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List of Abbreviations:	
BIS	Bureau of Indian Standards
CT	Current Transformer
CRCA	Cold Rolled Cold Annealed
DCS	Distributed Control System
FRP	Fibre Reinforced Plastic
HV	High Voltage
LED	Light Emitting Diode
MCC	Motor Control Center
MCCB	Miniature Case Circuit Breaker
NC	Normally Closed Contact
NO	Normally Open Contact
PLC	Programmable Logic Controller
PT	Potential Transformer
PVC	Poly Vinyl Chloride
SWG	Standard Wire Gauge
VCB	Vacuum Circuit Breaker
VT	Voltage Transformer
XLPE	Cross Linked Poly Ethylene

1.0 SCOPE

This specification covers the design, manufacture, testing, packing and supply of indoor, draw-out type High Voltage Switchboards up to and including 33 kV, incorporating Vacuum Circuit breakers.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of latest revision of the following standards issued by BIS (Bureau of Indian Standards), unless otherwise specified:

IS-5	Colours for ready mixed paints and enamels.
IS-694	PVC - insulated cables for working voltages up to and including 1100 V
IS-1248	Direct acting indicating analogue electrical measuring instruments and their accessories
IS-2071	Methods of high voltage testing
IS-2544	Porcelain post-insulators for systems with nominal voltage greater than 1000 V
IS-2705	Current transformers
IS-3156	Voltage transformers
IS-3231	Electrical relays for power system protection
IS-3427	AC Metal enclosed switchgear and control gear for rated voltages above 1 kV up to and including 52 kV
IS-3618	Phosphate treatment of iron and steel for protection against corrosion
IS-5082	Material data for aluminium bus bars
IS-5578	Guide for marking of insulated conductors
IS-6005	Code of practice of phosphating of iron and steel
IS-9920	Switches and switch isolators for voltages above 1000 V
IS-9921	AC disconnectors (isolators) and earthing switches for voltage above 1000 V
IS-10601	Dimensions of terminals of high voltage switchgear and control-gear
IS-11353	Guide for uniform system of marking and identification of conductors & apparatus terminals
IS-12661	HV motor starters
IS-12729	General requirements for switchgear and control gear for voltages exceeding 1000 V
IS-13118	General requirements for circuit breakers for voltages above 1000 V
IS-13703	Low voltage fuses for voltages not exceeding 1000 V AC or 1500 V DC

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

2.3 The switchboards shall also conform to the provisions of Indian Electricity rules 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 / 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 following order of decreasing priority shall govern:

(i) Statutory regulations.
(ii) Data sheets.
(iii) Job specification.
(iv) This specification.
(v) Codes and standards.

3.0 GENERAL REQUIREMENTS

3.1 The switchboards shall be suitable for installation and satisfactory operation in a pressurised sub-station or in a substation with restricted natural air ventilation in a tropical, humid and corrosive atmosphere. The switchboards shall be designed to operate under site conditions as specified in the data sheets. If not specifically mentioned therein, a design ambient temperature of 40°C and an altitude not exceeding 1000 metres above mean sea level shall be considered.

3.2 All equipment supplied under the purview of this specification is intended for continuous duty operation, as per nameplate rating under the specified ambient conditions.

3.3 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least for 15 years from the date of supply.

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

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

3.6 **Enclosure and Protection**

a) The High Voltage Switchboard shall be metal-enclosed and shall comprise of standard pre-fabricated, cold-rolled, sheet steel units, assembled to form a rigid, freestanding, dead-front structure. As a minimum, 2 mm (14 SWG) sheet steel shall be used for all front and rear doors and covers and 1.6 mm (16 SWG) sheet steel for inter-panel partitions. Wherever required, stiffeners shall be provided to increase stiffness of large size doors and covers.

b) Vertical panels shall be assembled to form a continuous line-up of uniform height. Rear panel sections for cable / bus-duct termination shall also be of the same height as that of the front panel section.

c) The switchboards shall be totally enclosed and vermin-proof. If necessary, openings for natural ventilation shall be provided. These shall be louvered and provided with wire mesh having opening less than 1 mm. The enclosure shall have complete protection against approach to live parts or contact with internal moving parts (IPH 6) as per IS: 3427.

d) All openings, covers and doors shall be provided with suitable neoprene gaskets.

e) Each unit of the switchgear shall have necessary internal sheet metal barriers to form separate compartments for circuit breaker, bus-bars, instruments and relays, cable connections, etc. Compartments for cable connections shall allow cable termination and connection work with the switchgear energised.

f) Suitable arc propagation metallic-barrier shall mandatorily be provided in the bus bar compartment at every junction between two adjacent cubicles. In case propagation barrier cannot be provided due to constructional factors, arc traps shall be provided, for example, at the end panels. Independent pressure relief devices shall be provided for all HV compartments, i.e. bus bar, cable and breaker compartments and each compartment shall have type test certificate for withstanding internal arc fault.

g) All identical equipment and corresponding parts shall be fully interchangeable.

h) Safety barriers I shutters shall be provided to permit personnel to work safely within an empty compartment with the bus bars energised.

i) It shall be possible to extend the switchgear in either direction at a later date. Ends of bus bars shall be suitably drilled for this purpose. Panels at extreme ends shall have openings, which shall be covered with plates screwed to the panel. Details of drilled holes in bus bar and openings in the panels, provided for future extension shall be clearly shown in the vendor drawings.

j) The breaker draw-out carriage on the switchboard shall have three positions: "Service", "Test" and "Draw out" viz.:

   (i) The "Full In" or "Service" position - In this position both power and control circuits shall be connected. This shall be the normal operating position of the circuit breaker.

   (ii) The "Test" position - The power contacts shall be disconnected in this position but the control connections shall not be disturbed, it shall be possible to close and trip the breakers in this position.

   (iii) The "Draw-Out" Position - both power and control circuits shall be disconnected in this position.

k) The circuit breaker shall be lockable in "service" and "test" positions. Automatic safety shutters shall be provided to ensure the inaccessibility of all live parts after the breaker carriage is drawn out.

l) There shall be a distinct overall door for the breaker compartment, which can be closed with the carriage in draw-out position and it shall be lockable type. In the service position, it shall not be possible to open the front breaker compartment door. The front breaker compartment door shall be openable only in conditions when the breaker is either in the "test" or in "draw out" conditions.

m) It shall not be physically possible to put the breaker in the "Service" position with the front breaker compartment door in open condition.

n) All front breaker compartment doors shall be provided with a Folding lockout hasp, allowing up to three padlocks to lock out the breaker compartment door for personnel safety. Three nos. locks with two keys each must be provided with every LOTO – Lock-Out-Tag-Out hasp.

o) All circuit breaker modules of the same rating shall be inter-changeable. Suitable interlocks shall be provided to prevent the following operations:
   (i) "Plugging-In" or "drawing out" of a closed breaker.
   (ii) "Plugging-In" a breaker with the earthing isolator closed. "Closing" of the earthing isolator with the breaker "Plugged-In".
   (iii) Pulling Out the auxiliary circuit plug with the breaker in the "Service" position.
   (iv) Pushing in the breaker to the "Service" & "Test" position, with the auxiliary circuit plug not in position.

p) All hardware shall be corrosion-resistant. All joints and connections of the panel members shall be made by zinc-passivated or cadmium-plated, high-quality Steel plates. All nuts, bolts & washers for assembling the panel shipping sections, for HV & Control Cable termination must be necessarily of stainless-steel and must be secured against loosening.

q) Suitable removable type eyebolts shall be provided for the lifting of the panel / shipping sections. These bolts, when removed shall not leave any opening in the panels.

r) Cable Glanding plates must be of removable type in multiple sections – construction must be such so as to minimise cutting / grinding of gland plates. HV Cable openings & cable terminals must be suitable for termination of HV Cables with overall outer diameters of 50 mm to 80 mm & suitably long bolts are to be provided for tightening of copper / aluminium cable lugs with washers & nuts.

s) Prefixed clamps must be made available on cable glanding plates to secure HV cables in plates upon panel entry. In cases wherein it is specifically mentioned for terminating multiple cables in a single compartment, adequately long cable terminals with multiple holes for bolting of cables are to be provided. The terminal holes must be so spaced so as to accommodate cable lugs placed adjacent to each other for each phase.

3.7 Accessibility for Panel Operation

a) All relays, metering and control components shall be mounted on the panel front only.

b) Checking and removal of components shall be possible without disturbing adjacent equipment. All equipment shall be easily accessible.

c) It shall be possible to set all measuring relays and instruments in situ without de-energising the switchboard. Mounting of relays for a particular breaker feeder panel shall be limited to that particular feeder only and must not be mounted on adjacent cubicles.

d) All mounted equipment shall have identification tags of self-sticking PVC tapes at the rear also. In addition, for all shipping sections, the serial nos. must be permanently etched / painted both on the front & rear sides for identification in a panel line-up.

e) Current Transformer secondary terminals must be easily accessible (facing outwards) for confirming tightness, cleaning & inspection. All CTs must be properly marked with legible name-plate details on the CT body.
f) The CT ratio for Feeder / Motor / Differential Protection & Metering must be marked on each of the Breaker front door nameplate along with the breaker rating, year of manufacture, P.O. Number.
g) Similarly, for Bus & Line PT cubicles, the PT details (voltage rating / turns ratio / PT Fuse details / etc) must be marked on the front door name-plate.
h) All terminals shall be shrouded with plastic covers to prevent accidental contact.
i) For ease of opening of panel rear doors (which must be of bolted type with two handles), these doors must not be larger than 800 mm X 800 mm in size. In case the rear opening is larger, multiple doors may be provided, but each door must be sized strictly within the specified dimensions. Each rear door must be provided with an inspection window of adequate size.

