection (Thermal Overload, Overcurrent, Earth leakage Protection, Ground fault, Stalled Rotor, Loss of load, Phase unbalance, Negative phase sequence, Reverse connection), overcurrent, undercurrent & under voltage protection.

ii) Each intelligent motor controller shall also have additional i.e Status, Number of operations, Motor current, Motor running up /starting time, Motor hour run, Local Stop, manual reset of all other alarms and trips, Configurable inputs for external trips (2 as a minimum), status monitoring of LOCAL/REMOTE switch of local control station near motor, Motor reacceleration, Monitoring of consumed active power and the power

iii) The intelligent motor controllers shall have an LCD human-machine interface panel for local programming and operation. All intelligent motor controllers shall have a serial interface in front of device for connection to a laptop computer via RS-232 or USB port configuration.

iv) These modules shall be suitable for communication with a personal computer based Operator work station (OWS) & Engineering Work Station (EWS), Hand held device/Laptops and remote Instrumentation DCS and upper level ECS/SCADA system.

11.0 INSPECTION, TESTING AND ACCEPTANCE

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

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

11.3 Test certificates of bought out components shall be submitted to the inspection agency, as per Inspection and Test Plan no. 6-81-1018.

12.0 PACKING AND DESPATCH

All the equipment shall be divided into several shipping sections for protection and ease of handling during transportation. The equipment shall be properly packed for selected mode of transportation i.e. by ship/rail or trailer. The panels shall be wrapped in polyethylene sheets before being placed in wooden crates /cases to prevent damage to the finish. Crates /cases shall have skid bottoms for handling. Special precaution notations such as 'Fragile', 'This side up', 'Centre of gravity', 'weight', Owner's particulars, Purchase order number etc. shall be clearly marked on the package together with other details as per purchase order.

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

अग्निरोधक प्लगों, साकेटों तथा हैंडलैम्पों के लिए विनिर्देश

SPECIFICATION FOR FLAMEPROOF PLUGS, SOCKETS AND HAND LAMPS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	31.08.20	REVISED AND ISSUED AS STANDARD SPECIFICATION	NNB/AR	ANPS	SA	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	29.08.07	REVISED AND ISSUED AS STANDARD SPECIFICATION	ANPS	UAP	JMS	VC
2	30.01.02	REVISED AND ISSUED AS STANDARD SPECIFICATION	UAP	AAN	VPS	GRR

Abbreviations:

BIS	Bureau of Indian Standards
BS	British Standard
CEA	Central Electricity Authority
COB	Chip On Board
DGMS	Directorate General of Mines Safety
DOB	Driver On Board
ES	Edison Screw
FRLS	Flame Retardant Low Smoke
FRP	Fibre Reinforced Plastic
GI	Galvanised Iron
HRC	High Rupturing Capacity
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical & Electronics Engineers
IP	Ingress Protection
IS	Indian Standard
LED	Light Emitting Diode
LV	Low Voltage
NABL	National Accreditation Board for Testing and Calibration Laboratories
NEMA	National Electrical Manufacturers Association
PCB	Printed Circuit Board
PESO	Petroleum and Explosives Safety Organisation
PVC	Poly Vinyl Chloride
RCCB	Residual Current Circuit Breaker
SPN	Single Phase Neutral
SS	Stainless Steel
TPN	Three Phase Neutral
VDE	Verband der Elektrotechnik, Elektronik und Information stechnik

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Ms. N. P. Guha (Projects)

CONTENTS

1.0 SCOPE

This specification covers the requirements of design, manufacture, testing, packing and supply of flameproof plugs, sockets, transformers, hand lamps 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-16101	:	General lighting – LEDs and LED modules – Terms and definitions.
IS-16102	:	Self-ballasted LED lamps for general lighting services.
IS / IEC 60079-0	:	Electrical apparatus for explosive gas atmospheres (General Requirements).
IS / IEC 60079-1	:	Electrical apparatus for explosive gas atmospheres (Equipment Protection by Flameproof Enclosures “d”).
IS / IEC 60529	:	Degrees of protection provided by enclosures (IP Code).
IS / IEC 60947	:	LV switchgear and control gear.

National Lighting Code (NLC)-2010

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 conform to the provisions of CEA Regulations with latest amendments and other statutory regulations currently in force in the country.

2.4 In case Indian standards are not available for any equipment, standards issued by IEC 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, petrochemical and fertilizer plants. Unless otherwise specified, a design ambient temperature of 40° C and an altitude not exceeding 1000 m above mean sea level shall be considered.

5.0 CERTIFICATION

The equipment shall have test certificates issued by 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 or IEC 60079 and as required by statutory authorities. All indigenous flameproof equipment shall have valid BIS license.

6.0 TECHNICAL REQUIREMENTS

6.1 Construction

6.1.1 The enclosures of the plugs, sockets, transformers and hand lamps shall be made of cast light metal alloy.

6.1.2 The equipment shall be suitable for use in outdoor open locations and shall have minimum IP-55 degree of protection. The sockets for fixed installation, i.e. 415 V three phase sockets and 240 V single phase sockets, shall preferably be provided with integral canopy. However, where the enclosure has been certified without integral canopy, a separate canopy can be accepted. The separate canopy shall be made of at least 1.6 mm (16 gauge) galvanised sheet steel/ FRP/ stainless steel minimum SS-304 (as specified in purchase specifications). The canopy shall be suitable for providing protection against rain from top, back and two sides.

6.1.3 The enclosures shall be provided with gaskets for IP, if required by equipment certification. Gaskets, wherever provided, shall be made of non-inflammable and self-extinguishing material.

6.1.4 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:

- Flame proof (Gas group IIA/ IIB) : Dark admiralty grey shade 632 of IS-5/ RAL 7031
- Flame proof (Gas group IIC) : Light yellow shade 355 of IS-5/ RAL 1012

All unpainted steel parts shall be suitably treated to prevent rust formation/ corrosion. If these parts are moving then these shall be greased. Grease, which does not solidify, shall be applied to flamepath.

6.1.5 Equipment shall be marked as per IS/IEC 60079.

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

6.1.7 All the non current carrying metallic parts of the equipment shall be inherently bonded together. The TPN sockets shall be provided with two earthing studs, with lugs on the exterior of the enclosure, suitable for termination of 10 mm dia. GI wire rope. Internal earth terminals shall be provided in each enclosure for all single phase plugs and sockets for connecting the earth core of the cables.

6.1.8 The terminal block enclosures shall be adequately sized to properly terminate the cables by taking into account the required bending radii of cable cores and shall have the following minimum gland to terminal distances:

Conductor Size	Up to 2.5 mm^2	Above 2.5 mm^2 & Up to 10 mm^2	Above 10 mm^2 & Up to 35 mm^2	Above 35 mm^2 & Up to 70 mm^2
Gland to terminal distance	35 mm	60 mm	100 mm	150 mm

6.1.9 The sockets shall be provided with 2 nos. suitably sized cable entries at the bottom for specified cable sizes and complete with 2 nos. flameproof double compression type nickel plated brass flameproof cable glands. The plugs shall be supplied with 1 no. suitably sized cable entry for specified cable size and complete with 1 no. double compression type nickel plated brass flameproof cable gland. Each socket shall be supplied with 1 no. flameproof nickel plated brass sealing plug, for plugging the unused cable entry.

6.1.10 The sockets shall have external fixing lugs for mounting on wall or column. The holes provided on these lugs shall be of oblong type.

6.1.11 A tag plate indicating Tag Number shall be provided on each socket. A nameplate shall be provided to indicate the Name of Manufacturer, test certificate number, serial number, BIS license number, applicable gas group etc. as per IS/IEC 60079 and any additional marking required by statutory authority like approval no. etc. The nameplates shall be engraved type or laser-marked and permanently fixed on the equipment. In case the standard details given above are embossed on the enclosures, the same need not be repeated on the name plate. All tag plates shall be engraved, 3 ply laminate fixed with screws and name plate shall be Al anodized or SS-304 engraved or laser-marked and fixed with rivets.

6.2 Socket Outlets & Plugs

6.2.1 The sockets shall be provided with a switch and a mechanical interlock so as to break the electrical circuit before the plug is completely withdrawn and make the circuit after the plug is fully inserted.

6.2.2 In order to prevent accidental removal of plug from socket, the engagement and disengagement shall be by two separate and distinct movement and positions.

6.2.3 415V, 63A three phase flameproof plugs and socket meant for welding receptacle/ any other three phase auxiliary load, shall be provided with 4 pins (3P+E).

6.2.4 4 pin socket shall be provided with 63A, three pole heavy duty switch; whereas, 5 pin socket shall be provided with four pole (TPN) heavy duty switch. Heavy duty switch shall be suitable for AC duty rating as applicable.

6.2.5 Both 24V and 240V, 15A single phase flameproof plug and socket shall be provided with 3 pins (2P+E).

6.2.6 Provision shall be made so that it shall not be possible to insert 24V plug on to a 240V socket.

6.2.7 The sockets shall be provided with either a spring loaded hinged cover, or with a cap connected through metallic chain, to close the same when not in service.

6.2.8 Scraping earth connection shall be provided between the plug and socket. Earth pin of plug shall first engage with earth pin of switch socket.

6.2.9 The plug assembly shall be mechanically rugged, light and shall not unduly stress the socket or its own pins when fitted on to the socket. The diameter of the earth pin of the plug and socket shall be at least 1.1 times the diameter of the phase pins.

6.3 240V/ 24V Portable Transformer units

6.3.1 The 240V/ 24V portable transformer unit shall be supplied complete with 240V/ 24V transformer having a 24V socket on the secondary side and 5 meter length of 3x1.5 mm^2 copper conductor, PVC insulated, metal braided flexible cable, duly terminated in the transformer primary at one end and having 240V plug on the other end. The socket outlets and plugs shall meet the requirements of clause 6.2 above.

6.3.2 The 240V/ 24V transformer shall be designed for 30VA rating on continuous basis. Insulation Class shall be "B", as a minimum. Automatic protection employing earth leakage detection scheme with 30mA current sensitivity shall be provided to disconnect supply on occurrence of an earth fault. 30mA RCCB (preferable)/ HRC fuses shall be provided on primary and secondary side of the transformer. The transformer shall have an earthed screen between primary and secondary winding.

6.3.3 Suitable handle for carrying the transformer unit shall be provided.

6.3.4 Alternatively, 24V socket outlet (as per Cl. 2.5 above) shall be provided with a built-in 240V/24V 30VA transformer duly protected by HRC fuse in phase on primary side. In this case, a separate portable 240/24V transformer unit is not required.

6.4 24V Hand Lamp units

6.4.1 Each hand lamp unit shall be supplied complete with 15 meter length of 3x1.5 mm² copper conductor, PVC insulated, metal braided flexible cable, duly terminated in the hand lamp at one end and having 24V plug on the other end. The plug shall meet the requirements of clause 6.2 above.

6.4.2 The well glass provided shall be clear and toughened type. Hand lamp shall be provided with 10W, 24V AC LED lamp with ES27 cap having minimum output of 900 lumens. Alternatively, if specified in MR, it shall be with lens/ glass and 20W, 24V AC COB/ discrete LED with driver/ LED PCB with DOB having minimum output of 1800 lumens. The minimum output for 10W or 20W shall be guaranteed at 18V to 26V.

6.4.3 Hand lamp shall be provided with either galvanised steel or epoxy powder coated mild steel protective wire cage using minimum 3mm welded steel construction and having mesh dimension not exceeding 50mm x 50mm.

6.4.4 Suitable handle for carrying the hand lamp unit and a stand type guard suspension hook shall be provided.

6.5 Terminals & Wiring

6.5.1 All equipments shall be provided with sufficient number of terminals. More than 2 wires per terminal shall not be permitted. If required, additional terminal with shorting link may be used. The terminals shall be suitable for termination of stranded conductors. Tinned copper lugs shall be provided for cable termination.

6.5.2 All internal wiring shall employ adequately sized, 660V grade, FRLS type, PVC insulated Copper conductor wires, colour coded for phase, neutral and earth, with minimum conductor sizes as below:

TPN Plugs and sockets:	16 mm²
SPN Plugs and sockets:	2.5 mm²

7.0 INSPECTION, TESTING AND ACCEPTANCE

7.1 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.

7.2 Type test certificates from NABL-approved/ Central Government Labs in India/ IECEx-certified/ equivalent Labs, Manufacturer's works test reports applicable PESO/ DGMS 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.

7.3 Test certificates of bought out components shall be submitted to the inspection agency, as per Inspection and Test Plan no. 6-81-1021.

7.4 All equipments shall be subjected to various routine/ acceptance tests as per Inspection and Test Plan no. 6-81-1021.

8.0 PACKING AND DESPATCH

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

'Weight', 'Owner's particulars','PO no.' etc., shall be clearly marked on the packages together with other details as per purchase order.

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

हाई मास्ट विद्युत प्रणाली के लिए विनिर्देश

SPECIFICATION FOR HIGH MAST LIGHTING SYSTEM

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	30.06.2020	REVISED AND REISSUED AS STANDARD SPECIFICATION	DR	VK	SA	SKS
3	28.04.2015	REVISED AND REISSUED AS STANDARD SPECIFICATION	VT	PG	BRB	SC
2	17.03.2010	REVISED AND REISSUED AS STANDARD SPECIFICATION	RS	PG	NS	JMS
1	21.02.2005	REVISED AND REISSUED AS STANDARD SPECIFICATION	SSM	RR	AAN	SKG

Abbreviations:

A	:	Ampere
BIS	:	Bureau of Indian Standards
BS	:	British Standard
CEA	:	Central Electricity Authority
CRCA	:	Cold Rolled Cold Annealed
EIL	:	Engineers India Limited
ELCB	:	Earth Leakage Circuit Breaker
EPR	:	Ethylene Propylene Rubber
FGL	:	Finished Grade Level
GI	:	Galvanized Iron
HPP	:	Highest Pavement Point
HRC	:	High Rupture Capacity
ICAO	:	International Civil Aviation Organisation
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical and Electronics Engineers
IP	:	Ingress Protection
IS	:	Indian Standard
LED	:	Light Emitting Diode
LM-6	:	Light Metal Alloy
MCB	:	Miniature Circuit Breaker
NEMA	:	National Electrical Manufactures Association
PO	:	Purchase Order
PVC	:	Poly Vinyl Chloride
QAP	:	Quality Assurance Plan
TMT	:	Thermo Mechanically Treated
TPN	:	Three Phase and Neutral
V	:	Volt
VDE	:	Verband Deutscher Elecktrotechniker

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
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Mr. Rajesh Sinha (Inspection)
Ms. N.P. Guha (Projects)

CONTENTS

1.0 SCOPE

This specification defines the requirements for design, fabrication, testing at manufacturer's works, supply, installation at site, testing and commissioning of high mast lighting system for safe area and hazardous area, including supply and installation of associated cables and materials, design and supply of civil and structural foundation and supply of all related materials.

2.0 CODES AND STANDARDS

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

IS-383	:	Specification for coarse and fine aggregates from natural sources for concrete
IS-455	:	Specification for Portland slag cement
IS-456	:	Plain & reinforced concrete – code of practice
IS-875	:	Code of practice for design loads (other than earth quake) for buildings and structures: Part-3- Wind loads
IS-1363	:	Hexagon Head bolts, screws and nuts of product Grade 'C' Part-1: Hexagon Head Bolts (size range M5 to M64)
IS-1489 PT-1	:	Specification for Portland Pozzolana cement (Fly Ash based)
IS-1554	:	PVC insulated (Heavy-duty) electrical cables
IS-1786	:	High strength deformed steel bars and wires for concrete reinforcement – Specification
IS-2062	:	Hot Rolled Medium and High Tensile Structural Steel
IS-2629	:	Recommended practice for hot dip galvanising of iron and steel
IS-3043	:	Code of practice of earthing
IS-3618	:	Specification for Phosphate treatment of iron and steel for protection against corrosion
IS-4759	:	Hot dip zinc coating on structural steel and other allied products
IS-6623	:	Specification for High Strength Structural Nuts
IS-6649	:	Hardened and tempered Washers for High Strength Structural Bolts and Nuts
IS-7098	:	Cross-linked polyethylene insulated PVC sheathed cables
IS-8112	:	43 Grade ordinary Portland cement-specification
IS-9103	:	Concrete Admixtures – Specification
IS-9968	:	Elastomer insulated cables (Part-1) for working voltage upto and including 1100V
IS-12269	:	Specification for 53 grade Ordinary Portland cement
IS-12330	:	Specification for Sulphate Resisting Portland cement
IS/IEC 12615	:	Energy efficient induction motors (three phase squirrel cage)
IEC-60034	:	Rotating Electrical Machines
IS / IEC 60079-0	:	Electrical apparatus for explosive gas atmospheres (General Requirements).
IS / IEC 60079-1	:	Electrical apparatus for explosive gas atmospheres (Equipment Protection by Flameproof Enclosures "d").
IS / IEC 60079-7	:	Electrical apparatus for explosive gas atmospheres (Equipment Protection by Increased Safety "e").
IS/IEC-60529	:	Degree of protection provided by enclosure of rotating electrical machinery

IS/IEC-60947	:	Specification for Low voltage switchgear and control gear
IS/IEC-62305	:	Protection against lightning
BS EN 10025	:	Hot rolled products of structural steels

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

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

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

2.5 In case of any conflict between various referred standard/specification/datasheet and statutory regulations, the most stringent requirement shall govern and decision of owner in this regard shall be final & binding.

3.0 GENERAL REQUIREMENTS

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

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

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

3.4 The high mast lighting system shall have a minimum design life of 25 years unless otherwise specified.

3.5 For installation in hazardous area, the equipments of High Mast Lighting system which are installed at ground level (i.e. Power tool for winch drive, Feeder Pillar Distribution Box, Local Control Station, cable glands, etc.) shall be flameproof (Ex-d) type.

3.6 The flameproof equipment shall have test certificates issued by recognized independent test house (CIMFR/ ERTL/ Baseefa/ LCIE/ UL/ FM or equivalent). All equipment (indigenous & imported) shall also have valid statutory approvals as applicable for the specified location. All indigenous flameproof equipment shall have valid BIS license and marking as required by statutory authorities.

3.7 A nameplate indicating Tag Number shall be provided on each flameproof equipment in case of High Mast Lighting System is to be installed in hazardous/classified area. Separate nameplate shall also be provided to indicate the details of testing agency (CIMFR or equivalent), test certificate reference, statutory approval agency (PESO / DGMS) and reference, BIS license number, applicable gas group etc. The nameplates shall be engraved type and permanently fixed on the equipment. In case the standard details given above are embossed on the enclosures, the same need not be repeated on the name plate.

4.0 SITE CONDITIONS

The equipment and materials to be supplied & installed by the vendor shall be suitable for continuous and trouble free operation at 40° C unless specified otherwise in the data sheet.

5.0 EQUIPMENT SPECIFICATIONS

The high mast and other equipment and materials shall be of the best quality and shall conform to the specifications given hereunder.

5.1 Mast

5.1.1 The high mast shall be of continuously tapered, min. 20 side polygonal cross section construction. Minimum height of mast shall be 30 meters unless otherwise specified. The mast shall be fabricated from minimum 4 mm thick steel plates in suitable number of sections, telescopically jointed, giving a continuous tapered profile and presenting good visual appearance. The material of construction (MOC) of high mast shall be of S-355 Grade of BS EN 10025. The thickness of base plate shall be of 25 mm minimum. The base flange shall be provided with gaskets and high/medium tensile anchor bolts. The bottom section shall have adequate sized opening with a hinged door to accommodate electric drive for winch, cable, plug socket, etc. The opening shall be such as to permit clear access to the above components inside the mast. The opening shall be complete with a close fitting, dust and vermin proof door, weather protected with gaskets of durable material and provided with a heavy-duty double locking arrangement.

5.1.2 The means for natural ventilation of the mast shall be provided.

5.1.3 Both the inner and the outer surfaces of the entire fabricated mast along with the attached accessories shall be hot dip galvanized. The amount of galvanizing shall be 610gm per sq. metre (85 micron uniform thickness) in accordance to IS: 2629 unless otherwise specified.

5.1.4 The whole head frame assembly shall be covered and protected by an aluminum/ galvanised sheet steel canopy secured to the frame by stainless steel bolts and nuts. The canopy shall have suitable prevention arrangement against entry of birds etc.

5.1.5 The mast shall have integral power tool for winch drive unless otherwise specified in the datasheet.

5.1.6 The mast shall have two nos. of stainless steel/galvanized earthing terminals at convenient location in the base compartment and these shall be suitable for connection with 50x6mm GI strip to the plant-earthing network/ earth pit unless otherwise specified.

5.1.7 Lightning rod at the top of the mast for the lightning protection of the lighting mast system as per standard IS/IEC-62305 shall be provided.

5.1.8 Horizontal deflection shall limited as per Professional lighting guide (PLG-07) - High Masts for lighting and CCTV of Institution of Lighting Professionals.

