

मध्यम वोल्टेज स्वीचबोर्ड के लिए विनिर्देश

SPECIFICATION FOR MEDIUM VOLTAGE SWITCHBOARD

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

Abbreviations:

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

Electrical Standards Committee

Convenor: Mr. B.R. Bhogal

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

CONTENTS

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

1.0 SCOPE

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

2.0 CODES AND STANDARDS

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

IS : 1248	:	Direct Acting Indicating Analogue Electrical Measuring Instruments and their Accessories
IS : 2705	:	Current transformers
IS : 2824	:	Method for determining the proof and the comparative tracking indices of solid insulating materials.
IS : 3156	:	Voltage transformers
IS : 3231	:	Electrical relays for power systems protection.
IS : 3618	:	Phosphate treatment of iron and steel for protection against corrosion.
IS : 5082	:	Wrought aluminum and aluminum alloy bars, rods, tubes and sections for electrical purposes.
IS : 5578	:	Guide for marking of insulated conductor.
IS : 8623	:	Low voltage switchgear and control gear assemblies. Particular requirement for bus bar trunking system.
IS : 11353	:	Guide for uniform system marking and identification of conductors and apparatus terminals.
IS : 13703	:	Low voltage fuses for voltages not exceeding 1000V AC or 1500V DC.
IS/ IEC: 60529	:	Degree of protection provided by enclosures (IP Code).
IS/ IEC: 60947	:	LV Switchgear and control gear.
IEC-61439	:	Low voltage switchgear and controlgear assemblies
IEC-61641	:	Enclosed low-voltage switchgear and controlgear assemblies - Guide for testing under conditions of arcing due to internal fault.

- 2.2** In case of imported equipments, standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.
- 2.3** The equipment shall also conform to the provisions of CEA Regulations with latest amendments and other statutory regulations currently in force in the country.
- 2.4** In case Indian standards are not available for any equipment, standards issued by IEC/BS / VDE/ IEEE/ NEMA or equivalent agency shall be applicable.
- 2.5** In case of any contradiction between various referred standards/specifications/data sheet and statutory regulations, the most stringent requirement shall govern and decision of owner/EIL in this regard shall be final & binding.

3.0 GENERAL REQUIREMENTS

- 3.1** The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.
- 3.2** Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment at least for 10 years from the date of supply.
- 3.3** Vendor shall give a notice of at least one year to the end user of equipment and EIL before phasing out the product/spares to enable the end user for placement of order for spares and services.

4.0 SITE CONDITIONS

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

5.0 DESIGN AND FABRICATION REQUIREMENTS

- 5.1 Medium voltage switchboard shall be metal enclosed fully draw out or fixed, as specified in datasheet/ job specification, free standing, floor mounting, compartmentalised, modular type suitable for indoor installation with form of internal separation "Form-4b" as per IEC-61439 (except for fixed type switchboards), unless otherwise specified elsewhere. The switchboard shall be a type tested assembly (TTA) as per IEC-61439.
- 5.2 The switchboard enclosure shall be dust and vermin proof and shall provide a degree of protection not less than IP-41.
- 5.3 The switchboard shall be assembled out of vertical panels of uniform height, not exceeding 2450mm in a single line up.
- 5.4 It shall be possible to extend the switchboard, in either direction at a later date. End of bus bars shall be suitably drilled for this purpose. Panels at extreme end shall have openings, which shall be covered with plates screwed to the panel.
- 5.5 The switchboard shall be designed to ensure maximum safety during operation, inspection, connection of cables, relocation of outgoing circuits and maintenance, with the bus bar system energised and without taking any special precautions.
- 5.6 Adequate means shall be provided to prevent shorting of power and / or control terminals due to accidental dropping of maintenance tools etc. inside the switchboard. Checking and removal of components shall be possible without disturbing adjacent equipment/modules/feeders.
- 5.7 All identical equipments and corresponding parts shall be fully interchangeable.
- 5.8 The frame, of individual vertical panels shall be fabricated using pressed and cold rolled sheet steel. The sheet steel used for panel shall be of minimum 2mm (14SWG) CRCA except the doors and covers that may be made of 1.6mm (16SWG) CRCA. Wherever required, stiffeners shall be provided to increase mechanical strength of large size doors and covers.

As an alternative to CRCA, Aluzinc/pre-galvanised sheet steel can also be provided for internal inter-panel partitions only as per vendor's standard manufacturing practices. However, all external surfaces shall be of CRCA with specified paint shade.
- 5.9 The switchboard shall be provided with integral base frame for each vertical panel. The switchboard integral base frame shall be suitable for tack welding.
- 5.10 All openings, covers and doors shall be provided with gaskets of Neoprene/HDPE/EPDM or equivalent around the perimeter to make the switchboard dust and vermin proof.
- 5.11 All hardware shall be corrosion resistant. All joints and connections of the panel members shall be made of galvanized or zinc passivated or cadmium plated high quality steel bolts, nuts and washers, secured against loosening.
- 5.12 Suitable removable type eyebolts/ lifting hooks shall be provided for lifting of the panel/shipping section. These eyebolts/ lifting hooks, when removed shall not leave any opening in the panels.

- 5.13 Non-magnetic cable gland plates (min. 3mm thick) shall be provided for termination of single core cables.
- 5.14 The switchboard shall be formed using distinct vertical panels each comprising of the following compartments.
- 5.14.1 A metal enclosed horizontal bus bar compartment running at the top or rear, unless otherwise specified.
- 5.14.2 Individual feeder modules in multitier mode.
- 5.14.3 Vertical bus bars serving all feeder modules in the vertical panel.
- 5.14.4 Cable termination compartment.
- 5.14.5 Perforated sheet steel / insulating material enclosed, horizontal auxiliary bus bars for control, interlock, indication and metering running horizontally.
- 5.15 Metal sheets shall be provided between two adjacent vertical panels running upto the full useful height of the switchboard.
- 5.16 MCC/MCC part of PMCC shall be of single/double front execution as specified in data sheet/job specification. However circuit breaker panels and fixed type switchboard shall be in single front execution only.
- 5.17 Motor starter and MCCB/switch fuse modules shall not be accommodated at front and rear of ACB Incomer and bus coupler panels.
- 5.18 The MCC/ASB/LDB switchboards shall be provided with castle-key interlock between incomers and bus-coupler for manual changeover of supplies unless otherwise specified elsewhere.
- 5.19 All metering and protection equipment associated with a particular circuit, as specified in data sheet, shall be housed in separate and independent compartment earmarked for that particular circuit and in the fixed portion of the vertical panel in case of breaker panels.
- 5.20 All auxiliary devices for control, reset, indication, measurement and protection such as push buttons, control and selector switches, indicating lamps, measuring instruments and protective relays shall be mounted on the front side of the respective compartment. The design shall be such that all power ON/OFF or START / STOP and relay reset operations shall be performed without opening the panel door.
- 5.21 Unless otherwise specified elsewhere, the switchboard assembly and components shall be suitable for use in pollution degree 3 environment as per IS/IEC.
- 5.22 In open doors condition of compartment, all live parts or terminals of all door-mounted, internal components and bus contact openings shall be IP-2X protected.
- 5.23 **LOTO arrangement**
- 5.23.1 Pad locking arrangement shall be provided for rack in operation of breaker as well as for the panel door meeting LOTO requirements.
- 5.23.2 LOTO arrangement shall be provided for each module of draw-out switchboard PCC/PMCC/MCC etc and shall include provision for the following:
- Provision for hooking lockout devices by multiple lock arrangement to prevent opening of panel door and racking-in of circuit breaker.
 - Provision for attaching tag-out device for warning against energisation and to provide information regarding date of isolation, agency working on the equipment, etc.
 - Provision for Hasp such that the same shall be put-in and closed in the locking arrangement of the breaker/switch and panel door.
- 5.24 Unless otherwise specified elsewhere, the switchboard shall be designed and tested to meet the requirements of IEC-61641 for arcing due to an internal fault of full short circuit current for

