

Pre-Qualification Criteria

Project: 800A, 6.6kV VCB Panel Switchboard for VFD System

Customer: BPCL-Bina Refinery Hydrogen Compressor

Consultant: Engineers India Ltd. (EIL)

VCB Specification: PS/445/3164, Rev. 01

1. The vendor shall be an Original Equipment Manufacturer (OEM) of VCB Panels. Only the OEM can submit offers.
2. The vendor should have designed, engineered, manufactured, type tested or got type tested (as per IEC/equivalent), supplied 800A, 6.6kV or higher rating VCB panels as on 01.03.2026. Vendor to furnish necessary supporting documents. The Reference List of supplies made giving the ratings, year of supply, application and details of the customers etc. to be provided along with the offer.
3. The vendor shall be an EIL approved Vendor for Indoor HV Switchboard with VCB. Technical clearance of Vendor's offer will be based on Customer/EIL acceptance of OEM Credentials (does not apply to approved vendors for this project).
4. The vendor or their authorized service representatives shall have trained engineers for supervision of testing and commissioning & service for the offered equipment and shall be in a position to provide prompt after sales service and spares support for our installations. This service network shall necessarily be available in India.
5. The vendor shall be in a position to undertake AMC or provide service support for the equipment supplied, after the expiry of the warranty / guarantee period either directly or through a service representative.

Note:

- a. Vendor must furnish all necessary supporting documents, as required, along with the bid to satisfy Pre-Qualification criteria as specified above.
- b. The Pre-Qualification criteria are mandatory requirements and the technical bids will be cleared only when the Pre-Qualification criteria are accepted by end customer.

Checklist for Pre-Qualification Criteria :

Sl. No.	Vendor Confirmation to the points above	Reference of documents attached
1	Yes / No	
2	Yes / No	
3	Yes / No	
4	Yes / No	
5	Yes / No	



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REVISION HISTORY SHEET

REV. NO.	DATE	NATURE OF CHANGE	REASONS	PREPARED BY	APPROVED BY
00	17-04-2026	FIRST ISSUE	-----	PA	GD
01	04-06-2026	SECOND ISSUE	-----	PA	GD

REVISION 01

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DATE
04-06-2026

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TECHNICAL SPECIFICATION FOR VACUUM CIRCUIT BREAKERS IN METAL ENCLOSED PANELS

1. Project Details

Sl. No.	Parameter	Specification
1	Project Location	BPCL-Bina Refinery, Madhya Pradesh, India
2	Project Title	Bina Petrochemical & Refinery Expansion Project.
3	Unit	Ethylene Cracker & Associated Unit (300)
4	Application	Hydrogen Compressor
5	Customer	Bharat Petroleum Corporation Ltd.(BPCL)
6	Consultant	Engineers India Ltd.(EIL)

2. Environment Specifications

Sl. No.	Parameter	Specification
1	Maximum Ambient Temperature	48°C
2	Minimum Ambient Temperature	1.1°C
3	Equipment Design Temperature (IS-9676)	45°C
4	Relative Humidity	86%
5	Altitude	Less than 1000m above mean sea level
6	Location of VCB Panels	Indoor
7	Seismic Zone	As per IS-1893-ZONE-II
8	Site Environment	Humid & Corrosive

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3. Input Data

Sl. No.	Parameter	Specification
1	System Voltage / Frequency / Phase	6.6kV / 50Hz / 3
2	Voltage Variation	± 10 %
3	Frequency Variation	± 3 %
4	Combined Voltage and Frequency Variation	± 10 %
5	Fault Level at nominal system voltage	40 kA for 1 Sec
6	Application	VFD Output Breakers [Scope of supply includes Output VCBs (Q2 & Q4) which is shown in the Figure-1].

4. VCB Specifications

Sl. No.	Parameter	Specification
1	Rated Voltage	7.2kV
2	Rated Current	800A
3a	Rated Short Time Current Rating	40kA RMS for 1 Second
3b	IAC Rating	40 kA for 1 sec (Refer Gasduct details in Job Spec. for more details)
4	Power frequency Withstand / Impulse Withstand	20kV / 60kV peak
5	Reference Standard	As per attached EIL specification for HV Switchboards
6	Type of Circuit Breaker	Truck mounted withdrawable type with wheels. 3-pole version with individual vacuum interrupter for each phase. If cassette type VCBs are being provided, then Breaker Transport trolleys shall be supplied.

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7	Closing / Opening Mechanism	Through spring charged electric motor mechanism; manual charging spring through crank handle to be provided as standby. Provision for closing and tripping circuit breaker from remote through contacts and from local by Trip-Neutral-Close (T-N-C) switch to be provided. Lockable Local/Remote Switch and Emergency Push Button shall be provided. Closing Coil, Tripping Coil and Spring Charging Motor are with 110 V DC supply. Mechanism shall be trip free type. Anti-Pumping circuit/mechanism shall be incorporated. 2 nos. of redundant feeders shall be provided for 110V DC Supply by customer for the complete Switchboard. Building up of necessary redundancy with auto changeover arrangement and internal distribution is in Vendor's scope. 1 no. 240V AC feeder shall be provided by Customer for Space Heater, etc.
8	VCB Panel Construction	❖ Vacuum Circuit Breaker panel should be as per attached EIL Specification for HV Switchboard and EIL Datasheet of HV Switchboard. ❖ Base channel of height 100 mm suitable for tack welding to the MS insert embedded in the floor shall be provided. ❖ Cutout to be given on door with toughened glass with beading to view contacts from the outside. ❖ A separate metering chamber with partitions shall be provided to house protective relays, meters, indicating lamps, switches, transducers etc. ❖ Neoprene rubber gaskets to be provided on bolt-on covers, doors, cable gland plates and all other places wherever found necessary. ❖ Each compartment like circuit breaker compartment, cable compartment etc. shall be provided with an explosion vent. ❖ Height of metal clad enclosure must be at least 2300 mm from the finished floor. See fig. 2 for typical sizes and arrangement of panels.
9	Class of Protection	Degree of Protection of Circuit Breaker panels shall be IP4X (minimum) as per IEC:60529.



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10	Termination Arrangement	All Incoming and Outgoing cable entries for Power and Control cables shall be from Bottom only. Details of Power Cable Terminations is in figure-2. The power terminals shall be at least 600 mm from the cable gland plate to facilitate termination. Tentative arrangement has been indicated in figure-2. Vendor to provide their proposed panel arrangement. For Power Cables and control cables, undrilled, detachable gland plates of sufficient size & thickness (3 mm minimum) Aluminium gland plate to be provided. Gland plate shall be of sufficient strength to handle all the cables. VCBs Q2 and Q4 busbar terminals shall be suitable for termination of cables sizes as shown in figure-1.
11	Cable Accessories	Double Compression type, Nickel plated brass cable glands (Weather proof) to be supplied by the vendor for Incoming and Outgoing cables. Cable size selected is 4R x 3C x 240 sq.mm, 6.6 kV, Al, XLPE cable. However, exact cable sizes shall be confirmed during drawing approval stage. HT Cables and Cable Termination Kits are in Customer's scope of supply. Cable Glands for all HT cable terminations shall be supplied along with the VCB Panels.
12	Painting	2 Coats of Primer and 2 Coats of Finish Paint to be given for all surfaces of enclosure. Paint shall be Epoxy Based with Powder Coated Finish. Paint: Paint colour shall be RAL-7032. Paint Thickness: 100 Microns (minimum). Exact paint shade will be confirmed during detailed engineering. Note - Vendor shall supply final paint (1 litre per switchboard) in non-returnable container for final touch up at site as per Cl. No. 5.11.4 of EIL Specification for HV Switchboard.
13	Main Busbars	For bus bar specification, refer Cl. No. 5.3 of attached EIL specification for HV Switchboards. Shorting of terminations shall be as shown in Figures 1 and 2.
14	Earth Busbars	For Earth bus bar specification, refer Cl. No. 5.7 of attached EIL specification for HV Switchboards.