5.1.9 The complete design of the mast and associated foundation shall be such that mast is structurally and mechanically safe.

5.2 Lantern Carriage

5.2.1 The Lantern carriage shall be of steel tubular ring type construction designed to accommodate the specified number of lighting fixtures and balance counter weights shall be provided wherever required. The carriage shall be fabricated in two halves jointed by bolted flanges to enable easy removal from the erected mast for replacement and maintenance purpose.

5.2.2 The complete lantern carriage assembly shall be hot dip galvanized after fabrication. It shall have perfect self-balance arrangement so as to avoid swing and to prevent damage to mast surface or other installed parts, during lowering/raising operation of carriage.

5.2.3 All hardware used shall have necessary corrosion protection. The carriage shall have weather protected IP-55 cast aluminum junction box with required number of terminals (phase, neutral and earth) for connection to the designed number of flood light fittings and associated control gear boxes fixed on the carriage.

5.2.4 Unless otherwise specified, Single arm lantern carriage shall be suitable for accommodating a minimum 12 nos. LED flood light fixtures. High Mast with a double arm lantern carriage shall be suitable to accommodate minimum 24 nos. of LED flood lighting fixtures. The number, wattage and type of lighting fixture of the high mast shall be supplied as specified in job specification/data sheet.

5.2.5 The LED flood light fixtures complete with integral driver & lamp, shall have die cast aluminum body with toughened glass, having min. IP-66 ingress protection and shall be provided with angle indicator for aiming.

5.2.6 Each high mast shall have minimum two numbers aviation obstruction lighting fixtures. The lighting fixtures shall have cluster LED lamps of medium intensity (as per ICAO regulations) and of red color.

5.2.7 Provision shall also be available to test the luminaries of safe area high mast while lantern carriage is in lower position by connecting the plug to the receptacle provided on the lantern carriage. In case of High Mast Light installed at hazardous areas, luminaries/fixtures shall be tested at other safe places (such as Plant workshop, etc.) as luminaries/fixtures are safe area type and not desired to be tested at hazardous areas.

5.3 Winch Assembly

5.3.1 For lowering and raising of lantern carriage assembly, a winch arrangement shall be fixed in the bottom of the mast. This shall have provision to operate both manually and electrically.

5.3.2 The winch shall be suitable to handle the weight of the lantern carriage assembly with lighting fixtures and all other accessories, with factor of safety not less than two unless otherwise specified.

5.3.3 Minimum two number of winch drums shall be provided for the winch assembly. The winch shall be of self-sustaining type with positive locking arrangement without the need for brake shoe, springs or clutches.

5.3.4 The winch shall be self-lubricating type by means of an oil bath.

5.3.5 The mast shall be fitted with flexible stranded high tensile strength stainless steel wire ropes, which shall have a factor of safety not less than five times the safe working load of winch.

5.3.6 Particular care shall be exercised in all aspects of design, manufacture, testing and installation arrangements of the system to ensure safety under all operation conditions.

5.3.7 The material of construction for top pulley block shall be non-corrosive and preferably made up of die cast LM-6 aluminum alloy, with self-lubricating bearing. The design shall ensure that the operation of pulleys is maintenance-free.

5.4 **Power Tool for Winch Drive**

5.4.1 The rating and capacity of the electric motor used in power tool shall be compatible to lift the design load of lantern carriage with design margin of minimum 20%. The winch drive shall incorporate torque limiter. Manual handle shall also be provided for hand operation of winches. Power tool shall have self-alignment arrangement. For hazardous area, power tool shall be flameproof (Ex-d) type.

5.5 Feeder Pillar Distribution Box

5.5.1 Each high mast shall be supplied with one power supply feeder pillar distribution box, which shall be located near it.

5.5.2 The feeder pillar distribution box shall be metal enclosed, pedestal mounted type made out of 2mm thick mild sheet steel/CRCA, epoxy painted and IP-55 weather protected. Additional canopy for rain protection shall be provided as an integral part of feeder pillar distribution box.

5.5.3 The feeder pillar distribution box shall be complete with incomer Switch, HRC fuse/MCB, ELCB, motor starters for winch drive, MCB for lighting control and a 3 pin 5/15A socket alongwith 15A MCB. MCB and ELCB shall be separate unit.

5.5.4 Motor starter shall be complete with switch, HRC fuse, contactor, and bimetal relay with single phasing prevention feature.

5.5.5 LEDs for indication of incoming power supply healthy for feeder pillar distribution box incomer shall be provided. Feeder pillar shall also have provision to receive emergency power supply for aviation fixtures in case specified in the data sheet.

5.5.6 Adequately rated space heater with MCB, thermostat shall be provided for the feeder pillar distribution box.

5.5.7 Feeder pillar distribution box shall have adequate space to receive incoming and outgoing cable terminations for 415V, TPN supply loop in and loop out arrangement.The feeder pillar distribution box shall be complete with double compression nickel-plated brass cable glands and tinned copper lugs. For hazardous area, flameproof (Ex-d) type feeder pillar distribution box along with required number of flameproof double compression nickel plated brass cable glands and flameproof nickel plated brass sealing plugs shall be provided.

5.5.8 The feeder pillar distribution box shall have two numbers external earthing terminals.

5.5.9 The feeder pillar distribution box shall have required wiring interface for taking signals from hand held external control push button station for raising and lowering of lantern carriage.

5.5.10 The feeder pillar distribution box shall be installed on a raised concrete foundation block and foundation shall be up to the level of minimum 300mm above ground level.

5.6 Local Control Station

5.6.1 Local control station shall be hand held type. This control station shall have necessary raise/lower pushbuttons, emergency stop push button etc.

5.6.2 The hand held control Pushbutton station shall be supplied with minimum of 5 meters length of 5Cx2.5 sq.mm. Copper conductor, XLPE/ PVC insulated, metal braided, overall PVC sheathed flexible cable.

5.6.3 The hand held control station and associated cable shall be kept inside feeder pillar distribution box when not in use and suitable arrangement shall be provided for the same.

5.6.4 For hazardous area, flameproof (Ex-d) type control station shall be provided.

5.7 Cable and Cable Connections

5.7.1 All power and control cables including flexible trailing cables shall be supplied laid and terminated by the high mast vendor.

5.7.2 The electrical connections from base compartment to the junction box on the lantern carriage shall be made through special multicore trailing cable of minimum size 4 sq.mm copper conductor, EPR insulated, metal braided and sheathed in heavy duty Polychloroprene.

5.7.3 Multi-core trailing cable of minimum 7 cores shall be provided unless otherwise specified. Separate cores shall be used for lighting fixtures, aviation fixtures and one dedicated core shall be kept for earthing. Suitable chemicals shall be added to outer sheath of cable to protect the cable against birds, rodent and termite attack.

5.7.4 All power and control cables shall be 1100V grade and shall conform to IS-7098 and all flexible-trailing cables shall also comply with requirement of IS-9968.

5.7.5 The trailing cable shall be terminated by means of metal cased plug and socket, which shall be provided at the base compartment to enable easy disconnection. The trailing cable at the lantern carriage shall be taken in flexible metal conduit.

5.7.6 The cable for connection to flood lighting fixtures /aviation lighting fixtures from junction box provided on lantern carriage shall be through 3Cx2.5 sq.mm copper conductor, XLPE insulated, armoured and overall PVC sheathed cable. In case unarmoured cable is provided by vendor then the same shall be laid through GI flexible conduit for mechanical protection of cables. The power cable from feeder pillar box to winch motor and MCB Isolator box in base compartment shall be minimum 4 sq. mm. and 6 sq. mm. copper conductor, XLPE insulated, armoured and overall PVC sheathed cable, respectively.

5.7.7 Connection to the power tool motor inside mast at the bottom shall be through metal cased plug and socket arrangement to enable easy disconnection.

5.7.8 All cabling from feeder pillar distribution box to high mast shall be laid in directly buried trenches.

5.7.9 For flameproof equipments of high mast lighting system, the terminal box can be provided in 'Ex-e' or 'Ex-d' execution.

6.0 CIVIL STRUCTURAL WORKS

6.1 Scope of Work

The scope of work under this also includes design, detailing, supply and construction of foundations for high mast lighting system works. The work shall in general be executed as per IS-456 and all referred codes therein.

6.2 Materials

6.2.1 Cement

The cement used shall be any one of the following types unless otherwise specified in project data sheet:

a. 43 Grade ordinary Portland cement conforming to IS-8112.
b. Portland Pozzolana Cement (Fly Ash based) conforming to IS: 1489 Pt-1.
c. 53 grade Ordinary Portland cement conforming to IS: 12269.
d. Portland slags cement conforming to IS-455.
e. Sulphate resisting Portland cement conforming to IS-12330.

6.2.2 Aggregates

a. Naturally occurring as well as manufactured aggregates conforming to IS-383 shall be used.
b. Coarse aggregate shall be 20mm down graded as per IS-383.
c. Fine aggregate shall be graded evenly from fine to coarse as per Zones II and III of IS-383. Zone IV aggregate shall not be used.

6.2.3 Water

Water used for manufacture and curing of concrete shall be clean and free from injurious amounts of oils, acids, alkalies, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel as specified in IS-456. Potable water shall be considered satisfactory.

6.2.4 Chemical Admixtures

a. Chemical admixtures, if used, shall conform to IS-9103.
b. Criteria of use of chemical admixtures shall be as per IS-456.

6.2.5 Reinforcing Steel

a. Only high strength deformed steel bars of grade Fe 500 (TMT)/ Fe 500 D conforming to IS: 1786 shall be used.
b. Minimum diameter of main reinforcing bars in foundation and pedestal shall be 12mm. Links shall be of minimum 8mm diameter.

6.2.6 Anchor / Foundation Bolts

High/Medium tensile steel bars for turning anchor bolts shall conform to IS-2062 Grade A/BR/BO. Nuts shall conform to IS-1363 & IS 6623. Washers shall conform to IS: 6649.

6.3 Concrete

The concrete shall be design mix of minimum grade of M25 or as per Geotechnical Document (whichever is higher) and other requirements as mentioned in project data sheet. 75mm thick lean concrete shall be provided under the structural foundation of proportion 1:5:10 using 40mm down aggregates. The mud mat of lean concrete shall project 50mm beyond all sides of the structural foundation slab. Minimum cover to reinforcement shall be 50 mm.

Height of pedestal shall be 500mm/300mm above FGL/HPP respectively. Sleeves for cable entry and exit shall be placed in the pedestal. Minimum thickness for foundation slab shall be 500mm.

6.4 Design of Foundation

a. The foundation shall be placed minimum 1.5 meters below Finished Grade Level (FGL) or as per Geotechnical Document.

b. Factor of safety against overturning and sliding shall be considered as 2.0 and 1.5, respectively. Only 50% of the overburden weight of backfilled soil over base slab of the foundation shall be accounted for checking of over-turning and sliding. All design parameters for foundation shall be as per IS-456 and referred BIS codes. Limit state method shall be used.

c. Information of Soil bearing capacity/filled up soil/ ground improvement etc. shall be as per Geotechnical Document.

6.5 Loadings

Loading in general shall be as per IS-875. The basic wind speed shall be as per the Project/site location and as called for in IS-875 (Part-3). The value of K_1, K_2, K_3 and K_4 shall be as follows:

K_1 = As per IS 875 for 25 Years
K_2 = 1.0
K_3 shall be appropriate to topography but not less than 1.0.
K_4 = 1.0

6.6 Review of Foundation Design/Drawing

Design and drawing shall be prepared on standard size sheets and submitted for review/approval prior to execution of works. Construction shall not be taken up prior to documents/drawings reviewed in code 1 or 2.

6.7 Construction Requirements

Construction shall be done following all safe practices required in IS-456 and other referred codes.

7.0 INSPECTION, TESTING AND ACCEPTANCE AT WORKS

7.1 During fabrication, the High mast lighting system equipment and materials shall be subject to inspection by EIL / Owner, or by an agency authorized by the Owner, to assess the progress of work, as well as to ascertain that only proven raw material is used. The manufacturer shall furnish all necessary information /data concerning the supply to EIL / Owner's inspectors. The vendor shall give at least 15 days notice to the purchaser regarding the date of testing to enable him or his representative to witness the tests.

7.2 Tests shall be carried out at the manufacturer's works under his care and expense. All routine tests as specified by the applicable standard codes shall be conducted. Type test certificates for the high mast lighting system equipments used shall be furnished from a recognized testing organization.

7.3 Inspection and testing requirements for high mast system shall be as per Inspection and test plan, specification no. 6-81-1039 and owner-approved vendor's QAP to check mechanical and electrical operation.

7.4. All tests shall be conducted as per relevant applicable standards.

7.5. 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.

8.0 PACKING AND DESPATCH

The equipment shall be divided into several shipping sections for protection and ease of handling during transportation. The equipment shall be properly packed for transportation by ship/rail or trailer. The equipment shall be wrapped in polyethylene sheets before being placed in wooden crates/cases to prevent damage to the finish. Crates/cases shall have skid bottoms for handling. Special notations such as 'Fragile', 'This side up', '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 should also be suitable for outdoor storage areas with heavy rains/ high ambient temperature unless otherwise agreed.

9.0 FIELD TESTING AND COMMISSIONING

9.1 Supervision during installation, testing and commissioning shall be carried out by vendor's experienced and trained engineer/supervisor. Any defect pointed out by EIL/Owner shall be rectified by vendor at no extra cost to the owner.

9.2 Before any part of the High mast lighting system is energised, the pre-commissioning tests shall be carried out. This shall include but not be limited to the following:

a. Insulation resistance tests
b. Continuity test
c. Earth continuity check and measurement
d. Load current in all phases shall be measured in each mast
e. All safety interlocks
f. Feeder pillar distribution box wiring schematics and functional requirements

All pre-commissioning checks and tests both for power distribution and lighting system shall be carried out by vendor in the presence of Engineer-in-charge of EIL/Owner.

9.3 After completion of job, vendor shall carry out the measurement of achieved illumination level in different areas and shall furnish test reports. The focusing angle of fixture shall be changed/ adjusted where required.

9.4 After inspection and pre-commissioning tests are carried out, vendor shall obtain necessary statutory approval of the system from Central Electricity Authority or any other statutory body as specified in the specification. All test results shall be recorded and submitted to EIL/owner.

शुष्क किस्म के लाईटिंग ट्रांसफॉर्मर के लिए विनिर्देश

SPECIFICATION FOR DRY TYPE LIGHTING TRANSFORMER

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	23.11.2022	REVISED AND REISSUED AS STANDARD SPECIFICATION	MKM	HK	MKS	SM
5	03.04.2017	REVISED AND REISSUED AS STANDARD SPECIFICATION	NT	SA	BRB	RN
4	08.04.2011	REVISED AND ISSUED AS STANDARD SPECIFICATION	MK	SA	UAP	DM
3	25.04.2008	REVISED AND ISSUED AS STANDARD SPECIFICATION	SA	NS	JMS	VC
2	25.03.03	REVISED AND ISSUED AS STANDARD SPECIFICATION	NPG	RR	VPS	SKG

Abbreviations:

AN	:	Air Natural
BIS	:	Bureau of Indian Standards
BS	:	British Standards
CEA	:	Central Electricity Authority
CRCA	:	Cold Rolled Cold Annealed
IEC	:	International Electro technical Commission
IEEE	:	Institute of Electrical and Electronics Engineers
IP	:	Ingress Protection
IS	:	Indian Standard
KVA	:	Kilo Volt Amperes
MSL	:	Mean Sea Level
MV	:	Medium Voltage
NEMA	:	National Electrical Manufacturers Association
PO	:	Purchase Order
PVC	:	Polyvinyl Chloride
SWG	:	Standard Wire Gauge
VDE	:	Verband Der Electrotechnik, Elecktronik und Information Stechnik

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Mr. Rajesh Sinha (Inspection)

CONTENTS

1.0 SCOPE

The intent of this specification is to define the requirements for design, manufacture, testing, packing and supply of cast resin / resin impregnated dry type lighting transformers suitable for indoor location.

2.0 CODES AND STANDARDS

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

IS: 5	:	Colours for ready mixed paints and enamels
IS: 1271	:	Electrical Insulation-thermal evaluation and designation.
IS: 2026: Part 11 / IEC: 60076-11	:	Dry Type Transformer
IS: 2705: Part I	:	Current transformers - General requirements
IS: 10028	:	Code of practice for selection, installation and maintenance of transformers.
IS/ IEC: 60529	:	Degree of protection provided by enclosures (IP Code)
ECBC 2017	:	Energy Conservation Building Code

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

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

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

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

3.0 GENERAL REQUIREMENTS

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

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

3.3 Vendor shall give a notice of at least one year to the 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

Transformer shall be suitable for installation and satisfactory operation in tropical, humid and corrosive atmospheres found in Refineries, Petrochemical and Fertilizer plants or as specified in the material requisition / tender. The transformer shall be designed to operate under site conditions as specified in data sheet. If not specifically mentioned therein, design ambient temperature of 40°C and altitude not exceeding 1000m above MSL shall be considered.

5.0 CONSTRUCTION

5.1 The transformer shall be dry type, AN cooled suitable for indoor installation. Transformer shall be conventionally housed in a freestanding panel type enclosure of welded sheet steel frames with expanded metal screens of suitable size or louvres backed by wire-mesh. Transformer and the enclosure shall be suitably reinforced to prevent distortion during handling.

For panel mounted transformer, if specified in datasheet, the panel shall be floor mounted type suitable for installation in substation and shall not have any wheels / rollers. The panel shall be provided with integral base frame which shall be suitable for tack welding.

The frame of vertical panels of panel mounted transformer shall be fabricated using pressed and cold rolled sheet steel. The sheet steel used for panel shall be of minimum 2mm (14SWG) CRCA except the doors and covers that may be made of 1.6mm (16SWG) CRCA. Wherever required, stiffeners shall be provided to increase mechanical strength of large size doors and covers.

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

5.3 The transformer shall be double wound core type with non-ageing, cold rolled grain oriented silicon steel insulated laminations with high magnetic permeability and clamped to minimise vibrations and noise. Core lamination shall be free of burrs and shall be stacked without Air gaps. Core fastening bolts shall be insulated to reduce losses and to avoid hot spots. All parts of the magnetic circuit shall be effectively connected to the earth system.

5.4 The winding shall be of copper and shall be designed for full load current and to withstand the thermal and electromagnetic stresses arising due to the through fault current. The current carrying winding joints shall be electrically brazed. Foil type windings are not acceptable.

5.5 Voltage ratio of lighting transformer shall be as mentioned in Datasheet/Material Requisition/Tender.

5.6 Vector group of transformer shall be as mentioned in Datasheet/Material Requisition/Tender. The windings shall be provided with class 'F' insulation for lighting transformers upto 100 KVA and class 'H' insulation for rating more than 100 KVA.

5.7 Conventional Lighting Transformer shall have minimum degree of protection as IP-23. The enclosure of panel mounted transformer shall be dust and Vermin-Proof and shall provide a degree of protection not less than IP-41. In case of conventional transformer, Marshalling box and cable termination box shall have degree of protection not less than IP-55.

5.8 Different non current carrying parts of the transformers shall be connected by copper flexibles for earth continuity purpose.

5.9 All doors and movable parts of panel mounted transformer shall be earthed, using flexible copper connections, to the fixed frame of the panel. The panel mounted transformer shall be provided with two earthing studs with lugs on the external surface of the enclosures suitable for termination of GI strip / earthing cable.

5.10 All the fasteners and bolts shall be galvanized. All surfaces to be painted shall be thoroughly cleaned, descaled, made free from rust and shall be epoxy painted.

5.11 A warning inscription "DO NOT OPEN WHEN ENERGIZED" shall be provided on panel mounted transformer. 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.

5.12 Dry type transformer shall be energy efficient with permissible maximum losses at 50% and 100% loading not exceeding the values as defined in Energy Conservation Building Code (ECBC) - 2017.

6.0 TERMINALS

6.1 Windings shall be brought out and terminated in cable boxes for conventional lighting transformer.

6.2 Cable boxes shall be supplied with cable lugs and glands. For MV XLPE power/control cables single compression cable glands and crimped type tinned copper cable lugs shall be supplied. Gland plate shall be removable type. For single core cables, gland plate shall be of non-magnetic material.

6.3 In case of panel mounted transformer, panel shall be provided with bottom cable entries for connecting both primary and secondary windings of transformer installed inside panel. Thus a separate cable termination box is not required. Primary and secondary cable termination arrangement inside panel shall be oriented accordingly for routing and termination of Owner's cables inside panel.

6.4 A separate neutral terminal on the secondary side shall be provided for neutral earthing of the transformers. The neutral terminal shall be complete with connector block assembly for easy termination of GI earth strip / cable.