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

5.25 Space Heaters & Panel Illumination

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

5.26 Auxiliary Bus Bars

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

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

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

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

5.27 Bus Bar

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

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

5.27.3 Both horizontal and vertical bus bars, bus joints and supports shall be capable of withstanding dynamic and thermal stresses of the specified short circuit currents.

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

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

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

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

5.27.8 Minimum clearance between live parts, between live parts/neutral to earth shall be 19 mm. However clearances between terminals at components shall be as per applicable individual standards for respective components.

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

5.28 Wiring and Terminals

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

5.29 Earthing

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

5.30 Nameplate

- 5.30.1 A nameplate with the switchboard designation shall be fixed at the top of the central panel. A separate nameplate giving details for each feeder compartment of all panels shall be provided. Danger nameplate shall be provided at the front and rear of each panel.
- 5.30.2 The nameplates for feeder compartments shall be in two parts. One part shall have necessary details pertaining to the compartments number of vertical panel of the switchboards. The other parts shall be removable and shall contain all details regarding the feeder number for drives/equipment controlled by the particular module as per approved single line diagram.
- 5.30.3 Blank nameplates shall be provided for all spare and vacant modules.

- 6.7.2 The current transformers for the ammeter/protection circuits shall be mounted on the fixed portion of the compartment. However, current transformers associated with built-in releases may be mounted on the breaker trolley.
- 6.7.3 All terminals except wiping/sliding type control terminals shall be shrouded with plastic covers to prevent accidental contact. For direct termination, clip-on shrouded type terminals shall be provided.
- 6.7.4 There shall be three positions for the draw out trolley viz:
- "Service" position - In this position both power and control circuits shall be connected. This shall be the normal operating position of the circuit breaker.
 - "Test" position - The power contacts shall be disconnected in this position but the control connections shall not be disturbed, testing provision for the entire control circuitry shall be available in test mode including close and trip of breakers.
 - "Drawout" Position - both power and control circuits shall be disconnected in this position and breaker removed from the cubicle.
- 6.7.5 The circuit breaker shall be lockable in "service" and "test" positions. Safety shutters shall be provided when the breaker is in withdrawn/drawout position.
- 6.7.6 The earth connection must remain connected in "Test" position; Earthing of the unit shall be done with a "pin" or with scrapping earth connections.
- 6.7.7 The earth connection shall make before the main power / control contacts make and break after the power /control contacts are disconnected. Earthing connection through a plug and socket connection shall not be acceptable

6.7 Interlocks

Following interlocks shall be provided:

- 6.7.1 Compartment doors shall be interlocked against opening when breaker is in closed condition. However, it shall be possible to defeat this interlock for inspection purposes.
- 6.7.2 It shall not be possible to push "in " a drawn out circuit breaker in closed condition or withdraw a circuit breaker in closed condition.
- 6.7.3 It shall be possible to operate a circuit breaker only in the defined "Full in" or "service" and "test" position inside the panel. It shall not be possible to operate the breaker in intermediate positions while inserting or withdrawing circuit breaker.
- 6.8 Any unused circuit breaker compartment shall be fully equipped and provided with compartment door, vertical busbars and control terminals/ wiring etc. such that the same could be used for housing outgoing breakers in future without any modifications to the panel.

7.0 SPECIFIC REQUIREMENTS OF FEEDERS OTHER THAN ACB FEEDERS

- 7.1 The design of drawout feeder modules shall not change for single front or double front execution. Separate vertical bus bars shall be provided for each front side modules.
- 7.2 All identical feeder modules shall be interchangeable.
- 7.3 Each vertical panel shall have a separate cable alley. The width of this cable alley shall be sufficient to accommodate all the cables and shall have free access for cable terminations and in any case shall not be less than 200mm minimum. Cable alleys shall be provided with suitable doors.
- 7.4 Sheet steel barrier shall be provided between individual compartments and cable alley. This barrier shall be provided with opening for power and control connections and it shall be possible to safely carryout maintenance work on cable connections to any one circuit in the cable alley with the busbars and the adjacent circuits live.
- 7.5 Maintenance and connection of cables to any modules shall be possible without having to take out the modules from its position from the panel.

- Copyright EIL – All rights reserved

- 8.2.2 FVR Full Voltage Reversing starter with minimum 24 control terminals.
- 8.2.3 FVNR - HD Full Voltage Non -Reversing Heavy Duty starter with long starting time such as for compressors and fans etc. with minimum 18 control terminals.
- 8.3 Switch fuse/MCCB /contactor feeder modules shall be of following types and internal control wiring of all modules of each type shall be identical for all ratings.
- 8.3.1 SFU/MCCB Switch Fuse Unit or MCCB modules with no control terminals.
- 8.3.2 SFC/MCCB+C Switch Fuse Contactor or MCCB with contactor modules with 18 control terminals.
- 8.4 Control transformer shall be provided for each FVR/FVNR/SFC starter/MCCB+C starter/feeder modules or bus section of the PMCC/MCC switchboard having contactor control feeders as specified in the datasheet/job specification or elsewhere. Each control transformer of starter/feeder module shall be sized for taking control supply load of all components of starter module. In case control transformer is provided in bus section, same shall be sized for control supply load of entire switchboard. Switchboard having two bus sections and coupled by bus tie shall have manual changeover switch for the control transformers. The control transformer shall have at least 10% spare capacity. The control transformer secondary shall be earthed at one end.
- 8.5 To facilitate site modification due to changes in motor KW ratings and to minimise spares inventory, overload relays and power fuse links shall meet the following requirements.
- 8.5.1 All bimetal overload relays shall be separately mounted type with connecting links rated for the maximum rating of the contactor in a starter module.
- 8.5.2 Bimetal overload relays of various current ranges required for motors likely to be connected to a contactor must be identical in dimension for inter-changeability. In case offered relays are with different dimension for any particular starter module, special mounting plate suitable for mounting different relays shall be provided in all the modules of that size.
- 8.6 Heavy duty starters shall be provided with saturable type, current transformer operated; overload relays only, which shall be suitable for motor starting time of 15-60 seconds.
- 8.7 All contactor controlled starter feeders shall meet the requirements of type-2 co-ordination as per IS/IEC: 60947. However, contactor controlled motor feeders shall meet the requirements of type-2 co-ordination as per IS/IEC: 60947 considering energy efficient motors of IE-2 type, unless otherwise specified elsewhere.
- 9.0 SWITCHBOARD COMPONENTS**
- 9.1 Circuit Breakers**
- 9.1.1 Circuit breakers shall be air break, draw-out type and 3/4 poles as specified in the datasheet/job specifications. However, all ACBs of PCC/PMCC incomers and bus-coupler(s) shall be with 4 poles unless specified elsewhere.
- 9.1.2 The circuit breakers shall be provided with mechanically operated emergency tripping device. This device shall be available on the front of the panel. Mechanically operated 'closing' device shall be provided for all breakers. However mechanical closing shall be inhibited for all breakers in service position.
- 9.1.3 The circuit breakers shall be provided with minimum 4 NO + 4 NC contacts, wired and available for owner's use. In case contacts are directly not available in breaker, auxiliary latching type relays shall be used to multiply the auxiliary contacts of the breakers.
- 9.1.4 Circuit breaker's Open and closed positions; Service and test locations and spring charged condition shall also be indicated mechanically in addition to electrical indications.
- 9.1.5 Unless otherwise specified, all circuit breakers in the switchboard shall be provided with electrical power operating mechanism. Wherever circuit breakers are provided in place of Isolators, Breaker can be manually operated type.