3.8 Bus Bars

a) The switchboard shall comprise of 3-phase bus bars which shall extend through all units of the switchgear line-up. The main bus bars shall have uniform cross-section throughout their length, and shall be sized to carry continuously the rated current specified in the data sheet. Preferably the bus-bars are to be of flat strip shaped with a rectangular cross section.
b) The Bus-bar shapes must be efficiently designed for heat dissipation and ideally have a high surface area to cross-sectional area ratio for high-current applications.
c) Bus bars shall be of high conductivity electrolytic copper only and supported on insulators made of non-hygroscopic, non-inflammable material with tracking index equal to or more than that defined in Indian standard.
d) Bus bars shall be housed in a separate chamber and shall be accessible for inspection. Wire guards or mesh shall be provided inside the enclosure to allow visual inspection of bus bars, to avoid accidental contact when the outer solid cover is removed.
e) Both bus bars and the supports shall be adequately sized and braced to withstand the specified short-circuit current for 1 second. Dynamic stresses shall be calculated on the basis of the specified peak short-circuit current. All bus supports shall be of non-carbonising material, resistant to acids and alkalies.
f) Bus bars shall be insulated by using heat-shrinkable PVC sleeves or with epoxy coating of requisite thickness. The insulating wrap or coat must be of Red, Yellow and Blue colours for phase-identification throughout the length of the switchboard and in all shipping sections. The sleeves / insulating coat shall be rated to withstand the system line-to-line voltage for 1 minute. This shall be verified by a type test in which the line voltage will be applied between the sleeved / coated main bus bar and an aluminium foil wrapped closely around the insulation over a length of at least 500 mm.
g) All bus-bar joints (T-type or L-type joints) and all tap-off connections from the main horizontal bus-bars shall be provided with removable flexible FRP shrouds of correct dimensions for making a proper fit.
h) The thermal design of the bus bars shall be based on installation of the switchgear in poorly ventilated conditions. The cooling air volume shall take into account only the bus bar enclosure.

i) The hot spot temperature for bus-bars including joints at design ambient temperature shall not exceed 95°C for normal operating conditions.
j) All bus-bar joints shall be provided with high tensile strength Stainless steel bolts, nuts and washers. Stainless-steel nuts / bolts / washers shall be used for all bus bar joints and supports.
k) The current rating as defined for switchboard and components in data sheet/job specification are for design ambient temperature at site conditions and for being inside the cubicle at fully loaded condition. The vendor shall suitably de-rate the nominal rating to suit the above condition.

3.9 HV Power Connections

a) The incoming power connection shall be through XLPE HV cables or bus-duct and outgoing power connection shall be through XLPE HV cables, as indicated in the data sheet. Ample space for connection for these cables shall be provided at the rear of the switchboards. In order to avoid accidental contact in the cable compartment while carrying out inspection by opening the rear cover, a removable expanded metal barrier shall be provided in the cable compartment. Unless otherwise specified, the power cable shall enter the switchboard from the bottom. Non-magnetic cable gland plates shall be provided for feeders wherever single core cables are used.
b) The switchboard shall be supplied complete with supports for clamping outgoing and incoming cables. The head-room available between cable gland plate and terminal lugs shall not be less than 800 mm for switchgear up to 11 kV, and 1000 mm for 22 and 33 kV cables.
c) In case the standard panel depth cannot accommodate the specified no. of cables, a rear extension panel of full height shall be provided. A copper earth strip of adequate cross-section & multiple holes (with stainless steel nuts & bolts) shall be brought near to the cable terminals along the bottom most part of the rear compartment – for terminating the shielding / armour braid extending from the cable termination kit. This will be applicable for any extension panel as well.
d) Unless otherwise specified, all power cables shall enter the switchgear from the bottom.

3.10 Auxiliary Wiring and Terminals

a) Inside the cubicles, the wiring for control, signalling, protection and instrument circuits shall be done with BIS approved, PVC insulated, flame retardant type, copper conductor wire. The insulation grade shall be 660 V. The wiring shall preferably be enclosed in plastic channels or neatly bunched together. Wiring between HV breakers or cable compartments to relay and metering compartments shall be routed through flexible conduits.
b) Separate colour coding shall be maintained for 110 V DC rated control cabling & 240 V / 415 V AC rated control cabling.
c) A minimum of 10% spare terminals shall be provided on each terminal block. Conductors shall be terminated with adequately sized compression-type lugs for connection to equipment terminals and strips. Stranded conductors shall be soldered at the ends before connections are made to the terminals. Sufficient terminals shall be provided on each terminal block to ensure that only one outgoing wire is connected per terminal. Terminal strips shall preferably be separated from power

circuits by metal barriers or enclosures. All spare contacts of auxiliary relays, timers, etc shall be wired up to the terminals.

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

e) 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 16 A distributions, the control fuse circuit must be done with 2.5 mm^2 copper conductors. Each wire shall be terminated at a separate terminal. CT Circuit wiring shall be done with 2.5 mm^2 copper conductors with Red Yellow Blue colour coding. Shorting links or suitable shorting arrangement for shorting CT secondary shall be provided.

f) Unless otherwise specified, all external control cables shall enter the switchgear from the bottom.

g) Supporting facilities shall be provided for clamping the control cables.

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

3.11 Control and Indication

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

   (i) One DC feeder shall be provided for each bus section. The bus coupler panel may be fed from either of the two supplies. Supply voltage shall be 110 V DC, unless otherwise specified.

   (ii) One separate, single-phase power supply shall be provided for each bus section for feeding space heaters, audible alarm hooters, convenience single-phase power sockets, etc. Supply voltage shall be 240 V AC, unless otherwise specified.

   (iii) Provision to receive DC and AC control supply shall preferably be provided in the bus-PT panel.

b) Breaker positions (CLOSE, OPEN, spring-charged, test position, service position) shall be indicated mechanically. Electrical indications, with colours as given below, shall also be provided:

(i)	Breaker 'CLOSE'	------	Red Lamp
(ii)	Breaker 'OPEN'	------	Green lamp
(iii)	Breaker auto-trip	------	Amber lamp
(iv)	Trip circuit healthy	------	White lamp
(v)	Spring charging	------	Blue lamp

c) A common DC control supply fail indication shall be provided for each bus section with a blue coloured lamp preferably on the respective Bus-PT panel.

3.12 **Earthing Connections**

a) All cubicles shall be connected to an earth bus-bar running throughout the length of the switchboard. The minimum earth bus bar size shall be 30 x 6 mm^2 copper for a short-circuit withstand capacity of up to 31.5 kA, and 50 x 6 mm^2 copper for a short-circuit withstand capacity above 31.5 kA.

b) All doors and movable parts shall be connected to the earth bus with flexible copper connections. The frame work of all the panel verticals shall be connected to this earth bar Provision shall be made to connect the earthing bus-bar to the plant earthing grid at the two ends of the switchboard line-up.

c) All non-current carrying metallic parts of the equipment and components shall also be earthed. The earth bus shall be brought back to each of the cable compartments near to the cable terminals – separated by a safe distance, and earthing bolts & nuts (all nuts / bolts / washers shall be of stainless steel) shall be provided to ground the cable armour. The mating surfaces of all bolted parts shall be zinc passivated to ensure continuity between them.

d) For Bus-Duct Earthing, two runs (double earthing) of copper strips of adequate cross-section, as per the short-circuit current withstand capacity, must run along the sides of the bus-duct throughout its entire length. These earth strips are to be terminated at the switchboard end with the main switchboard earth bus-bar – adequate openings shall be made on the switchboard enclosure for taking-in the bus-duct earth strips. At the other end, the bus-duct earth strips are to be terminated with the transformer earth-grid.

3.13 **Space Heaters**: The panels shall be provided with space heaters to prevent moisture condensation and maintain cubicle temperature 5°C above the ambient. The space heaters shall be located at the bottom of the panel and shall be controlled through a MCB and a thermostat with an adjustable setting. One such thermostat shall mandatorily be located in the metering or relay chamber. In addition to the instrument / metering chamber, the CT compartment is also to be kept at a higher temperature for avoiding moisture condensation on CT surface & resultant flashovers. Hence along with the metering / instrumentation compartment, the cable terminal compartment – housing the CTs is also to be provided with separate space heaters.

3.14 **Panel supporting Base-Frames** (to be supplied & installed by the owner): The panels shall be suitable for installation on panel supporting base-frames fabricated out of mild-steel. Hence the panel verticals shall be suitable for tack welding at the bottom, directly to this base-frame.

3.15 **Nameplates**

a) A nameplate with the switchboard designation shall be fixed at the top of the central panel. Separate nameplates giving details for each feeder / breaker (such as CT ratio, Breaker rating, P.O. Number, Date of Manufacture, etc.) shall be provided on the front doors of each of the panel verticals.

b) A Danger notice plate (Skull & Bones Arrangement with voltage rating in Red Background) shall be provided at the front and rear of each panel vertical. The danger notice plate shall indicate danger notice with voltage rating both in Hindi and English. Overall dimensions of the danger notice plate shall be 150 mm - wide & 150 mm – high.

c) The nameplates for feeder compartments shall contain all details regarding the feeder type (incomer / bus-coupler / plant-feeder / Motor Feeder / Capacitor Feeder / Transformer Feeder / etc.) for drives / equipment controlled by the particular module as per approved single line diagram, including the rating of the feeders.

d) Blank nameplates shall be provided for all spare and vacant modules, indicating "SPARE FEEDER" and also indicating the type & rating of the feeder.

e) Nameplate or polyester adhesive stickers shall be provided for all equipment mounted inside the switchboard. Inside the feeder compartments, the electrical components, equipment, accessories like switchgear, control gear, LED Indication lamps, relays, MCBs. Control Fuses, etc. shall be suitably be identified by providing permanently affixed stickers.

f) Special warning plates " ISOLATE SUPPLY BEFORE OPENING THIS COVER" shall be provided on removable covers or doors giving access to cable terminals and bus bars maintained at High Voltage.

g) Special warning labels shall also be provided inside the switchboards, wherever considered necessary. Identification tags shall be provided inside the panels matching with those indicated on the switchboard wiring diagrams.

h) Engraved nameplates shall preferably be of 3-ply (Black-White Black) lamicoid sheets or anodised aluminium. However back engraved perspex sheet nameplates may also be acceptable. All such nameplates & danger notice plates must have rounded corners and shall be fastened by counter sunk removable screws and not by adhesives.

3.16 **Painting**

a) All metal surfaces shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surface shall be prepared by applying a coat of phosphate paint and coat of yellow zinc chromate primer. The under surface hall be made free from all imperfections before undertaking the finishing coat.