7.0 ACCESSORIES

Tappings shall be provided on the Primary side. Tap changer shall be off-circuit rotary type or tap links type. Under conditions of external short circuit, the tap changing equipment shall be capable of carrying the same current as the winding. Tap changer regulation range shall be +5% / -7.5% with each step of 2.5%. Tap changing mechanism shall be easily accessible and it shall be possible to change the taps without opening the main transformer enclosure.

Base channels shall be provided with skids and pulling eyes to facilitate handling. Tag plate shall be provided. In case of panel type transformer, suitable removable type eye bolts /lifting hooks shall be provided on the panel to facilitate lifting and handling of the panel. These eyebolts /lifting hooks when removed shall not leave any opening in the panel.

Temperature monitoring system shall be supplied with temperature sensors fitted in each limb. Temperature monitoring system shall initiate alarm and trip for winding over temperature. Alarm and trip temperatures value shall be site settable. The monitoring system shall also have an indicating device.

240V SPN supply at one point shall be provided by purchaser at transformer panel. All the further distribution from this point shall be done by vendor.

ON/OFF Indication Lamps mounted on the door and LED lamp controlled through a door limit switch shall be provided for illumination inside the panel for panel mounted type transformer.\

8.0 NOISE LEVEL

Audible noise level for lighting transformers shall not exceed the limits specified as below:

KVA	Average sound level in decibels (At 30 cm from transformer)
0-50	50
51-150	55
151-300	58
301-500	60

9.0 INSPECTION AND TESTING

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

9.2 For testing requirements, refer Inspection & Test Plan doc. no. 6-81-1042. Prior notice of minimum 4 weeks shall b given to EIL/Owner for witnessing the final testing of the complete assembly to ensure satisfactory operation of all components. All testing shall be carried out at manufacturer's works under his care and expense.

9.3 Test certificates of bought out components shall be submitted to the inspection agency, as per Inspection and Test Plan no. 6-81-1042.

10.0 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. The equipment shall be wrapped in polythene sheets before being placed in the crates/ cases to prevent damage to the finish. Crates / cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Centre of gravity', 'Weight', 'Owner's particulars', 'P.O. numbers' etc., shall be clearly marked on the package together with other tag numbers, P.O. number etc.

The equipment may be stored outdoors for long periods before erection. The packing shall be suitable for outdoor storage in areas with heavy rains/ high ambient temperature.

न्यूट्रल ग्राउंडिंग रेसिस्टर के लिए विनिर्देश

SPECIFICATION FOR NEUTRAL GROUNDING RESISTOR

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
8	02.07.21	REVISED AND ISSUED AS STANDARD SPECIFICATION	AR	SV	PG	SM
7	08.04.16	REVISED AND ISSUED AS STANDARD SPECIFICATION	MS/PK	SV	BRB	RN
6	21.03.11	REVISED AND ISSUED AS STANDARD SPECIFICATION	PK	SV	UAP	DM
5	22.08.05	REVISED AND ISSUED AS STANDARD SPECIFICATION	NMS	AKT	AAN	VJN

Abbreviations:

AC	Alternating Current
ASTM	American Society for Testing and Materials
BIS	Bureau of Indian Standards
CEA	Central Electricity Authority
EIL	Engineers India Limited
GI	Galvanised Iron
IEC	International Electro technical Commission
IEEE	Institute of Electrical and Electronics Engineers
IP	Ingress Protection
IS	Indian Standards
LV	Low Voltage
MCB	Miniature Circuit Breaker
NEMA	National Electrical Manufacturer's Association
NGR	Neutral Grounding Resistor
PO	Purchase Order
XLPE	Cross Linked Poly Ethylene

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Mr. Rajesh Sinha (Inspection)
Mr. Ayush Mathur (Projects)

CONTENTS

1.0 SCOPE

1.1 The intent of this specification is to define the requirements for design, manufacture, testing, packing and transport of Neutral Grounding Resistor (NGR).

2.0 CODES AND STANDARDS

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

IS: 5	:	Colours for ready mixed paints and enamels.
IS: 2705	:	Current transformers.
IS : 3043	:	Code of practice for earthing.
IS/IEC 60529	:	Degrees of protection provided by enclosures
IS/IEC 60947	:	Low Voltage Switchgear and control gear.
IS/IEC 62271	:	High voltage switchgear & control gear – Part 200: AC Metal enclosed switchgear & controlgear for rated voltage 1kV and upto and including 52kV
IEEE: 32	:	Neutral Grounding Devices- Standard requirements, terminology and test procedure.
ASTM-A240	:	Specification for heat resisting Chromium and Chromium-Nickel stainless steel plate, sheet and strip for pressure vessels.

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

2.3 The equipment shall also conform to the provisions of CEA Regulations with latest amendments and 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 shall be applicable.

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

3.0 GENERAL REQUIREMENTS

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

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

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

4.0 SITE CONDITIONS

The Neutral Grounding Resistor shall be suitable for outdoor installation (without a shed) for satisfactory operation under conditions of restricted natural ventilation in a tropical humid and corrosive atmosphere as prevalent in refineries, petrochemical and fertilizer plants. The NGR shall be designed to operate under site conditions as specified in the data sheet. If not specifically mentioned therein, a design ambient temperature of 40^0 C and an altitude not exceeding 1000 m above mean sea level shall be considered.

5.0 TECHNICAL REQUIREMENTS

5.1 Resistors

5.1.1 The resistor elements shall be made of unbreakable, corrosion proof, joint-less stainless steel grid conforming to ASTM standard A240-304. The grids shall be in punched form. For NGR with ratings 25 A and below, robust wire wound resistor element of Stainless steel as per ASTM Standard A240-304 can be provided.

5.1.2 The resistor shall be sized for carrying the rated current specified in the data sheet for 10 seconds with maximum temperature limited to 790^0 C for stainless steel resistor elements, while limiting the temperature of aluminium conductor / bus bar to 350^0 C.

5.1.3 If specified in the data sheets, the resistor shall also be sized to carry 10% of the rated current continuously with the maximum operating temperature of resistor elements limited to 415^0 C. Further, the temperature rise of the resistor elements when they carry 10% of the rated current followed by the specified rated current for 10 seconds shall not exceed the temperature limits specified in clause 5.1.2 above. Under the steady-state conditions when the NGR carries 10% of the rated current, the surface temperature of the enclosure i.e. all four sides, bottom and the canopy shall be limited to maximum 70^0 C.

5.1.4 Grids/resistor shall be mounted on steel rods insulated by special heat-resistant insulating materials, suitable for the above temperatures. Ceramic/ porcelain insulators shall be used to insulate the resistor elements from the enclosure. The insulators and terminal bushings shall have adequate minimum creepage values (total and protected) for the required voltage grade.

5.1.5 Resistor banks shall be provided in series and parallel combinations to achieve the overall resistance value. Minimum two paths in parallel shall be provided in the system, unless specified otherwise.

5.2 Enclosure

5.2.1 The resistor elements shall be housed in a naturally ventilated sheet steel enclosure with minimum IP-31 degree of ingress protection and suitable for outdoor installation.

5.2.2 The enclosure thickness shall be min. 3 mm. The NGR shall have a suitable arrangement for fixing it on concrete foundations/ grouting in floor.

5.2.3 The terminals for neutral connections (from transformer neutral to NGR) shall be housed in a separate vermin-proof, weatherproof terminal box with minimum IP-55 degree of ingress protection. The terminal box shall be provided with a separate bolted removable undrilled gland plate of non-magnetic material. This shall be drilled at site to suit the cable entry. Suitable nickel plated brass double compression type cable glands & crimp type tinned cu lugs shall be provided. Lugs to be supplied shall be long barrel heavy duty type. For connection on earthing side, separate terminal bushing shall be provided.

5.2.4 A separate canopy shall be provided above the enclosure roof with a suitable air gap between them. It shall also cover the terminal compartment. Suitable lifting arrangement shall be provided to lift the canopy.

5.2.5 Facility shall be provided to earth the enclosure at two points. For this purpose, suitably sized studs shall be provided on the sides of the enclosure to accommodate the connection of GI strip/Single core copper/aluminum conductor PVC/ XLPE insulated Earthing Cable.

5.2.6 The bottom of the enclosure shall be provided with a drain plug to remove water that may get collected in the enclosure.

5.3 Terminals

5.3.1 The two ends of the resistor shall be brought out to suitable epoxy/ porcelain bushing type terminals of adequate rating for the neutral and earth connections. The terminals shall be suitable for terminating the specified size of cables/ earthing strip and shall be supplied complete with tinned-copper lugs. Bolted type link shall be provided for isolating the resistor at the neutral end.

5.4 Space Heater

Suitable anti-condensation space heater shall be provided inside the NGR enclosure to prevent condensation of moisture. This shall be rated to operate from a 240 V, 50 Hz, single phase power supply. The terminals of the space heater shall be brought out to a separate weatherproof terminal box. The terminal box/ marshalling box shall have minimum IP-55 degree of ingress protection.
The space heater shall be controlled using a double pole MCB and thermostat provided in the terminal box. The MCB shall be operable from the front of enclosure without opening the terminal box cover.

5.5 The current transformer, if specified, shall be of cast resin type suitable for the applicable voltage grade. The secondary connections of the current transformer shall be brought out to suitable terminals in Marshalling Box and shall be provided with a shorting link.

5.6 Cooling

The Neutral Grounding Resistor shall be natural air cooled. Forced cooling shall not be used. If required, louvers can be provided in the enclosure provided they are completely guarded on the inside with a fine wire mesh.

5.7 Nameplate Marking

The equipment shall be provided with a stainless steel nameplate located prominently indicating following minimum information:

a. Neutral Grounding Resistor
b. Manufacturer Name / Make
c. Serial Number
d. Tag No.
e. Nominal resistance value in Ohms
f. Temperature Coefficient of Resistance and Resistance at 25°C
g. Rated Voltage
h. System Voltage and Frequency
i. Rated Current (Continuous & Short-Time)
j. Time Rating in seconds (Continuous & Short-Time)
k. Temperature Rise in °C
l. Enclosure Protection Class
m. Weight

5.8 Painting

5.8.1 All metal surfaces shall undergo manufacturer's standard cleaning /painting cycle.

5.8.2 After preparation of the under surface, the NGR shall be painted with two coats of epoxy based final paint. Colour shade of final paint shall be 632 of IS: 5/RAL-7032 unless specified otherwise.

5.8.3 All unpainted steel parts shall be suitably treated to prevent rust formation.

6.0 INSPECTION, TESTING AND ACCEPTANCE

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

6.2 For testing requirements refer Inspection & Test Plan No. 6-81-1043. Prior notice of minimum 4 weeks shall be given to EIL/owner for witnessing the final testing of the complete assembly. Tests shall be carried out at manufacturer's works under his care and expense.

6.3 Test certificates of bought out components shall be submitted to the inspection agency, as per Inspection and Test Plan no. 6-81-1043.

7.0 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 selected mode of transportation i.e. 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', `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 should also be suitable for outdoor storage areas with 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.

वाल्व रेगुलेटिड स्टेशनरी लैड एसिड बैटरीज के लिए विनिर्देश

SPECIFICATION FOR STATIONARY VALVE REGULATED LEAD ACID BATTERIES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	03.09.2021	REVISED & RE-ISSUED AS STANDARD SPECIFICATION	SS	RS	PG	SM
3	05.09.2016	REVISED & RE-ISSUED AS STANDARD SPECIFICATION	PB/MHR	RS	BRB	RN
2	11.04.2011	REVISED & RE-ISSUED AS STANDARD SPECIFICATION	CS	PG	UAP	DM
1	27.08.2007	REVISED & RE-ISSUED AS STANDARD SPECIFICATION	AP	NS	JMS	VC

Abbreviations:

AC	Alternating Current
Ah	Ampere hour
BIS	Bureau of Indian Standards
CEA	Central Electricity Authority
DC	Direct Current
EIL	Engineers India Limited
IEC	International Electrotechnical Commission
IS	Indian Standard
MSL	Mean Sea Level
PO	Purchase Order
PVC	Poly Vinyl Chloride
UPS	Uninterrupted Power Supply
V	Volt

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Mr. Ayush Mathur (Projects)
Mr. Rajesh Sinha (Inspection)

CONTENTS

1.0 SCOPE

This specification covers the design, manufacture, testing and supply requirements of Valve Regulated stationary Lead Acid cell/batteries for DC Power System/ AC UPS application.

2.0 CODES AND STANDARDS

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

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

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

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

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

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

3.0 GENERAL REQUIREMENTS

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

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

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

4.0 SITE CONDITIONS

Valve Regulated stationary Lead Acid cell/battery shall be suitable for operating satisfactorily in humid and corrosive atmosphere found in fertilizer plants, refineries, petrochemical and gas processing plants, metallurgical plants and other industrial plants. Service conditions shall be as specified in the data sheets/job specification. If not specifically mentioned therein, a design ambient temperature of 40°C and an altitude not exceeding 1000m above MSL shall be considered, with minimum temperature of 10°C for battery sizing.

5.0 TECHNICAL REQUIREMENTS

5.1 The Valve Regulated cell/battery shall be suitable for float duty operation with a constant voltage permanently applied to its terminals which is sufficient to maintain it in a state close to full charge and shall be designed to supply load in the event of normal power supply failure.

5.2 The standard rated ampere hour capacity of the cell/ battery shall be at a reference temperature of 27°C, constant current discharge at 10 hours rate (C10) and an end cell voltage of 1.8V/cell.

5.3 Ampere hour of the battery shall be selected based on the following criteria:

a. Minimum site ambient temperature of 10°C
b. Discharge duty cycle
c. End cell voltage
d. Ageing factor of 0.8
e. Capacity rating factor

5.4 Number of cells and end cell voltage shall be decided by the vendor on the basis of maximum permissible voltage to the load when batteries are float charged while feeding the load. The system output voltage at the end of design duty cycle shall not be less than 95% for nominal system voltage up to 48V DC and 90% for nominal system voltage of 110V DC and above. However, the minimum number of cells and end cell voltage shall be as per datasheet.

5.5 On float, the cell/battery shall be suitable for being recharged to 90% of ampere hours within 24 hours and to 100% within 4 days.

5.6 The components such as containers, lids, covers and seals used in manufacture shall meet the Fire, flame and smoke resistance rating as defined in IS 15549 and have an oxygen Index of at least 28 in accordance with ASTM D-2863.

5.7 Each cell/battery shall have a separate container of 2.0V (nominal voltage). The cell container shall be made of high strength acid resistant material and designed to withstand mechanical stresses, shocks, vibrations and shall be consistent with the life of the battery.

5.8 The design of valve regulated cell shall be such that regulating valve shall not allow the gas (air) to enter into the cell but shall allow the gas to escape from the cell above certain internal pressure which shall not lead to deformation or cause container to crack or cause failure of seals or shall not cause bulging/ cracking of cell cover.

5.9 The hydrogen released from valve regulated lead acid cells shall be sufficiently low to make these cells suitable for use in office, control rooms and equipment environments. The gas leakage rate of the cell shall not exceed 0.05cm^3/hr at 27°C and 101.3kpa.

5.10 Valve Regulated stationary Lead Acid cells/battery shall be designed to withstand the mechanical stresses encountered during normal transportation and handling.

5.11 Venting device shall be provided with Flame arrestor and shall be mounted on the cell so that all the vented gasses diffuse through the arrestor to the outside environment. The construction of the arrestor shall be such that hydrogen burning on the external surface of the arrestor shall not propagate back in to the cell to cause explosion.

5.12 The terminal posts shall be casted of lead alloy with copper/brass insert for enhancement of conductivity. The terminals shall be suitable for maximum discharge current and short circuit current without damage to the cell as a result of terminal heating.

5.13 The temperature of the valve regulated lead acid cells shall be sufficiently low to prevent thermal runaway (critical condition arising due to constant voltage charging).

5.14 The following information shall be permanently marked on the cell.

- Nominal voltage
- Name of manufacturer/model reference
- Rated capacity in ampere hours (Ah) with end cell voltage
- Voltage for float operation at 27°C with tolerance of ±1%
- Month and year of manufacture
- Polarity marking
- Batch No. and Serial No. of Cells

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

a. Battery stand in formation / steel modules for multi tier stacking as per data sheet. Mild steel stand/module pretreated and epoxy painted /epoxy powder coated/ PVC coated.
b. Inter cell, inter row and inter bank connectors and end take offs. These shall be of lead plated copper or flexible insulated copper cable or completely insulated solid copper connectors.
c. Cell insulator as applicable.
d. Stand insulator.
e. Cell number plates/permanent stickers, Lugs for cable termination, as required.
f. Other accessories and their quantity as per data sheet.

6.0 PERFORMANCE

Valve regulated Stationary Lead Acid batteries shall have been type tested to meet the performance requirements for each design and Ah rating of cells as per the relevant Indian standard referred in clause 2.1 above.

7.0 INSPECTION, TESTING AND ACCEPTANCE

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

7.2 For Testing requirements, refer Inspection & Test Plan for Stationary valve regulated lead acid battery (Standard no. 6-81-1048). EIL / Owner's inspector shall be given free access in the works from time to time for stage wise inspection and progress reporting. Prior notice of minimum 4 weeks shall be given to EIL/Owner for witnessing the final tests of battery. Tests shall be carried out at manufacturer's works under his care and expense.

7.3 Test certificates of bought out components shall be submitted to the inspection agency, as per Inspection and Test Plan no. 6-81-1048.

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

8.0 PACKING AND DESPATCH

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for transportation by ship/rail or trailer. The equipment shall be wrapped in polythene sheets before being placed in crates/ cases to prevent damage to finish. Crates/cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Centre of gravity', 'Weight', 'Owner's

particulars', 'PO nos.' etc., shall be clearly marked on the package together with other details as per purchase order.

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

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

मध्यम एवं उच्च वोल्टेज केबल एवं असेसरिज के लिए विनिर्देश

SPECIFICATION FOR MEDIUM AND HIGH VOLTAGE CABLES & ACCESSORIES

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

Abbreviations:

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

Electrical Standards Committee

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Ms. Shirali Aggarwal
Mr. Ayush Mathur (Projects)
Mr. Rajesh Sinha (Inspection)

CONTENTS

1.0 SCOPE

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

2.0 STANDARDS

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

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

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.

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

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

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.

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.)

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%).

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

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

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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)

CONTENTS

1.0 SCOPE

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

2.0 CODES AND STANDARDS

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

2.1 BIS and other Standards

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

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.

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.

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.

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.

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.

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.

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

6.5.2 **Special Tests**

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

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

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

7.0 PACKING AND DESPATCH

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

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

7.3 The drum lengths for cables shall be as below:

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

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

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

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

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

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SPECIFICATION FOR NUMERICAL RELAYS & SUBSTATION AUTOMATION SYSTEM

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
3	30-09-19	REVISED AND ISSUED AS STANDARD SPECIFICATION	AKG	SV	SA	RKT
2	12-06-14	REVISED AND ISSUED AS STANDARD SPECIFICATION	AS	SV	BRB	SC
1	24-03-09	REVISED AND ISSUED AS STANDARD SPECIFICATION	SKM	AK	JMS	ND
0	12-08-02	ISSUED AS STANDARD SPECIFICATION	RCS	AAN	VPS	GRR

Abbreviations:

AC	:	Alternating Current
BS	:	British Standard
BTD	:	Bearing Temperature Detector
CBCT	:	Core Balance Current Transformer
CPU	:	Central Processing Unit
CT	:	Current Transformer
DC	:	Direct Current
DCS	:	Distributed Control System
ECS	:	Electrical Control Station
EMI	:	Electromagnetic Interference
FIFO	:	First in first out
FO	:	Fibre Optic
GPS	:	Global Positioning System
HV	:	High Voltage
I/O	:	Input/output
ICT	:	Intermediate Current Transformer
IDMTL	:	Inverse Definite Minimum Time Lag
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical and Electronics Engineers
IP	:	Ingress Protection
IRIG- B	:	Inter-Range Instrumentation Group Subcarrier Channel-B
KEMA	:	Keuring Electrotechnisch Materieel Arnhem
LAN	:	Local Area Network
LCD	:	Liquid Crystal Display
LED	:	Light Emitting Diode
HMI	:	Human Machine Interface
TCP-IP	:	Transmission Control Protocol-Internet Protocol
MOG	:	Magnetic Oil Gauge
NEMA	:	National Electrical Manufacturers Association
NO	:	Normally Open
OTI	:	Oil Temperature Indicator
PC	:	Personal Computer
PCB	:	Printed Circuit Boards
PLC	:	Programmable Logic Controller
PRP	:	Parallel Redundancy Protocol
PT	:	Potential Transformer
PVC	:	Poly Vinyl Chloride
REF	:	Restricted Earth Fault
RSTP	:	Rapid Spanning Tree Protocol
RTD	:	Resistance Temperature Detector
RTU	:	Remote Terminal Unit
SNTP	:	Simple Network Time Protocol
SOE	:	Sequence of event
VDE	:	Verband Deutscher Elecktrotechniker
WTI	:	Winding Temperature Indicator

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Ms. N.P. Guha (Projects)

CONTENTS

1.0 SCOPE

The intent of this specification is to define the minimum requirement of design, manufacture, testing, packing and dispatch of numerical relays. The specification also defines the requirement of communication and integration for Substation Automation System.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of latest revision of following IEC standards / equivalent Indian Standards, unless otherwise specified:

IEC 60068 : Environmental Testing

IEC 60073 : Basic safety principles for man machine interface, marking & identification – Coding principles for indicators and actuators

IS/IEC 60529 : Degree of protection provided by enclosure (IP Code)

IEC 60255 : Electrical relays

IEC 61000 : Electromagnetic compatibility (EMC)

IEC 61850 : Communication networks & systems in substations

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

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

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

2.5 In case of any contradiction between various referred standard/ specification/ data sheet and statutory regulation, most stringent requirements shall prevail. However, Owner's decision in this regard will be final and binding.