9.1.6 Operating Mechanism

- a) Electric power operating mechanism shall be motor wound spring charged stored energy type. However, manual-operating mechanism may be of the spring charging stored energy type or spring assisted type. For circuit breakers with electrical power operating mechanism, provision shall also be made for manual spring charging. Closing time of circuit breakers with manual operating mechanism shall be independent of the speed of the operating handle.
- b) All stored energy operating mechanisms shall be equipped with the following features:
 - i) Failure of springs, vibrations or shocks shall not cause unintended operation of breaker or prevent intended tripping operation.
 - ii) Closing of circuit breakers shall be prevented unless the spring is fully charged.
- c) All electrical power operating mechanisms shall be suitable for remote operation and shall be equipped with the following features:
 - i) Provided with universal motor operable on AC or DC control supplies.
 - ii) Provided with emergency manual charging facility. The motor shall be automatically, decoupled (mechanically) once the manual-charging handle is inserted.
 - iii) Closing operation of circuit breaker shall automatically initiate charging of the spring for the next closing operation without waiting for tripping of circuit breaker.
 - iv) Closing operation shall be completed once the closing impulse is given and the first device in the control scheme has responded even though the control switch / Push Button is released, provided no counter trip impulse is present.

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

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

9.1.9 Circuit breakers shall be provided with operation counters.

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

9.2 Switches

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

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

9.3 Fuses

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

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

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

9.4 Contactors

- 9.4.1 The contactors shall be air break type, equipped with three main contacts and minimum 1NO+1NC auxiliary contacts. The main contacts of a particular contactor for motor starter module shall have AC-3 or AC4 ratings, as specified in data sheet
- 9.4.2 Unless specified otherwise, the coil of the contactor shall be suitable for operation on 240 V, 1 Phase, AC supply.

9.5 Thermal Overload Relay

- 9.5.1 Bimetal relays shall be provided for protecting the motor from thermal overload.
- 9.5.2 Bimetal relays shall be manually reset type with the reset push button brought out on the front of the panel. The reset push button shall be capable of being operated without opening the compartment door.
- 9.5.3 Bimetal relays shall be positive acting ambient temperature compensated type with adjustable setting range.
- 9.5.4 Bimetal relays shall have built-in single phasing prevention feature, which operates even with 50% rated current at the time of single phasing.

9.6 Moulded Case Circuit Breakers

- 9.6.1 MCCBs shall be provided with spring assisted quick make/ break manually operated trip free mechanism. Wherever specified, MCCB shall be suitable for remote tripping operation and the tripping device shall be suitable for the specified control supply voltage.
- 9.6.2 MCCBs shall be provided with a tripping device with inverse time characteristic for over load protection and instantaneous characteristics for short circuit protection and MCCB rated above 125A shall preferably have adjustable settings.
- 9.6.3 'ON' and 'OFF' position of the operating handle of MCCB shall be displayed and the operating handle shall be mounted on the door of the compartment housing MCCB.
- 9.6.4 Each MCCB shall be provided with minimum 1 NO + 1 NC auxiliary contact and 1NO contact for tripping indication/alarm for owner's use.
- 9.6.5 MCCBs shall be provided with solenoid/ motorised closing mechanism to make them suitable for remote closing operation if specified. The closing solenoid/motor shall be suitable for specified control supply voltage.
- 9.6.6 MCCB's as part of motor starter module shall be current limiting type and type tested for type-2 co-ordination as per IS/ IEC-60947 considering energy efficient motors of IE-2 type unless otherwise specified elsewhere.

9.7 Relays

- 9.7.1 Type of relay shall be numerical, static or electro-mechanical type as specified in the data sheet /job specification.
- 9.7.2 All electro-mechanical protective relays shall be back connected, of drawout type, suitable for flush mounting, and fitted with dust-tight covers. Alternatively, "plug-in" type relays will also be acceptable. Auxiliary relays and lock out relays are acceptable in fixed execution.
- 9.7.3 The protective (static or electro-mechanical type) relay cases shall have a provision for insertion of a test plug at the front for testing and calibration purpose using an external power supply. It shall be possible to test the relays without disconnecting the wiring and without withdrawing the relays. The insertion of the test plug shall automatically short circuit the CTs and permits extension of external power supply to the relay.
- 9.7.4 Each protective relay shall be provided with minimum 2 numbers potential free contacts of required configuration.
- 9.7.5 Each tripping relay shall be of lockout type with hand reset coil cut-off contact.

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

9.8 Instrument Transformers (CTs/PTs)

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

9.8.2 For general guidance the vendor shall note that the protective current transformers shall have an accuracy class "5 P" and an accuracy limit factor greater than "10 ". However CTs for restricted earth fault shall be of class "PS"/"PX". Vendor shall co-ordinate the knee point voltage, magnetising current for PS class CTs to avoid saturation and mismatching of CTs provided at other end by other vendor.

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

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

9.8.5 The voltage transformers shall be cast resin type transformers and PT shall generally conform to IS: 3156. PT shall be provided with HRC fuses on primary side and Miniature circuit breakers with auxiliary contact on the secondary side.

9.9 Measuring Instruments

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

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

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

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

9.9.4 Digital meters shall be provided, if specified in job specification/data sheets. All digital meters shall be highly reliable, accurate, compact and self powered. Digital meter data shall be saved in case of power failure. Field programming from front of the meter shall be possible and shall have RS232/485 port in case specified in the job specification/data sheet.