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

c) Colour shade of the switchboard final paint shall be as per BS 627 (Light Aircraft Gray) unless specified otherwise.

d) The finished panels shall be dried in stoving ovens in dust free atmosphere. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint etc. Vendor shall supply final paint in spray-paint bottles (total of 15 spray-paint cans per switchboard) for final touch up at site.

e) All unpainted steel parts shall be of stainless steel only. If these parts are moving elements then they shall be greased.

3.17 Marshalling Cabinet & DCS Interface Signals

a) A separate vertical with control cable terminals for terminating all control cables for DCS interface must be provided for each bus-section.
b) Provisions for terminating & glanding several multi-core control cables must be made at the bottom of the Marshalling cabinets.
c) Each feeder must be internally wired up to the respective bus-section's marshalling cabinet and the following signals must be made available as a minimum for relaying up to the owner's DCS:

Digital Inputs to Owner's DCS	Run Indication (Breaker On)
	Breaker Off Indication
	Breaker Trip Indication (fault indication)
Digital Output from Owner's DCS	Breaker Start Command
	Breaker Stop Command
4-20 mA Signals to Owner's DCS over 24 V - DC	From Current Transducers in Motor Feeders – for current indication
	From Voltage Transducers in Switchboard Incomers – for voltage indication.

d) Inside the Marshalling Cabinet, all terminals pertaining to a single feeder must be grouped together, with adequate gaps / partitions between each such groups.
e) Adequate naming of marshalling cabinet terminals and printed barrel ferruling for inter-panel wiring must be strictly followed easy identification.

4.0 SWITCHBOARD COMPONENTS

4.1 Circuit Breakers:

a) Vacuum circuit breakers shall be used in all the High Voltage switchboards rated from 3.3 kV upwards up to 33 kV. The exact type and rating of breakers shall be as indicated in the data sheet. Breaker transport trolleys must be provided for cassette-mounted breakers for each switchboard / isolator panel. One trolley per Bus-Section / isolator panel must be mandatorily supplied.
b) Vacuum circuit breakers shall be designed to have low switching-over voltage levels and with a long switching life. The interrupter shall be leak-free.
c) Each of the breakers shall have at least 6 normally open (NO) and 6 normally closed (NC) spare auxiliary contacts for purchaser's use. If these are not available, auxiliary relays shall be used to multiply the auxiliary contacts of the breakers.
d) The breakers shall have a universal motor-operated, spring-charged mechanism. It shall also be possible to charge the springs manually. The closing spring shall get

re-charged (for subsequent closing) soon after a closing shot and prior to breaker tripping. In case the limit switch fails to cut out the spring-charging motor with the springs fully charged, the motor shall be automatically de-coupled. The control circuit shall be suitable for local as well as remote control. Breakers shall be trip-free and shall have an anti-pumping device. The breaker operating duty shall be O – 0.3 Seconds – CO – 3 Minutes – CO unless otherwise agreed. (O - Open, C - Close).

e) Operating Mechanism:
   1) 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 the 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.
   2) All stored energy operating mechanism shall be equipped with 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.
   3) All electrical power operating mechanisms shall be suitable for remote operation and shall be equipped with 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.

f) 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.

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

h) The breakers shall be shall be provided with anti-pumping & trip free provision. Each breaker shall be also provided with an operation counter.

i) Metal Oxide surge suppressors shall be provided on all outgoing vacuum circuit breakers to limit the over voltage to a maximum of 2.2 p. u. rated peak line to earth voltage.

j) Line PT shall be mounted in a separate draw-out carriage. In case of truck mounted breaker, line PT shall be provided in a separate panel.

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

l) An integral earthing system, or a separate earthing carriage/truck, shall be provided. In case of a separate earthing carriage, the necessary trolleys for bus-side and line (cable)-side earthing shall be supplied. After withdrawing the circuit breaker, this can be inserted to facilitate earthing of cables and bus bars. Earthing truck shall be complete with the PT and voltmeter, giving audio-visual indication and solenoid inter-lock to prevent closing of bus side earthing truck on live bus-bars. Earthing truck operation with door open is acceptable.

m) The actual numbers & type of earthing trucks shall be as per attached data sheet.

n) For tripping of circuit breakers, Open – to – Trip type feature must be built in the tripping logic circuit. For all purposes, such as process trip command from Owner's DCS or a faulty DCS Interface Cable, the breakers must trip upon sensing a Open circuit.

4.2 Current Transformers:

a) Current transformers shall conform to IS: 2705. The short-time rating shall be equal to that of the HV switchboard. They shall be mounted on the stationary part of the switchboard. The CT ratings shall be as shown in the data sheet. Protective CTs shall have an accuracy class of SP and an accuracy limit factor greater than 10. CTs for instruments shall have an accuracy class of 1.0 and an accuracy limit factor less than 5.0. One leg of the CTs shall be earthed. Separate CTs shall be provided for Differential and Restricted Earth fault protections.

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

c) Proper access to each set of CTs especially to check the tightness of the CT secondary terminals - shall be available for repair & maintenance.

d) Each CT must have a name-plate – with legible letters – indicating the CT serial no. / CT parameters.

4.3 Potential / Voltage Transformers:

a) The voltage transformers shall conform to IS: 3156. The voltage transformers shall be of draw-out type and shall be provided with 4 pole miniature circuit breakers with auxiliary contacts on the secondary side.

b) The draw-out mechanism shall disconnect the VT from the bus-bars. The primary connection shall be disconnected before the VT becomes accessible. Neutral point of the star connected VTs both on the primary and secondary sides shall be earthed.

c) The VTs shall have an over-voltage factor of 1.9 for 30 seconds, and an accuracy class of 1.0 from 10% to 120% of normal voltage. The VTs selected shall be compatible with the system grounding.

d) The primary rated voltage shall be equal to the rated voltage V of the system or V / √3, if the VT is connected between phase and neutral.

e) If not otherwise specified, the secondary voltage shall be 110 V, or 110 / √3 V. The burden and class of accuracy shall be as specified in data sheets. For directional relays, either a 3 - phase 5 - limb VT or 3 single-phase VTs with secondary windings connected in open delta shall be provided.

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

Digital instruments shall also be acceptable, provided specific approval from the Owner is obtained (for make and model) before placement of switchboard order.

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

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

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

d) **Multi-Function Meters:** Wherever specified, digital multi-function meters (MFMs) – with 7-segment LED displays shall be provided in addition to analogue meters. The MFM shall have 3-row / 8-digit display configuration and shall be communicable on RS 485 interface over MODBUS RTU protocol.

4.5 Relays:

a) Type of relay i.e. electromechanical, static or numerical shall be as defined in the attached data sheet (MRPL/Elect/Data Sheet/002) or job specification.

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

c) 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 permits extension of external power supply to the relay.

d) 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 type relays. It shall be possible to reset the flag without opening the relay case.

e) 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. Tripping relays will be acceptable in non-draw-out cases.

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

4.6 Auxiliary Equipment:

a) **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.

b) **Control switches**: All control switches shall be rotary type, having a cam-operated contact mechanism. Unless otherwise stated, circuit breaker control switches shall be 3-position C-N-T, spring return to Neutral (N) from both Close (C) and Trip (T) positions. They shall have pistol-grip handles with a lockable arrangement.
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 three line (RY - YB - BR) voltages and the fourth shall be for the OFF position.

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

d) **Indicating Lamps**: Clustered LED type indicating light with minimum 8 mm diameter size shall be provided for indications.

e) **Current Transducers**: For every HV Motor Feeder, a current transducer of matching ratings must be provided for taking a 4-20 mA signal over 24 V DC to owner's DCS / PLC. The Current Transducers must be of three element type for a three-phase true RMS value indication and a 110 V DC auxiliary voltage.

f) **Voltage Transducers:** For each of the Incomer Feeders in the HV Switchboard line-up, voltage transducers are to be provided for taking a hard-wired voltage indication to the owner's DCS. The Voltage Transducers must give a 4-20 mA signal over 24 V DC with an input signal voltage of 110 V - AC from the secondary of potential transformers and an auxiliary voltage of 110 V DC. The Voltage transducers are to be of 3-phase / 3-element, 3-wire type for giving true RMS value indications.

5.0 SPARES & ACCESSORIES

The following accessories must be mandatorily supplied with the HV Switchboards – without any additional cost implication as part of switchboard supply:

a) Bus & Line Side Earthing Trucks;
b) Breaker Trolleys (for each bus-section or isolator panel) for cassette type breakers;
c) Earthing / Discharge Rods of adequate voltage grade (one each for every bus-section);
d) One Digital Multi-meter of MRPL approved make;
e) 15 nos. Spray Paint Bottles / Cans for final touch-up paint with each switchboard line-up.

The following spares must be mandatorily supplied with the HV Switchboards – without any additional cost implication as part of switchboard supply:

a) One set (3 nos. each) of Bus & Line PT Fuses;
b) One no. each of all types of numerical & auxiliary relays;
c) 20 nos. of control fuse-links of all current ratings;
d) One set (3 nos.) of Current Transformers of all current ratios;
e) One set (3 nos.) of Line PTs & Bus PTs;
f) 5 nos. each of LED indication lamps of all colours;
g) One no. each of all types of Rotary Switches & Selector Switches;
h) One no. each of all types of Digital Multifunction & Analogue Meters;

The above enlisted accessories & spares will be supplied as part of all switchboard packages without any additional cost to the owner. In cases, where additional quantities of the above enlisted switchboard components are envisaged or components other than those enlisted above are required to be supplied, the same will be specified in the respective data-sheets for which the supplier may quote prices separately.

6.0 INSPECTION AND TESTING

6.1 During fabrication, the switchboard shall be subject to inspection by the 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 being used in the process. The manufacturer shall furnish all necessary information concerning the supply to the Owner's inspectors.

6.2 All routine tests shall be carried out as per IS:12729 at the manufacturer's works under his care and expense.

6.3 Type tests, if specified shall be performed. Short circuit and internal arc tests shall be performed at CPRI or equivalent independent testing lab. Impulse withstand and Heat run tests may be performed at manufacturer’s works.