3.0 SITE CONDITIONS

3.1 The relay shall be tropicalised, for satisfactory operation when installed in a panel located in a pressurised substation with restricted natural air ventilation, in tropical humid and corrosive atmosphere. Relay shall be designed to perform all its functions and operate under site conditions specified in numerical relay data sheet. If not specifically mentioned there in, a design ambient temperature of 40°C and an altitude not exceeding 1000M above the mean sea level shall be considered.

4.0 GENERAL REQUIREMENTS

4.1 The equipment offered shall be brand new with state of the art technology with proven field track record of similar type and model or model in same series with additional features. No prototype equipment shall be offered.

4.2 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.

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

4.4 In case of relays manufactured outside India, the relay manufacturer through his Indian establishment or associate in India shall provide application, testing, commissioning, after sales service and other necessary support for minimum of 10 years to customer. Their Indian establishment or associate company in India shall also maintain adequate inventory of each type of relay or spares to meet the requirement arising during project execution and plant operation. Relay manufacturer shall possess a signed Memorandum of Understanding with their Indian associate for providing customer support

5.0 TECHNICAL REQUIREMENTS

5.1 Auxiliary Power Supply

Unless otherwise specified, numerical relays, data concentrator, Ethernet switches, gateway & HMI shall be suitable to accept both AC/DC supplies with range 110V to 240V with tolerance of ± 15%. The auxiliary power supply shall preferably be site-selectable requiring no additional hardware.

5.2 Basic Requirement and Construction Details

5.2.1 Relay shall be suitable for flush mounting. The relay enclosure front shall be dust tight having degree of protection minimum as IP5X.

5.2.2 Relay terminals shall be suitable for termination of 1.5/2.5/4 sq mm wires, for all hardwired connections.

5.2.3 Relay should have drawout feature with CT shorting arrangement. Alternatively, relay shall be modular with plug in type PCB for easy replacement. The relay terminals shall be easily accessible for testing and commissioning.

5.2.4 Current operated relay shall have provision for minimum 3 number phase CT inputs and 1 number CBCT input. Voltage operated relay shall have provision of minimum 3 numbers PT inputs. The exact number of CT and PT inputs shall be based on the schematic requirements, relays shall be selected accordingly.

5.2.5 CT shorting link shall be provided at terminal block as required.

5.2.6 All numerical relays shall have key pad/ keys to allow relay setting from relay front. All hand-reset relays shall also have reset button on relay front. Self reset or hand reset feature of the relay shall be software selectable and password protected.

5.2.7 Relay shall be suitable for 1 A or 5A CT secondary. CT secondary 1A or 5A shall either be software selectable or by providing suitable link. Selection between 1A or 5A should be possible at site.

5.2.8 Relays shall have self-diagnostic feature with indication of relay failure on relay front. Relay faults (Self- diagnostic) shall be communicated and annunciated to substation automation system.

5.2.9 Relays shall, as a minimum, have protection functions as per feeder equipment data sheets. Other functions such as metering and control shall be provided, if specified in data sheets/job specifications.

5.2.10 The PCB used in relay should have harsh environment G3 conformal coating as per standard IEC 60068.

5.3 Software Security

The relay should comply with international standard of NERC CIP of BREW for cyber security to provide protection against unauthorized disclosure, transfer, modification or destruction of information and/or information systems, whether accidental or intentional.

The security should be available for change in relay settings locally from relay HMI as well as when relay is accessed remotely through manufacturer software/ remote HMI.

5.4 Display and Indication

5.4.1 All relays shall have LCD display along with LED indications for display of settings, status, faults and events. Relays for generator protection, switchyard and GIS shall be provided with medium size LCD display having facility for graphical display of mimic with upto 15 objects on each page.

5.4.2 LCD display shall be backlit and temperature compensated up to 55°C for contrast and legibility.

5.4.3 Relays shall have 3 fixed LEDs for Relay ON/Control supply ON, fault trip & relay unhealthy apart from freely configured LEDs.

5.5 Protection Functions

5.5.1 Over Current/Earth Fault Protection

i) This section describes over current & earth fault protection function, which mainly include different setting stages such as low set, high set and high set instantaneous (51, 50, 51N, 50N). Over current protection function provided should have IDMTL characteristic for low set and high set stages and definite time delay for high set instantaneous stage.

ii) Over current relay shall be three phase type with 4 elements; 3 elements for inverse and definite time delay over current and one element for inverse and definite time delay earth fault current. Selection of inverse or definite time feature shall be user selectable.

iii) The IDMTL characteristic (for 51 and 51N) shall be as per IEC. The inverse characteristics shall include normal inverse, very inverse, extremely inverse, long inverse and shall be soft ware selectable. Inverse element shall have two or more stages (low and high set) for selection of required inverse characteristic to achieve close protection as required.

Definite time characteristic shall have minimum 2 stages with adjustable current and time setting.

iv) Relay shall also have separate current input from CBCT for measured earth fault current element. It shall be possible to connect earth fault element either through CBCT or to be connected residually. Minimum setting current for sensitive earth fault element shall be 1%.

v) Directional overcurrent & earth fault element shall be provided, wherever required.

vi) Voltage biased overcurrent / earth fault element shall be provided wherever required.

5.5.2 Motor Protection

i) Motor protection relay shall have all protection function such as over current, thermal (over load), locked rotor current, zero sequence, negative sequence, maximum number of start, motor overload pre-alarm, motor re-acceleration, lock out, sensitive earth fault protection, inhibit of over current protection during motor starting through contactor feeders, hour run count, inhibit start after elapse of maximum number of starts etc. Relay shall be provided with resistors/ metrosil to avoid spurious tripping due to earth fault. Cold load pick-up settings shall be available to prevent spurious tripping during motor start-up.

ii) The relay shall be provided with 6 Nos. RTD and 2 Nos. BTD analog inputs, if specified in the data sheet / job specification. The numerical relay with RTD / BTD inputs shall be suitable for shielded triad cable of conductor size upto 2.5sqmm copper, unless otherwise specified. Numerical relays with RTD/BTD shall provide data for viewing of RTD/BTD parameters at DCS end.

iii) Separate motor differential protection shall be provided, wherever specified.

5.5.3 Transformer Protection

i) In addition to overcurrent & earth fault function, wherever required, the main numerical relay shall also include standby earth fault protection function (51G) for the transformer. The standby earth fault shall operate from a separate neutral CT input and shall have definite time / IDMTL characteristics as per IEC. Cold load pick-up settings shall be available to prevent spurious tripping during transformer in-rush.

ii) Wherever the transformer requires restricted earth fault protection (64R), separate numerical relay shall be provided. 64R function can be included as a part of main differential protection relay (87T), unless otherwise specified. For details of transformer differential protection relay refer Cl. 5.5.6. Resistor/ Metrosil to be provided to avoid spurious tripping due to earth fault.

iii) Transformer auxiliary protection (OTI/WTI/Buchholz/MOG etc) shall be included as a part of numerical relay.

iv) Transformer differential protection shall be provided, wherever specified.

5.5.4 **Generator Protection**

i) Medium Voltage Generators (415V) shall have all protection functions such as voltage restrained overcurrent (51V), standby earth fault (51G), negative sequence (46), Reverse power (32), under voltage (27), overvoltage (59), thermal overload (49), PT fuse failure monitoring function (60), generator differential (87G) as a minimum.

ii) In addition to the above, HV generators (turbine / diesel engine driven) shall have additional protection functions such as rotor back up earth fault (64R)-1st and 2nd stage, low forward power flow (37), loss of excitation (40), under frequency (81U), rate of change of frequency (df/dt) unless otherwise specified.

iii) If specified in the datasheet, additional protection functions such as field overcurrent, over frequency (81O), back up impedance (21), over fluxing (99), out of step shall be provided as a part of generator protection numerical relay.

iv) The generator protection functions can be included as a part of one numerical relay or a separate numerical relays can be provided.

5.5.5 **Voltage Operated Protection Functions**

i) These functions include under voltage (27), over voltage (59), ON delay and OFF delay timers, phase sequence voltage, neutral displacement and Synchro-check functions etc.

ii) The under voltage and overvoltage protective function shall have different stages with definite time characteristics.

iii) If specified in datasheet, the relay shall have under and over frequency function along with frequency supervised Rate of change or average rate of change of frequency function.

5.5.6 **Differential Protection**

Suitable differential protection shall be provided as required as per data sheet / job specification for the specific application such as for generator, transformer, overall generator & transformer, motor, feeder, bus section etc. The following requirements, as applicable, shall be complied:

i) Differential protection shall be either high impedance or low impedance type. In case of high impedance type, suitable non linear resistor shall be provided to limit the peak overvoltage.

ii) Transformer differential protection shall have suitable harmonic restraint feature to avoid maltripping during switching.

iii) For transformer differential protection, necessary correction for ratio error and for transformer primary and secondary vector grouping shall be taken care in the relay itself without additional ICTs. The required relay setting for this shall be programmable.

iv) Bus differential relay shall have feature for CT supervision and check differential.

v) In case separate hard-wired relay is used for check differential, the status/ event of same shall be communicated through the numerical relay provided for main differential application.

vi) Unless otherwise specified, the differential relays such as generator differential, transformer differential, overall generator transformer differential, motor differential, feeder differential etc. shall be suitable for cable connection between CTs and relay using 2.5 sq.mm., Cu conductor, PVC insulated, armoured cable. However for differential protections provided for feeders having long lengths, armoured FO cable may be considered. In cases where FO cable is not suitable, shielded twisted pair cable of conductor size upto 2.5 sqmm copper

shall be specifically mentioned by the bidder in the offer for EIL/Owner's acceptance on case to case basis.

5.6 Metering Functions

The metering function shall be provided as required and same shall be built inside the numerical relays.

5.7 Control Functions

5.7.1 The control function shall be built inside the numerical relays. For this purpose relays shall have all graphical PLC/Boolean logic functions such that complete control logic of the feeder along with all necessary interlocks as required can be developed inside the relay.

5.7.2 Relays for motor feeder shall be equipped with all control functions and interlocks related to motor feeder. If reacceleration is a part of motor feeder, the control function shall also cover reacceleration logic.

5.7.3 Relays shall have sufficient integral I/Os to take care of complete feeder logic. External I/O module for implementation of logics is not acceptable.

5.7.4 Numerical relays shall have provision of online supervision of logic function configured in the relay.

5.8 Lock Out (86), Trip Circuit Supervision (95), Auxiliary Relays and Timer Functions

5.8.1 Unless otherwise specified the numerical relays shall have built in lock out function. For motor feeders additional built-in lockout element shall be provided to receive process trip signals. Lock out elements shall be self reset or hand reset and shall be software selectable.

5.8.2 The numerical relays shall have built in trip circuit supervision function, unless otherwise specified.

5.8.3 Auxiliary relays/ Timers function etc as required for control schematics shall be programmable as a part of numerical relay. The number of such elements as required for schematic shall be considered.

5.8.4 Timer function shall be programmable for both ON/OFF delays.

5.9 Disturbance/ Event Recording and Data Storage

5.9.1 Breaker trip/ close status, relay faults, trip values, event data and disturbance record data shall be stored in the relay in non-erasable memory or memory backed up by lithium battery. Under no circumstances such as withdrawal of power to the relays shall the status, data and events in the memory get erased. Unless otherwise specified, it should be possible to store total 50 seconds of disturbance recording and 1000 sequence of event records. Subsequent events shall be overwritten following principle of FIFO.

5.9.2 All disturbances/ events shall be time stamped within the relay.

5.10 Input/ Output Interface, Filters and Galvanic Isolation

5.10.1 Voltage (through PT) input to relay, shall be 110V +/- 10%, unless otherwise specified.

5.10.2 Out put relays shall have 4 numbers spare NO contacts; each shall separately be programmable for either hand reset or self- reset.

5.10.3 Contacts of pushbuttons from field, interlocks from DCS/ other switchboards shall be wired to the relay as binary input using 1.5/2.5sqmm, multi core, shielded copper conductor cables. The distance between push buttons/ interlock to switchboard may be considered as 1000m, unless otherwise specified. The pick-up voltage for BIs/BOs shall be site selectable. The additional components as required to overcome the cable capacitance effect shall be considered as a part of supply of relay. The binary input to relay from field contacts and interlocks shall be momentary type. Logic to latch the momentary contact, as required shall be built as a part of protection relay.

5.10.4 All I/Os shall have galvanic isolation. Analog inputs shall be protected against switching surges, harmonics etc.

5.11 Relay Communication

5.11.1 All numerical relay shall have RS232/RJ45/USB port on the front for hooking laptop.

5.11.2 At the rear numerical relays shall have suitable redundant communication port for communication with data concentrator/ HMI/ Station bus. The type of port shall be selected based on method of communication (Serial or Ethernet) and type of physical transmission medium (twisted pair copper or fiber optic). For serial communication, the relay port shall be RS485 or FO (fiber optic) and for Ethernet (IEC 61850 based) communication same shall be RJ45or FO.

5.11.3 The communication protocol shall be selected to transfer all information including time stamp data from relay to data concentrator/ substation HMI. The relays shall communicate on industry open protocol such as IEC 60870-5-103/IEC 61850/ Modbus-RTU / Modbus TCP-IP or any other open protocol.

5.11.4 For IEC 61850 based communication, each relay shall be suitable for communicating with minimum four numbers client devices.

5.11.5 The relay must support IEC 61850 Edition 1 & Edition 2. They must support IEC 61850 Goose Messaging & meet the performance requirements for tripping applications (<10 ms) so that anytime critical interlocking can be built over communication. The relay should support sharing analog values such as temperature, resistance and tap position using IEC 61850 Goose messaging. Time synchronization of all relays should be possible over IEC 61850 network over SNTP.

5.11.6 Relay should have support for redundant communication over PRP to have seamless changeover.

6.0 SUBSTATION AUTOMATION SYSTEM

Substation automation system broadly comprises of numerical relays, data concentrator panels (as required), HMI, laptop, printers and their associated software for monitoring of the electrical system.

6.1 Communication

Communication is the backbone of any substation automation system. It is through this medium, the monitoring of various parameters takes place effectively.

6.1.1 **Serial Communication**

i) Data concentrator shall have two serial ports (1 no. in each CPU module) for simultaneous remote communication on relay LAN. The relays shall be multi-dropped on RS485 through single drop from LAN to each relay. In the event of either failure of any relay or break in LAN cable or failure of port at data concentrator, the redundant hardware shall ensure healthy communication between relay and data concentrator (refer Figure-1).

ii) Alternatively, relays shall communicate in star topology using star coupler. Communication from relays to star coupler shall be through single communication port. Communication from star coupler to data concentrator shall be through redundant communication link (each link part of separate star coupler unit). RS485 to FO converters wherever required shall be part of offered relay/ other hardware. Star coupler shall be provided with dual power supply module

iii) The maximum number of relays in one loop shall be decided so as to achieve maximum scan time as 500 ms for status input and maximum 6 sec for analog and historical data considering total number of serial loop and star coupler as a total integration. The above scan time does not include screen refresh rate at HMI.

iv) For sequence of event recording, time discrimination between two events shall be maintained to 1 m sec or better.

6.1.2 **IEC-61850 based Communication**

i) Ethernet switches shall provide error free communication in harsh substation environment and shall be immune to EMI. The Ethernet switches shall comply to IEC 61850-3 and shall be KEMA approved or equivalent.

ii) For real time deterministic performance, managed Ethernet switch shall be considered in the Ethernet network. The switch shall support following features:

- Full duplex operation
- Priority Queuing
- Virtual LAN (VLAN)
- Rapid Spanning tree
- Multicast filtering

iii) Dedicated Ethernet switches shall be provided for each switchboard. 20% spare ports shall be provided in each Ethernet switch.

iv) Ethernet switch shall have dual DC power supply facility.

v) Communication between relay and HMI shall be provided as follows:

Redundant Ethernet communication architecture shall have RSTP topology. Numerical relays shall be hooked up to Ethernet switch in star topology and the switches (within the switchboard) shall be further connected in ring (refer Figure 2).

Alternatively, from each switch (within the switchboard) redundant communication link shall be extended to two number backbone switches to be located within the switchboard (refer Figure 3)

For PRP type of connectivity each switchboard shall be provided with redundant ring with dedicated Ethernet switches connected to the Master Ethernet switches (refer Figure 4)

For hooking up to HMI/gateway for upper level connectivity, redundant communication link either from any two switches within the ring or from back bone switches shall be further extended and hooked up to two numbers master Ethernet switches dedicated for hooking HMI/gateway/printers/GPS etc. From HMI redundant communication link shall be extended to the master Ethernet switches.

6.2 Data Concentrator

6.2.1 Data concentrator shall be supplied to facilitate communication with relays on open protocol.

6.2.2 As a minimum data concentrator shall have separate power supply module, CPU module and I/O module. To achieve redundant architecture, either separate data concentrator shall be considered or data concentrator shall have redundant power supply module and redundant CPU module. The CPU module shall have sufficient communication ports depending on relay LAN requirement.

6.2.3 Data concentrator shall provide gateway to upper level control system on Ethernet/ IEC61850 protocol/Modbus-RTU protocol or protocol as specified in the data sheet. The communication to upper level control system shall be redundant as per data sheet/ system architecture.

6.2.4 Data concentrator shall have binary and analog (4 to 20mA) I/O cards suitable for interface requirement specified in data sheet. Unless otherwise specified, 20% I/Os shall be considered as spare. Alternatively, a separate Data Acquisition Unit may be supplied for binary and analog interface.

6.2.5 Data concentrator shall have required number of ports for relay LAN/ star couplers. Number of relay LAN/ star couplers shall be as per project requirement. 20% or minimum 2 Nos. spare ports whichever is maximum shall be provided for future extensions.

6.2.6 Data concentrator shall have required number of RS232/ RS422/RJ45 ports for connection to Laptop PC and substation HMI having operator's work station and engineering station PC.

6.2.7 Data concentrator shall have redundant RS485/ FO/ Ethernet port for communication to substation HMI and upper level ECS-RTU. Hook up to upper level system shall be carried out by extending serial connectivity from each communication ports in two CPU modules.

6.3 Gateway

6.3.1 Gateway for upper level connectivity if separately provided shall have redundancy in power supply module, CPU module. Alternatively, redundant gateways can be provided.

6.3.2 In case of IEC-61850 based communication, if gateway is envisaged, gateway shall have binary and analog (4 to 20mA) I/O cards suitable for interface requirement specified in datasheet. Unless otherwise specified, 20% I/Os shall be considered as spare. Alternatively, a separate Data Acquisition Unit may be supplied for binary and analog interface with communicates to ethernet switch on IEC-61850 protocol.

6.4 Human Machine Interface (HMI)

6.4.1 Relays connected in LAN shall also be provided with web based HMI interface which shall have following functions :

- Programmable LEDs and event lists
- System Supervision
- Parameter Settings
- Measurement Display
- Disturbance Records
- Phasor diagram
- Single Line Diagram
- Importing and Exporting of parameters
- Historical Data & Trending

6.4.2 Human machine interface shall include engineering and operator function. Engineering and operator workstations shall be separate.

6.4.3 HMI shall be of industrial grade suitable for continuous operation at design ambient temperature with restricted natural ventilation.

6.4.4 HMI shall be of latest version of industrial grade PC and the same shall be provided with 21" color monitor (TFT flat screen) with non glare glass filters to minimize glare from external lighting.

6.4.5 Operator workstation shall have user friendly software for interactive display of substation data in multiwindow feature. Software shall have capability to display substation single line diagrams, display of electrical system parameters, reports, alarm annunciation, daily and monthly data logging, continuous polling, relay monitoring, relay supervision, fault disturbance record of each relay, graphic representation and trending of data etc. The offered system shall comply with requirements of IEC for basic and safety requirements for Human-machine interface.

6.4.6 Engineering workstation shall have software for engineering, detailed self diagnostic for maintenance, trouble shooting and changing parameters. Further, it shall also have facility to program and configure numerical relays, data concentrator and other intelligent devices. In addition engineering work station shall have all the facilities as provided for operator workstation.