9.10 Control Switches

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

9.10.2 Ammeter selector switches shall have make before break feature on its contacts. The selector switch shall generally have 4 positions, three for reading 3 phase currents and the fourth position for off. The voltmeter selector switch shall also have 4 positions. Three positions shall be used to measure phase-to-phase voltage and fourth shall be OFF position.

9.11 Push Buttons

Push button colours shall be as follows:

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

The stop push button shall be stay put type.

9.12 Indication

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

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

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

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

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

9.13 Auxiliary Relays/Contactors

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

9.14 Timers

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

9.15 Miniature Circuit Breaker

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

10.0 INSPECTION, TESTING AND ACCEPTANCE

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

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

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

11.0 PACKING AND DESPATCH

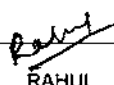
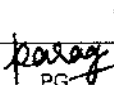
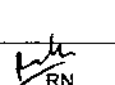
All the equipment shall be divided into several shipping sections for protection and ease of handling during transportation. The equipment shall be properly packed for selected mode of transportation i.e. by ship/rail or trailer. The panels shall be wrapped in polyethylene sheets before being placed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

up', 'Centre of gravity', 'weight', Owner's particulars, Purchase order number etc. shall be clearly marked on the package together with other details as per purchase order.

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

रिले तथा कन्ट्रोल पैनलों के लिए विनिर्देश

SPECIFICATION FOR RELAY & CONTROL PANELS

5	31.05.16	REVISED & ISSUED AS STANDARD SPECIFICATION	 RAHUL	 PG	 BRB	 RN
4	07.04.11	REVISED & ISSUED AS STANDARD SPECIFICATION	RKS	SA	UAP/JMS	DM
3	21.04.06	REVISED & ISSUED AS STANDARD SPECIFICATION	AK	NS	JMS	VJN
2	27.11.02	REVISED & ISSUED AS STANDARD SPECIFICATION.	AK	RPG/AAN	VPS	GRR
1	22.04.97	REVISED & ISSUED AS STANDARD SPECIFICATION.	AK/AAN	VPS	SG	AS
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

Abbreviations:

AC	Alternating Current
AVR	Automatic Voltage Regulator
BIS	Bureau of Indian Standards
BS	British Standards
CEA	Central Electricity Authority
CRCA	Cold Rolled Cold Annealed
CT	Current Transformer
DC	Direct Current
EIL	Engineers India Limited
EPDM	Ethylene Propylene Diene Monomer
FRLS	Flame Retardant Low Smoke
HDPE	High Density Poly Ethylene
HRC	High Rupture Capacity
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IP	Ingress Protection
IS	Indian Standards
ISA	Instrument Society of America
LED	Light Emitting Diode
MCB	Miniature Circuit Breaker
MSL	Mean Sea Level
NEMA	National Electrical Manufacturers Association
PCB	Printed Circuit Board
PF	Power Factor
PVC	Poly Vinyl Chloride
SWG	Standard Wire Gauge
VDE	Verband Der Electrotechnik, Elektronik und Information Stechnik
VT	Voltage Transformer

Electrical Standards Committee

Convener: Mr. B.R. Bhogal

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

CONTENTS

1.0	SCOPE.....	4
2.0	CODES AND STANDARDS.....	4
3.0	SITE CONDITIONS	5
4.0	GENERAL REQUIREMENTS.....	5
5.0	TECHNICAL REQUIREMENTS.....	5
6.0	INSPECTION, TESTING AND ACCEPTANCE.....	16
7.0	PACKING AND DESPATCH	16

1.0 SCOPE

The scope of this specification is to define the requirements of design, engineering, manufacture, testing, packing and supply of relay and control panels.

2.0 CODES AND STANDARDS

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

IS: 5	:	Colours for Ready Mixed Paints & Enamels.
IS: 694	:	PVC Insulated Cables for Working Voltages upto & including 1100V
IS: 1248	:	Direct Acting Electrical Indicating Instruments.
IS: 2419	:	Dimensions for Panel Mounted Indicating and Recording Electrical Instruments.
IS: 2705	:	Current Transformers.
IS: 3156	:	Voltage Transformers.
IS: 3231	:	Electrical Relays for Power System Protection.
IS: 3842	:	Application Guide for Electrical Relays for AC Systems.
IS: 4794	:	Push Button Switches: General Requirements and Tests.
IS: 5578	:	Marking of Insulated Conductors.
IS: 5786	:	Fixed resistors, general purpose low power.
IS: 5834	:	Electrical Timer Relays for Industrial Purposes.
IS: 6236	:	Direct Recording Electrical Measuring Instruments.
IS: 6553	:	Environmental Requirements for Semiconductor Devices and Integrated Circuits.
IS: 8530	:	Maximum Demand Indicators.
IS: 8686	:	Static Protective Relays.
IS: 9124	:	Guide for Maintenance and Field Testing of Electrical Relays.
IS: 9347	:	Charts for Recording Instruments.
IS: 11353	:	Uniform System of Marking and Identification of Conductors and Apparatus Terminals.
IS: 11954	:	Guide for Colour Coding of Electrical Mimic Diagrams.
IS: 12021	:	Specifications for Control Transformers for Switchgear and Control gear for Voltages not exceeding 1000V AC.
IS: 12083	:	Electrical Relays.
IS: 13010	:	AC Watt-hour Meters, Class 0.5, 1 and 2
IS: 13703	:	Low Voltage Fuses.
IS: 13779	:	AC Static Watt-hour Meters, Class 1 and 2
IS: 14372	:	Volt-Ampere-Hour Meters for Full Power Factor Range.
IS: 14415	:	Volt-Ampere-Hour Meters for Restricted Power Factor Range.
IS: 14901	:	Semiconductor Devices: Discrete Devices & Integrated Circuits.
IS/IEC: 60529	:	Degrees of Protection Provided by Enclosures (IP Code).
IS/IEC: 60947	:	LV Switchgear and Control gear.
IEC: 60255	:	Measuring relays and protection equipment.
IEC: 60688	:	Electrical measuring transducers for converting AC and DC electrical quantities to analogue or digital signals.

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

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



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

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

3.0 SITE CONDITIONS

The relay & control panels shall be suitable for installation in a closed room with restricted natural air ventilation in tropical, humid and corrosive atmosphere. The equipment shall be designed to operate under site conditions as specified in the data sheet. If not specifically indicated, design ambient temperature of 40° C and altitude not exceeding 1000m above MSL shall be considered.

4.0 GENERAL REQUIREMENTS

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

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

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

5.0 TECHNICAL REQUIREMENTS

5.1 Constructional Features

5.1.1 The panels shall be Simplex, Duplex, Control Desk or Console type as specified in data sheet.

5.1.2 The panels shall be sheet steel enclosed, dust and vermin proof having minimum degree of protection as IP-41. The panels shall be floor mounting, free standing type mounted on a supporting structure so as to form a rigid enclosure suitable for the application. The frames shall be fabricated by using minimum 2mm thick CRCA sheet steel while the doors and covers shall be made from 1.6 mm thick CRCA sheet steel. Wherever, required suitable stiffeners shall be provided. All openings, covers and doors shall be provided with gaskets of Neoprene/HDPE/EPDM or equivalent around the perimeter to make the panel dust and vermin proof. Hinged doors shall be complete with door handles, lock and latching facility. Ventilating covers, if provided shall have screens and filters.