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15 Features

- a) For auxiliary wiring and terminals, refer attached EIL specification for HV Switchboards.
- b) All hardware shall be corrosion-resistant. All joints and connections of the panel members shall be made by zinc-passivated high-quality Grade 8.8 or superior steel bolts, nuts and washers, secured against loosening.
- c) Facility for locking of VCB panel doors shall be provided.
- d) **All components/items shall be as per attached EIL's Master Vendor List.**
- e) Elmex type TBs CATDM4 to be provided for CT circuits to facilitate testing.
- f) Detachable type Operating Handle
- g) Mechanical ON/OFF Position Indicator on enclosure front.
- h) 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.
- i) Plugs and Sockets for low voltage wiring.
- j) Manual Spring charging port with indicator.
- k) Drawout Lever
- l) Interlock Lever
- m) Operation Counter
- n) Handle for spring charging
- o) Spring charging motor with its protection circuit.
- p) Anti pumping relay and associated circuit
- q) Isolating contact in motor circuit when manual closing handle is inserted.
- r) Suitable rating Surge Arrestors to be provided for VFD Outgoing VCBs (Q2 & Q4).
- s) Atleast 10% spare terminals for each type of TB's and space for adding another 10% spare terminals shall also be available.
- t) LOTO arrangement shall be provided for breaker.
- u) Line PT (if applicable as per BOM) provided shall be withdrawable in line with EIL Standard Specification clause no. 6.1.12.



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16	Gasducts	Refer Cl. No. 5.4.7 of attached EIL Job Specification (Electrical). Vendor shall consider additional duct length, if required, to meet the requirements of the type-tested design.
17	Safety Interlocks	The following minimum safety interlocks are to be provided. i. The truck cannot be moved from either Test to Service position or vice versa, when Circuit Breaker is "ON". ii. The Circuit Breaker cannot be switched "ON" when truck is in any position between Test and Service positions. iii. The front part of the VCB shall have a locking facility. iv. There shall be no approach to high voltage points when the front door is open and Circuit Breaker is in "SERVICE" position. v. Rear door interlock shall be provided as per Cl. No. 5.4.12 of EIL Job Specification (Electrical). vi. Any other safety interlocks as may be required shall be provided for safe operation and maintenance. Refer Cl. No. 5.4.5 of attached EIL Job Specification (Electrical).

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Accessories
(As per BOM)

- a) Current Transformers shall be as per attached EIL specifications. All CT connections to be taken through TBs with links.
Dual Core Resin Cast Current Transformer with bar primary. The bar primary shall be capable of carrying 40kA for 1 sec during fault. Working Voltage: 7.2kV, Insulation Class: B.
Core 1: 15VA, Class 1.0 Metering, XXX/1A
Core 2: 15VA, Class 5P10 Protection, XXX/1A
All CT connections to be taken through Elmex make (or as per customer sub-vendor list) TBs with links – Type CATDM4.
- b) 3 phase drawout Cast Resin Potential Transformer with Fuses, Insulation Class: B,
Vector Group to be selected based on bus PT vector group. Primary 7.2kV L-L RMS; Secondary 110V L-L RMS, Rating 50VA minimum. Fuses to be integral with PT. Accuracy Class 1.0. LV neutral of the PT shall be insulated to full line voltage. PT secondary R, Y, B, n connections to be brought out to external terminals for remote measurements.
- c) Digital Ammeter (Flush Mounted). Input 0-1A fed from Core 1 of CTs above. Accuracy Class: 1.0, Item 1 →Scale 0-600A.
Auxiliary Supply: 110V DC.
- d) Digital Voltmeter (Flush Mounted). Scale 0-7200V. Input 0-110V fed from PTs above. Accuracy Class: 0.5, Auxiliary Supply: 110V DC
- e) Ammeter Selector Switch (4 position).
- f) Voltmeter Selector Switch (4 position).
- g) High Speed Tripping Relay – VAJH23. Coil Voltage 110VDC. Flag – Hand Reset, Flush mounting type.
- h) Trip Circuit Supervision Relay – VAX31, Contacts 1NO+2NC, 110V DC supply. 1NO+1NC Contacts to be wired to TBs for external signalling. Flush mounting type. Other details as per EIL spec.
- i) Details of connection and wiring will be discussed and finalized during detailed engineering. For indicating Lamps, refer clause no. 6.6.4 of EIL specification for HV Switchboards.



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18	Accessories (As per BOM)	j) Each Circuit breaker will be provided with following indicating lamps: Indicating Lamp "ON" - Red, Indicating Lamp "OFF" - Green, Indicating Lamp and Push Button "TRIP CIRCUIT TEST" - White, Indicating Lamp "SPRING CHARGED" - Blue, Indicating Lamp "AUTO TRIP" - Amber, Indicating Lamp – Phase Indication "R", "Y", "B" - Red, Yellow, Blue, Indicating Lamp "TRIP CKT HEALTHY" - White, Indicating Lamp "SPARE" - Amber k) "Trip-Neutral-Close" Switch .– 6 pole l) "Local-Remote" Switch – 8 pole lockable m) "Emergency Trip" – Push Button, 2NO+2NC, Mushroom Type, Lockable – Twist to Release n) Limit Switch for Door Interlock to be provided. Contacts to be wired to TBs. o) Auxiliary Contactor for contact multiplication and interlocking 4NO+4NC, 110V DC coil Interlocking Scheme to be finalized during detailed engineering, p) Space Heater with Thermostat, MCB for Space heater: Refer EIL specification for HV Switchboards. Rating : 230V AC q) Covered CFL illumination lamp with ON/OFF switch & MCB, Rating: 230V AC r) Switch socket unit for each panel s) Dual O/P transducer for 4-20 mA Current feedback to i) DCS ii) Spare t) One set of accessories consisting 1 no. each of slow closing handle, spring charging handle, lever's used for providing status of test mode and service mode & Wedge shaped platform shall be supplied loose alongwith switchboard.
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19	OTMS(Online Temperature Monitoring System)	Switchboard shall be provided with online wireless temperature monitoring facility(OTMS). The passive sensor should be wireless, battery less, dielectrically safe, robust to high voltage, high electromagnetic field, and harsh environment. It should take direct measurement on critical point. This facility shall be interfaced with ECS. For detailed spec. refer Cl. No. 5.4.9 of EIL Job Spec. Electrical attached. Approved vendors for OTMS shall be Schneider/ABB/Rugged or Equivalent.
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Note:

1. VCB vendor should decide VA rating of PT during detail engineering.
2. For detailed of specification of CT & PT, please refer customer specification/ datasheet.
3. CTs and PTs shall be suitable for variable frequency operation.
4. Make of items: As per attached customer sub-vendor list.