6.4.7 The HMI system shall be provided with color laser jet A3 printer for generating hardcopy of alarm, event and logging report. The printing shall be on demand, unless otherwise agreed.

6.4.8 If specified, separate laptop shall be provided. The laptop shall include all functionalities as specified for HMI system and the same shall be provided with required licensed software,

hardware, accessories and material. System configuration shall be latest proven model and upgradable.

6.4.9 HMI system shall be provided with all associated furniture for PC, printer etc.

6.5 Time Synchronization

6.5.1 All internal clocks of numerical relay, data concentrator, SOE modules, HMI etc. shall always work in synchronism such that there is one and only one system-wide time. GPS shall be considered to synchronize with an external satellite clock. The time synchronization accuracy shall be ± 1.0 msec or better.

6.5.2 The GPS system shall consist of GPS antenna, lightning arrestor, GPS receiver/server and associated cables.

6.5.3 The time synchronization shall be carried out either through communication over substation relay LAN or by considering dedicated time synchronization channel. In case of synchronization through relay LAN, the communication protocol shall support to carry time synchronization message to the relays/data concentrator/HMI and maintain the desired accuracy. In case of time synchronization through dedicated time synchronization channel, relays, data concentrator and HMI shall be provided with IRIG- B port and the same shall be directly hooked up to GPS receiver.

6.5.4 In Ethernet based communication network, GPS receiver shall be directly hooked up to Ethernet LAN and all internal clocks of HMI and numerical relays shall be updated using SNTP protocol.

7.0 INSPECTION, TESTING AND ACCEPTANCE

7.1 During assembly, EIL / Owner or his authorized representative shall be permitted to assess the progress of work as well as to ascertain that quality raw material is used for the same. All assistance as required during inspection shall be given to inspector.

7.2 For testing requirements refer Inspection & Test Plan No. 6-81-1055.

8.0 PACKING AND DESPATCH

The equipment shall be properly packed for transportation by ship/rail or trailer. All equipments shall be wrapped in polyethylene sheets before being placed in wooden crates/ cases with fillers to prevent damage to the finish. Crates/cases shall have skid bottoms for handling. Special notations such as 'Fragile', 'This side up', 'centre of gravity', 'weight', 'Owner's particulars', 'PO nos.' etc. shall be clearly marked on the package together with other details as per purchase order.

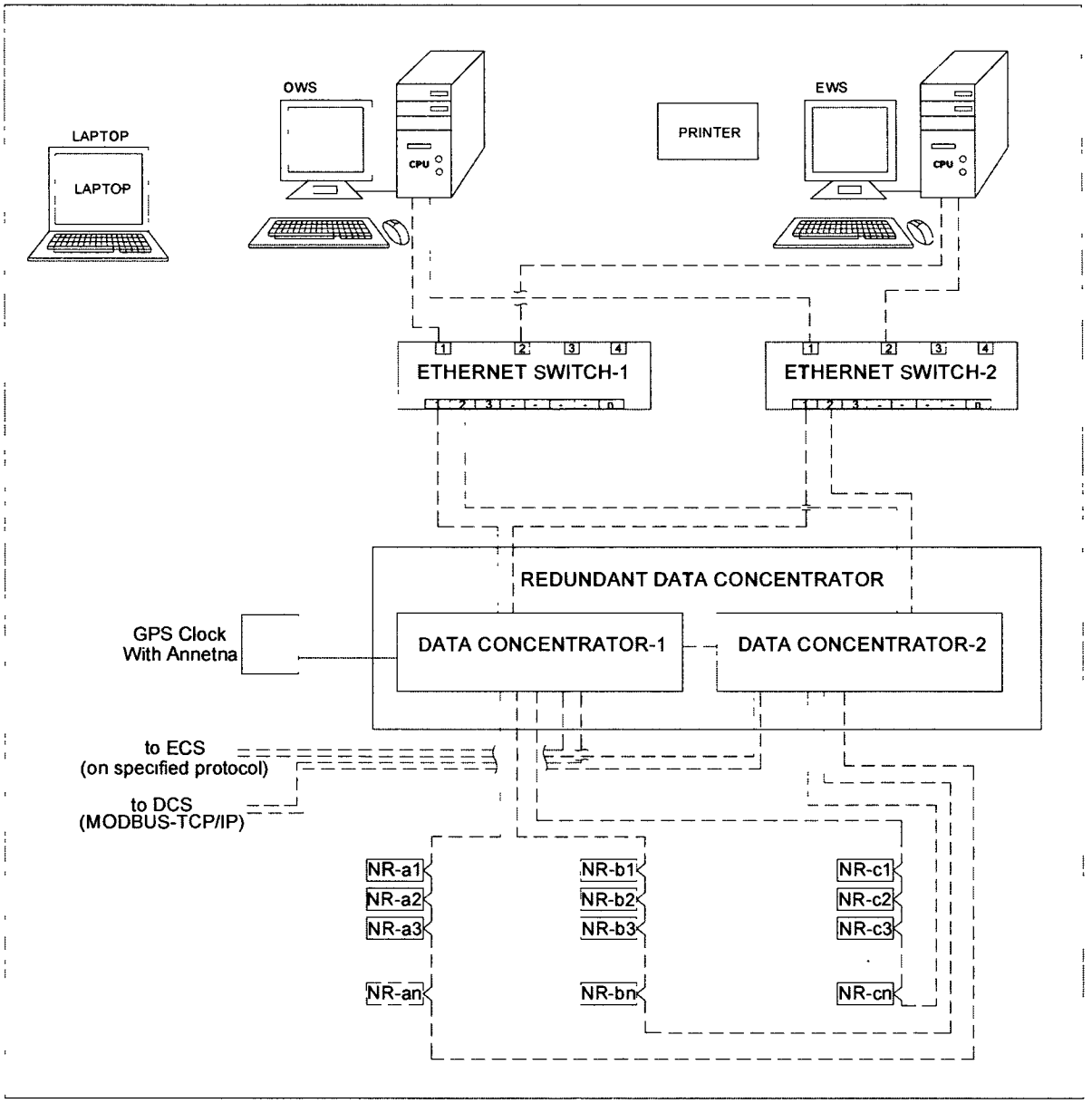


FIGURE 1: TYPICAL ARCHITECTURE FOR SERIAL COMMUNICATION

Note : Relays have been indicated connected in a ring topology, alternatively relays can be connected in star topology also.

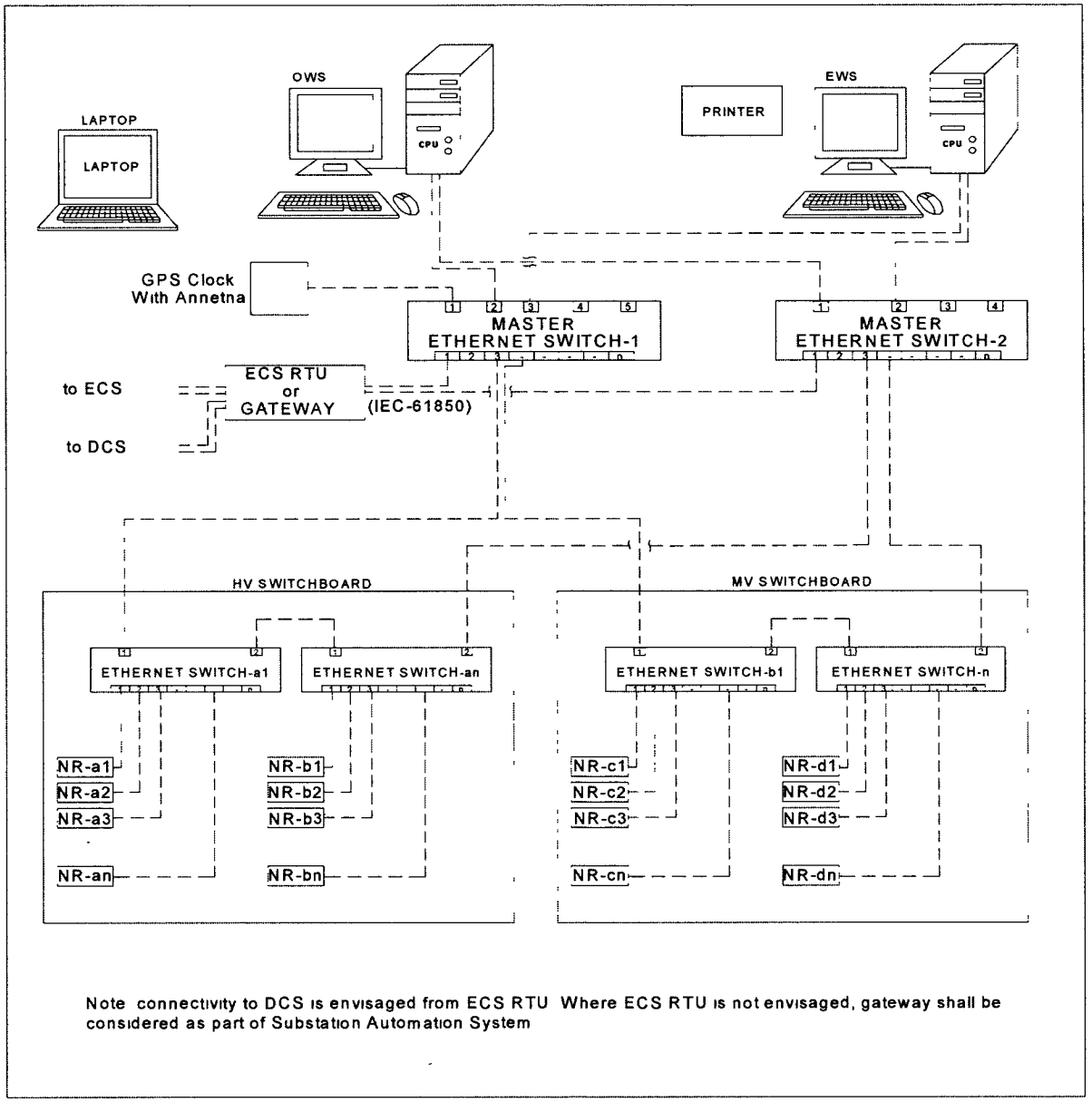
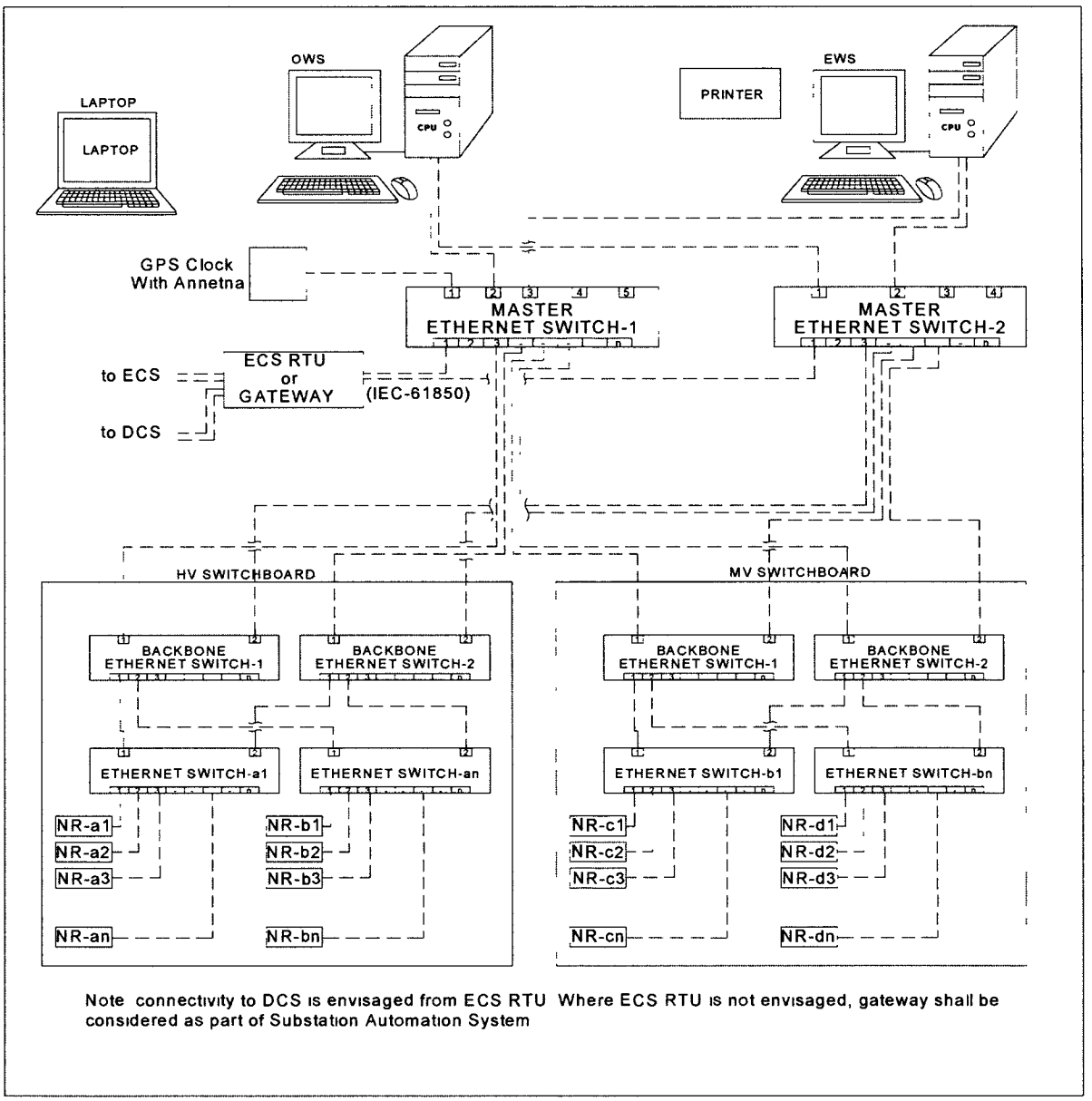
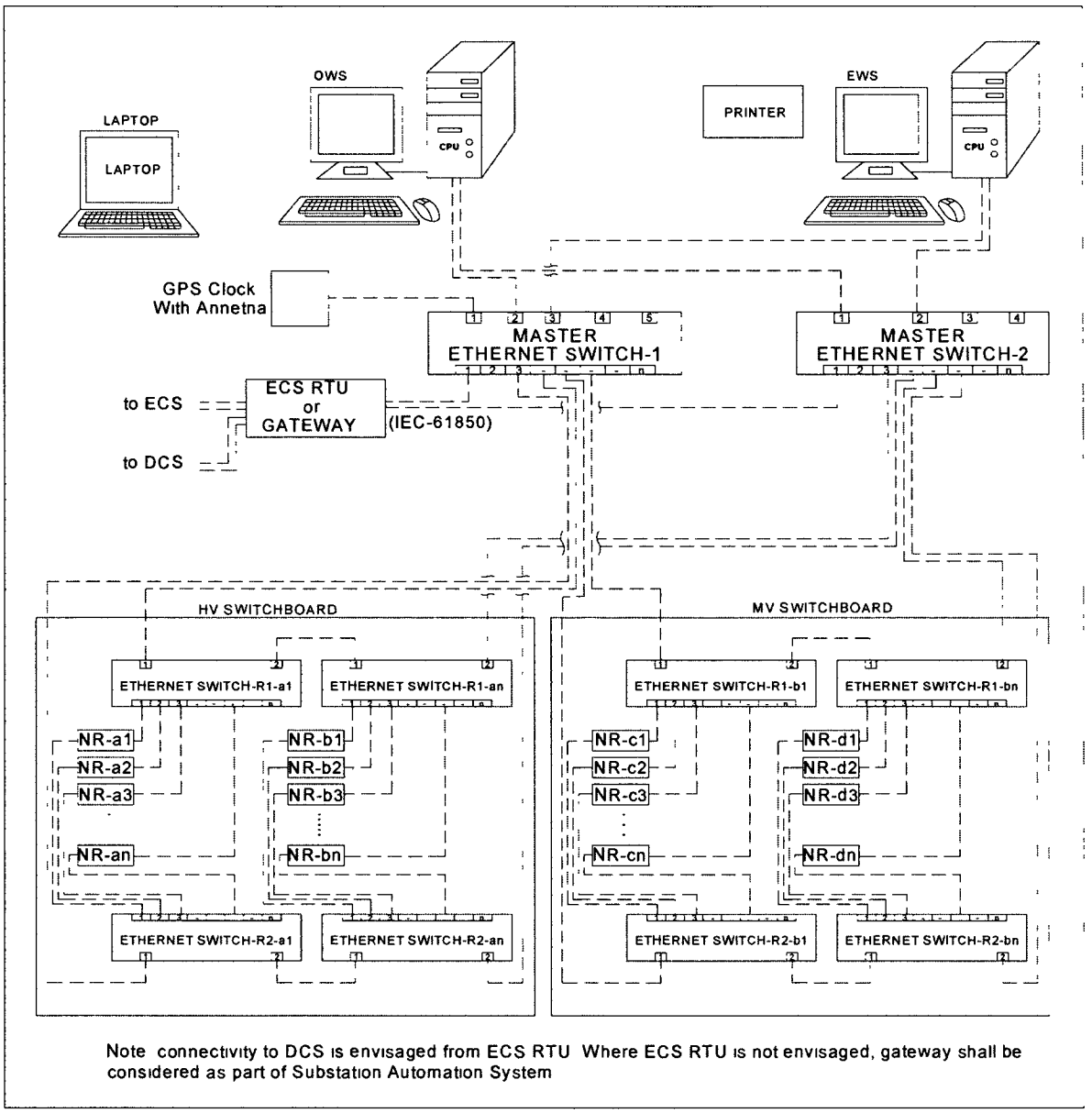


FIGURE 2: TYPICAL ARCHITECTURE FOR IEC-61850 COMMUNICATION



Note connectivity to DCS is envisaged from ECS RTU Where ECS RTU is not envisaged, gateway shall be considered as part of Substation Automation System

FIGURE 3: TYPICAL ARCHITECTURE FOR IEC-61850 COMMUNICATION



Note connectivity to DCS is envisaged from ECS RTU Where ECS RTU is not envisaged, gateway shall be considered as part of Substation Automation System

FIGURE 4: TYPICAL ARCHITECTURE FOR IEC-61850 COMMUNICATION

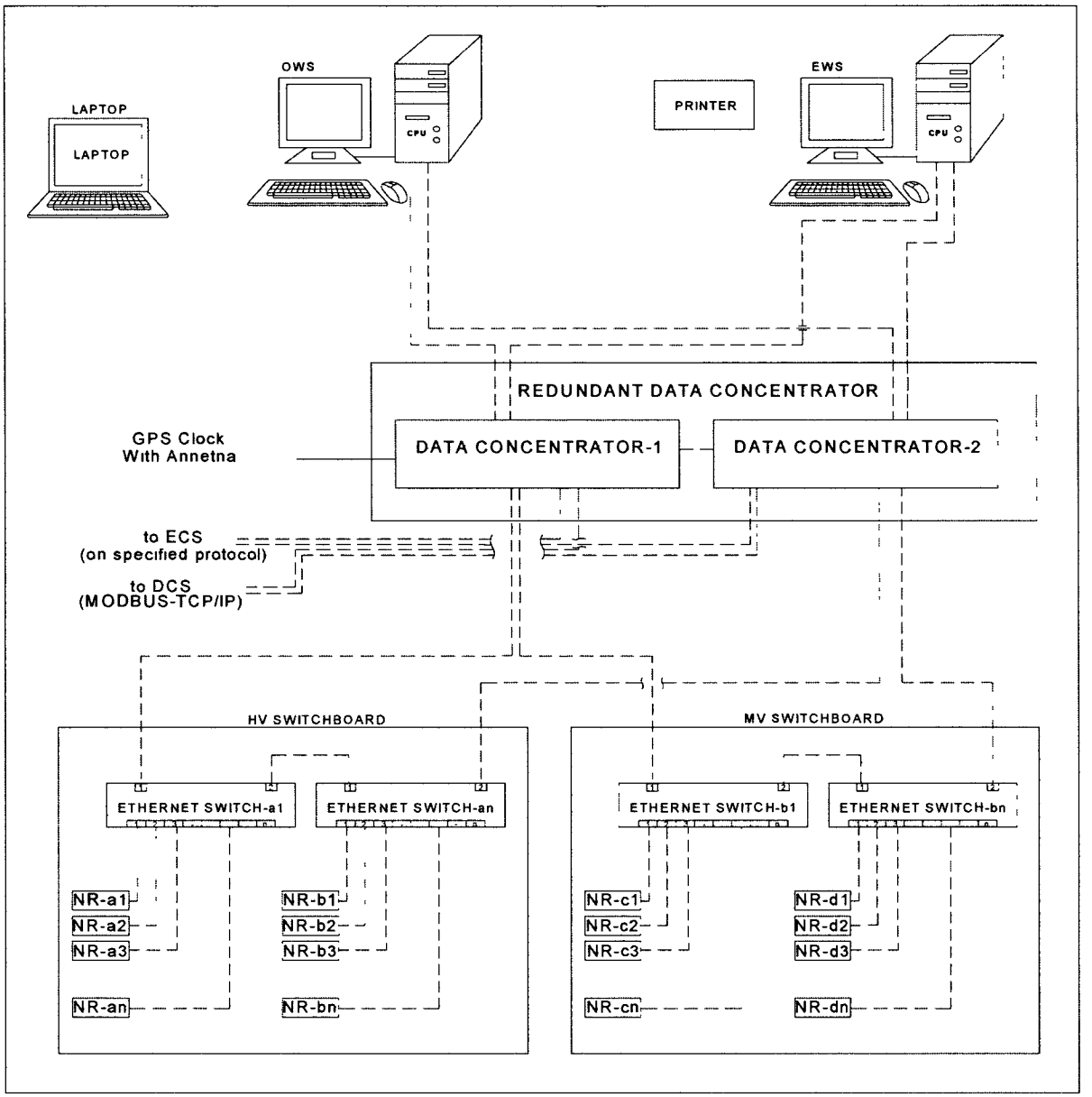


FIGURE 5: TYPICAL ARCHITECTURE FOR IEC-61850 COMMUNICATION

एफ आर पी केबल ट्रे के लिए विनिर्देश

SPECIFICATION FOR FRP CABLE TRAYS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
2	28.01.2021	REVISED AND ISSUED AS STANDARD SPECIFICATION	PK	VKJ	PG	SM
1	15.01.2016	REVISED AND ISSUED AS STANDARD SPECIFICATION	AKP	PS	BRB	SC
0	24.09.2010	ISSUED AS STANDARD SPECIFICATION	DA	SD/SG	NS/ JMS	ND

Abbreviations:

ANSI	:	American National Standards Institute
API	:	American Petroleum Institute
ASTM	:	American Society for Testing and Material
BIS	:	Bureau of Indian Standards
BS	:	British Standards
CEA	:	Central Electricity Authority
EIL	:	Engineers India Limited
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical & Electronics Engineers
IS	:	Indian Standards
FRP	:	Fibreglass Reinforced Plastic
NEMA	:	National Electrical Manufacturer's Association
NFPA	:	National Fire Protection Association
UL	:	Underwriter's Laboratory
UV	:	Ultra Violet
SS	:	Stainless Steel
VDE	:	Verband Deutscher Elektrotechniker

Electrical Standards Committee

Convenor: 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. Ayush Mathur (Projects)
Mr. Rajesh Sinha (Inspection)

CONTENTS

1.0 SCOPE

This specification covers the minimum requirements for design, manufacture, testing, and supply of Fibreglass Reinforced Plastic (FRP) cable trays, FRP tray covers, necessary hardware, accessories and fittings etc. suitable for outdoor installation, required for cable laying.