6.4 Type and shop tests shall be witnessed by an inspector of the Owner, or of an agency authorised by the Owner. Prior notice of minimum 4 weeks shall be given to the Owner/ inspector for witnessing the tests.

6.5 **Acceptance Tests**: The following acceptance tests shall be carried out at the manufacturer's works under his care and expense

a) A general visual check shall be carried out matching with the detailed Bill of Materials for the switchboard. This shall cover measurement of overall dimensions, location, number and type of devices, location and connection of terminals, etc.
b) Manual and electrical operation of all circuit breakers and all numerical / auxiliary relays shall be checked under the worst conditions of auxiliary supply voltage.
c) Dry insulation test with power-frequency voltage shall be conducted for the main and auxiliary circuits.
d) Insulation resistance of the main and auxiliary circuits shall be checked before and after power frequency voltage withstand test.
e) Operation and scheme check shall be carried out for every control function as per the approved schematic diagrams by manually simulating fault conditions and operation of control switches, numerical / auxiliary relays, etc. For example, in a two incomer & one bus-coupler arrangement, all schemes & interlocks as per the switchboard data-sheets are to be simulated at the testing location and offered for witnessing.
f) For equipment bought from other sub-suppliers, certified test reports of the tests carried out at the manufacturer's works shall be submitted. Normally, all routine tests as specified in the relevant standards shall be conducted by the sub-supplier at his works.
g) Each of the switchboard feeders must be checked for functionality after testing of individual feeder protection CTs & Bus / Line PTs (insulation resistance tests, winding resistance tests, ratio tests, etc.). For differential protection CTs, fault-conditions are to be created at the testing location and the tripping of associated numerical relays is to be demonstrated. Bus Differential protection feature needs to be demonstrated at the testing location.

7.0 PACKING AND DESPATCH

The switchboard shall be divided into several shipping sections for protection and ease of handling during transportation. All outgoing feeders shall be packed as separate shipping sections. The equipment shall be properly packed for selected mode of transportation i.e. ship / rail / trailer. The panels shall be wrapped in polyethylene sheets in multiple layers before being placed in wooden crates / cases to prevent damage to the finish. All such crates / cases shall have hard skid bottoms made of non-perishable plastic / polycarbonate base material for lifting / shifting / handling.

All interconnecting accessories such as nuts / bolts / washers / bus-bars / shrouds / gaskets / interconnecting wires & sockets including the spared shall be packed in separate wooden

crates. These boxes must be with seaworthy packing with a detailed packing list placed inside the box as well as attached with other transit documents.

Packing must protect the front panel of every shipping section very effectively – including the Numerical Relays / Auxiliary relays / LED Indications / Meters / selector & T-N-C switches which must be given additional cushion packing. The crate package must bear the following essential indications:

(i) Fragile (glass);
(ii) Not waterproof (umbrella);
(iii) Position: top (this side up), bottom (arrows);
(iv) Centre of gravity (G);
(v) Lifting points (chains);
(vi) Owner's particulars;
(vii) P.O. Nos.; etc.

The switchboards & associated equipment will be stored outdoors for long periods before installation. The packing should be suitable for outdoor storage areas with heavy rains / high ambient temperature unless otherwise agreed. It is the supplier's responsibility to ensure that all panels are delivered in undamaged condition to MRPL and any damages to the switchboards & associated components during transit must be repaired / replaced by the supplier free of cost.

CONTENTS

1.0 SCOPE

The intent of this specification is to define the minimum requirement of design, manufacture, testing, packing and despatch of numerical relays. The specification also defines the requirement of serial communication and integration with data concentrator, substation Man Machine Interface and upper level control system.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of latest revision of following standards, unless otherwise specified:

IEC 60068-2 - 1 / 2 / 30 / 48	Basic environmental testing procedure (part 1 - cold, part 2 - dry heat, part 30 - damp heat, cyclic, part 48 - storage temperature)
IEC 60529	Degree of protection provided by enclosure
IEC 60255	Electrical relays
IEC 60255-3	General performance requirement
IEC 60255-5	Insulation tests for electrical relays (Voltage withstand test, insulation resistance test, Dielectric test, Impulse voltage withstand test, clearance and creepage distance.
IEC 60255-6	Measuring relays & protection equipment (Measurement of accuracy, rated burden, thermal requirement, dynamic value, limits & dependency of frequency, ambient temperature & auxiliary voltage range, marking & data, mechanical durability)
IEC 60255-11	Interruption to and alternating component (ripple) in de auxiliary energizing quantity of measuring relays.
IEC 60255-21 - 1 / 2 / 3	Vibration tests/ Shock and bump test/ Seismic test
IEC 60255-22 - 1	1 MHz burst disturbance test
IEC 60255-22-2	Electrostatic discharge test
IEC 60255-22-3	Radiated electromagnetic field disturbance tests
IEC 60255-22-4	Fast transient disturbance test
IEC 60255-22-25	Conducted and radiated radio frequency emission tests
IEC 60255-23	Contact performance requirement
IEC 61000	Electromagnetic compatibility (EMC)

IEC 61000-4-2	Electrostatic discharge immunity test
IEC 61000-4-3	Radiated, radio frequency and electromagnetic field immunity
IEC 61000-4-4	Electrical fast transient/ burst immunity test
IEC 61000-4-5	Surge immunity test
IEC 61000-4-6	Immunity to conducted disturbance induced by radio frequency field
IEC 61000-4-8	Power frequency magnetic field immunity test
IEC 61000-4-9	Pulse magnetic field immunity test
IEC 61000-4-10	Damped oscillatory magnetic field immunity test
IEC 61000-4-11	Voltage dips, short interruption and voltage variation immunity test
IEC 61000-4-16	Immunity to conducted, common mode disturbances in the frequency range of 0 Hz to 150 Hz
ENV 50204	Radiated electromagnetic field disturbance test
EN 55022	class A Radio interference test

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

2.3 The equipment shall also conform to the provisions of Indian Electricity rules 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 / BSNDE / 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 following order of decreasing priority shall govern:

- Statutory regulations.
- Data sheets.
- Job specification.
- This specification.
- Codes and standards.

3.0 SITE CONDITIONS

The relays shall be suitable for satisfactory operation when installed in a panel located in a pressurized substation with restricted natural air ventilation, in tropical humid and corrosive atmosphere. Relay shall be designed to perform all its functions and operate under site conditions specified in switchboard data sheet. If not specifically mentioned there in, a design ambient temperature of 40°C and an altitude not exceeding 1000 Meters above the mean sea level 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 for 15 years from the date of supply.

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

4.4 The Relay manufacturer through his Indian partner or subsidiary company in India shall provide application, testing, commissioning and other necessary support for minimum of 15 years to customer. Their Indian partner or subsidiary company in India shall also maintain adequate inventory of each type of relay or spares to meet the requirement arising during project execution and plant operation. Relay manufacturer shall possess a signed MoU with their Indian Partner / Subsidiary for providing customer support.

5.0 TECHNICAL REQUIREMENTS

5.1 **Auxiliary Power Supply**: Unless otherwise specified, relay shall be suitable to accept both AC/DC supplies with range from 0 V to 240V with tolerance of ± 15%. The auxiliary power supply shall preferably be site-selectable requiring no additional hardware.

5.2 **Basic Requirements & Construction Details**:

(i) Relay shall be suitable for flush mounting. The relay enclosure shall be dust tight having degree of protection minimum as IP5X.

(ii) Relay terminals shall be suitable for termination of 2.5 / 4 sq mm wires.

(iii) Relay shall have draw out feature with plug in type PCB for easy replacement. In case of fixed type relays, the relay terminals shall be easily accessible for testing and commissioning.

(iv) Current Operated relay shall have provision for 4-wire CT input and 2 wires CBCT input. However the voltage-operated relay shall have provision for 4-wire PT input. In case of comprehensive single numerical relay, the relay shall have provision of both current and voltage inputs.

(v) CT Shorting link shall be provided at terminal block as required.

(vi) All Numerical Relays shall have key pad / keys to allow relay setting from relay front. All hand-reset relays shall also have reset button on relay front. Self reset or hand reset feature of the relay shall be software selectable and password protected.

(vii) Relays shall be suitable Relay shall be suitable for both 1 A or 5 A CT secondary. CT secondary 1 A or 5 A shall either be software selectable or by providing suitable link. Selection between 1 A or 5 A should be possible at site.

(viii) Relays shall have self-diagnostic feature with indication of relay failure on relay front. Relay faults (Self- diagnostic) shall be communicated and annunciated to data concentrator/ substation MMI.

(ix) All Numerical Relays shall be of communicable type.

(x) The Relays shall, as a minimum, have protection functions as per feeder equipment data sheets. Other functions such as metering and control shall be provided, if specified in data sheets.

5.3 **Software Security:**

The relays shall be provided with suitable security (pass word protection) against unauthorized WRITE ACCESS for change in relay setting. However, it should be possible to view metering, protection settings, status and event data as READ ONLY without password protection.

5.4 **Display & Indication:**

(i) All relays shall have LED/ LCD display for display of settings, status, faults and events. If specified in data sheet relay shall have graphic display for mimic/ motor starting characteristic, setting, status, faults and events in place of LED/LCD display.

(ii) LCD display shall be backlit and temperature compensated up to 65 °C for contrast and legibility.

(iii) As a minimum, the relay shall have LED- indicating lamps for Fault trip, Relay healthy, Relay unhealthy, Control- supply ON.

5.5 **Protection Functions:**

(i) Over Current Protection:

(a) This section includes Non directional over current protection function, which mainly include different setting stages such as low set, high set and high set instantaneous (51, 50, 51N, 50N). Over-current protection function provided should have IDMTL characteristic for low set and high set stages and definite time delay for high set instantaneous.

(b) The Over current relay shall be three phase type with 4 elements; 3 elements for inverse and definite time delay over current and one element for inverse and definite time delay earth fault current. Selection of inverse or definite time feature shall be user selectable.

(c) The IDMTL characteristic (for 51 and 51N) shall be as per IEC. The inverse characteristics shall include normal inverse, very inverse, extremely inverse, long

inverse and shall be soft ware selectable. Inverse element shall have two or more stages (low and high set) for selection of required inverse characteristic to achieve close protection as required.