5.1.3 The panels shall be provided with integral base frame, suitable for tack welding to floor embedded insert plate/flat/channel.

5.1.4 The height of control panels shall not exceed 2400 mm. In case more than one panel is used, all the panels shall be arranged to form a continuous line up of uniform height and depth.

5.1.5 The bottom of all panels shall have a 100 mm kick plate all around.

5.1.6 Cable entry shall be from bottom unless specified otherwise. A suitable removable undrilled gland plate shall be provided for cable entry.

5.1.7 Suitable hooks shall be provided for lifting the panels.

5.2 Types of Panels

5.2.1 Simplex Panel

Simplex type panels shall be with equipment mounted on the vertical front and access door to wiring from rear.

5.2.2 Duplex Panel

Duplex panel shall consist of a front and a rear panel connected back to back with a 750 mm (minimum) walk way in central corridor. There shall be complete access through the corridor to terminal blocks, internal wiring and components mounted on the panel. Separate cable entries shall be provided for front and rear panels. Interconnection between front and rear panels shall be by interpanel wiring (through the corridor) at the top, inside the panel. Adequately sized hinged type access doors shall be provided at both ends of panel line up.

5.2.3 Control Desk

Control desk shall consist of an enclosure having inclined horizontal surface. The horizontal surface shall have a minimum height of 800 mm. The layout shall be such that various control devices are within convenient reach of the operator. All necessary switches, push buttons and indicating lamps etc. shall be mounted on the horizontal inclined surface. Control desk shall have a removable front cover and rear hinged door.

5.2.4 Control Desk Console

Control desk console shall have one horizontal inclined surface and one vertical inclined surface. The horizontal inclined surface shall have a minimum height of 800 mm. The height of vertical surface shall be limited to 1500 mm. Control switches, push buttons and indicating lamps etc. shall be mounted on horizontal face and all instruments shall be on vertical face, all within the full view of the operator. The Control desk Console shall have a removable front door and rear hinged door.

5.3 Mounting of Components

5.3.1 All controls, indications, meters, annunciators, mimic diagram, protective relays having flags/operations indicators and lock out relays requiring hand reset shall be mounted on panel front without overcrowding & cramping. The auxiliary relays can be mounted inside. In case of duplex panels, controls, indications, meters, annunciators and mimic diagram shall be mounted on the front panel and the relays shall be mounted on the rear panel.

All equipment mounted on front/rear panels shall be flush mounting type. All meters/components shall be suitable for vertical/horizontal mounting position in which they are to be installed. Test blocks for devices as required shall be provided.

5.3.2 The centre line of switches, push buttons etc. shall be not less than 750 mm & shall not be more than 1800 mm from the bottom of the panel. Centre line of relays, meters, recorders etc. shall be not less than 450 mm from the panel bottom. Alarm facia shall be located at a minimum height of 900 mm from panel bottom.

The centre line of switches, push buttons & indicating lamps shall be matched to give a neat & uniform appearance. Likewise the top of all meters, relays & recorders etc. shall be in one line.

- 5.3.3 Provisions for cut-outs and their wiring for items to be supplied by Purchaser shall be as per respective manufacturer's drawings. Cut-outs for equipments that are to be mounted in future shall be blanked.
- 5.3.4 Checking, removal & replacement of individual components shall be possible without disturbing the adjacent equipment. It shall be possible to test all the protective relays 'in-situ'. The internally mounted components, auxiliary equipment such as transducers, interposing CTs etc. shall be mounted in such a way as to be readily accessible, without impeding the access to internal wiring and other components.

5.4 Wiring & Terminals

- 5.4.1 All wiring inside the panel shall be done with adequately sized, BIS approved, PVC insulated, FRLS type, 660V grade, single-core, stranded, annealed copper conductor wires. For CT circuits the cross section of the wires shall be 2.5-mm² minimum.
- 5.4.2 Each wire shall be identified at both ends with wire numbers by means of PVC ferrules.
- 5.4.3 All external connections shall be through terminal block. The terminal blocks shall be mounted minimum 300 mm above the gland plate. Each wire shall be terminated at a separate terminal. Shorting links shall be provided for all CT terminals and wherever necessary.
- 5.4.4 All spare contacts of relays, timers, etc shall be wired up to the terminal block.
- 5.4.5 Terminal block shall be moulded piece made of non-inflammable plastic and complete with insulating barriers, stud type terminals, washers, nuts, lock nuts, inserts etc. Marking on the terminal strip shall correspond to wire number and terminal numbers on the wiring diagram. Minimum 20 % spare terminals shall be provided in each terminal block.
- 5.4.6 Clamp type terminals suitable for termination of crimped type lugs shall be provided for all control cable connections. Suitable power terminals shall be provided for incoming power cables.
- 5.4.7 All terminals shall be properly shrouded against accidental contact.
- 5.4.8 Wiring between panels shall be routed through PVC sleeves or rubber grommets. All inter panel wiring within each shipping section shall be done at Vendor's works. For wiring between shipping section, Vendor shall provide terminal blocks on adjacent shipping sections and supply suitable jumpering wires. Alternatively, rolled up wires with necessary ferruling for inter panel wiring shall be provided.

5.5 Earthing

- 5.5.1 All panels shall be connected to an earth bus bar of suitable size having continuity throughout the length of the panel line-up. 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.

5.6 Panel Illumination and Space Heaters

- 5.6.1 LED lamps working on 240 V AC, operated by door switches shall be provided for internal panel illumination of each panel and corridor.
- 5.6.2 A 240 V, single phase, 5 A, 3 pin socket shall be provided in the panel corridor or interior of each cubicle with on-off switch for connection of hand lamps.

5.6.3 The panels shall be provided with space heaters, controlled through MCB and thermostat with an adjustable setting.

5.7 Painting

5.7.1 All metal surfaces shall undergo manufacturer's standard cleaning/painting cycle.

5.7.2 After preparation of the under surface, the panels shall be painted with two coats of epoxy based final paint. Colour shade of final paint shall be 631 of IS: 5/RAL-7032.

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

5.8 Mimic

5.8.1 Mimic diagram shall be provided on panels when specified in data sheet. Mimic diagram shall be screwed on to the panels and shall be made of anodised aluminium or plastic of approved fast colour. The mimic shall be 10 mm wide for horizontal run and 5 mm wide for vertical run.

5.8.2 When semaphore indicators are used for indicating isolator/ breaker position, they shall be automatic type and shall be so mounted in the mimic such that isolator (or breaker) closed position shall complete the continuity of the mimic. The mimic diagram shall incorporate red and green lamps for position indication and controlling switches for breakers. Alternatively if specified in data sheet, discrepancy switches having built in hand operated semaphore and position indicating lamps for breaker control & indication shall be provided. The discrepancy switch shall perform the following functions:

- The breaker on-off control shall be through this switch.
- The lamp will remain steady when the semaphore position corresponds with the breaker position.
- The lamp shall flicker if the semaphore position does not correspond with the breaker position.