2.0 CODES AND STANDARDS

2.1 The cable trays and accessories shall comply with the requirements of latest revision of following standards:

ASTM-D149	Standard test method for dielectric breakdown voltage and dielectric strength of solid electrical insulating materials at commercial power frequencies
ASTM-D256	Standard test methods for determining the izod pendulum impact resistance of plastics
ASTM-D635	Standard test method for rate of burning and/or extent and time of burning of plastics in a horizontal position
ASTM-D638	Standard test method for tensile properties of plastics
ASTM-D790	Standard test methods for flexural properties of unreinforced and reinforced plastics and electrical insulating materials
ASTM-D2863	Standard test method for measuring the minimum oxygen concentration to support candle-like combustion of plastics (oxygen index)
ASTM-E84	Standard test method for surface burning characteristics of building materials
ASTM-G154	Standard practice for operating fluorescent light apparatus for UV exposure of non-metallic materials
IS 6746	Unsaturated polyster resin system for low pressure fibre glass reinforced plastic
NEMA FG1	National Electrical Manufacture's Association – Fibre glass cable tray system
UL 94	Standard for safety of flammability of plastic materials for parts in devices and appliance testing

2. 2 The cable trays and accessories shall also conform to the provisions of CEA Regulations with latest amendments and other statutory regulations currently in force in the country.

2.3 In case of any conflict between various referred standards/specifications and statutory regulations, the most stringent requirement shall prevail. However, owner's/ EIL's decision in this regard shall be final & binding.

3.0 SITE CONDITIONS

All the cable trays and their accessories shall be suitable for outdoor installation and shall be designed to operate under specified site conditions. If not specifically mentioned, a design ambient of 40°C and an altitude not exceeding 1000 m above mean sea level shall be considered.

4.0 TECHNICAL REQUIREMENTS

4.1 FRP cable trays shall be ladder type or perforated channel type with solid bottom as per the job requirements. They shall be complete with installation and mounting accessories of FRP such as bends, tees, crosses, reducers, splices, tray covers and other necessary hardware, etc.

4.2 FRP cable trays shall be designed and manufactured meeting the requirements of NEMA FG1, IS-6746 and ASTM E-84 standards.

4.3 All cable trays, covers and accessories shall be corrosion/ chemical resistant, weather resistant, UV resistant, antistatic, easy to drill and cut, lightweight, high strength and flame retardant (Class A Rating) in accordance with ASTM E-84. All the composite materials shall have UV light inhibiting chemical additives to resist degradation from ultra violet light. The minimum glass content in FRP material shall be 45%.

4.4 The ladder type trays shall have side runner and horizontal rungs. The rungs shall be placed at a distance of 250 mm apart from each other. The side runner of the cable tray shall be FRP channel of 100 mm height. Standard straight length of cable tray shall be 3 metres.

4.5 The tray construction shall be such as to facilitate easy handling and to ensure easy laying of cables without causing damage to them. The edges shall be smooth and free from burrs or projections.

4.6 Each section of tray shall be complete with necessary connector plates and hardware. The hardware shall conform to NEMA FG1 and shall be able to withstand the loading as specified below. The bends, tees, reducers, crosses and droppers shall have required bending radii as per job requirements subject to minimum bending radii not less than 750 mm.

4.7 For tray system design, in addition to self load and wind forces, following guidelines for design shall be considered:

a) Support span : 1500 mm

Cable load for 150 mm width: 30 kg/ linear meter

b) Support span : 3000 mm

Cable load for:

i) 300 mm width : 60 kg/ linear meter

ii) 450 mm width : 70 kg/ linear meter

iii) 600 mm width : 90 kg/ linear meter

iv) 750 mm width : 100 kg/ linear meter

In addition to this, 70 kg concentrated load at centre of span shall be considered.

4.8 The FRP trays thickness shall be calculated as per the loading criteria mentioned above. However the minimum thickness of FRP trays shall not be less than as mentioned below:

i) FRP cable tray upto 300 mm width : Thickness of 5 mm

ii) FRP cable tray above 300 mm and upto 750 mm width : Thickness of 6 mm

4.9 The side runners and all accessories shall have the oblong holes on each end for fixing the connector plates. The connection between two sections of the cable trays or a section of cable tray with associated accessories shall be done by bolting only. Nuts, bolts and washers shall be of stainless steel SS 316.

5.0 INSPECTION, TESTING AND ACCEPTANCE

Testing and Inspection of cable trays shall include but not be limited to the following:

5.1 Visual Inspection and dimension check shall be made to ensure that good workmanship and practice were maintained throughout the fabrication.

5.2 Quantitative check shall be made to ensure that all items with accessories are present according to the order and the packing list.

5.3 FRP cable trays shall be tested as per NEMA-FG1/ ASTM standards/ IS 6746 (most stringent one to apply in case of contradiction). Following tests, as a minimum, should have been performed on each type of tray system, type test certificates for the same shall be furnished

i) Destruction Load Test

ii) Deflection Test

iii) Drop/impact Test

iv) Vertical burning Test

5.4 FRP material shall be tested for flammability as per IS 6746 (for fire retardance), ASTM E84 (for surface burning characteristics, flame spread and smoke density), ASTM-D-635 (for rate and/or extent and time of burning) and UL 94 (vertical burning).

5.5 EIL/ Owner reserve the right to witness the final test and inspection. Prior notice of at least 4 weeks shall be given to enable the purchaser to depute his representative to witness the test.

5.6 Type test certificates / reports shall be considered acceptable if they are in compliance with the latest applicable relevant Standards and conducted at recognized laboratory. If the type test reports submitted are not in accordance with the requirements, Owner/EIL reserves the right to ask for the type tests to be repeated in the vendor's premises or other recognized place. The recognized laboratory shall issue the relevant type test certificates upon successful testing.

6.0 PACKING AND DESPATCH

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

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 and a set of final drawing shall be enclosed in a waterproof cover along with the shipment.

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

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)

CONTENTS

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,

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-

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.

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

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.

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

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)

CONTENTS

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.

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

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.

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

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.

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.

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.

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.

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.

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

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.

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.

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

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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

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
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Ms. Shirali Aggarwal
Ms. Rashmi Singh Rathaur
Mr. Ayush Mathur (Projects)
Mr. Rajesh Sinha (Inspection)
Ms. Shalini Verma (PEM)

CONTENTS

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

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.

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.

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

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.

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

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.

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.

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.

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	--	--

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)

CONTENTS

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

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.

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

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.

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

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.

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.3rd 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

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.

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

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.

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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

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

CONTENTS

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.

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.

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.

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.

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.

विद्युत संस्थापनों के साइट निरिक्षण, परिक्षण व कमीशनिंग के लिए विनिर्देश

SPECIFICATION FOR FIELD INSPECTION, TESTING AND COMMISSIONING OF ELECTRICAL INSTALLATIONS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	13 08 19	REVISED & ISSUED AS STANDARD SPECIFICATION	RM	RS	SA	RKT
3	10 6 14	REAFFIRMED & ISSUED AS STANDARD SPECIFICATION	AKG	SA	BRB	SC
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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

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

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Ms. Shalini Verma
Mr. Raman Sood
Ms. Shirali Aggarwal
Ms. N.P. Guha (Projects)
Mr. Rajesh Sinha (Inspection)

CONTENTS

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.

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

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

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.

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).

पेविंग कार्यों के भाग के रुप में वैद्युत कार्यों के लिए विनिर्देश

SPECIFICATION FOR ELECTRICAL WORKS AS PART OF PAVING WORKS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	16 12.2019	REVISED AND REISSUED AS SPECIFICATION	RM/DK	RS	SA	RKT
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0	06 01.2000	ISSUED AS STANDARD SPECIFICATION	BLC	RR	VPS	AS

Abbreviations:

BIS	Bureau of Indian Standards
GI	Galvanised Iron
IS	Indian Standard
NB	Nominal Bore
PVC	Poly Vinyl Chloride
SWG	Standard Wire Gauge

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)

CONTENTS

1.0 SCOPE

This specification defines the requirements for supply and installation of materials such as earth electrode, earth strip, GI conduit sleeves etc. by contractor in the areas to be paved.

2.0 CODES AND STANDARDS

The work shall be carried out in the best workman like manner in conformity with this specification, EIL Installation standards, latest edition of codes of practice of Bureau of Indian Standards and the regulations laid down by the Electrical Inspectorate and other concerned authorities as applicable.

IS : 3043	Code of practice for earthing
IS : 1239 Part-I	Mild steel tube, tubular and other wrought steel fittings.
IS : 1239 Part-II	Mild steel sockets tubular and other wrought steel pipe fittings.
IS : 4736	Hot dip zinc coating on mild steel tubes.
SP-30(BIS)	Special publication-National electrical code

3.0 MATERIAL SPECIFICATIONS

All materials and hardware to be supplied by the contractor shall be new, unused and of best quality and shall conform to the specifications given hereunder and installation standards attached with the tender. Contractor shall bring material samples to site and get it approved by Engineer-in-charge before installation.

3.1 Earth Grid

The main earth grid conductor shall be hot dip galvanised mild steel flat/as specified in design basis. Sizes for main conductors shall be as indicated on the layout drawing.

3.2 Earth Electrodes

Earth electrodes shall be of hot galvanised medium grade mild steel pipe, 65 mm NB diameter as per EIL installation standard unless otherwise specified as per job specification.

3.3 Earth Plate

This shall be of size 400 x 75 x 10 mm GI Earth plate (hot dip galvanised) as per installation standard unless other wise specified.

3.4 GI Pipes Sleeves

These shall be of galvanised medium grade mild steel pipe of standard diameters viz. 40, 50, 65, 80, 100, 125, 150 mm NB as required.

3.5 Galvanising

The amount of galvanizing for material shall be minimum 610 gm. per sq. meter unless otherwise specified in job specification

4.0 INSTALLATION

4.1 Earth Electrode in Test Pit

4.1.1 Earth Electrode shall be installed as shown on installation standard.

4.1.2 The location of earth pit shown on the layout drawings is indicative. The exact location of earth electrodes in the field shall be determined by the contractor in consultation with the site Engineer-in-charge.

4.1.3 Earth electrodes shall be located avoiding interference with road, building foundation, column, pipelines etc. to the extent possible. The civil area drawings shall be referred for this.

4.1.4 The distance between two electrodes shall preferably not be less than twice the depth of electrode.

4.1.5 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.

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

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

4.1.8 Location of earth electrode shall be marked by permanent markers for easy identification. Top cover of electrode shall be serial numbered and also marked on "As built drawing" for reference.

4.1.9 Each earth plate shall be connected to main earth grid by two vertical risers (earth strip) from earth grid. Where earth plates are not indicated on the drawing, vertical riser (earth strip) from earth grid upto 300 mm above finish level of pavement/floor shall be provided as per layout.

4.2 Earthing Network

4.2.1 This consists of main earth conductor (grid conductor) forming a closed ring network with required number of earth electrodes to provide a common earth path for electrical devices and metallic structures. From each earth electrode two distinct connections shall be made to the main earth conductor.

4.2.2 The earth conductor shall be laid as indicated on the earthing layout drawing and exact route may be modified at site to suit site conditions.

4.2.3 Earthing conductors shall be buried in both longitudinal and transverse directions to facilitate the earthing of various equipments.

4.2.4 The reinforcement of pavement shall also be connected to the plant earthing grid by means of welding /clamping at an interval of 25m (max.).

4.2.5 Earth conductor running along lined trenches shall be firmly cleated on the structure surface using GI spacers and clamps at intervals of approximate 1000mm unless specified otherwise and also clamps shall be installed near to termination ends.

4.2.6 Earth conductor, in case laid underground, shall be at a depth of 300mm below finished pavement level.

4.2.7 Joints and tappings in the main earth loop shall be made in such a way that reliable and good electrical connections are permanently ensured.

4.2.8 All joints below grade shall be welded on all four sides and shall be suitably protected by giving two coats of bitumen and covering with hessian tape.

4.2.9 Earth strip laid above ground shall be welded across straight through joints and joints shall be suitably protected by giving two coats of bitumen. Welding shall be done with an overlapping of strip equivalent to double the width of the strip and all four sides (Three on top and one on bottom) shall be continuously welded.

4.2.10 Earth plates shall be provided for taking earth connections to different equipment. For this, earth strips (two nos.), welded to earth network, below ground shall be extended above grade level and connected to earth plate.

4.2.11 Earth Electrodes for lightning protection shall be dedicated. These shall be bonded atleast at two points below ground, with the main earthing network.

4.3 GI Pipe Sleeves

All GI Pipes shall be laid as per layout drawings for the purpose of taking electrical cables to electric Motor/Other equipment. Fabrication of various profiles shall be made by hydraulically operated bending machine (which is to be arranged by the contractor) and all the burrs in the pipes shall be removed.The number of bends made in each pipe length shall be restricted to one. GI Pipes, buried in soil shall have bitumen coating on the buried portion Installation of GI Pipes shall be undertaken well before paving is done. GI lids or PVC bushes (size to suit pipe) shall be provided at both the ends of pipe. Pull wire (16 SWG steel wire) shall be provided inside pipe having length more than 3 meters for ease of cable pulling by other agency at later stage.

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SPECIFICATION FOR ELECTRIC SURFACE HEATING SYSTEM

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	02 08 19	REVISED AND REISSUED AS STANDARD SPECIFICATION	PK	SV	SA	RKT
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Abbreviations:

BASEEFA	:	British Approvals Service for Electrical Equipment for Flammable Atmospheres
BIS	:	Bureau of Indian Standards
CCOE	:	Chief Controller of Explosives
CEA	:	Central Electricity Authority
CIMFR	:	Central Institute of Mining and Fuel Research
CT	:	Current Transformer
DGMS	:	Directorate General of Mines Safety
ELCB	:	Earth Leakage Circuit Breaker
ERTL	:	Electronics Regional Test Laboratory
FM	:	Factory Mutual Research Corporation
GI	:	Galvanised Iron
IEC	:	International Electro Technical Commission
IEEE	:	Institute of Electrical & Electronics Engineers
IP	:	Ingress Protection
IS	:	Indian Standards
LCIE	:	Laboratorie Central Des Industries Electriques
LDP	:	Local Distribution Panel
MCB	:	Miniature Circuit Breaker
MS	:	Mild Steel
OISD	:	Oil Industry Safety Directorate
PDB	:	Power Distribution Board
PEM	:	Project Engineering Management
PESO	:	Petroleum and Explosives Safety Organisation
PO	:	Purchase Order
PVC	:	Polyvinyl Chloride
RTD	:	Resistance Temperature Detector
SWG	:	Standard Wire Gauge
TPN	:	Three Phase Neutral
UL	:	Underwriters Laboratories

Electrical Standards Committee

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

CONTENTS

1.0 GENERAL

1.1 This specification and project data sheets define the requirements for system design, engineering, supply, installation, testing and commissioning of electric surface heating (ESH) devices as applied to fluids/materials in piping and associated equipments, both in safe and hazardous areas (classified as Zone -2), in accordance with applicable standards.

1.2 Contractor shall ensure that the design, product selection and installation are carried out as per good engineering practices, which shall also include the requirements of safety, reliability, ease of maintenance and operation.

1.3 Compliance with this specification and /or approval of any of the contractor's documents shall not relieve the contractor of his responsibility towards the contractual obligation with regard to the completeness and satisfactory operation of the electric surface heating system.

2.0 CODES AND STANDARDS

2.1 The equipments covered by this specification shall comply with the requirements of the latest edition of applicable standards issued by BIS, IEC and IEEE including the following:

IS-5	:	Colours for ready mixed paints and enamels
IS-1554	:	PVC insulated (heavy duty) electric cables.
IS/IEC 60079-1	:	Electrical equipment with type of protection 'd'
IS-3043	:	Code of practice for earthing
IS-5571	:	Guide for selection of electrical equipment for hazardous area.
IS/IEC-60079-15	:	Electrical equipment with type of protection 'n'.
IS-8623	:	Specification for low voltage switchgear and control gear assemblies.
IS/IEC-60079-0	:	General requirements for electrical apparatus for explosive gas atmosphere.
IS-13703	:	Specification for low voltage fuses
IS/IEC-60947	:	LV switchgear and control gear.
IEC-61439	:	Low voltage switchgear & controlgear assemblies
IS/IEC 60079-30-1	:	Electrical apparatus for explosive gas atmosphere Electrical resistance trace heating Part-1, General & testing requirements
IS/IEC 60079-30-2	:	Electrical apparatus for explosive gas atmosphere-Electrical resistance trace heating
IEC 60751	:	Industrial platinum resistance thermometer sensor Part-2, Application guide for design, installation and maintenance
IS/IEC 60529	:	Degree of protection provided by enclosures (IP Code)
IEEE-515	:	Standards for the testing, design, installation and maintenance of Electrical Resistance Heat Tracing for Industrial applications.
IEC/IEEE-60079-30-1	:	Explosive atmospheres Electrical resistance trace heating - General & testing requirements
IEC/IEEE-60079-30-2	:	Explosive atmospheres-Electrical resistance trace heating-Application guide for desing, installation and maintenance

In case of conflict between requirements specified in various referred standards/specification/data sheets/and the statutory regulations, the most stringent one shall prevail. However, owner's decision in this regard shall be final and binding.

2.2 In addition, work shall conform to the following statutory requirements as applicable.

- CEA regulations
- Fire insurance regulations
- Regulations laid down by Chief Controller of Explosives/DGMS as applicable.
- Indian Petroleum Rules
- OISD guidelines/standards
- Regulations laid down by local authorities from time to time.

2.3 Where Indian Standards do not exist, the relevant IEC, IEEE standards shall apply.

3.0 SYSTEM DESIGN REQUIREMENTS

3.1 Electrical Surface Heating

3.1.1 The design shall be based on continuous and reliable service, safety to personnel and equipment, ease of maintenance and interchangeability, wherever applicable.