20	Identification of Panel	a) An Identification Plate has to be fixed on the front and rear of the Panel. The rear side identification plate shall be fixed on the panel frame and not on removable covers. Inscription details will be VFD1 Output Breaker (Q2) and VFD2 Output Breaker (Q4) as shown in Figure-1. b) Cable Identification Plates screwed on edge of cable gland plate indicating the source and destination of incoming and outgoing cables to be provided. Details will be provided during detailed engineering.
21	Routine Testing	All routine tests shall be conducted and type test reports shall be submitted as per attached EIL ITP for HV Switchboards (6-81-1001 Rev. 4) and EIL Datasheet for HV Switchboard (B957-000-16-50-DS-0101 Rev. B)



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22	Type tests	Type Test certificates (not more than 10 Years old from 01.03.2026) to be furnished for similar switchboard in line with attached Job Specification Electrical, EIL HV Switchboard Datasheet and EIL ITP. Vendor shall furnish back up documents to establish that no major change has been introduced in the basic design/ technology/ material/ mechanical construction/ functionalities of the equipment/ performance characteristic/ manufacturing process of the equipment. If valid type test certificates as above are not available, vendor shall conduct type tests without any cost implication to BHEL- EDN.
23	Quality Plan	Vendor should submit ITP for BHEL / Customer Approval as per Customer ITP. Customer Approved Quality Plan / Requirements will have to be adhered to during design / manufacture / material procurement / testing and despatch.
24	Inspection	Final Inspection: BHEL / Customer / Customer representative / Third Party Inspector (TPI) will be present at manufacturer's works for witnessing of final testing. This is to be incorporated in the Quality Plan. Hiring of Third Party Inspector (TPI) shall be in Customer scope.
25	Packing	Packing shall be suitable for storage in areas with heavy rains and high ambient temperature as per EIL Specification for HV Switchboards cl. 8.0 & attached packing instructions.

5. Confirmations / Deviations to Specifications

Point-wise confirmation to this specification & EIL Specification to be given along with offer. Deviations, if any, shall be indicated separately. If there are no deviations to the specifications, vendor shall mention the same explicitly. A reply from vendor stating that "Equipment will generally meet the specifications" will not be accepted by BHEL. Clause-wise Confirmation / Clarifications of all Clauses in this Specification, Customer specifications/documents and ITPs shall be furnished in the format below. This is mandatory. Deviations furnished below ONLY will be considered by BHEL. Deviations mentioned elsewhere will not be allowed. BHEL has the right to not accept the deviations mentioned by Vendor.

Point No.	Page No.	Confirmation / Clarification / Information / Deviation	Details	Remarks, if any



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6. Spares :

A	Commissioning Spares:	1 set of commissioning spares to be supplied along with main equipment.
B	Recommended spares for 2 years:	Supplier should quote item wise price for the recommended 2 years O&M spare list attached. These prices shall remain valid up to 2 years validity beyond the contractual completion/delivery period of order. Order of recommended two years operation and maintenance spares may be placed by BPCL/EIL/BHEL separately, if required. BHEL/BPCL reserves the right to select and order any of the spares out of above list within the validity period.

A. Commissioning spares:

Sl. No.	Item	Qty
1	Control fuses / MCB (all type & rating)	5 nos. of each rating and type
2	Auxiliary relays	2 nos. (min) of each type
3	Indicating lamp with covers	5 nos. of each colour

B. Recommended Spares for 2 years:

Sl. No.	Parameter	Qty. Recommended Spares for 2 years
1	Complete Breaker Trolley (for each rating)	1 no.
2	Spring charging motor	1 no.
3	Closing/tripping coils	1 no.
4	Control contactors for all ratings	1 no.
5	CT (for each type/rating)	1 no.
6	PT (for each type/rating)	1 no.
7	Spare Vacuum bottles	1 no.
8	Control Circuit fuses	1 no.
9	Indicating lamps (LED Type)	1 no.
10	Control Switches/MCB	1 no.
11	Breaker Pads (Male) (for each type and rating)	1 no.



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7. Bill of Material

S.No	Item	VFD1 O/P (Q2)	VFD2 O/P (Q4)
1	7.2kV VCB	1	1
2	CT – XXX/1A – dual core	-	-
3	Ammeter 0 - XXXA with ASS	-	-
4	PT 7.2kV/110V L-L with Fuses	-	-
5	Voltmeter 0-7200V with VSS	-	-
6	Indicating Lamps and Push Buttons (*)	1 Set	1 Set
7	High Speed Tripping Relay VAJH23	1	1
8	Trip Circuit Supervision Relay VAX31	1	1
9	Auxiliary Contactor 4NO+4NC (*)	6*	6*
10	T-N-C Switch – 8 Pole – ODS	1	1
11	Emergency Trip PB – 2NO+2NC	1	1
12	Limit Switch	1	1
13	Local-Remote Switch – 8 Pole	1	1
14	Space Heater	1	1
15	Illumination Lamps	1	1
16	Surge Arrestors	1 set	1 set
17	Switch socket	1	1
18	Dual O/P transducer	1	1
19	Numerical Relay (O/C & E/F)	-	-
20	Earthing Truck	1	
21	Breaker Handling trolley (for Cassette type Breaker only)	1	
22	*Ethernet Switch	1 Set	
23	*OTMS System	1 Set	

Note:

- 1) * As per requirement.
(Vendor to consider same as per logic requirement during detailed engineering stage, without any price implication).
- 2) Only major relays, meters and controls are indicated in BOM. Any other auxiliary relays, timers, switches, contactors, indications etc. as required while implementing the control schematics or felt necessary for safe operation, even if these are not specifically mentioned, shall be supplied without any time and price implications.



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8. Scope of Supply & Services

Sl. No.	Item	Quantity
1	800A, 6.6kV Switchboard (consisting of 2 nos. VCBs)	1 no.
2	Breaker Earthing Truck for Feeder & Bus	1 Set
3	Accessories for Cable & Breaker	1 Set
4	Commissioning Spares	1 Set
5	Erection Supervision & Commissioning charges (Vendor to quote lumpsum charges for 4 mandays for 2 Nos. VCBs which shall be considered for bid evaluation)*	1 lot
6	PWAMC charges**	1 Lot
7	Recommended Spares for 2 Years (optional for Ordering)***	1 Set

Note:

* Payment for Commissioning:

Payment shall be made for actual man-days consumed with per man-day charges calculated on the basis of the lumpsum charges quoted above. Lumpsum charges quoted shall include travelling, boarding and lodging expenses.

**PWAMC:

Placement of this Comprehensive Post Warranty Annual Maintenance Contract (PWAMC) shall be done prior to the expiry of the warranty period. This PWAMC is applicable for a period of 5 years after completion of warranty period. Breakup Shall be furnished in EIL Format attached.

*** Recommended Spares for 2 years:

These shall be considered for Bid evaluation.

9. Data Sheet

Data Sheet is to be filled up by the Vendor as per customer format and submitted as a part of the Technical Bid and Final Version during Drawing Approval stage.



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10. Documentation

Sl. No.	Parameter	Specification
1	Attached Documents	a) SLD of VFD System, Drg. No. 3-674-00-52-003, Rev. 01 b) EIL Specification of HV Switchboard, 6-51-0001, Rev. 08 c) EIL Datasheet for HV Switchboard, B957-000-16-50-DS-0101, Rev. B d) EIL ITP for HT Switchboard, 6-81-1001, Rev. 04 e) EIL Job Spec(Electrical), B957-300-16-50-SP-5020 Rev. B f) EIL Sub-Vendor list. g) ECS I/O List h) Hardware Datasheet of HV Switchboard, B957-000-16-50-DS-0118, Rev. A i) EIL SLD for VFD System, B957-000-16-50-DS-0458, Rev B j) PWAMC Details, Annexure-I to B957-300-KA-MR-5020 k) PQC (BHEL Pre-Qualification Criteria)
2	Technical (unpriced) and Commercial (priced) Bids – For Evaluation	Refer Scope of Supply and Services (Sl. No. 8).
3	Technical Information required along with Offer	a) OGA Drawing of VCB Panels, Weight b) Technical Catalogue of VCB being offered (including details of Safety Interlocks provided) c) Confirmation / Clarification / Information / Deviation List as per Point no. 5 above. d) Filled up Data Sheet as per Point no. 9 above. e) Confirmation / Deviation to Customer/BHEL Specifications
4	Information required for Approval after Placement of Purchase Order	a) OGA Drawing & Schematic diagram b) Technical Catalogue of VCB being offered, including details of Safety Interlocks provided. c) Filled up Data Sheet as per Point no. 9 above d) Bill of Materials e) Quality Plan, Test Protocol for Routine Tests f) Type test certificates as per EIL specification g) Busbar sizing calculation
5	Information Required along with Supply. Maintenance Manuals and Documentation	Soft copies of Erection, Commissioning and Maintenance Manuals along with Final Drawings and Documentation, Test and Guarantee Certificates, Complete Bill of Material for the equipment supplied.