5.8.3 The colour code for various voltages in the mimic diagram shall be as per IS: 11954 as detailed below:

Voltage Level	Mimic Colour	Shade as per IS: 5
400 KV AC	Signal Red	537
220 KV AC	Light Orange	557
132 KV AC or 110 KV AC	Lemon	355
66 KV AC	Golden Brown	414
33 KV AC or 22 KV AC	Olive Green	220
11 KV AC	Sea Green	217
6.6 KV AC	Air Craft Blue	108
3.3 KV AC	Sky Blue	101

415 V AC or 240 V AC	Dark Violet	796
220 V DC or 110 V DC	Black	-

- 5.8.4 In general all colours shall be so chosen as to be distinguishable from others appearing in the mimic diagram. These shall be subject to review by Owner/EIL during detailed engineering.
- 5.8.5 Actual value of voltage, Bus Number and other details shall be indicated in alpha-numeric characters, suitably on the mimic.

5.9 Equipment Specifications

5.9.1 Instruments

All instruments shall be switchboard type, flush mounted, dust tight and tropicalised. The instruments shall be digital/analogue type. The analogue indicating meters shall be in square shape of size 96x96 mm². These shall be taut band type having a scale covering 0-240°. The instruments shall have minimum accuracy class of 1.0.

Zero adjustment for pointers shall be accessible from the front of the instruments. All auxiliary equipment such as shunts and transducers etc as required shall be provided.

5.9.1.1 Frequency Meters

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

5.9.1.2 Ammeters, Voltmeters, kW/kVA/kVAR meters, kWh/kVAh/kVARh meters

Meters shall be suitable for the specified CT ratios and VT secondary voltage of 110V or directly from 415/240V circuit, as the case may be. The kW/kVA/kVAR meters and kWh/kVAh/kVARh meters shall be suitable for measuring unbalanced loads on a 3-phase, 3 wire system. If specified, bi-directional type kW/kVA/kVAR meters shall be provided.

5.9.1.3 Power Factor Meters

The range of PF meters shall be 0.5 lag - 1.0 - 0.5 lead. If specified, four-quadrant type power factor meters shall be provided, suitable for bi-directional flow of power. The PF meters shall be suitable for 110V VT secondary.

5.9.1.4 Recording Instruments

The recording instruments shall be continuous recording type. These shall be suitable for the Current / Voltage signals as applicable for the specified parameters to be recorded. The recording instrument shall be complete with automatic chart feed control mechanism, isolating switch for chart drive, necessary transducers etc. as required. Each recorder shall be supplied with chart rolls and inking system for minimum 6 months continuous operation.

5.9.2 Indicating Lamps

The indicating lamps shall be of cluster LED type having minimum outer dia of 10 mm. All lamps shall be interchangeable, panel mounting type with rear terminal connection and shall afford easy replacement from front of the panel. The lamp cover shall be screwed type, unbreakable.

5.9.3 Control Switches

All control switches shall be rotary type. Circuit breaker control switches shall be 3-position Close-Neutral-Trip, spring return to neutral from both Close and Trip positions. They shall have pistol-grip handles. Minimum one spare way shall be provided on these switches for each position.

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

5.9.4 Control Fuses

All control fuses shall be of HRC cartridge link type.

5.9.5 Annunciator / Annunciation Scheme

5.9.5.1 Facia window type annunciators shall be provided on the control panels. These shall be of solid state type, with modular construction.

5.9.5.2 Visual indication shall be flush mounted, back lighted type, consisting of translucent facia of unbreakable acrylic material. Trip and non-trip alarms shall be segregated. The colour of windows shall be 'Red' for trip alarms and 'White' for all other alarms.

5.9.5.3 Annunciation facia shall be suitable for accommodating at least 15 standard capital size letters / numerals in Gothic form per line with 4 lines. Minimum size of the letter shall be 4 mm. Spacing between the 2 lines shall be minimum 2 mm. The facia window shall have a minimum display area of 1500 mm².

5.9.5.4 Each facia window shall be provided with at least two sets of super bright cluster LEDs in parallel to ensure highly reliable visual annunciation of adequate light intensity.

5.9.5.5 On occurrence of fault (s) one of the alarm sequences, as per Figure A (Sequence M of ISA S 18.1) or as per Figure B (Sequence F2M-1 of ISA S 18.1) shall be provided, as stated in the data sheet. If not specified therein, sequence as Figure A (Sequence M of ISA S 18.1) shall be provided.

5.9.5.6 Static control circuits shall be used for alarm logics incorporating audible and visual alarms. These shall be mounted on PCBs. The PCBs for identical logic units shall be interchangeable.

5.9.5.7 All requisite accessories including separate push buttons for ACKNOWLEDGE/ ACCEPT, RESET, SILENCE, and TEST functions shall be provided common for all annunciator windows. These shall be located on front of the panel.

5.9.5.8 Annunciator shall be designed to lock in even during TEST mode if the field contacts get actuated at that instant.

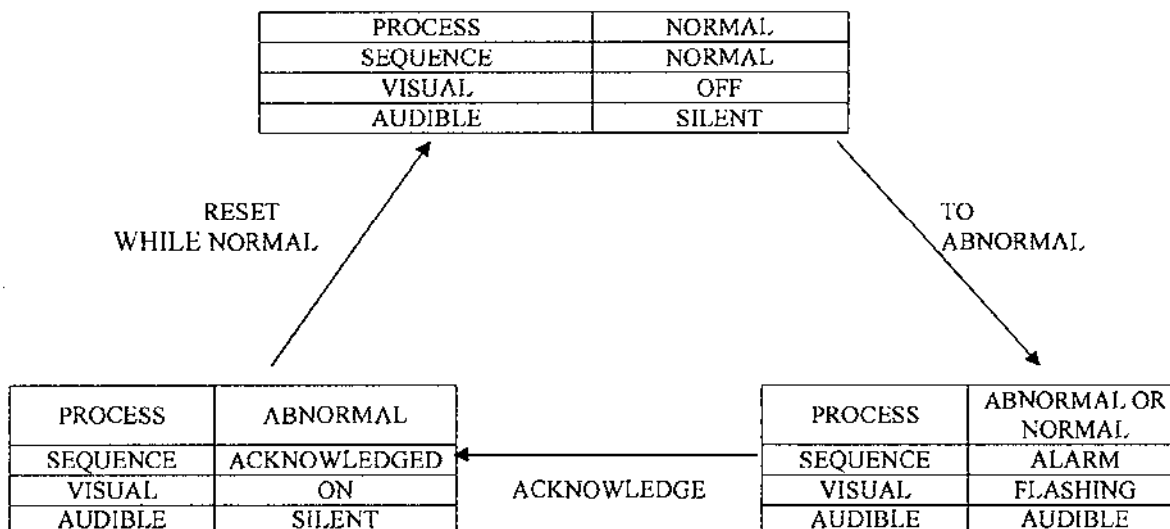
5.9.5.9 The annunciator circuit design shall ensure that momentary short circuits in lamp circuit do not affect it. Visual and audible alarm circuits shall be independent i.e. the failure of one shall not affect the other.