(d) The Definite time characteristic shall have minimum 2 stages with adjustable current and time setting.

(e) The Relay shall also have separate current input from CBCT for earth fault current element. It shall be possible to connect earth fault element either through CBCT or to be connected residually. Minimum setting current for sensitive earth fault element shall be 1%.

(ii) Motor Protection:

(a) The Motor protection relay shall have all protection function such as over current, thermal (overload), locked rotor current, zero sequence, negative sequence, maximum number of start, motor overload pre-alarm, motor re-acceleration, lock-out, inhibit of over-current protection during motor starting through contactor feeders, hour run count, inhibit start after elapse of maximum number of starts etc.

(b) The Relay shall be provided with 6 nos. RTD and 2 nos. BTD analog inputs if specified in the data sheet. The distance, if not specified in data sheet, between motor and switchboard may be considered as 1000 m and the cable as 2.5 sq. mm, multi core, Copper conductor cable.

(c) In comprehensive motor protection relay, start/ stop push-button from field and interlocks from DCS shall directly be wired to the relay as digital input using 2.5 sq. mm, multi-core, copper conductor cables. The distance between push buttons / interlock to switchboard, if not specified in data sheet; may be considered as 1000 m. The additional components as required to overcome the cable capacitance effect shall be considered as a part of supply of relay. The digital input to relay for start / stop and interlock contacts shall be momentary type. Logic to latch the momentary contact, as required shall be built as a part of comprehensive motor protection relay.

(iii) Special Protection Functions:

(a) These protection functions shall include minimum but not limited to directional over current, feeder and bus differential, voltage biased over-current, restricted earth fault, generator protection, reverse power functions, distance protection etc.

(b) A separate numerical relay shall be considered for providing the above special protection function.

(c) The differential relay and REF relay shall have feature for CT circuit supervision. Bus differential relay shall be provided with feature having check differential.

(d) In case separate hard-wired relay is used for check differential, the status/ event of same to be communicated through the numerical relay provided for main differential application.

(e) Relay shall be supplied with stabilizing resistor and non-linear resistor (varistor) as required for differential and REF applications.

(f) No ICT shall be provided either for ratio error correction or for transformer primary and secondary vector grouping. The necessary correction shall be programmable at numerical relay.

(g) Transformer differential relay shall be suitable to achieve harmonic restraint during switching.

(h) Directional relays, power relays and voltage biased over current relay shall have analog inputs for both current and voltage.

(iv) Voltage Operated Protection Functions:

(a) These functions include under voltage (27), over voltage (59), ON delay and OFF delay timers, phase sequence voltage, neutral displacement and synchro-check functions, etc.

(b) If specified in data sheet, relay shall have under and over frequency protection function.

5.6 Lock-Out (86), Trip-Circuit Supervision (95), Auxiliary Relays & Timer Functions:

(i) All Numerical Relays shall have built in lock out function. Lock out feature shall be self reset or hand reset and shall be software selectable.

(ii) All Numerical Relays shall have built in trip circuit supervision function. If this function is not available as a part of numerical relay, the hardwired relay shall be provided and the annunciation from hard -wired relay shall be communicated to numerical relay for display and further communication to data concentrator/ substation MMI.

(iii) Auxiliary relays / Timers function etc as required for control schematics shall be programmable as a part of numerical relay. The number of such elements as required for schematic shall be considered.

(iv) Timer function shall be programmable for both ON/OFF delays.

5.7 Disturbance/ Event Recording and Data Storage:

(i) Type Status, event data and disturbance record data shall be stored in the relay in non-erasable memory or memory backed up by lithium battery. Under no circumstances such as withdrawal of power to the relays shall the status, data and events in the memory get erased. Unless otherwise specified, it should be possible to save minimum 3 records of each event and the last disturbance record. Subsequent event shall be overwritten following principle of FIFO.

(ii) All disturbances/ events shall be displayed with time stamp.

(iii) The RTC of relay shall be synchronized with plant clock/ GPS/ RTC of data concentrator / MMI through serial communication from data concentrator or from substation MMI.

5.8 Input/ Output Interface, Filters and Galvanic Isolation:

(i) Relay shall have current input from CT secondary rated either 1 A or 5 A. It shall have flexibility to set the relay operating parameter as 1 A or 5 A through programming or through hard-wired selection at site.

(ii) Voltage (through PT) input to relay, shall be 110 V +/- 10%.

(iii) Output relays shall have at least 4NO contacts; each shall separately be programmable for either hand reset or self- reset. The contact rating shall be minimum 5 A at 250 V AC/DC.

(iv) Relay shall be made immune to capacitance effect due to long length of cables. Any external hardware, if required for avoiding mal-operation of relay due to cable capacitance shall be included as a standard feature.

(v) All IOs shall have galvanic isolation. Analog inputs shall be protected against switching surges, harmonics etc.

5.9 **Serial Communication:**

(i) Relay shall have RS485 or FO (fiber-optic) port for serial communication with data concentrator / MMI.

(ii) Serial communication between relay and data concentrator / MMI shall be provided either to achieve non-redundant or redundant communication architecture as specified in data sheet.

(iii) In Non-redundant serial communication architecture, data concentrator shall have one port for each relay LAN with relays multi-dropped on LAN. Under this configuration, relay supplier shall ensure that de-linking / disconnecting of one relay from LAN shall not affect the communication with other relays. Alternatively relays shall have FO port and shall communicate in star topology and shall be connected to star coupler using FO cables.

(iv) In Dual redundant serial communication architecture, data concentrator shall have two serial ports for simultaneous remote communication on relay LAN. The relays shall be multi-dropped on RS-485 through single drop from LAN to each relay. In the event of either failure of any relay or break in LAN cable or failure of port at data concentrator, the redundant hardware shall ensure healthy communication between relay and data concentrator.

(v) Alternatively relays, if specified, shall communicate in star topology using star coupler. Communication from relays to star coupler shall be through single communication port. Communication from star coupler to data concentrator shall be simultaneous on redundant ports. RS-485 to FO converters wherever required shall be part of offered relay/ other hardware.

(vi) The communication protocol shall be selected to transfer all information including time stamp data from relay to data concentrator/ substation MMI. The relays shall preferably communicate on industry open protocol such as IEC 870-5-103 / RTU MODBUS / TCP-IP or any other open protocol. Proprietary protocol shall require specific approval of Owner.

(vii) The maximum number of relays in one LAN shall be decided so as to achieve maximum scan time as 500 ms for SOE and 3 to 6 sec for status and historical data considering total number of serial loop and star coupler as a total integration. The above scan time does not include screen refresh rate at MMI.

5.10 **Data Concentrator / Data Communicator:**

(i) Data concentrator, if specified, shall be supplied to facilitate communication with relays on open protocol. Proprietary protocol shall require specific approval of Owner.

(ii) In case of proprietary protocol, the protocol converter shall be supplied as a part of data concentrator. Protocol converter, if provided, should not affect speed of communication.

(iii) Data concentrator shall provide gateway to upper level control system on MODBUS-RTU protocol or protocol as specified in the data sheet. The communication to upper level control system shall be on dual redundant as per data sheet/ system architecture

(iv) Data concentrator shall have digital and analog (4 to 20 mA) I/O cards suitable for interface requirement specified in data sheet. Unless otherwise specified, 20% I/Os shall be considered as spare. Alternatively, a separate Data Acquisition Unit may be supplied for digital and analog interface.

(v) Data-concentrator shall have required number of ports for relay LAN / star-couplers. Number of relay-LAN/ star couplers shall be as per project requirement. 20% or min. 2 nos. spare ports whichever is maximum shall be provided for future extensions.

(vi) Data concentrator shall have required number of RS232/ RS422 ports for connection to LAP top PC and substation MMI having operator's work station & engineering station PC.

(vii) Data concentrator shall have dual redundant RS485/ FO port (as per data sheet) for communication to substation MMI and upper level ECS-RTU. The power supply to Data concentrator shall be same as specified for numerical relay and shall be site selectable.

(viii) Where MR allows system integration using common PC based data concentrator and MMI, it shall have suitable interfacing hardwired digital and analog inputs through suitable modules connected in relay serial LAN.

6.0 TESTING & ACCEPTANCE

6.1 The Relays shall have been type tested as per relevant Indian / international standards. Type tests shall include as minimum but not be limited to the following:

(i) Temperature withstand;

(ii) Disturbance immunity;

(iii) Electromagnetic compatibility (EMC);

(iv) HV withstands test for insulation;

(v) Impulse voltage test;

(vi) Functional tests and Communication integrity;

(vii) Relay characteristics verification;

(viii) Degree of protection;

(ix) Mechanical stress/ vibration test.

6.2 The During assembly, owner or his authorized representative shall be permitted to assess the progress of work as well as to ascertain that quality of raw material are used for the same. All assistance as required during inspection shall be given to inspector.

6.3 Final acceptance tests shall be carried out at manufacturer/ assembler's works under his care and expense. Manufacturer shall also arrange instruments and equipment as required for testing. Owner's representative shall be given minimum 2 weeks prior notice for witnessing the tests. Manufacturer shall furnish test certificates indicating test results. Acceptance tests shall include visual checks, insulation checks, heat run tests and functional tests as a minimum or as per the manufacturer's quality plan.