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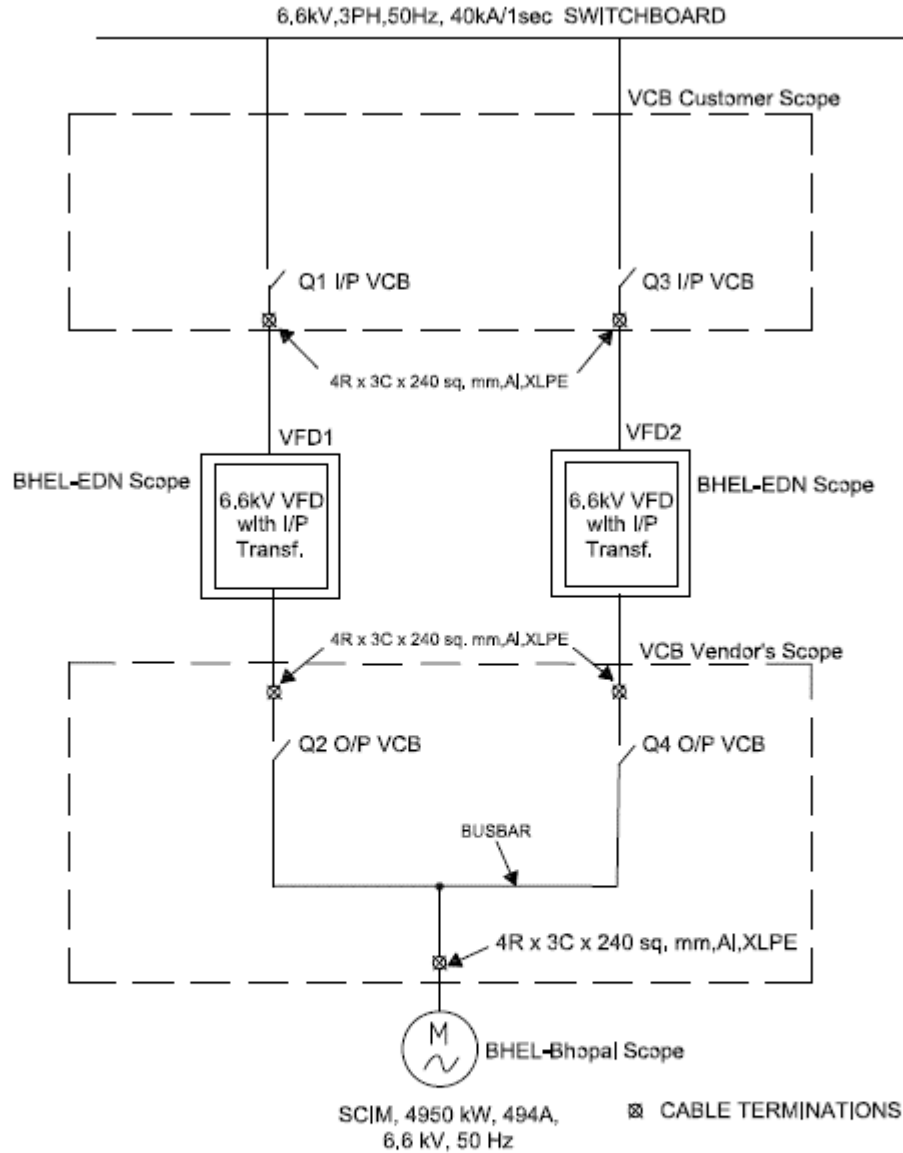
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NOTE:

- 1) OUTPUT TERMINALS OF Q2 & Q4 BREAKERS TO BE SHORTED INTERNALLY BY COPPER BUSBARS
- 2) CABLE TERMINATIONS SHALL BE SUITABLE FOR CABLE SIZES AS INDICATED IN THE DIAGRAM ABOVE

FIGURE 1 - SINGLE LINE DIAGRAM



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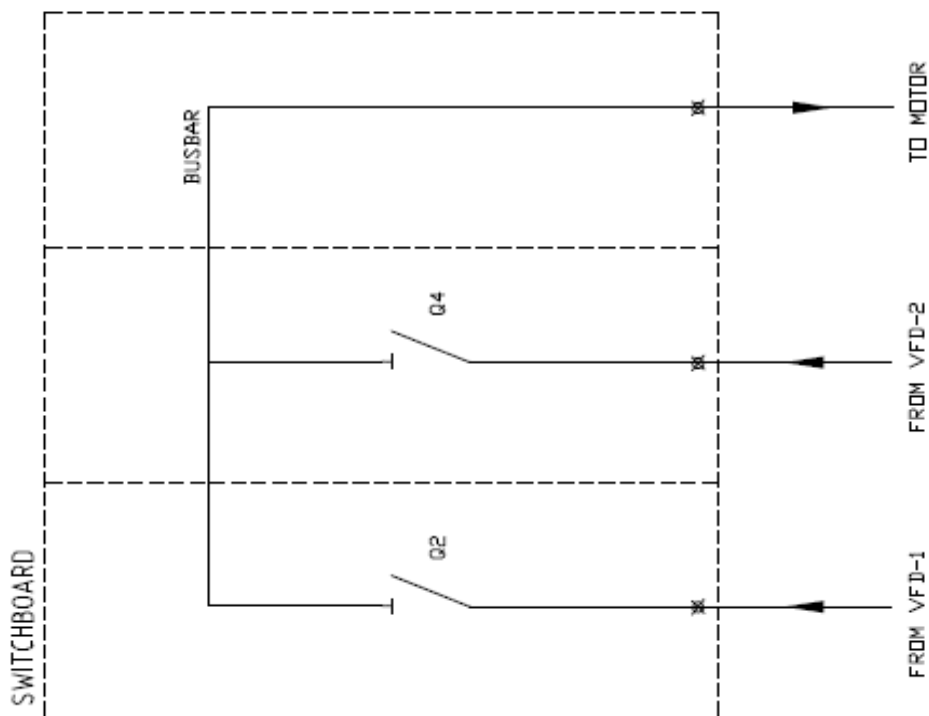
PURCHASE SPECIFICATION

GROUP:

P.S NO.: PS/445/3164

REV. NO: 01

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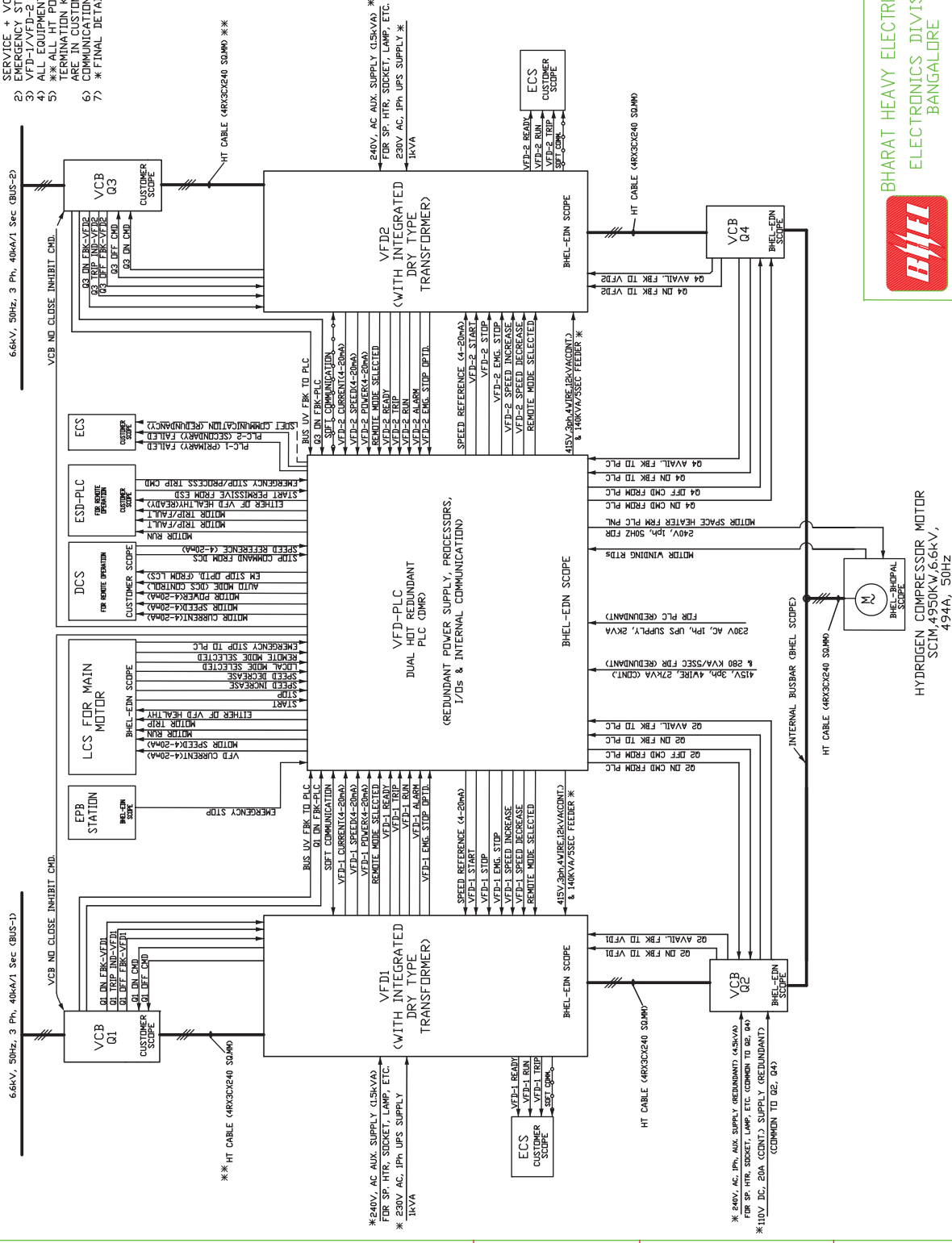
※ : TERMINATION SUITABLE FOR 4Rx3Cx240 sq. mm, Al XLPE

FIGURE 2 – SWITCHBOARD CONFIGURATION (TENTATIVE ARRANGEMENT)

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NOTES:

- 1) VCB AVAILABLE SIGNAL (Q2 & Q4) SHALL CONSIST OF TRIP CKT HEALTHY + VCB IN SERVICE + VCB IN REMOTE + VCB SPRING CHARGED.
- 2) EMERGENCY STOP PUSH BUTTON (CN LCS) SHALL BE SHROUDED & LOCKABLE TYPE.
- 3) ALL WIRING SHALL BE IN ACCORDANCE WITH THE IEC STANDARDS.
- 4) ALL EQUIPMENTS SHALL HAVE BOTTOM CABLE ENTRY.
- 5) *** ALL HT POWER, LT POWER, LT CONTROL & INSTRUMENTATION CABLES, LUGS, HT TERMINATION KITS (EXCEPT HT CABLES BETWEEN DRY TYPE TRANSFORMER AND VFD) SHALL BE IN ACCORDANCE WITH THE IEC STANDARDS.
- 6) COMMUNICATION LINK (MODBUS) TOP/IP PROTOCOL.
- 7) *** FINAL DETAILS SHALL BE FURNISHED AFTER FINALISATION OF VFD MANUFACTURER.



CONTROL LOGIC SELECTION TABLE
<CONTROL LOGIC MADE IN PLC>

LCS L/R SW. POS.	VFD HMI	START/ STOP CTRL	SPEED REFERENCE SEL.
LOCAL	REMOTE	LCS	LCS SPEED INCR & DEC. PB
LOCAL/ REMOTE	LOCAL	VFD	VFD PANEL HMT
REMOTE	REMOTE	DCS (STOP ONLY)	DCS (4-20mA)

IP CLASS	VFD PANEL : IP31 PLC PANEL : IP42 VCB PANEL : IP4X LCS : IP65
DESIGN AMBIENT FOR VFD	45 °C

[illegible]

उच्च वोल्टेज स्विचबोर्डों
के लिए
मानक विनिर्देश
SPECIFICATION
FOR
MEDIUM VOLTAGE SWITCHBOARDS

8.	20.11.2024	REVISED & ISSUED AS STANDARD SPECIFICATION	VB/MKM	RKS	HK	MN
7.	10.01.2019	REVISED & ISSUED AS STANDARD SPECIFICATION	VB	HK	BRB	RKT
6.	15.10.2013	REVISED & ISSUED AS STANDARD SPECIFICATION	VB	HK	UAP/JMS	SC
5.	28.04.2010	REVISED & ISSUED AS STANDARD SPECIFICATION	HK	SA	NS/JMS	ND
4.	03.03.2005	REVISED & ISSUED AS STANDARD SPECIFICATION	RM	AKT	AAN	SKG
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

Abbreviations:

A	Ampere
AC	Alternating Current
BIS	Bureau of Indian Standards
BS	British Standard
CNT	Close-Neutral-Trip
CEA	Central Electricity Authority
CPRI	Central Power Research Institute
CRCA	Cold Rolled Cold Annealed
CT	Current Transformer
DC	Direct Current
EPDM	Ethylene Propylene Diene Monomer
FBT	Fast Bus Transfer
FRP	Fiber Reinforced Polyester
MV	Medium Voltage
Hz	Hertz
IAC	Internal Arc Classification
IEC	International Electro-Technical Commission
IEEE	Institute of Electrical & Electronics Engineer
IP	Ingress Protection
kV	Kilo Volt
kW	Kilo Watt
kWH	Kilo Watt Hour
LED	Light Emitting Diode
LOTO	Lock-Out Tag-Out
LSC	Loss of Service Continuity
MCB	Miniature Circuit Breaker
MCC	Motor Control Center
MCCB	Moulded Case Circuit Breaker
NEMA	National Electrical Manufacturers Association
NO	Normally Open Contact
NC	Normally Close Contact
OTMS	Online Temperature Monitoring System
PO	Purchase Order
PT	Potential Transformer
PU	Polyurethane
p.u.	Per unit
PVC	Poly Vinyl Chloride
RAL	Reichs-Ausschuss für Lieferbedingungen
SF ₆	Sulphur Hexafluoride
SWG	Standard Wire Gauge
VCB	Vacuum Circuit Breaker
VDE	Verband Deutscher Elektrotechniker
VFD	Variable Frequency Drive
VT	Voltage Transformer
XLPE	Cross linked Poly Ethylene

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1.0 SCOPE

This specification covers the design, manufacture, testing, packing and supply of indoor, drawout type Medium Voltage Switchboards >1 kV up to and including 33 kV, incorporating Vacuum or SF₆ 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, unless otherwise specified:

IS: 1248	Direct acting indicating analogue electrical measuring instruments and their accessories
IS: 2071	High Voltage Test Technique
IS: 2544	Porcelain post-insulators for systems with nominal voltage greater than 1000V
IS: 2705-1	Current transformers specification: Part 1 General Requirements
IS: 3618	Specification for phosphate treatment of iron and steel for protection against corrosion
IS: 5082	Wrought aluminium and aluminium alloy bars, rods, tubes, sections, plates and sheets for electrical applications
IS: 5578	Guide for marking of insulated conductors
IS: 6005	Code of practice for phosphating of iron and steel
IS: 16227	Instrument transformers
IS: 11353/ IEC 60445	Basic and safety principles for man-machine interface marking and identification - identification of equipment terminals conductor terminations and conductors
IS: 13703-4	Specification for low - voltage fuses for voltages not exceeding 1000V AC or 1500V DC : supplementary requirements for fuse links for the protection of semiconductor devices
IEC 60282-1	High voltage fuses -- Current Limiting fuses
IS/IEC 60168	Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1000V
IS/ IEC 60529	Degree of Protection provided by Enclosure
IS/IEC 62271	High Voltage Switchgear and Controlgear (Part 1, 100, 102, 103, 105, 106, 200, 201, 301)
IEC 62271	High Voltage Switchgear and Controlgear

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

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

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

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

3.0 GENERAL REQUIREMENTS

3.1 The offered equipment shall be brand new with state of art technology and proven track record of the manufacturer of similar product. No equipment without mandatory type test shall be offered.