3.1.2 a) Product classification approach shall be followed for determining heating device's sheath temperature unless otherwise agreed.

b) Systems approach may be permitted in those instances where the sheath temperature determination as per product classification approach exceeds 200° C.

c) In exceptional cases requiring high maintenance temperatures as specified in project data sheet, the design may be based on systems approach wherein the electric heating tape may not necessarily be certified under product classification approach.

d) In case of system approach, the design of the electric heating system shall be based on stabilised design approach where the maximum surface temperature of the heating device shall be determined without temperature control.

e) In system approach, Controlled design approach shall be used either in case of constant wattage cables or in case of self regulating/ power limiting trace systems when maintenance temperature is more than121 degree.

f) Double insulation technique shall not be permitted.

g) The following table shall be followed for selection of the heat tracing system

Maintenance temperature	Operating (Continuous power ON)	Exposure/ Intermittent Power OFF	Tracer type	Approach (Product/ system)
<=121	<=121	<=250	Self Regulating	Product
From 121 to 150	From 121 to 150	<=250	Self Regulating	Product/Stabilised (Refer c,d & e)
From 151 to 200	From 151 to 200	<=250	Self Regulating / Power Limiting	Product/Stabilised (Refer c,d & e)
>200	>200	Any	Mineral Insulation	Controlled

h) The heating tape shall be suitable for continuous/ intermittent exposure temperature under power ON/power off condition as specified in project data sheet.

i) All necessary type test certificates including those for 'T' rating, service life bench mark performance test shall be furnished.

3.1.3 Overlapping of heating tapes shall be permitted only in case of heating tapes with burnout proof feature.

3.1.4 The heating tapes shall be suitable for use in area defined in project data sheet. It shall be provided with corrosion resistant tinned copper braid for both safe and hazardous area applications. For applications requiring high exposure temperature, the braid may be of nickel plated copper. An outer sheath over the metallic braid shall also be provided for corrosion resistance and additional mechanical protection. Fluropolymer overjacket shall be used over metallic braid in areas where exposure to hydrocarbon based chemical solutions or vapours are expected.

3.1.5 The surface temperature of the heating tapes/electrical equipment intended to be used in hazardous area shall not exceed 200 °C (T3 rating) unless otherwise specified in the project data sheet.

3.1.6 The selection of heating tapes and other devices shall be done by the contractor considering the following:

- Specified maintenance/heating temperature requirements,
- Minimum design ambient temperature
- Intermittent Exposure temperature
- Operating temperature
- Design temperature
- Thermal insulation (Type and thickness)
- Tolerance on supply voltage and voltage drop on feeding cables
- Minimum heater output rating at operating conditions
- Site environment conditions
- Specified hazardous area classification and 'T' rating
- Design margin

3.1.7 If specified in data sheet, for critical applications where heat up time is an important factor during start up or power shut down, extra heating capacity shall be taken into design in addition to that required for temperature maintenance.

Apart from above, there may be a need to heat up (to melt) the contents within a certain period under specified ambient condition, additional heating capacity need to be installed for such duty.

3.1.8 The method of calculation of heat loss and related parameters shall be as per guidelines given in the standards. The losses from each part of the surface shall be calculated using the appropriate formula and added together to determine the total heat loss. A minimum design margin of 10% shall be considered on the rate of heat loss calculated.

3.1.9 The tracer shall withstand the highest equilibrium pipe temperature that occurs when the heating tape is continuously energised at the maximum ambient temperature and at the maximum operating voltage. The maximum continuous exposure temperature of the heating

tapes in "Power ON" condition shall be more than the highest equilibrium pipe/equipment temperature or 20°C above the specified maintenance temperature of the pipes/equipment whichever is higher.

3.1.10 Heat tracer shall have temperature withstand capacity of not less than the maximum operating temperature

3.1.11 Heating tape used for piping and other equipments that will undergo periodic steam cleaning shall have intermittent exposure minimum withstand temperature with power off as specified in project data sheets. Tracer shall be suitable for withstanding exposure temperature for "power OFF" condition for cumulative duration of at least 1000 hrs.

3.1.12 The heat output at the end of the heater tape shall meet the minimum heat loss requirement, considering negative tolerance on supply voltage, voltage available at the end of the tape and considering minimum heater output rating at operating conditions.

3.1.13 Extra heater tape length shall be provided for valves, flanges, pipe supports and similar heat sinks. The heater tapes shall be installed so as to permit easy maintenance or removal of the valve, pipe support or similar heat sink however, installation shall be done without overlapping.

3.1.14 Each heater circuit shall be provided with independent thermostat (temperature set point manually adjustable) / RTD with multi circuit control and monitoring system for energy conservation requirements. The type of temperature sensing device i.e. thermostat or RTD shall be as per data sheet. The location of thermostats/RTD shall be decided at the most strategic points which are governed by process / site conditions. The capillary of the thermostat tube shall have mechanical protection.

3.1.15 Number of circuits shall be decided considering all possible flow conditions.

3.1.16 Suitable flexible material shall be used for proper positioning of the heater tape on pipeline, equipment. No increase in allowance on heat output shall be permitted on this account.

3.2 Electrical Power Distribution

3.2.1 Power supply shall be provided in owner's substations for feeding power to the PDBs or LDPs. In case bulk supply to heat tracing system is considered, PDBs shall be provided for distributing power to LDPs. Power supply to the heater tapes shall be provided from LDPs located in the field at strategic locations /load centres to be decided by the contractor.

3.2.2 For power cable sizing, total voltage drop from owner's switchgear to heater tape shall be limited to 5% under full load condition. The voltage drop between owner's switchgear to PDB/LDP shall be 3% and PDB/LDP to heater tape shall be 2%.

All power cables (from substation to PDB/LDP and LDP to heater tape) shall be properly sized to carry current without undue temperature rise under site derated conditions. The derating shall take into account ambient air temperature/ground temperature, grouping and proximity of cables with each other, thermal resistivity of soil etc. as applicable for installation.

Further, the selected cable size shall also be adequate to carry the maximum anticipated heater start up current while the heating device is at minimum temperature.

3.2.3 3 core-armoured cables shall be used for power supply to heater tape for single-phase circuits. (2 cores for phase and neutral and third core for earth conductor).

3.2.4 The incoming cables to PDBs / LDPs shall be four core (conductor size for neutral shall be same as that for phase conductors).

3.2.5 Thermostats, if used, in power circuit, as well as Components used in the local distribution panels shall be sized for 125 % of starting current at rated voltage and considering maximum heater output rating.

3.2.6 The load shall be balanced in all the 3 phases to the extent possible in each LDP.

3.2.7 **Monitoring Facility**

Unless otherwise specified in the data sheet, the monitoring facility for power supply healthiness of feeders in LDP feeders shall be done by providing one auxiliary contactor in each feeder which shall remain energised under power supply healthy condition. The contact (Normally open) of this auxiliary contactor of all feeders shall be wired in series in each LDP to give one common alarm contact for remote annunciation (open to alarm) against loss of voltage, earth leakage, and fault.

4.0 EQUIPMENT AND MATERIAL SPECIFICATIONS

All materials to be used for the job shall be field proven in similar services and under similar conditions with proven track record. The workmanship shall be of high quality in every respect.

The main heater tape shall be as detailed in section 3.1. The requirements in respect of other items are detailed below.

4.1 Power Distribution Boards (PDB)/ Local Distribution Panels (LDP)

4.1.1 PDB/LDP shall conform to attached EIL specifications and data sheet. PDB shall preferably be installed in outdoor safe areas.

4.1.2 PDBs/LDPs intended for installation in outdoor safe areas shall be housed in outdoor kiosk to make it totally weather protected. Necessary glass windows shall be made in outdoor kiosk, so that the operator can see all indications and energised / de-energised position of different switches/ MCCB's and other device from outside without opening the door and without taking any special precautions.

4.1.3 The incomer feeder of PDB shall be isolator /breaker feeder and shall have voltmeter with selector switch, ammeter, ammeter selector switch indication lamps .Outgoing feeder shall be switch fuse feeder with ON/OFF/trip indication lamps.

4.1.4 LDP incomer shall be TPN load break switch feeder of required rating. The incomer feeder shall have voltmeter with selector switch, ammeter, ammeter selector switch and 3 Nos. pilot lamps for supply indication. Each out going circuit shall comprise of Miniature Circuit Breaker (MCB) with thermal over current and magnetic short circuit releases, Earth Leakage Circuit Breaker (ELCB) (M9 Category), power contactor of required rating if thermostat rating is inadequate. MCB shall be double pole for single phase circuits. MCB rating shall be such that it shall not operate on starting current. The ELCB shall have nominal 30 mA and 30-msec.-trip rating, in case this setting results in nuisance tripping, ELCB may be selected above 30 mA but not greater than 300mA and 150 msec. Ammeter (CT operated) and indication lamp for feeder status shall be provided for each outgoing circuit. Indication circuit shall include the status of the thermostat (ON/OFF) installed in the field.

4.1.5 PDB/LDP shall have 20% spare feeders, which shall include minimum of one spare feeder of each rating.

4.2 General Requirements

4.2.1 Junction boxes /power connectors used for power cable / heater tape termination shall be weatherproof for use in safe areas. Flameproof Ex-d junction boxes /power connectors shall be used for hazardous areas as a minimum.

4.2.2 All power, control and signal cables shall be as per specifications attached.

4.2.3 All outdoor enclosures shall be provided with IP 55 protection.

4.2.4 All equipments such as PDB's/LDPs, thermostats etc intended for installation in hazardous area shall be of flameproof type with, Temp. Class T3 and suitable for applicable gas group (IIA, IIB or IIC) as per project data sheet. The enclosure shall also have IP-55 weather protection. Canopy shall be provided for additional weather protection.

4.2.5 Nickel plated brass double compression cable glands shall be used for cable termination in all equipments.

4.2.6 Heater tape termination and support clamps shall withstand the maximum temperatures, temperature cycling and thermal expansion of piping or equipment to be heated. These shall not be affected by rainwater, firewater spray and site environment.

4.2.7 Electric surface heating system shall be complete with all accessories for fixing and installing the heater tape and junction boxes, power connectors, T connectors, end connectors etc.

4.2.8 Each heater shall be tagged with non-corrosive metallic tag indicating heater number, type and pipe line/equipment number.

4.2.9 Pipe lines, instruments and vessels heated with heater tape shall be provided with suitable metallic caution signs visible from all sections of the heated system. Caution signs on traced pipe lines shall not be more than 6 m apart. In addition, each instrument, level gauge, vessel etc. that by the nature of their function require operation or maintenance, shall carry an individual sign. The sign shall read "Electric surface heated" and shall be of size 200 mm x 60 mm (minimum).

4.2.10 All electrical equipments to be supplied by the contractor be epoxy painted. Unless otherwise specified, the colour shade shall be shade 632 as per IS: 5.

4.3 Local Thermostats

4.3.1 Capillary Type

The capillary shall not be more than 5 m long. The contacts of thermostat used for direct switching shall have a minimum rating of 16 A. Each contact shall not be loaded with more than 75% of its nominal rating. The temperature setting accuracy shall be better than $\pm$ 5% of set value.

4.3.2 Flameproof and weather protected (IP-55) thermostats shall be used in classified areas. All thermostats shall be factory calibrated, non-indicating type, equipped with internally adjustable set point.

4.4 RTD with Multi Circuit Control and Monitoring Facility

4.4.1 RTD shall be 3 wire type with platinum element having 100 ohms resistance at 0°C, selected for desired temperature range.

4.4.2 The element shall be of highly refined material of reference grade and shall have been stress relieved. RTD calibration shall be as per IEC-60751-2.

4.4.3 Multi circuit temperature controllers (provided in PDB/LDP) shall have facility to connect required numbers of RTDs. Controllers shall be of Heat tracer supplier make. Controllers shall be connected preferably in ring topology to central monitoring system through RS-485 / FO cable. Location of central monitoring system shall be as defined in job specific documents. All data available in LDPs shall be available at central monitoring system. The HMI for central monitoring system shall be industrial type and supplied with latest configuration & latest version of Microsoft windows and all softwares provided shall be suitable for the same. HMI shall be capable for storage of more than 1 year data of all connected LDPs including 20% margin capacity. HMI shall have provision for communicating all data to owner DCS on Modbus TCP/IP through FO cable.

4.4.4 All components for the system shall be suitable for hazardous area in line with area classification requirements.

4.4.5 Provision for monitoring of following minimum alarm conditions shall be provided in LDP for all circuits

- Low / high temperature
- RTD failure
- Communications failure
- Ground-fault
- Low / high current

Additionally actual analogue temperature value shall also be communicated.

4.4.6 Central monitoring system provided in LDP shall have provision to communicate with upper level system/automation. The type of protocol for communication with upper level system shall be as defined on the data sheet.

5.0 INSPECTION, TESTING AND ACCEPTANCE

5.1 All equipment and materials to be supplied by contractor shall be subject to inspection by EIL/Owner, at manufacturer's works. Manufacturer shall furnish all necessary information concerning supply to EIL / owner's inspectors. The inspector shall have free access to the manufacturer's works for the purpose of inspecting the process of manufacture in all its stages to assess the progress of works as well as to ascertain the quality of raw materials used.

5.2 All routine and acceptance tests as specified by the applicable standard codes and enclosed EIL specifications shall be conducted. Shop tests shall be witnessed by Inspector of EIL / Owner or of an agency authorised by owner.

5.3 For equipment bought from sub-suppliers, certified test reports of tests carried out at the manufacturer's works shall be submitted. The sub-supplier at his works shall conduct normally all routine tests as specified in the relevant standards.

5.4 All sundry installation materials brought to site directly, will be inspected and approved by Engineer-in-charge before installation.

6.0 INSTALLATION

6.1 Heater Tape

6.1.1 Before installation of heater tapes on pipes and other equipments, contractor shall arrange to clean properly the surfaces to the extent required.

6.1.2 Installation shall be done in accordance with applicable standards.

6.1.3 Heating tapes shall not be installed until pipe lines and equipment have passed all required tests and clearance is given by engineer-in-charge.

6.1.4 Heaters and controls shall be carefully located and installed to prevent damage during normal operation and maintenance.

6.1.5 The electric surface heating for instruments, valves and flanges shall be done in such a way that servicing of instruments, opening of valves and servicing of flanges is possible with ease and without disconnecting wiring.

6.1.6 Field installation works shall be carried out in such a manner that the work of other agencies (piping, insulation contractor etc.) operating at the site is not hampered due to any action of the contractor and proper coordination with other agencies shall be contractor's responsibility.

6.2 Cabling System

6.2.1 Cable shall preferably be laid in overhead / surface mounted cable trays along the pipe rack/ pipe track wherever available. GI cable trays shall be used unless otherwise specified. Cable trays shall be supported at a distance not exceeding 3000 mm. Tray widths shall be preferably 300 / 450 mm and shall be arranged in single/ multi-tiers as required. All supporting steel shall be painted before laying of cables.

6.2.2 All power, control, signal cables in unpaved areas shall be directly buried unless specified otherwise. After required earth excavation, cable shall be laid at a depth of not less than 750 mm and shall be covered with 150 mm of sand on top of the largest diameter cable followed by a protective covering of 75 mm thick second-class red bricks. The remainder of the trench shall then be back filled, rammed and levelled. Where underground cables cross roadways, pipe sleepers at grade etc., they shall be taken through existing Electric Road Cross (ERC) or duct. Cables rising from grade shall be protected by GI conduits up to a min. of 300 mm above grade and open ends shall be sealed. Cable route markers shall be provided by contractor for underground-buried cable trench at an internal of 30 m.

Cables in paved areas shall be taken in trenches provided by purchaser. The trench covers shall be removed by contractor and shall be reinstated after cable laying. Trenches in hazardous area shall be completely filled up with sand.

Where trenches are not available in paved areas, contractor shall take cables in GI sleeves to be laid in paved area or through overhead cable trays.

6.2.3 All power and control cables shall be of continuous lengths without intermediate joints. All cables shall be identified close to their termination point by cable number (as per cable schedule), punched on 2 mm thick aluminium strap securely fastened to the cable. Each underground cable shall be provided with identity tags made of lead securely fastened at every 30 m of its underground length with at least one tag at each end before the cable enter/leaves the ground. In case of control cables, all cores shall be identified at both ends by their terminal numbers using PVC ferrules as per interconnection diagrams.

6.2.4 All PVC cables up to 1.1 kV grade shall be terminated at the equipment by means of double compression type cable glands and crimping type lugs. All cable entries shall be through bottom only unless otherwise approved.

6.3 Earthing System

6.3.1 All metallic non current carrying parts of electrical apparatus, PDBs, LDPs, Heater tape mounting accessories, junction boxes, thermostats etc. shall be earthed.

6.3.2 For earthing of PDB/ LDP and other equipment and devices, contractor shall tap from the nearest available existing main earth grid by providing two runs of 40 x 5 GI strip. Amount of galvanizing shall be 610 g/sq. mm (Min).

Joints and tapings with the main earth grid shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below grade shall be welded and suitably protected by giving two coats of bitumen and covered with hessian tape. Earthing network shall be augmented by providing additional earth electrode in test pits where required.

Multiple earth connections shall be taken from suitably located earth plates connected to earth grid. Equipment handling more than 250 V power shall be earthed at two points. Size of strip/ conductor for LDP shall be same as that of the earth grid.

For connection from earth plate to different equipment mountings, and accessories of surface heating system, GI wire rope/ PVC insulated aluminium conductor cable as specified on the data sheet shall be used. Size of earth wire shall be such that the current rating is at least 60 % of power cable rating / equipment rating. Minimum size shall however be 6 sq. mm. for aluminium wire / 8 SWG for GI wire.

6.3.3 All hardware used for earthing installation shall be hot dip galvanised /zinc passivated / chromium plated. Spring washers shall be used for all earthing connections of equipment.

7.0 FIELD TESTING AND COMMISSIONING

7.1 Inspection during installation and after completion of installation shall be carried out by contractor's adequately trained supervisor /engineer in accordance with guidelines given in the standards. Contractor at no extra cost to the owner shall rectify any defect pointed out by EIL/OWNER'S site-in-charge.

7.2 Before any part of the electric surface heating system is energised, the precommissioning tests shall be carried out. This shall include and be not limited to the following:

- Insulation resistance tests
- Continuity test
- Earth loop impedance

Field testing and commissioning procedure shall be submitted by the contractor for owner/EIL approval.

All pre-commissioning checks and tests both for power distribution and heating system shall be carried out by the contractor in the presence of Engineer-in-charge. Test readings are to be recorded by contractor and copies of test certificates shall be furnished to EIL /owner.

7.3 After inspection and pre-commissioning tests are carried out, contractor shall obtain necessary statutory approval of the system before energizing the installation. Current shall be noted at the time of initial energization of the circuits and again when readings have stabilized. All results shall be recorded and furnished to the owner to form part of system documentation.

8.0 CERTIFICATION AND APPROVALS

Electrical equipments for hazardous areas shall have type test certificates issued by recognised independent test house such as CIMFR/ERTL/BASEEFA/LCIE/UL/FM. All equipment (indigenous/imported) shall have valid statutory approvals (CCOE/DGMS) as applicable for use in specified hazardous area. All Indigenous flameproof equipment shall have valid BIS license and as required by statutory authorities.

9.0 PACKING AND DESPATCH

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

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

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SPECIFICATION
FOR
LIGHTNING ARRESTORS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	17.06.2021	REVISED AND ISSUED AS STANDARD SPECIFICATION	SH	VKJ	PG	SM
5	11.05.2016	REVISED AND ISSUED AS STANDARD SPECIFICATION	CS	PG	BRB	RN
4	08.04.2011	REVISED AND ISSUED AS STANDARD SPECIFICATION	DA	BRB	UAP	DM
3	06.03.2009	REVISED AND ISSUED AS STANDARD SPECIFICATION	HK	BRB	JMS	ND
2	28.03.2003	REVISED AND ISSUED AS STANDRAD SPECIFICATION	AKT	AAN	VPS	SKG

Abbreviations:

AC	:	Alternating Current
BIS	:	Bureau of Indian Standards
CEA	:	Central Electricity Authority
EIL	:	Engineers India Limited
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical & Electronics Engineers
IP	:	Ingress Protection
IS	:	Indian Standard
MCOV	:	Maximum Continuous Operating Voltage
PO	:	Purchase Order

Electrical Standards Committee

Convenor: 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. Ayush Mathur (Projects)
Mr. Rajesh Sinha (Inspection)

CONTENTS

1.0 SCOPE

The specification covers the design, manufacture, testing, and supply of gapless metal oxide type lightning arrestor for alternating current systems suitable outdoor installation.