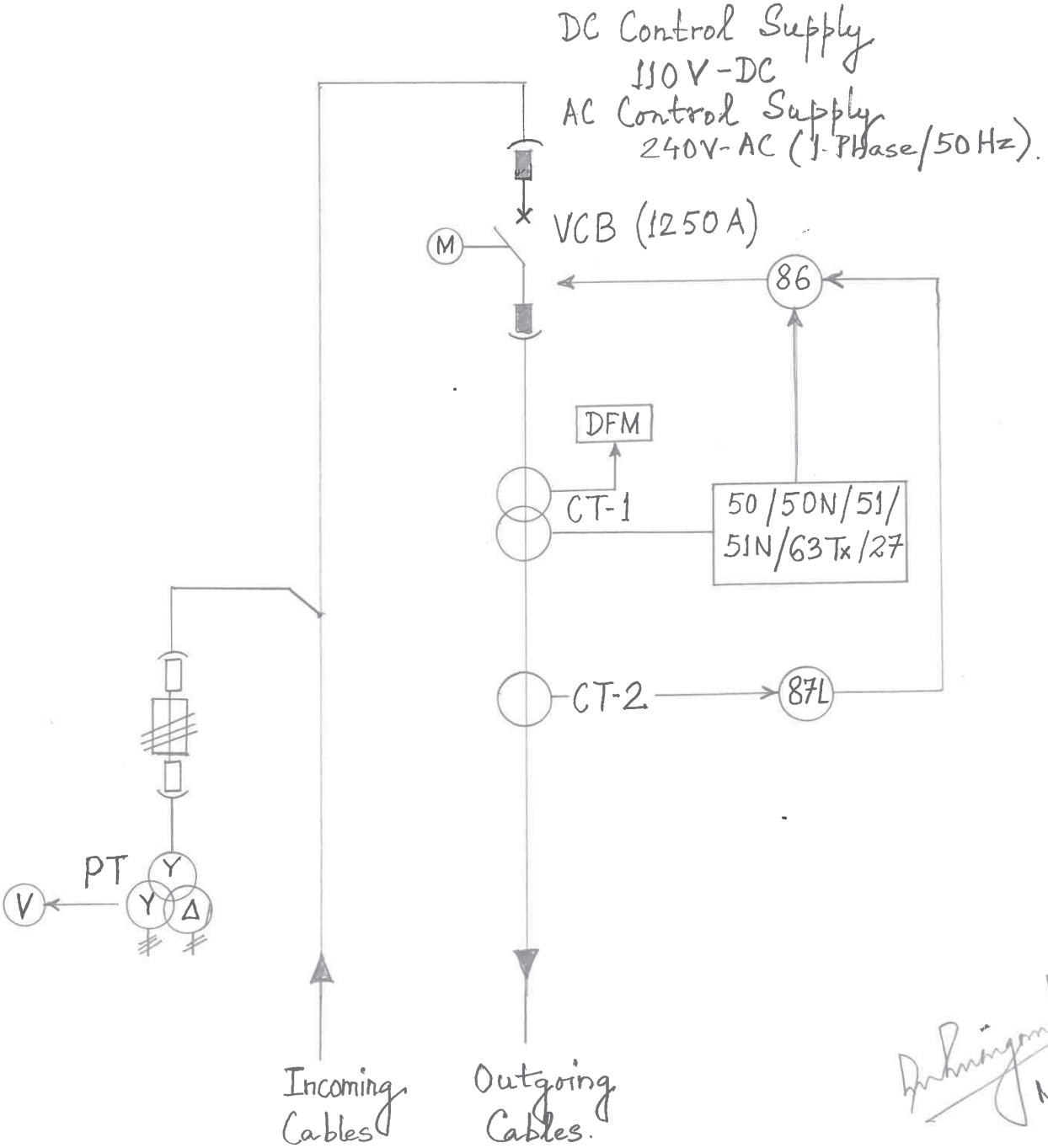
6.4 In case of fully assembled and tested relays sourced from abroad, manufacturer shall furnish type, routine and acceptance test certificates along with the supply of numerical relays for owner's perusal.

7.0 PACKING AND DESPATCH

The relays along with six set of detailed catalogue, type test certificate, acceptance test certificate shall be shipped to switchboard manufacturer in world-class packing as per manufacturer's standard. The relay shall be duly protected with polythene sheets and packed in box duly filled with fillers to prevent damage. Necessary warning "HANDLE WITH CARE" shall be inscribed on the box.

ANNEXURE - I

Hardware data-sheet for 6.6 kV Isolating Breaker Panels for ETP.



M. MITRA

2 Runs x 3C-300 sq.mm
Copper Conductor
XLPE insulated cables.

1.0 SPECIAL INSTRUCTIONS TO BIDDERS

1.1 The 6.6 kV rated Isolating Breaker Panels to be supplied vide this tender shall be given the following tag nos.:

(i) Panel-1: SWGR-252 (6.6 kV Isolating Breaker Panel for ETP-1 S/S-7);

(ii) Panel-2: SWGR-2257 (6.6 kV Isolating Breaker Panel-1 for ETP-2 S/S-27);

(iii) Panel-3: SWGR-2256 (6.6 kV Isolating Breaker Panel-2 for ETP-2 S/S-27).

1.2 Bidders shall note that the 6.6 kV rated Isolating Breaker Panels with VCBs & Line Differential Relays shall comply with the requirements of latest revision of codes & standards attached or referred in the tender document. In case of any conflict between the various documents, the most stringent one shall be followed and MRPL's decision in this regard shall be final and binding

1.3 Selection, sizing and suitability of all components shall be the vendor's responsibility. The equipment offered shall be inherently safe & its satisfactory operation shall be considered a part of vendor's scope, even if not specifically mentioned in the tender.

1.4 The Isolating Breaker Panels being offered for this tender - shall be of proven design and shall have been successfully type tested. Type test certificates for an exactly identical design of offered high voltage switchboard shall be furnished by bidders. These test reports shall be not more than 5 years old, as on the final bid opening date. In case these type tests have not been conducted during the last 5 years, bidder shall conduct these type tests on the offered design of switchboard before despatch without any extra cost and delivery impact.

1.5 The Isolating Breaker Panels shall have a single Vertical / Panel Section comprising of the Breaker Compartment, withdrawable Line PT Cubicle, Control / Instrumentation Chamber, Incoming & Outgoing Cable Compartments with CTs, etc.

1.6 The scope of supply includes supplying Line Differential Protection Numerical Relays in matching pairs – one relay installed on the 6.6 kV Isolating Breaker Panel being supplied vide this order and one matching relay for the up-stream feeder – to be supplied loose condition (for owner's HT panel). Hence a total of 6 nos. of Line Differential Protection Numerical Relays shall be supplied through this order.

1.7 The Incoming Feeder Line Length in each of the three (3) nos. Isolating Breaker Panels shall be considered around 3 km. Hence the Line Differential protection Pilot Wire shall be considered through Single Mode Optical Fiber Cable. Hence the Numerical Relays for Line Differential protection shall be provided with Single Mode FO Port. The vendor's scope of supply will include LIU, Patch-Cords, Signal Converters, etc. for both ends of Line Differential Relays, i.e. six (6) sets.

1.8 The feeder protection & metering CTs shall be combined in a Dual Core CT Unit, whereas the line differential protection CT shall be separate. The Line Differential protection CT parameters shall match and complement with the upstream CTs – which are of Accuracy

Class 5P10 type. The CT details for all three (3) Isolating Breaker Panels are tabulated below:

6.6 kV Isolating Breaker Panel CT Details				
CT-1	Core-1	Metering - Class-1	Ratio - 300/1 A	Burden 15 VA
	Core-2	Protection - Class 5P10	Ratio - 300/5 A	Burden 15 VA
CT-2	Line Differential Protection - Class 5P10		Ratio - 300/5 A	Burden 15 VA

1.9 The Line PT shall be Cast Resin type in draw-out / cassette configuration having dual core and ratio of 6600 / V3/110 / V3 with VA Burden as designed by the supplier.

1.10 The 6.6 kV rated Isolating Breaker Panels shall feed power to 2.5 MVA, 6.6 / 0.433 kV Distribution Transformers, hence the protection numerical relays shall have all typical alarm & trip features suitable for Transformer Feeder protection.

1.11 The scope includes vendor's supervision of installation, testing and commissioning of the 6.6 kV rated Isolating Breaker Panels with VCBs, including the testing / programming / configuration of Numerical Relays, Trip Setting parameters, Auxiliary Relays (if any), etc. The panel installation & testing shall be in MRPL's scope. However for commissioning, the bidder shall be required to depute its representative to the site for supervision for a total duration of ten (10) days – for the all three (3) nos. of Isolating Breaker Panels, the price for which shall be included in the overall cost of the High Voltage Switchboards.

1.12 The vendor must depute its switchboard engineer for supervision of panel testing & commissioning within fifteen (15) days' time from the date of intimation by MRPL to that effect. An amount of 5% of the overall P.O. value shall be withheld until the successful completion of supervision & numerical relay testing.

1.13 The vendor is required to quote supervision charges on man-day basis (inclusive of travel + lodging + boarding), in case additional time is required for completing the site works / commissioning supervision, over & above the stipulated 10 days duration as indicated against point no. 1.4. The additional days' charge shall be certified & paid based on MRPL's discretion.

1.14 One set of recommended tools, tackles and special equipment required for the maintenance of the panels, breakers, relays, etc. shall be supplied along with the Isolating Breaker Panels and the cost for the same shall be included in the price quoted for the HV Panels. List of such tools and tackles and special equipment shall be furnished with the bid.

1.15 The switchboard supplier shall supply the below mentioned mandatory spares along with the HV Isolating Breaker Panels at no additional cost to MRPL:

(a) Breaker Closing Coils: 2 Nos. of each type & rating;
(b) Breaker Shunt Trip Coils: 2 Nos. of each type & rating;
(c) Breaker Spring Charging Motor: 2 Nos. of each type & rating Auxiliary Contactors with NO / NC Add-on Blocks: 2 Nos. of each type & rating;

(d) Push-Buttons with NO / NC Contacts: 2 Nos. of each type & rating;
(e) LED Indicating Lamps with Covers: 2 Nos. of each type / colour & rating;
(f) Control Fuse Links with Bases (if any): 2 Nos. of each type & rating;

1.16 The Bidder shall quote unit price for Two Years Operation and Maintenance Spares along with recommended quantity for safe & seamless functioning of the switchboard.