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

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

4.0 SITE CONDITIONS

- 4.1 The switchboards shall be suitable for installation and satisfactory operation in an air conditioned/ pressurised sub-station or in a substation with restricted natural air ventilation or in a covered shed/ enclosed electrical room (e-room) in a tropical, humid and corrosive atmosphere.
- 4.2 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.
- 4.3 All equipments described in this specification are intended for continuous duty operation, as per nameplate rating under the specified ambient conditions, unless indicated otherwise.

5.0 DESIGN AND FABRICATION REQUIREMENTS

5.1 Enclosure and Protection

- 5.1.1 The Medium 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, 2mm (14 SWG) CRCA sheet steel shall be used for all front and rear doors and covers, and 1.6mm (16 SWG) CRCA sheet steel for inter-panel partitions. Wherever required, stiffeners shall be provided to increase stiffness of large size doors and covers.
- As an alternative to CRCA, Aluzinc/pre-galvanised sheet steel can also be provided for internal inter-panel partitions only. However, all external surface shall be of CRCA with specified paint shade.
- 5.1.2 Vertical panels shall be assembled to form a continuous line-up of uniform height both for HV chamber as well as control chamber. Rear extension panels shall also be of full height. However, HV chamber height can be different from control chamber height.
- 5.1.3 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 1mm. Design of louvers/ opening shall be such that the arc does not come out in case of internal arc. The same shall be type tested for internal arc, as specified. The enclosure shall have complete protection against approach to live parts or contact with internal moving parts (IP-4X) as per IS/IEC: 60529.
- 5.1.4 All openings, covers and doors shall be provided with suitable Neoprene/ XLPE/ EPDM gaskets around the perimeter to make the switchboard dust and vermin proof.
- 5.1.5 Each unit of the switchgear shall have necessary internal sheet metal barriers to form separate compartments for circuit breaker, busbars, instruments and relays, cable connections etc. Compartments for cable connections shall allow cable termination and connection work with the switchgear energised. Suitable interlock shall be provided such that cable compartment can be opened only when earth switch is ON or Earthing truck is inserted.
- 5.1.6 The panel shall be internal arc tested as per IS/IEC 62271-200 requirements for full short circuit current and for a duration of 0.5 second (minimum) unless specified otherwise in job specification/ datasheet and shall be qualified to comply with all the 5 criteria as per IS/IEC 62271-200. 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 internal arc classification (IAC) as per IS/IEC 62271-200 for the short circuit current and duration as specified. IAC test shall be conducted on the offered panel variants such as smallest width panel, panel with louvers, panel with thermography window and any other variants (as applicable) as per job requirements. The panel shall also be AFLR tested as per IS/IEC 62271-200 requirements.

For panels having busduct entry in place of cable entry, busduct interface with panel shall be such that it does not interfere with the IAC type tested design of panel. Separate rear extension panel shall be provided for the Busduct entry. Wall through bushings shall be provided at interface point between busduct and panel.

In case vendor has considered pressure relief/ gas duct above switchboard for release of gases due to internal arc; vendor shall preferably provide suitable absorbers in the switchboard to prevent the release of harmful gases in the switchgear hall. Alternatively, duct including all accessories/supporting arrangement/sealing material/bends/installation material etc. shall be provided for evacuating harmful gases. The offered arrangement of pressure relief/ gas duct shall be as per type tested design.

- 5.1.7 All identical equipment and corresponding parts shall be fully interchangeable.
- 5.1.8 Safety barriers / shutters shall be provided to permit personnel to work safely within an empty compartment with the bus bars energised. Loss of Service Continuity (LSC) category of the switchgear shall be LSC2B as per IS/IEC-62271-200.
- 5.1.9 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.
- 5.1.10 The drawout carriage on the switchboard shall have three positions: "Service", "Test" and "Drawout" viz:
 - "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.
 - "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.
 - "Draw out" Position - both power and control circuits shall be disconnected in this position. Alternatively, "Test Position" with the secondary control circuit disconnected may be provided in lieu of "Draw out Position"

Circuit breaker operation shall be possible only in "Service" and "Test" positions. The circuit breaker shall be lockable in "Test" / "Draw-out" positions. Automatic safety shutters shall be provided to ensure the inaccessibility of all live parts after the carriage is drawn out.

There shall be a distinct overall door for the breaker compartment, which can be closed with the carriage in drawout position and it shall be lockable type.

- 5.1.11 All circuit breaker modules of the same rating shall be inter-changeable. Suitable interlocks shall be provided to prevent the following operations:

- "Plugging in" or "drawing out" of a closed breaker.
- "Plugging in" a breaker with the earthing isolator closed.
- "Closing" of the earthing isolator with the breaker "plugged in".
- Pulling out the auxiliary circuit plug with the breaker in the service position. Pushing in the breaker to the service position, with the auxiliary circuit plug not in position.

Additionally, the following shall also be provided:

- All operations such as breaker rack-in, breaker rack-out, breaker On/Off, spring charging, earth switch On/Off etc. shall be possible only with panel door closed.
- Pad locking arrangement shall be provided for rack in operation of breaker as well as for the panel door meeting LOTO requirements.

LOTO arrangement shall include provision for the following:

- a) Provision for hooking lockout devices by multiple lock arrangement to prevent opening of panel door and racking-in of circuit breaker.
- b) Provision for attaching tag-out device for warning against energisation and to provide information regarding date of isolation, agency working on the equipment, etc.
- c) Provision for Hasp such that the same shall be put-in and closed in the locking arrangement of the breaker/switch and panel door.

- 5.1.12 All hardware shall be corrosion-resistant. All joints and connections of the panel members shall be made by zinc-passivated high-quality Grade 8.8 or superior steel bolts, nuts and washers, secured against loosening.
- 5.1.13 Suitable eyebolts/ lifting clamps shall be provided for the lifting of the panel/shipping section. The bolts, when removed shall not leave any opening in the panels.
- 5.1.14 If specified in job specifications/datasheet/Tender, light/ arc/ pressure based sensors with controller shall be provided to quickly detect internal arc and immediately initiate tripping action.
- 5.1.15 Thermography window for infrared electrical inspection shall be provided if specified in job specifications/datasheet/Tender. The switchgear with thermo-graphy window shall be type tested and certified for internal arc faults as per IS/IEC 62271-200 requirements. In case IAC test report with thermography window is not available, IAC test report to be submitted for the panel along with internal arc withstand capability report for the material used for thermography window.
- 5.1.16 MV Switchgear shall be provided with online wireless temperature monitoring facility if specified in job specifications/datasheet/Tender. The passive sensor shall be wireless, battery less, dielectrically safe, robust to high voltage, high electromagnetic field, and harsh environment. It shall take direct measurement of temperature from critical points. This facility shall be interfaced with Substation Automation System/ ECS.