5.9.5.10 The annunciators shall be suitable for operation with normally open fault contact which closes on a fault. It shall be possible to make them suitable for normally closed fault contact by field modification.

- 5.9.5.11 Annunciator shall be able to lock in for momentary actuation of field contacts.
- 5.9.5.12 The system shall have protection against malfunctioning due to voltage spikes.
- 5.9.5.13 DC Control supply, at the specified voltage, shall be provided by the Purchaser, as indicated in the data sheet. Necessary power supply module(s), if required, to generate different voltages for various annunciator elements shall be included in Vendor's scope. DC supply failure indication shall be provided separately with DC under voltage relays. On failure of DC supply to the panel, a lamp and an audio buzzer fed from AC supply shall operate. There shall be provision for silencing / acknowledging the buzzer. The buzzer shall have distinctly separate tone from other audible alarms.

FIGURE A: SEQUENCE-M, MANUAL RESET

SEQUENCE DIAGRAM



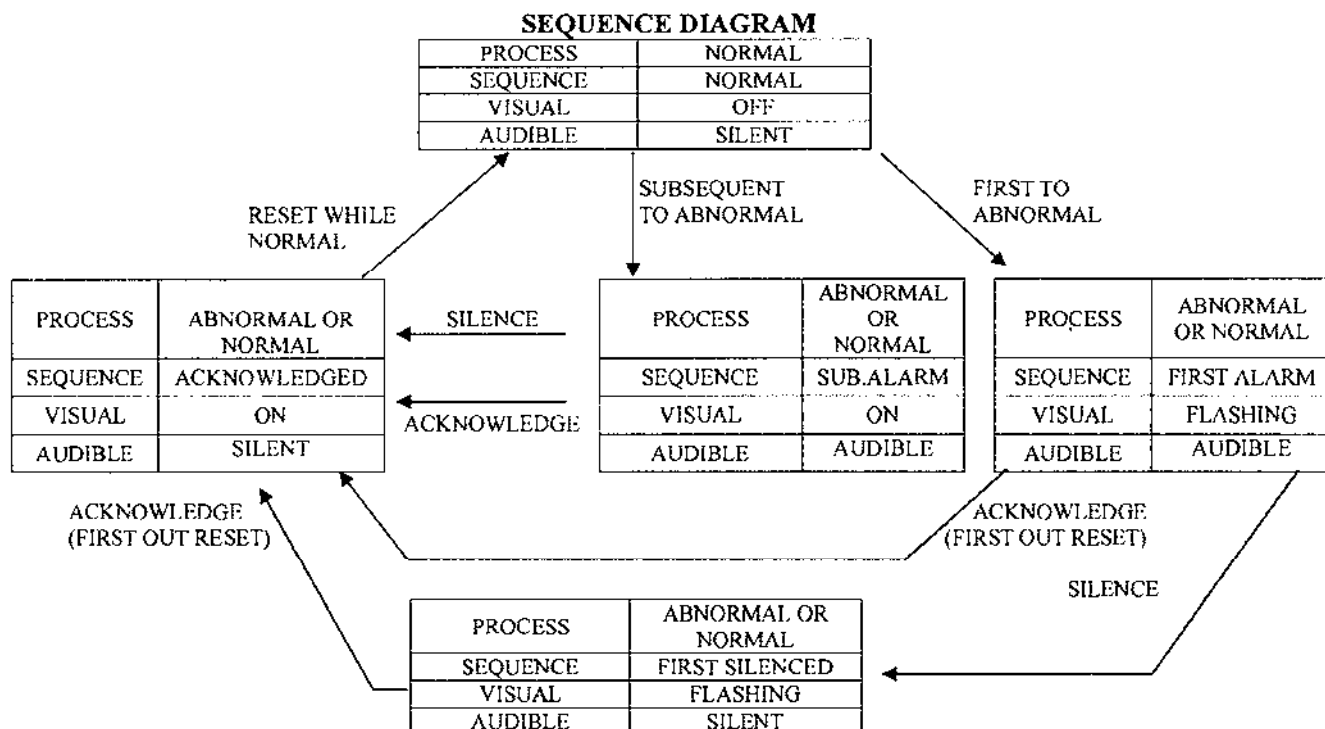
SEQUENCE TABLE

LINE	PROCESS CONDITION	PUSHBUTTON OPERATION	SEQUENCE STATE	VISUAL DISPLAY	ALARM AUDIBLE DEVICE	REMARKS
1	NORMAL	-	NORMAL	OFF	SILENT	
2	ABNORMAL	-	ALARM	FLASHING	AUDIBLE	LOCK-IN
3	ABNORMAL OR NORMAL	ACKNOWLEDGE	ACKNOWLEDGED	ON	SILENT	MANUAL RESET REQUIRED
4A	ABNORMAL	RESET	TO LINE 3			
4B	NORMAL		NORMAL	OFF	SILENT	MANUAL RESET

SEQUENCE FEATURES :

1. ACKNOWLEDGE, RESET AND TEST PUSHBUTTONS.
2. ALARM AUDIBLE DEVICE.
3. LOCK-IN OF MOMENTARY ALARMS UNTIL ACKNOWLEDGED.
4. THE AUDIBLE DEVICE IS SILENCED & FLASHING STOPS WHEN ACKNOWLEDGED.
5. MANUAL RESET OF ACKNOWLEDGED ALARM INDICATIONS AFTER PROCESS CONDITIONS RETURN TO NORMAL.
6. OPERATIONAL TEST.

FIGURE B: SEQUENCE-F2M 1, MANUAL RESET FIRST OUT WITH NO SUBSEQUENT ALARM FLASHING AND SILENCE PUSH BUTTON



LINE	PROCESS CONDITION		PUSHBUTTON OPERATION	SEQUENCE STATE	VISUAL DISPLAY	ALARM AUDIBLE DEVICE	REMARKS
1	NORMAL		-	NORMAL	OFF	SILENT	
2	FIRST	ABNORMAL	-	FIRST ALARM	FLASHING	AUDIBLE	LOCK-IN
3	SUB			SUB ALARM	ON	AUDIBLE	LOCK-IN
4	FIRST	ABNORMAL OR NORMAL	ACKNOWLEDGE BEFORE SILENCE	TO LINE-7			FIRST OUT RESET
5	SUB	ABNORMAL OR NORMAL					
6	FIRST	ABNORMAL OR NORMAL	SILENCE	FIRST SILENCED	FLASHING	SILENT	
7	SUB	ABNORMAL OR NORMAL		ACKNOWLEDGED	ON	SILENT	MANUAL RESET REQUIRED
8	FIRST	ABNORMAL OR NORMAL	ACKNOWLEDGE AFTER SILENCE	TO LINE-7			FIRST OUT RESET
9	NORMAL		RESET	NORMAL	OFF	SILENT	MANUAL RESET