2.0 MRPL'S APPROVED VENDOR LIST

2.1 The switchboard supplier must ensure that the following switchboard components comply with the MRPL's approved vendor list:

Sl. No.	Component	MRPL Approved Makes
(i)	Vacuum Circuit Breakers	Schneider Electric; Siemens Ltd.; ABB Ltd.
(ii)	Auxiliary Relays	L & T; Schneider Electric; Siemens Ltd.; ABB Ltd.
(iii)	Bimetal Relays	L & T; Schneider Electric; Siemens Ltd.; ABB Ltd.
(iv)	Contactors	L & T; Schneider Electric; Siemens Ltd.; ABB Ltd.
(v)	Control Switches (for Breakers)	Reliable Electronic Components; Switron Devices; GE / Alstom T&D India Ltd.
(vi)	Control Switches / Selector Switches	L & T; Schneider Electric; Siemens Ltd.; ABB Ltd.; Switron Devices; Kaycee Industries; Reliable Electronic Components
(vii)	ELCBs	L & T; Schneider Electric; Siemens Ltd.; ABB Ltd.; Legrand India Pvt. Ltd.; Hager
(viii)	Fuses	Cooper Bussman India Pvt. Ltd.; L & T; C&S Electric; Siemens Ltd.
(ix)	Heavy Duty Switches / Load Break Switches	L & T; Siemens Ltd.; ABB Ltd.; C&S Electric
(x)	Instrument Transformers (CTs & PTs – High Voltage)	Pragati Electricals; Precise Electricals; Kalpa Electrikal; Gilbert & Maxwell Electricals Pvt. Ltd.
(xi)	MCBs	L & T; Schneider Electric; Siemens Ltd.; ABB Ltd.; Legrand India Pvt. Ltd.; Hager
(xii)	MCCBs	L & T; Schneider Electric; Siemens Ltd.; ABB Ltd.; Legrand India Pvt. Ltd.; Hager
(xiii)	Meters	L & T; Automatic Electric Ltd.; Meco Instruments Pvt. Ltd.; Rishabh Instruments Pvt. Ltd.; Selec Controls Pvt. Ltd.
(xiv)	Numerical Relays	ABB Ltd.; Siemens Ltd.; Schneider Electric (Sepam / Micom); SEL
(xv)	Other Protection Relays (ELRs, etc.)	ABB Ltd.; Siemens Ltd.; Schneider Electric; Prok Devices; GE/Alstom T&D
(xvi)	Push Buttons & Indicating Lamps	L & T; Schneider Electric; Siemens Ltd.; Teknic Controls;
(xvii)	Timers	Electronic Automation; GIC; L & T; Siemens Ltd.
(xviii)	Switch-Fuse Combinations	L & T; Siemens Ltd.; ABB Ltd.; C&S Electric

(xix)	Relays & Control Panels	ABB Ltd.; Siemens Ltd.; Schneider Electric; Enpro Industrial Automation; GE/Alstom T&D India

2.2 The list is 'Preliminary' and the switchboard supplier shall take one time approval of all desired sub-vendors after award of Purchase order / contract.

2.3 The switchboard supplier may procure material from any of MRPL's approved vendors. However current validity and range of approval as per enlistment letter, workload, stability and solvency need to be verified by the Vendor before placement of order.

2.4 For components other than the above, vendor shall submit past track record for the proposed sub-vendors and obtain written approval from MRPL before placing order.

3.0 JOB SPECIFICATIONS FOR 6.6 KV ISOLATING BREAKER PANELS:

3.1 In addition to the requirements enlisted in the standard specifications of HV Switchboards & Numerical Relays, the 6.6 kV Isolating Breaker Panels shall also comply with the following points. In case of conflict among various standards and specifications, the most stringent shall follow and MRPL decision in this regard shall be final and binding.

3.2 The Hardware data sheet for the isolating breaker panel – attached with this document as Annexure-I include only the major relays, meters and controls switches. Any auxiliary relays, timers, switches, etc., as required, while developing the control schematics and for safe operation, even if these are not specifically included, shall be supplied by the Bidder without any price and time implication to Purchaser.

3.3 The bidder shall be solely responsible to coordinate the relay characteristics with relay supplier for the proper selection of all CTs with special care to select class PS CTs. The VA burden, knee-point voltage, CT resistance and magnetizing current shall be calculated by the Bidder for Owner's review before proceeding with manufacturing.

3.4 The Switchboard supplier shall provide the CT and PT of adequate rating and burden. CT / PT application check and sizing calculations shall be furnished by the vendor during detail engineering. Any increase in the VA burden shall be incorporated by the vendor without any cost and time implication to Owner.

3.5 CT Ratios indicated in the tender documents of outgoing feeders are tentative. CT ratio shall be finalized during drawing review. Bidder shall not raise any claim for additional price and time for these changes being done during review. The VA burden, knee-point voltage, CT resistance and magnetizing current shall be calculated by the Vendor for Owner's review before proceeding with manufacturing.

3.6 All numerical relays shall be comprehensive units including all protection and metering functions. Controls and logic shall be through numerical relays i.e. all logics shall be

built inside numerical relay and not externally. Provision of adequate I/O count in the relays shall be ensured.

3.7 Minimum 2 nos. inputs and 2 nos. output spare I/Os shall be provided in each numerical relay. Numerical relay contacts shall ideally be of rated for 8 - 10 Amps - to avoid the rupturing of internal contact elements during relay pick-up / breaker operation. All binary inputs and outputs within the Numerical Relays shall be optically isolated for 5 kV peak / 2 kV RMS voltage.

3.8 Master Tripping Relay (ANSI Code - 86) of conventional / electro-mechanical type shall be provided in each of the Isolating Breaker Panels for all trip signals from the Numerical Relays to the breaker being routed through this Master Trip / Lock-Out Relay.

3.9 Dummy Panels and rear extensions, as required, for cable terminations, mounting of relays, meters, control components etc. shall be supplied as required without time and cost implication to owner. Rear cable chamber provided for the switchboard shall be of height similar to other vertical panels.

3.10 All Low Voltage Terminal Connections in the isolating breaker panels shall be screw less type with cage clamp connections. All CT connections shall be with provided with isolation feature wherein CT connections get shorted on sliding of lever.

3.11 All Vacuum circuit breaker cubicles shall have physical lock out provision to facilitate the “lock out tag out” procedure for breakers for ensuring safe operation. All VCB modules shall also be supplied with the LOTO Hasps & LOTO Locks-keys

3.12 Only Stainless Steel SS Bolts, Nuts & Washers are to be supplied with all panel sections / vertical - members & joint; similarly only SS Bolts, Nuts & Washers are to be used for all bus-bar joints and supports.

3.13 All the cable Gland Plates shall be provided with clamps (non-magnetic material) with nuts-bolts for supporting of cables inside the cable compartments.

3.14 The Neoprene / Rubber Gaskets of all openings, doors & covers shall be permanently fixed (self-adhesive type) on to the frames to provide complete sealing; these gaskets shall not be loosely fitted.

3.15 The CT / PT Name Plate Details (Ratio / Class / Make / etc.) and the Power Cable details (No. of Runs / Size / Type / etc.) shall be embossed on the rear / front of the isolating breaker panels for information.

3.16 The vendor shall submit one original set of final documentation (1 Hard Copy through Post / Courier + 1 Soft Copy through E-mail) for the 6.6 kV Isolating Breaker Panels being supplied, which shall primarily include Switchboard Data sheets, General arrangement Drawings, Bill of Material, Switchboard Scheme / Internal wiring drawings, Test Reports for Switchboard Bought-Out Components, Switchboard Type Test & Factory (Routine) Test Reports, Catalogues for Switchboard Bought-Out Components & Warranty Certificate.

3.17 Data Sheet for High Voltage Switchboards – with VCBs is tabulated below:

PURCHASER'S DATA			
1	Maximum Ambient Temperature		38ºC
2	Minimum Ambient Temperature		16ºC
3	Design Ambient Temperature		40ºC
4	Relative Humidity		91%
5	Altitude Above MSL		Less than 1000 Meters
6	Environment		Humid & Highly Corrosive
TECHNICAL PARTICULARS / OPERATING CONDITIONS			
1	Voltage		6.6 kV (±6%)
2	Frequency		50 Hz (±3%)
3	No. of phases		Three
4	System Fault Level		40 kA for 1 Second 2 6.6 kV Level
5	System Earthing		Resistance Earthed
6	Auxiliary supply		AC: 240 V (±10%), 1-Phase 50 Hz;
			DC: 110 V (+10%, –15%)
7	Fault Level		40 kA
8	Short circuit withstand capacity for 1 second		40 kA
9	Bus-Bar current rating inside panel at specified ambient		1250 A or as specified in Single Line Diagram
10	Bus-Bar Material (Horizontal / Vertical)		Copper with Heat Shrink Polyolefin Insulating Sleeves having R-Y-B Colour Coding
11	System Breaking capacity		40 kA
12	System % DC Component		As per IEC
13	System making capacity		2.55 times System Breaking Capacity or 100 kA as per IEC
14	Type of Circuit Breaker		Vacuum Circuit Breaker
15	Operating Sequence / Duty Cycle of Breaker		O - 3 Minutes - CO - 3 Minutes - CO
16	Incoming power entry		Through Cables
17	Cable entry (Incoming & Outgoing)		Bottom of Panels
18	Suitability of Capacitor Switching		Yes
19	Surge Suppressors in Cable Compartment		Only for Motor Feeders
20	Interface with SCADA / Electrical Control System		Provision to be made for future use
21	Painting / paint shade		Epoxy Paint Flint Grey Shade - RAL 7032
22	Cable gland / lugs		Not Included in Scope.
23	Number of HV Power Cables for Termination	Incoming	2 Runs – 3 Core X 300 sq. mm.
		Outgoing	2 Runs – 3 Core X 300 sq. mm.
24	Floor fixing		Yes
25	Separate bolted removable cable-gland plate		Required (Gland Plate holes will be drilled at Site of Installation)
SWITCHBOARD MANUFACTURER'S DATA			
1	Tag No.		
2	Make		
3	Type Designation		