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

5.2 Accessibility

- 5.2.1 All relays, metering, and control components shall be mounted on the panel front only. However, auxiliary contact multiplier relays with auto reset can be mounted inside the panel.
- 5.2.2 The switchgear shall be considered to be accessible to authorized personnel having access all around and shall be tested for following type of accessibility as per IS/IEC 62271-200:

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

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

5.3 Bus Bar

- 5.3.1 The switchboard shall comprise of 3-phase bus bars which shall extend through all units of the switchgear line-up. The main bus bars shall have uniform cross-section throughout their length and shall be sized to carry continuously the rated current specified in the data sheet.
- 5.3.2 Bus bars shall be of high conductivity electrolytic aluminium or copper supported on insulators made of non-hygroscopic, non-inflammable material with tracking index equal to or more than that defined in Indian standards. Self supporting busbars can also be accepted provided the same is type tested design.
- 5.3.3 Bus bars shall be housed in a separate chamber and shall be accessible for inspection. Wire guards /cover shall be provided inside the enclosure to avoid accidental contact when the cover is removed.
- 5.3.4 Both bus bars and the supports shall be adequately sized and braced to withstand the specified short-circuit current for 1 second. Dynamic stresses shall be calculated on the basis of the specified peak short-circuit current. All bus bars supports shall be of non-carbonising material, resistant to acids and alkalies.
- 5.3.5 Bus bars shall be insulated by using heat-shrinkable sleeves or glass fibre tubes suitable for withstanding heat under worst operating condition as per type tested design. The sleeves/ tubes shall be rated to withstand the system line-to-line voltage for 1 minute. This shall be verified by a type test in which the line voltage will be applied between the sleeved/ tubed main bus bar and an aluminium foil wrapped closely around the insulation over a length of at least 500mm.
- 5.3.6 All bus bar joints and all tap-off connections from the main horizontal bus bars shall be provided with removable FRP/PU/PVC/EPDM/Nylon shrouds. The material of the shrouds shall be flame retardant (FR).
- 5.3.7 Bus bars shall be prominently marked with Red, Yellow and Blue colour rings/ stickers for easy phase identification at regular interval and at every power tap off point.
- 5.3.8 The thermal design of the bus bars shall be based on installation of the switchgear in poorly ventilated conditions. The cooling air volume shall take into account only the bus bar enclosure.
- 5.3.9 The hot spot temperature of busbars, including joints, at design ambient temperature shall not exceed 100°C under normal operating conditions while for silver plated joints, the allowable maximum temperature shall be 115°C in line with IS/IEC-62271-1.
- 5.3.10 Only zinc passivated high tensile strength high-quality Grade 8.8 or superior steel bolts, nuts and washers shall be used for all busbar joints and supports. Also, instruction label for torque tightening of busbar coupling shall be provided on switchboard.
- 5.3.11 The current rating as defined for switchboard and components in data sheet/job specification are for design ambient temperature at site conditions and for being inside the cubicle at fully loaded condition. The vendor shall suitably derate the nominal rating to suit the above condition.

5.4 HV Power Connections

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

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

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

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

5.5 Auxiliary Wiring and Terminals

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

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

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

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

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

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

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

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

5.6 Control and Indication

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

- One DC feeder shall be provided for each bus section. The bus coupler panel may be fed from any of the two supplies.
- One separate, single-phase power supply shall be provided for each bus section for feeding space heaters, etc. Supply voltage shall be 240 V AC, unless otherwise specified.

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

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

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

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

5.7 Earthing Connections

All cubicles shall be connected to an earth bus bar running throughout the length of the switchboard. The minimum earth bus bar size shall be 30 x 6 mm² copper up to short-circuit withstand capacity of 31.5 kA and 50 x 6 mm² copper for a short-circuit withstand capacity above 31.5 kA and upto 40 kA. All doors and movable parts shall be connected to the earth bus with flexible copper connections. Provision shall be made to connect the earthing bus bar to the plant earthing grid at two ends. All non current-carrying metallic parts of the equipment and components shall be earthed. The earth bus shall be brought back to the cable compartment, and earthing bolts shall be provided to ground cable armour. The mating surfaces of all bolted parts shall be zinc passivated to ensure continuity between them.

5.8 Space Heaters

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

5.9 Panel Supporting Frame

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

5.10 Nameplates

- 5.10.1 The switchgear shall be provided with durable and clearly legible nameplate in accordance with Table-1 of IS/IEC 62271-200 requirements.
- 5.10.2 A nameplate with the switchboard designation shall be fixed at the top of the central panel. A separate nameplate giving details for each feeder compartment of all panels shall be provided. Danger plate (Red) shall be provided at the front and rear for each panel.
- 5.10.3 The nameplates for feeder compartments shall be in two parts. One part shall have necessary details pertaining to the compartment's number of vertical panel of the switchboards. The other parts shall be removable and shall contain all details regarding the feeder number for drives/equipment controlled by the particular module as per approved single line diagram.
- 5.10.4 Blank nameplates shall be provided for all spare and vacant modules.
- 5.10.5 Nameplate or polyester adhesive stickers shall be provided for each equipment mounted inside the switchboard. Special warning plates shall be provided on removable covers or doors giving access to cable terminals and bus bars.

- 5.10.6 Special warning labels shall be provided inside the switchboards also, wherever considered necessary. Identification tags shall be provided inside the panels matching with those shown on the circuit diagram.
- 5.10.7 Engraved nameplates shall preferably be of 3- ply (Black-White-Black) lamicoid sheets or anodised aluminium. However back engraved perspex sheet nameplates may also be acceptable. Nameplates shall be fastened by screws and not by adhesives.

5.11 Painting

- 5.11.1 All metal surfaces shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. Alternately, supplier's standard paint procedure as per their ISO standard is also acceptable. The under surface shall be made free from all imperfections before undertaking the finishing coat.
- 5.11.2 After preparation of the under surface, the switchboard shall be spray painted with two coats of epoxy based final paint or shall be powder coated.
- 5.11.3 Colour shade of final paint shall be as RAL 7032 unless specified otherwise.
- 5.11.4 The finished panels shall be dried in stoving ovens in dust free atmosphere. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint etc. Vendor shall supply final paint (1 litre per switchboard) in non-returnable container for final touch up at site.
- 5.11.5 All unpainted steel parts shall be Zinc passivated or suitably treated to prevent rust formation. If these parts are moving elements then they shall be greased. Aluzinc/ pre-galvanised sheet, wherever provided, need not be painted.

6.0 SWITCHBOARD COMPONENTS

6.1 Circuit Breakers

- 6.1.1 Vacuum or SF₆ circuit breakers shall be used in the switchboard. The exact type and rating of breakers shall be as indicated in the data sheet. Breaker transport trolleys required for cassette-mounted breakers shall be provided for each switchboard. Number of trolleys to be provided shall be as per data sheet.
- 6.1.2 Vacuum circuit breakers shall be designed to have low switching-over voltage levels and with a long switching life. The interrupter shall be leak-free. The VCB shall be type tested with the offered make & model of vacuum interrupter.
- 6.1.3 In case of SF₆ circuit breaker, each pole shall be provided with a pressure switch to monitor the gas pressure with local indication / lockout, and remote annunciation in the event of SF₆ gas leakage.
- 6.1.4 The breakers shall have at least 6 normally open (NO) and 6 normally closed (NC) spare auxiliary contacts for purchaser's use. If these are not available, auxiliary relays shall be used to multiply the auxiliary contacts of the breakers.
- 6.1.5 The breakers shall have a motor-operated, spring-charging mechanism. It shall also be possible to charge the springs manually. The closing spring shall get re-charged (for subsequent closing) soon after a closing shot and prior to breaker tripping. In case the limit switch fails to cut out the spring-charging motor with the springs fully charged, the motor shall be automatically de-coupled or else positive isolation (at both ends) of power supply to spring charging motor shall be ensured. The control circuit shall be suitable for local as well as remote control. Breakers shall be trip-free and shall have an anti-pumping device. The breaker operating duty shall be O-3min.-CO-3min.-CO, unless otherwise agreed.