SEQUENCE FEATURES:

1. SILENCE, ACKNOWLEDGE, RESET AND TEST PUSHBUTTONS.
2. ALARM AUDIBLE DEVICE.
3. LOCK-IN OF MOMENTARY ALARMS UNTIL ACKNOWLEDGED.
4. OPTION-1: SILENCE PUSHBUTTON TO SILENCE THE ALARM AUDIBLE DEVICE WHILE RETAINING FIRST OUT FLASHING INDICATION.
5. FLASHING INDICATION FOR FIRST ALARMS ONLY. NEW SUBSEQUENT ALARMS HAVE THE SAME VISUAL INDICATION AS ACKNOWLEDGED ALARMS.
6. FIRST OUT INDICATION IS RESET WHEN ACKNOWLEDGED.
7. MANUAL RESET OF ACKNOWLEDGED ALARM INDICATIONS AFTER PROCESS CONDITIONS RETURN TO NORMAL.
8. OPERATIONAL TEST.

5.9.6 Relays

5.9.6.1 Protective Relays

- i) Type of relay i.e. electromechanical, static or numerical shall be as defined in data sheet/ job specification.
- ii) All electromagnetic protective relays shall be back-connected, of drawout type, suitable for flush mounting, and fitted with dust-tight covers. Auxiliary relays and tripping relays are acceptable in fixed execution.
- iii) The 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 insertion of the test plug shall automatically short circuit the CTs and permit extension of external power supply to the relay.
- iv) All protective relays shall have hand reset facility and clear operating indication, e.g. flags for 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.
- v) All tripping relays 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.
- vi) The tripping relay shall be suitable for satisfactory operation from 50% to 110% of the specified control supply voltage.
- vii) Stabilising resistors, interposing CTs /VTs, metrosils etc., wherever required, shall be part of the relay.

5.9.6.2 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.

5.9.7 Clock

5.9.7.1 An electronic digital clock having 7 segment LED display (Red Colour) shall be provided on the top of the panel line up. The display shall have date, hour and minute display with blinking dots. The AM/PM or 24 hour mode shall be field selectable. The display shall be visible from a distance of 7 metre arc covering an angle of 120°. The numeral height of the digit shall be minimum 5 cm. The intensity of the display shall be sufficient to view in broad day light. The accuracy of the clock shall be better than ± 10 sec. per month.

5.9.7.2 Power supply for the clock shall be derived from the incoming main supply to the panel and shall be backed by lithium batteries.

5.9.8 Transducers

Transducers designed for 4-20mA output signal shall be provided as specified in data sheets/as per requirements of approved schemes. Transducers shall be suitable for accuracy class 0.5 (max.). Galvanic isolation shall be provided between input and output circuits. The isolation insulation shall withstand minimum 2 kV, 50 Hz for 1 minute. The transducers shall be protected against input and output voltage surges. The transducers shall be suitable for driving 600 ohms load impedance located min. 500 m away and connected through 0.5 mm² copper conductor cables. The transducers shall be suitable for minimum 125 % continuous overload in input voltage/ current parameters.

The transducer characteristics shall be linear throughout the measuring range and its output shall be load independent. The transducer shall also have a low AC ripple on output less than the 1%.



5.9.9 Nameplates

5.9.9.1 Engraved nameplates indicating the panel designation shall be provided at the top (on front and back) of each panel. These shall be fixed in such a way that these can be removed and refitted when desired.

5.9.9.2 Nameplate or polyester adhesive 'identification tags' shall be fixed on each panel mounted equipment inside the panel and shall be provided on panel walls, to indicate permanent location of the components. Labels shall be provided for every component on the cards, connecting wires, as well as, for the terminals in the terminal strip inside the panel.

5.9.9.3 Nameplates shall also be fixed on the exterior of the panels at appropriate places to indicate the description/function of various relays, meters, control switches, push buttons, lamps and other equipment.

5.9.9.4 Special warning plates shall be provided on all removable covers or doors giving access to energised metallic parts above 24 volts.

5.9.10 Auxiliary VTs and CTs

Necessary auxiliary voltage transformers for open delta and auxiliary current transformers, wherever required, shall be included in Vendor's scope of supply.

Auxiliary CT required for summation of two or more feeders and auxiliary VT's required for galvanic isolation of different synchronising inputs shall be included in Vendor's scope of supply.

5.9.11 Tariff Metering

Wherever called for, integrating meters of the trivector or equivalent types capable of indicating kWh, kVARh and kVAh directly, along with maximum kVA and kW demand shall be provided.

These shall be suitable for 3 phase, 3 wire with unbalanced loading and with two sets of elements connected to current and potential transformers of specified ratio, and shall be fitted with reverse stop and impulse contacts to operate printo-maxigraphs where required. The printomaxigraph shall be operated from the impulses received from the Trivector meter and shall print the maximum demand in figures as well as record the shape of the load curve. The recording shall be inkless type.

5.10 Synchronisation Panel/Trolley

Whenever called for, swinging type synchronising panel / synchronisation trolley complete with running and incoming voltmeters, running and incoming frequency meters, synchroscope, synchronising check and guard relays, synchronising switches, lamps etc. shall be provided. Automatic synchronising device with inputs to governor control and excitation panel shall be provided if specifically asked for. The synchronising switches shall be lockable type. One common key shall be provided for all synchronising switches to ensure that only one incoming source (from only one synchronising switch) is selected at a time.

The swing type panel shall be mounted on one side of the main panel with hinges and shall be so located as to enable easy operation of all breakers provided with synchronisation facility. Synchronising trolley shall be on wheels and shall be complete with multipin plug and flexible lead. Matching sockets shall be provided on main panels wherever required for synchronising.

5.11 Mounting of Loose Equipment/Components

Purchaser may buy loose equipment to be mounted on the control panel from different Vendors, e.g. On Load Tap-Changer controls, AVR equipment, transformer fan and temperature control, special relays etc. as specified in data sheets. The cutout and wiring details for such items shall be supplied to the successful Vendor. The panels shall be supplied duly drilled, wired etc. for mounting & wiring of the loose items.

6.0 INSPECTION, TESTING AND ACCEPTANCE

6.1 During fabrication, the panels 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. Minimum three weeks notice shall be given to EIL/owner for witnessing the final testing of the complete equipment.

6.2 For testing requirements, refer Inspection & Test Plan No. 6-81-1004. Prior notice of minimum 4 weeks shall be given to EIL/owner for witnessing the final testing of panel to ensure satisfactory operation of all components. Tests shall be carried out at manufacturer's works under his care and expense.

7.0 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'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 erection. The packing shall be completely suitable for outdoor storage in areas with heavy rains / high ambient temperature, unless otherwise agreed. A set of instruction manuals for installation, testing and commissioning, a set of operation & maintenance manuals and a set of final drawing shall be enclosed in a waterproof cover along with the shipment.