2.0 CODES AND STANDARDS

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

IS: 5	:	Colours for ready mixed paints and enamels.
IS: 2071	:	Method of high voltage testing.
IS: 2629	:	Recommended practice for Hot dip galvanizing of Iron and Steel.
IS: 6209	:	Methods of Partial Discharge measurement.
IS: 11353	:	Guide for uniform system marking and identification of conductors and apparatus terminals.
IS: 15086	:	Surge Arresters Part 4 Metal-Oxide Surge Arresters without Gaps for AC Systems.
IS/ IEC: 60071	:	Insulation Co-ordination Application Guide.
IS/ IEC: 60137	:	Insulated Bushings for Alternating Voltages above 1000 V.
IS/ IEC: 60168	:	Tests on Indoor and Outdoor Post Insulators of Ceramic Material or Glass for Systems with Nominal Voltages Greater than 1000 V.
IS/ IEC: 60529	:	Degree of protection provided by enclosures (IP Code).
IS/IEC: 60947	:	Specification for low voltage Switchgear and control gear.
IS/ IEC: 62155	:	Hollow Pressurized and Unpressurized Ceramic and Glass Insulators for Use in Electrical Equipment with Rated Voltages Greater Than 1000 V.

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

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

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

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

3.0 GENERAL REQUIREMENTS

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

4.0 SITE CONDITIONS

The lightning arrestors shall be suitable for outdoor installation and shall be designed to operate under tropical, humid, corrosive and very heavy polluted site conditions as specified in data sheet. If not specifically mentioned therein, a design ambient of 40°C and an altitude not exceeding 1000 m above mean sea level shall be considered.

5.0 TECHNICAL REQUIREMENTS

5.1 Lightning arrestors shall be of hermetically sealed type, self-supporting construction, suitable for mounting on steel structures.

5.2 Lightning arrestor housing shall be of porcelain having adequate mechanical strength and rigidity. Lightning arrestors shall have cantilever strength as specified in data sheet. Porcelain shall be thoroughly glazed & completely vitrified and shall be free from imperfections, blow holes, micro cracks, voids etc. The shed design shall be such as to minimise surface contamination by natural action of wind and rain. Lightning arrestors shall be suitable for live line washing, if specified in data sheet.

5.3 All cemented and detachable ferrous hardware shall be hot dip galvanised.

5.4 Lightning arrestors shall have adequate thermal discharge capacity for severe switching surges, long duration surges and multiple strokes. The lightning arrestors when provided with pressure relief device shall be capable of withstanding the internal pressure developed during the above discharges without operation of pressure relief devices. The pressure relief devices shall prevent the shattering of porcelain housing in case of arrestor failure.

5.5 The non-linear resistor blocks shall be of sintered metal oxide material. These shall be provided in such a way as to obtain robust construction, with excellent mechanical and electrical properties even after repeated operations. Uniform density of oxide material shall be maintained to provide uniform current distribution.

5.6 Lightning arrestors shall be capable of discharging over voltages occurring during lightning, switching surges, switching of unloaded transformers, reactors, capacitor banks and long lines.

5.7 Lightning arrestor shall be complete with insulating boxes having provision for bolting to the flat surface of supporting structure. Each single pole unit shall be provided with self-contained discharge counter suitably enclosed for outdoor use with IP-55 degree of protection and requiring no auxiliary or battery supply. The discharge counter shall be visible through an inspection window. The counter terminals shall be robust and shall be so located that the incoming and outgoing connections are made with minimum bends. Suitably sized bypass shunts of copper to facilitate bypassing the discharge counter shall be provided. The design of the terminal connectors shall permit the connection of these shunts.

5.8 A leakage current detector as an integral part of the discharge counter shall be so arranged that it will be possible to read leakage current values from ground level. The value of leakage current beyond which the operation is abnormal shall be clearly marked in red colour on the detector.

5.9 The connecting conductor from lightning arrestor earth terminal to discharge counter incoming terminal shall be insulated and shall be supplied alongwith the arrestor. This insulating conductor shall be of type, which does not require sealing ends.

5.10 Grading rings shall be provided on each complete lightning arrestor unit for proper stress distribution as dictated by the voltage class of the arrestor.

5.11 Lightning arrestor shall be complete with line and earth terminals. The terminal clamps / connectors on the earth terminal of the arrestor and discharge counter incoming and outgoing terminals shall be supplied alongwith the arrestor.

5.12 Each single pole arrestor shall be provided with suitable name plate complete with details i.e. name of device, manufacturer name, year of manufacture, applicable standard, serial no., voltage & frequency rating, nominal discharge current, MCOV, discharge class, energy discharge capability, pressure relief value etc.

6.0 INSPECTION, TESTING AND ACCEPTANCE

6.1 During fabrication, the equipment shall be subjected to inspection by EIL/ Owner or by an agency authorised by the Owner, 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.

6.2 Test certificates of bought out components shall be submitted to the inspection agency, as per Inspection and Test Plan no. 6-81-1096.

6.3 All equipment shall be subjected to various routine / acceptance tests as per Inspection and Test Plan no. 6-81-1096.

7.0 PACKING AND TRANSPORT

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for selected mode of transportation i.e. by ship/rail or trailer. The 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', `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 should also be suitable for outdoor storage areas with 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.

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DESIGN PHILOSOPHY FOR ELECTRICAL FACILITIES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
7	15 10 19	REVISED AND ISSUED AS STANDARD SPECIFICATION	DA/JLC	PG	SA	RKT
6	27 08 14	REVISED AND ISSUED AS STANDARD SPECIFICATION	RS	PG	BRB	SC
5	15 04 09	REVISED AND ISSUED AS STANDARD SPECIFICATION	AM	UAP	JMS	ND
4	31 03 04	REVISED AND ISSUED AS STANDARD SPECIFICATION	AKG	AAN	VPS	SKG
3	01 12 99	REVISED AND ISSUED AS STANDARD SPECIFICATION	UAP	AAN	VPS	AS

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

Electrical Standards Committee

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Ms. ANP Singh
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Mr. Rajesh Sinha (Inspection)

CONTENTS

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

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.

- 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.

4.3.3 Power system studies shall be performed using standard software in support of design, as required.

4.3.4 Special attention is drawn to chapter IX of CEA regulations, which includes requirements for design of electrical system as applicable to Mines and oil fields installation.

4.4 Capacity of Electrical System

4.4.1 All the components of the electrical system shall be sized to suit the maximum load, under the most severe operating conditions. The amount of electrical power consumed by each process unit shall be calculated for its operation at the design capacity. System design shall permit direct on line starting of all motors unless specified otherwise.

4.4.2 For Electrical load analysis, loads shall be classified as continuous loads, intermittent loads and standby loads based on their operation. Following factors shall be applied to calculate the total operating load, unless otherwise specified:

100% (Continuous Loads) + 30% (Intermittent Loads)[1] + 10% (Standby Loads)[2,3,4]

Notes:
1. 30% of intermittent loads such as EOT cranes, MOVs, etc. or the largest intermittent load whichever is higher.
2. 10% for only those Standby Loads which are required in emergencies only, such as fire-water pumps or those of normally not running electrically driven units in stand-by mode for normally running turbine driven loads.
3. Driven equipment 'Standby' in 'Normal-Standby' combination shall not be considered as a standby load.
4. 10% of standby loads or the largest standby load whichever is higher.

4.5 System Voltages

System voltages shall be as defined in project design data sheet.

4.6 Voltage Drops

4.6.1 The maximum voltage drops in various sections of the electrical system under steady state conditions at full load shall be within the limits stated in the following table:

Sl. No.	System Element	Maximum Permissible Voltage Drop
a)	Cable between transformer secondary and Switchboards	0.5%
b)	Cable between PCC/PMCC and MCC or auxiliary switchboard i) MCC /Auxiliary Switchboard near PCC/PMCC ii) MCC/Auxiliary Switchboard situated remote from PCC/PMCC	 0.5% (Note-3b) 2 to 2.5% (Note-3a)
c)	Cables between HV Switchboard and HV Motor	3% (Note-4)
d)	Cable between PCC/PMCC and motor	5.5% (Note-4)
e)	Cable between MCC (situated near PCC / PMCC) and motors	4.5 to 5% (Note-4)
f)	Cable between MCC (situated remote from PCC / PMCC) and motors	3% (Note-4)

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)

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.

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.

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.

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.

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

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.

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.

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.

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

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.

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:

- 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.

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.

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:

Transformers installed adjacent to sub-station/building or in Switchyards shall be provided with oil containing pits. Also Nitrogen Injection Fire Protection System (NIFPS) shall be provided for transformers, unless otherwise specified.

The oil containing pit may be shaped as per OISD STD-173. The pit shall extend all around the transformer for a width of 20% of the transformer height, with a minimum width of about 800 mm around the transformer tank/radiator. In case oil capacity exceeds 9,000 litres, in any chamber, provision shall be made for draining away of any oil, which may escape or leak from the tanks, to a waste oil tank.

6.14 NIFPS control panel shall not be kept in the same bay as of transformer, which is being protected by that panel. Piping from transformer to panel shall not block/ obstruct free movement.

6.15 The substation building shall be sized to maintain adequate clearances between equipment for ease of maintenance. The following minimum clearances around various equipment shall be maintained:

Sl. No.	Location	Clearance
a)	Front clearance for HV switchboard including HV GIS	2000 mm
b)	Front clearance for various switch boards/panels	1500 mm
c)	Clearance between front to front of two switchboards facing each other	2000 mm
d)	Rear clearance for panels having maintenance access from front only	Less than 200 mm or more than 750 mm
e)	Rear clearance for panels requiring maintenance from rear	1500 mm (HV swbd) & 1000 mm (MV swbd)
f)	Side clearance between two switch boards or from nearest obstruction	1000 mm after considering space for future panels as per cl. 6.16
g)	All around clearance for transformers	1000 mm
h)	All around clearance for NGR	1000 mm on two sides, 200 mm on other two sides
i)	All around clearance for capacitor bank/ series reactor	1000 mm
j)	Battery rack to wall clearance for - Single row, single/double tier - Double row, single tier - Double row, double tier - Multistep racks	 100 mm 100 mm 750 mm 750 mm
k)	Battery rack to rack clearance	750 mm
l)	Head room clearance below bus ducts or any other overhead equipment	2000 mm
m)	Front clearance for wall mounted equipment	1000 mm
n)	Front clearance for operation work station/ annunciation/ control panel/ HMI	2000 mm

Clear vertical clearance above the top of the highest equipment shall be minimum 1000 mm measured from the bottom of the lowest roof beam. However for the areas with false ceiling, minimum clearance of 750 mm shall be provided between false ceiling and top of any equipment.

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.

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.

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.

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.

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

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

	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.

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.

जंक्शन बॉक्स व केबिल ग्लैंड के लिए मानक विनिर्देशन

STANDARD SPECIFICATION FOR JUNCTION BOXES AND CABLE GLANDS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	19.07.21	Revised and Reissued as Standard Specification	RSM/AJS	KS	MN	SM
4	01.04.16	Revised and Reissued as Standard Specification	SM	SM	RG	RN
3	29.11.10	Revised and Reissued as Standard Specification	MN	RG	TGM/JMS	ND
2	03.05.05	Revised and Reissued as Standard Specification	SM	AKG	PM	VJN
1	01.11.96	Revised and Reissued as Standard Specification	RK	BRS	RB	AS

Abbreviations:

IP	:	Ingress Protection
NPT	:	National Pipe Thread
PVC	:	Poly Vinyl Chloride
SS	:	Stainless Steel
Sq.mm	:	Square millimeter (mm2)

Instrumentation Standards Committee

Convener: Mr. Mainak Nandi

Members: Mr. Arupjyoti Saikia
Mr. Sachin Garg
Mr. Jerry Johnson
Mr. Mayank Kaushik
Mr. Sourav Mukherjee
Ms. K Pratheepa
Mr. R K Gupta (Projects)

CONTENTS

1.0 GENERAL

1.1 Scope

1.1.1 This standard specification, together with the data sheets describes the requirements for design, materials, nameplate marking, testing and shipping of junction boxes and cable glands which include the following types:

a) Electrical junction boxes
b) Cable glands
c) Plugs
d) Reducers/Adaptors

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions unless otherwise specified;

ASME	American Society of Mechanical Engineers.	
	B 1.20.1	Pipe Threads, General Purpose (Inch).
EN	European Standards	
	10204	Inspection Documents for Metallic Products.
IS/IEC	Indian Standards/ International Electro-technical Commission	
	IS-5	Colours for ready mixed paints and enamels.
	IS/IEC-60079	Electrical Apparatus for Explosive Gas Atmosphere.
	IS/IEC-60529	Degrees of Protection Provided by Enclosures. (IP Code)

1.1.3 In the event of any conflict between this specification, data sheets, related standards and codes, the following order of priority shall govern:

a) Statutory Regulations

b) Data Sheets

c) Standard Specification

d) Codes and Standards

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached along with the Material Requisition.

1.2.2 Deviation on technical requirements shall not be entertained.

1.2.3 All documentation submitted by the vendor including their drawings, installation manual etc shall be in English language only.

1.2.4 Statutory Approvals

Junction boxes and cable glands located in the hazardous area shall be certified by the local statutory authorities for their use in the specified hazardous area classification. In general following certification shall be given:

i) For all flameproof Junction box and cable which are manufactured abroad and certified by any statutory authority like Laboratorie Central Des Industries Electriques (LCIE), British Approval Service for Electrical Equipment in Flammable Atmospheres (Baseefa), Factory Mutual (FM), Underwriters laboratories (UL) etc. for compliance to ATEX directives or other equivalent standards. All these junction boxes and cable glands shall additionally have the approval of Petroleum and Explosives Safety Organisation (PESO), Nagpur, if installed in INDIA and the same is mandatory.

ii) For all flame proof junction box and cable gland manufactured locally (indigenously), the testing shall be carried out by any of the approved test house like Central Institute of Mining & Fuel research (CIMFR)/Electronics Regional Testing Laboratory (ERTL) etc. The equipment shall in addition bear the valid approval from Petroleum and Explosives Safety Organisation (PESO), Nagpur and a valid BIS license.

iii) Approvals other than above shall neither be offered nor will these be acceptable.

1.3 Drawings and Data

1.3.1 Detailed drawings, data, catalogues and manuals shall be submitted by the vendor as per vendor data requirement attached with the requisition.

1.3.2 Final documentation consisting of design data and installation manual submitted by the vendor after placement of purchase order. As per vendor data requirement, shall include the following, as a minimum;

a) Specification sheet for each junction box and its accessories like cable glands, plugs etc.

b) Installation procedure for junction boxes and its accessories.

2.0 DESIGN AND CONSTRUCTION

2.1 Junction Boxes

2.1.1 Junction boxes shall be either of the following type as specified in data sheets.

a) Weather proof junction boxes.

b) Weather proof and flameproof junction boxes

No other type of junction boxes shall be offered / supplied unless specifically indicated otherwise by Purchaser.

2.1.2 Unless otherwise specified, the enclosure shall conform to the following standards:

Weatherproof housing : IP 65 to IS/IEC-60529
Flameproof housing : Flameproof, Ex(d) as per IS/IEC-60079.

Flameproof housing shall also be made weatherproof.

2.1.3 Number of cable entries shall be as per Purchaser's data sheet and their location shall be bottom in general for both multi pair and single pair cables. Side cable entries for branch cables shall only be considered when specifically indicated in the Purchaser's data sheets. Junction boxes with top entries shall not be offered. The size of cable entries shall be as per the cable gland sizes indicated in the data sheet.

2.1.4 Multi-pair junction boxes shall be provided with telephone sockets and plugs for connection of hand-powered telephone set.

2.1.5 **Electrical Junction Boxes**

a) The material of construction of junction boxes shall be followed as below:
   i) Enclosures : Cast light metal alloy
   ii) Internal plate : Nickel plated steel / Aluminium rails

b) Weatherproof junction box shall have door with SS hinge and with Neoprene /Silicon rubber gasket, which shall be fixed to the box by SS countersunk screws.

c) Flameproof junction box shall have detachable cover, which shall be fixed to the box by means of cadmium plated triangular head/hexagonal head screws of SS material

d) Flameproof junction boxes for signal, alarm and control shall have the following warning engraved/integrally cast on the cover:

"Isolate power supply elsewhere before opening"

e) Power junction boxes (junction boxes for power supply cable / distribution) shall have either the warning cast or shall have warning plate with following marking:

"Isolate power supply elsewhere before opening".

f) Unless otherwise indicated in the job specification, power junction boxes shall be suitable for incoming armoured power cable up to 185 sq.mm conductor size; exact requirement of cable entry shall be specified in purchaser's datasheet.

g) Terminals shall be spring loaded, vibration proof, clip-on type, mounted on nickel plated steel rails complete with end cover and clamps for each row.

h) Terminals shall be non-hygroscopic type made up of unbreakable, fire-retardant, safe extinguishable, halogen free polyamide compound.

i) The metal parts of terminals shall be of high quality (pure electrolytic) copper and shall be tin or nickel plated (of thickness up to 15 micron). The spring material for all terminals shall be chrome nickel spring steel of high tensile strength and of excellent corrosion resistance.

j) All terminals used in signal, alarm and control junction boxes shall be suitable for accepting minimum 4.0 sq.mm copper conductor, in general.

k) Terminal used in power junction boxes / power supply distribution box shall be suitable for accepting conductor size of 4.0 Sq. mm to up to 50 sq. mm. Exact requirement shall be specified in purchaser's datasheet. Higher size of terminals shall be provided when indicated.

Bus bar terminals shall be provided for cable size 50 sq. mm and above. Suitable size of lugs shall be provided to suit cable size specified.

l) **Number of terminals/ junction Box:**

Each junction shall have minimum of 30% spare terminal of those actually required to be utilised. Unless higher numbers of terminals are specified in the purchaser's data sheet, the number of terminals for various types of junction boxes shall be as follows:

- For 6 pair junction box : 24 Nos terminals
- For 12 pair junction box : 48 Nos terminals
- For 6 triad junction box : 36 Nos terminals
- For 8 triad Junction Box : 48 Nos terminals
- For 3 way Junction Box : 12 Nos terminals

m) Terminals shall be identified as per the type of input signal indicated in data sheets e.g all terminals for intrinsically safe inputs shall be blue while others shall be grey in colour.

n) Junction boxes shall be provided with external earthing lugs.

o) **Internal design of a Junction Box:**

Sizing shall be done with due consideration for accessibility and maintenance in accordance with the following guidelines:

Following gap shall be maintained strictly when designing the junction box sizes:

i) 50 to 60 mm gap between two terminal strips and sides of box parallel to terminal strip for upto 50 terminals and additional 25 mm for each additional 25 terminals.
ii) 100 to 120 mm between two terminal strips for upto 50 terminals and additional 25 mm for each additional 25 terminals.
iii) Bottom/top of terminal shall not be less than 100 mm from bottom / top of the junction box.

2.1.7 **Painting**

a) Surface shall be prepared for painting. It shall be smooth and devoid of rust and scale.

b) Two coats of lead-free base primer and two final coats of lead free, epoxy based paint shall be applied both for interior and exterior surfaces, powder coating shall also be acceptable. The colour shall be as specified in data sheets. However, following philosophy shall be followed, in general:

i) Light blue for all intrinsically safe junction boxes.
ii) Light grey for all others

2.2 Cable Glands, Plugs and Reducers/Adaptors

2.2.1 Cable glands shall be supplied by vendor as per the purchaser data sheets.

2.2.2 Cable glands shall be double compression type for use with armoured cables.

2.2.3 The cable glands shall be of nickel plated brass, as a minimum and shall be provided with PVC shrouds.

2.2.4 All the cable glands shall be weatherproof and flameproof (Ex'd') to gas group IIA / IIB as a minimum, unless otherwise specified in data sheets.

2.2.5 Cable glands shall be supplied to suit the cable dimensions along with tolerances indicated in data sheets. Various components like rubber ring, metallic ring, metallic cone and the outer / inner nuts etc. shall be capable of adjusting to the indicated tolerances of cable dimensions.

2.2.6 Reducers / adapters shall be supplied as per details indicated in data sheets. They shall be nickel-plated brass, as a minimum. These shall also be weatherproof and / or flame proof wherever specified.

2.2.7 Plugs shall be provided wherever specified. They shall be of nickel-plated brass.

2.2.8 Plugs shall be certified flameproof, when used with flameproof junction boxes.

3.0 NAMEPLATE

Each Item covered under requisition i.e. Junction box, Cable glands, Adapters, Plugs etc shall have shall have proper identification as per details below:

3.1 For Junction boxes:

Two name plated shall be provided with an anodised aluminium sheet as below:

i) Name plate-1: It shall be permanently fixed on the JB at a visible place furnishing the following information:

a. Type of Junction box
b. Type of protection for use in hazardous area.
c. Manufacturer's serial number and model number.
d. Manufacturer's name / trade mark.
e. Stamp of certifying agency with certificate number.
f. Provision of space for Tag number plate as per purchaser's data sheet to be permanently fixed at site with suitable provisions as per detail below.

ii) Name plate-2:

It shall be as per purchaser's data sheet to be fixed at site permanently with rivet type arrangement. It shall be supplied loose separately with a reference table identifying the Tag number of Junction box as per the requisition item number and data sheet.

3.2 For cable Glands/ Adapter/ Plugs:
Each item shall be marked with Size, applicable area classification and type of thread i.e. NPT.