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4	Degree of protection		
5	Overall weight of Isolating Breaker Panel Vertical		
6	Overall Switchboard dimensions (L X W X H)		
7	Weight of Largest Shipping section:		
8	Dimensions of Largest shipping section (L X W X H):		
9	Recommended clearances for Switchboard (Front – Rear – Above)		
10	Shock loading on foundation		
11	Clearance in air	Phase to Phase	
		Phase to Earth	
12	Maximum Size / No. of Cables that can be terminated inside the Panel.		
13	Horizontal bus-bar Dimensions (No. of Flats X Size of each Flat)		
14	Vertical bus-bar Dimensions (No. of Flats X Size of each Flat)		
15	Main Horizontal / Vertical bus-bar current rating at design ambient temperature		
16	Earth bus bar Dimensions		
17	Earth bus bar Material		Copper
18	Insulation Material (Bus-Bar Supports, etc.)		
19	1 Minute Power Frequency Withstand Voltage (rms)		
20	Over Voltage factor for PTs		
21	Impulse Withstand Voltage (peak)		
22	Wave shape for Impulse Voltage		
23	1 Second Short Circuit Withstand Capacity		
24	Peak Dynamic Withstand Capacity		
25	Panel Hardware material (Nuts / Bolts / Washers / Screws / etc.)		
26	Whether Panels shall be packed & transported with Breakers inside the cubicle.		Yes / No
27	**Safety Features**		
27-a	Heat Shrinkable sleeves provided on bus-bars – rated to withstand system L-L voltage for 1 Minute		Yes / No
27-b	Removable FRP Shrouds provided for all Bus-Bar Joints and Tap-Off Connections		Yes / No
27-c	Arc Propagation barrier provided in bus-bar compartment		Yes / No
27-d	Arc Sensors provided in HV Compartments		Yes / No
27-e	Phase-Phase Barriers provided in between cable terminals		Yes / No
27-f	Breaker Service, Test, Isolated (Drawn-Out) positions provided along with indications		Yes / No
27-g	Distinct Overall Lockable door provided for Breaker & PT Compartments		Yes / No
27-h	Automatic Safety Shutters provided		Yes / No
27-i	Breaker Operation provided with LOTO Feature		Yes / No

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27-j	Independent Pressure Release Flaps provided for all HV Compartments	Yes / No
27-k	Wire Mesh provided for all louvered openings	Yes / No
27-l	Breaker Trolley Movement & Operation (ON / OFF) possible in closed door condition	Yes / No
28	**Circuit Breakers**	
28-a	Type	SF_6 / VCB
28-b	Make	
28-c	Type Designation	
28-d	Circuit Breaker mounting inside panel	Truck Mounted / Cassette Mounted
28-e	No. of poles / phase	
28-f	Current Rating (in free air)	
28-g	Current Rating inside panel at specified design temperature	
28-h	Short Time Rating (1 second)	
28-i	Symmetrical Breaking Capacity	
28-j	% DC Component	
28-k	Peak Making Current	
28-l	1 Minute dry withstand voltage (power frequency)	
28-m	Breaker Duty Cycle	
28-n	Total Opening & Closing Times (maximum)	
28-o	Power required for Opening / Closing	
28-p	Time taken for Spring Charging	
28-q	Power required for Spring Charging Motor	
28-r	Breaker Closing Mechanism	
28-s	Provision for Manual Spring Charging	Yes / No
28-t	Mechanical Trip Push-Button provided	Yes / No
28-u	Mechanical ON / OFF Indication provided	Yes / No
28-v	Breaker Operation Counter provided	Yes / No
28-w	Interrupter make & model	
28-x	Earthing System for Breaker	Integral Earthing System / Separate Earthing Carriage or Trolley
29	**Copies of following Type Test Certificates provided**	**Yes / No**
29-a	Short Circuit Tests for Panels (Peak and 1 Second Withstand)	Yes / No
29-b	Heat Run Test for Panels	Yes / No
29-c	Internal Arc Test for Panels	Yes / No
29-d	Impulse & Power Frequency Withstand Test for Panels	Yes / No
29-e	Short Circuit Test Duties for Circuit Breaker	Yes / No
29-f	Degree of Enclosure Protection	Yes / No

3.18 Data Sheet for Numerical Relays is tabulated below:

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PURCHASER'S DATA			
1	Maximum Ambient Temperature		38ºC
2	Minimum Ambient Temperature		16ºC
3	Design Ambient Temperature		40ºC
4	Relative Humidity		91%
5	Altitude Above MSL		Less than 1000 Meters
6	Environment		Humid & Highly Corrosive
TECHNICAL PARTICULARS / OPERATING CONDITIONS			
1	Voltage		6.6 kV (±6%)
2	Frequency		50 Hz (±3%)
3	No. of phases		Three
4	System Fault Level		40 kA for 1 Second 2 6.6 kV Level
5	System Earthing		Resistance Earthed
6	Auxiliary supply		AC: 240 V (±10%), 1-Phase 50 Hz;
			DC: 110 V (+10%, –15%)
7	Fault Level		40 kA
8	Short circuit withstand capacity for 1 second		40 kA
9	Bus-Bar current rating inside panel at specified ambient		1250 A or as specified in Single Line Diagram
10	Bus-Bar Material (Horizontal / Vertical)		Copper with Heat Shrink Polyolefin Insulating Sleeves having R-Y-B Colour Coding
11	System Breaking capacity		40 kA
12	System % DC Component		As per IEC
13	System making capacity		2.55 times System Breaking Capacity or 100 kA as per IEC
14	Type of Circuit Breaker		Vacuum Circuit Breaker
15	Operating Sequence / Duty Cycle of Breaker		O - 3 Minutes - CO - 3 Minutes - CO
16	Incoming power entry		Through Cables
17	Cable entry (Incoming & Outgoing)		Bottom of Panels
18	Suitability of Capacitor Switching		Yes
19	Surge Suppressors in Cable Compartment		Only for Motor Feeders
20	Interface with SCADA / Electrical Control System		Provision to be made for future use
21	Painting / paint shade		Epoxy Paint Flint Grey Shade - RAL 7032
22	Cable gland / lugs		Not Included in Scope.
23	Number of HV Power Cables for Termination	Incoming	2 Runs – 3 Core X 300 sq. mm.
		Outgoing	2 Runs – 3 Core X 300 sq. mm.
24	Floor fixing		Yes
25	Separate bolted removable cable-gland plate		Required (Gland Plate holes will be drilled at Site of Installation)
SWITCHBOARD MANUFACTURER'S DATA			
1	Tag No.		
2	Make		
3	Type Designation		
4	Degree of protection		
5	Overall weight of Isolating Breaker Panel Vertical		
6	Overall Switchboard dimensions (L X W X H)		

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7	Weight of Largest Shipping section:		
8	Dimensions of Largest shipping section (L X W X H):		
9	Recommended clearances for Switchboard (Front – Rear – Above)		
10	Shock loading on foundation		
11	Clearance in air	Phase to Phase	
		Phase to Earth	
12	Maximum Size / No. of Cables that can be terminated inside the Panel.		
13	Horizontal bus-bar Dimensions (No. of Flats X Size of each Flat)		
14	Vertical bus-bar Dimensions (No. of Flats X Size of each Flat)		
15	Main Horizontal / Vertical bus-bar current rating at design ambient temperature		
16	Earth bus bar Dimensions		
17	Earth bus bar Material		Copper
18	Insulation Material (Bus-Bar Supports, etc.)		
19	1 Minute Power Frequency Withstand Voltage (rms)		
20	Over Voltage factor for PTs		
21	Impulse Withstand Voltage (peak)		
22	Wave shape for Impulse Voltage		
23	1 Second Short Circuit Withstand Capacity		
24	Peak Dynamic Withstand Capacity		
25	Panel Hardware material (Nuts / Bolts / Washers / Screws / etc.)		
26	Whether Panels shall be packed & transported with Breakers inside the cubicle.		Yes / No
27	**Safety Features**		
27-a	Heat Shrinkable sleeves provided on bus-bars – rated to withstand system L-L voltage for 1 Minute		Yes / No
27-b	Removable FRP Shrouds provided for all Bus-Bar Joints and Tap-Off Connections		Yes / No
27-c	Arc Propagation barrier provided in bus-bar compartment		Yes / No
27-d	Arc Sensors provided in HV Compartments		Yes / No
27-e	Phase-Phase Barriers provided in between cable terminals		Yes / No
27-f	Breaker Service, Test, Isolated (Drawn-Out) positions provided along with indications		Yes / No
27-g	Distinct Overall Lockable door provided for Breaker & PT Compartments		Yes / No
27-h	Automatic Safety Shutters provided		Yes / No
27-i	Breaker Operation provided with LOTO Feature		Yes / No
27-j	Independent Pressure Release Flaps provided for all HV Compartments		Yes / No
27-k	Wire Mesh provided for all louvered openings		Yes / No

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27-l	Breaker Trolley Movement & Operation (ON / OFF) possible in closed door condition	Yes / No
28	**Circuit Breakers**	
28-a	Type	SF_6 / VCB
28-b	Make	
28-c	Type Designation	
28-d	Circuit Breaker mounting inside panel	Truck Mounted / Cassette Mounted
28-e	No. of poles / phase	
28-f	Current Rating (in free air)	
28-g	Current Rating inside panel at specified design temperature	
28-h	Short Time Rating (1 second)	
28-i	Symmetrical Breaking Capacity	
28-j	% DC Component	
28-k	Peak Making Current	
28-l	1 Minute dry withstand voltage (power frequency)	
28-m	Breaker Duty Cycle	
28-n	Total Opening & Closing Times (maximum)	
28-o	Power required for Opening / Closing	
28-p	Time taken for Spring Charging	
28-q	Power required for Spring Charging Motor	
28-r	Breaker Closing Mechanism	
28-s	Provision for Manual Spring Charging	Yes / No
28-t	Mechanical Trip Push-Button provided	Yes / No
28-u	Mechanical ON / OFF Indication provided	Yes / No
28-v	Breaker Operation Counter provided	Yes / No
28-w	Interrupter make & model	
28-x	Earthing System for Breaker	Integral Earthing System / Separate Earthing Carriage or Trolley
29	**Copies of following Type Test Certificates provided**	**Yes / No**
29-a	Short Circuit Tests for Panels (Peak and 1 Second Withstand)	Yes / No
29-b	Heat Run Test for Panels	Yes / No
29-c	Internal Arc Test for Panels	Yes / No
29-d	Impulse & Power Frequency Withstand Test for Panels	Yes / No
29-e	Short Circuit Test Duties for Circuit Breaker	Yes / No
29-f	Degree of Enclosure Protection	Yes / No