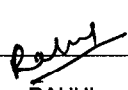
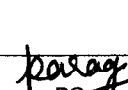
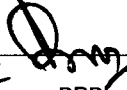
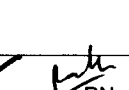


Annexure-10: Specification for Relay and control panel

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SPECIFICATION FOR RELAY & CONTROL PANELS

5	31.05.16	REVISED & ISSUED AS STANDARD SPECIFICATION	 RAHUL	 PG	 BRB	 RN
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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, Elecktronik und Information Stechnik
VT	Voltage Transformer

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	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 40⁰ 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, annunciations, 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, annunciations 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.

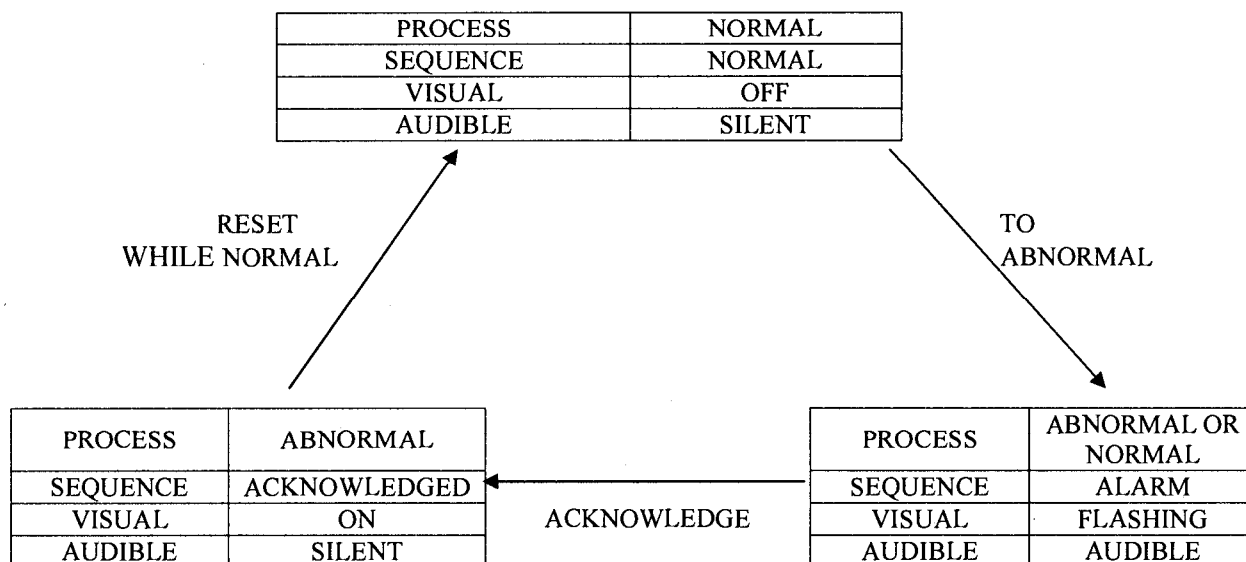
5.9.5.9 The annunciator circuit design shall ensure that momentary short circuits in lamp circuit do not affect it. Visual and audible alarm circuits shall be independent i.e. the failure of one shall not affect the other.

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



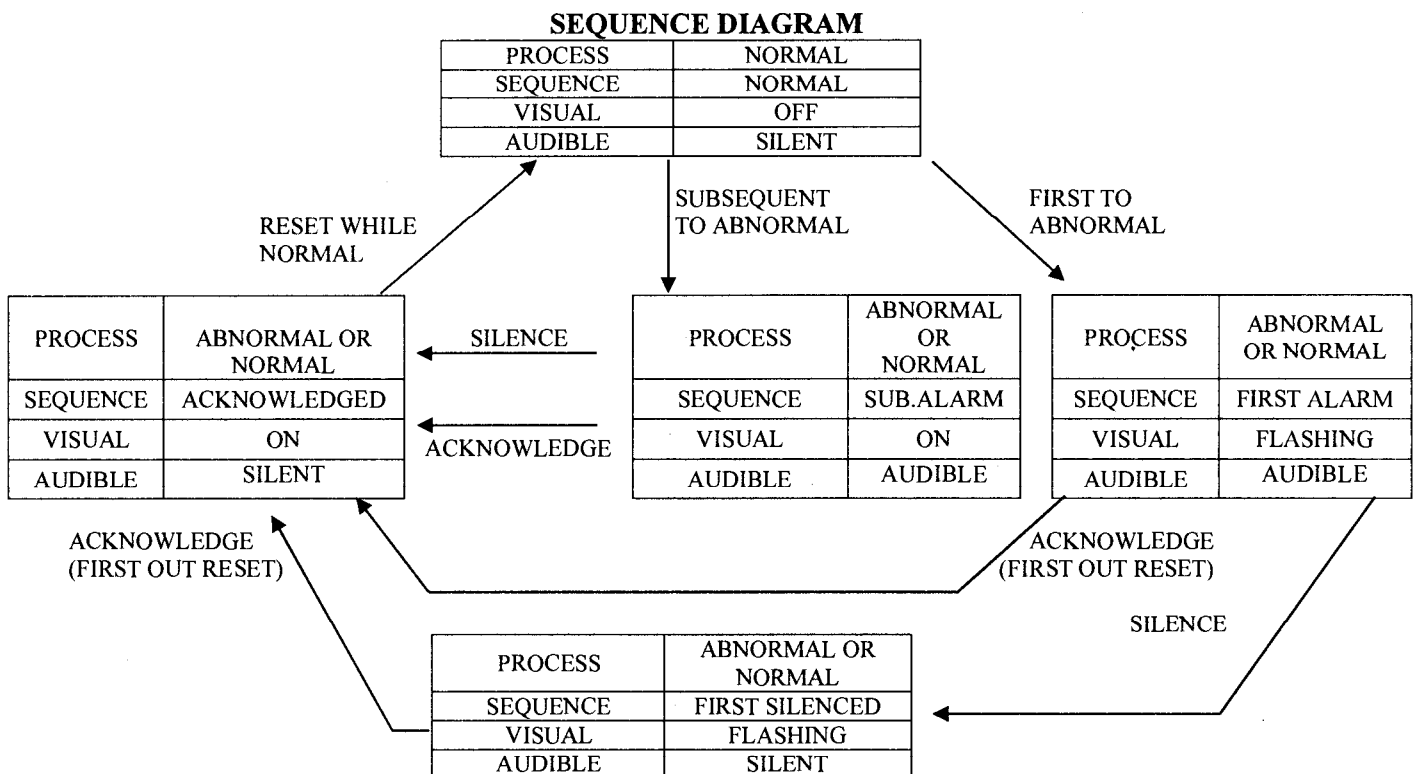
SEQUENCE TABLE

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



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

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.