6.1.6 Operating Mechanism

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

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

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

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

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

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

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

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

- 6.1.13 The complete breaker assembly should have inter-changeability with breakers of identical ratings.
- 6.1.14 The switchgear shall be supplied in single tier arrangement i.e. one circuit breaker in one vertical panel. For switchgears specified with double tier circuit breaker arrangement, the outgoing feeder breakers shall have double tier arrangement and incomer breakers with Line/bus PT shall be housed in one vertical panel. In double tier arrangement, sheet steel partitions shall be provided for each compartment. Compartmentalization shall be such that maintenance of one breaker is possible without disturbing the adjacent breaker compartment. Suitable trolley(s) shall be supplied for drawing out the breakers in upper tier. The maximum height of the operating handle/switches/reset knobs/pushbuttons shall not exceed 1900 mm and minimum height shall not be below 300 mm.
- 6.1.15 An integral earthing system, or a separate earthing carriage/truck, shall be provided. In case of a separate earthing carriage, the necessary trolleys for bus-side and cable-side earthing shall be supplied. After withdrawing the circuit breaker, this can be inserted to facilitate earthing of cables and bus bars. Earthing truck shall be complete with the PT and voltmeter giving audio-visual indication and solenoid interlock to prevent closing of bus side earthing truck on live busbars. In case voltmeter cannot be provided suitable voltage detecting system shall be provided. Suitable interlock shall also be provided for Earthing switch. Earthing truck/earthing switch operation shall be only with door closed.
- Integral earthing switch shall be suitable for short time withstand current and peak withstand current rating equal to the corresponding breaker withstand rating.
- 6.1.16 Number and type of earthing trucks shall be as specified elsewhere.
- 6.1.17 Circuit breaker electrical endurance shall be class E2 and mechanical endurance shall be class M2 as per IS/IEC-62271-100. Probability of restrike during capacitive current breaking shall be of class C1 as per IS/IEC-62271-100 except for capacitor feeders which shall be of class C2 as per IS/IEC-62271-100.

6.2 Fuse Contactor Units

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

Fuse contactors shall be fully drawable type.

Contactors shall comply with IS/IEC-60470 and shall be suitable for intermittent duty class 0.1 as well as for uninterrupted duties.

The minimum short circuit breaking capacity of the contactor shall be at least 6 kA at rated voltage.

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

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

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

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

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

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

6.3 Instrument Transformers

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

6.3.1 Current transformer

- i) Current transformers shall conform to IS: 2705 Part-1 and IS:16227 Part-1 & 2. The short-time current rating shall be equal to that of the switchboard. They shall be mounted on the stationary part of the switchboard. The CT ratings shall be as shown in the data sheet. Protective CTs shall have an accuracy class of 5P and an accuracy limit factor greater than 10. CTs for instruments shall have an accuracy class of 1.0 and an accuracy limit factor less than 5.0. For numerical relays having protection and metering functions, dual rated CT shall be provided suitable for protection class and metering class. One leg of the CTs shall be earthed. Separate CTs shall be provided for each of Differential protections such as transformer, line, bus, motor, Restricted Earth fault protection, etc. However, common CT having separate cores for any differential and Restricted Earth fault protection is acceptable.
- ii) All CTs shall be star connected. Interposing CT (ICT) shall be provided (if required) for differential protection of transformers having star-delta connection.
- iii) Proper access to each set of CTs shall be provided for repair / maintenance.
- iv) Core Balance Current Transformer shall be provided in motor feeders for sensitive earth fault protection, if specified in job specifications/datasheet/Tender.

6.3.2 Potential transformer

- i) The potential transformers shall conform to IS: 16227-1 & 16227-3. The potential transformers shall be of drawout-type, and shall be provided with 4 pole miniature circuit breakers with auxiliary contacts on the secondary side.
- ii) The drawout mechanism shall disconnect the PT from the busbars. The primary connection shall be disconnected before the PT becomes accessible. Neutral point of the star connected PTs both on the primary and secondary sides shall be earthed.
- iii) The PTs shall have an over-voltage factor of 1.2 continuous and 1.9 for 30 seconds, and an accuracy class of 1.0 from 10% to 120% of normal voltage. PT selected shall be compatible with system grounding. Also precaution shall be provided to mitigate the problem of ferroresonance.
- iv) The primary rated voltage shall be equal to the rated voltage V of the system, or $V/\sqrt{3}$, if the PT is connected between phase and neutral.
- v) If not otherwise specified, the secondary voltage shall be 110 V, or $110/\sqrt{3}$ V. The burden and class of accuracy shall be as specified in data sheets. For directional relays, either a 3-phase 5-limb PT, or 3 single-phase PTs with secondary windings connected in open delta shall be provided.

6.4 Measuring Instruments

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

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

6.4.1 Ammeters and voltmeters

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

6.4.2 kW / kWh meters

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

6.4.3 Frequency meters

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

6.4.4 Power factor meters

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

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

6.5 Relays

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

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

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

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

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

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

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

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

6.6 Auxiliary Equipment

6.6.1 Auxiliary relays and contactors:

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

6.6.2 Control Switches:

- i) All control switches shall be rotary type, having a cam-operated contact mechanism otherwise stated. Circuit breaker control switches shall be 3-position CNT, spring return to neutral from both Close and Trip positions. They shall have pistol-grip handles and shall be lockable.
- ii) Ammeter selector switches shall have a make-before-break feature on its contacts. The selector switch shall generally have four positions, three positions for reading 3-phase currents and the fourth position for OFF. The voltmeter selector switch shall also have four positions, three positions shall be used to measure phase-to-phase voltages and the fourth position shall be for OFF.

6.6.3 Timers:

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

6.6.4 Indicating Lamps:

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

7.0 INSPECTION, TESTING AND ACCEPTANCE

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

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

8.0 PACKING AND DESPATCH

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

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

 ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)		HV SWITCH BOARD DATA SHEET		Document No. B957-000-16-50-DS-0101 Rev. No. B Page 1 of 4	
Project	Overall Project Management as MPMC and PMC/EPCM Services for Ethylene Cracker Unit and U&O for BPREP			Client	BPCL
Unit	Common	Location		Job No.	B957
				Unit No.	000
PURCHASER'S DATA					
A. Site Conditions					
1.	Maximum Ambient Temperature	°C	48		
2.	Minimum Ambient Temperature	°C	1.1		
3.	Design Ambient Temperature	°C	45		
4.	Relative Humidity	%	86		
5.	Altitude Above MSL	mm	<1000		
6.	Environment	Hot, humid & corrosive			
B. Operating Conditions					
1.	Voltage	kV	By Vendor +/- 10 %		
2.	Frequency	Hz	50+/-5%		
3.	No of phases	Three			
4.	System fault level	kA	40		
5.	System earthing	Resistance Earthing			
6.	Auxiliary supply				
	AC	V	240 +/- 5 %		
	DC	V	110 +/- 10 % DC		
C. Electrical Data					
1.	Busbar current rating (inside panel at design temp.)	By Vendor			
2.	1 sec. Short Circuit withstand capacity	kA	40		
3.	System Breaking capacity	kA	40		
	% D.C. Component	As per IEC			
4.	System making capacity	kA(peak)	100		
5.	Type of Circuit Breaker	VCB			
	Shunt Trip Coil-1 :	V	110 DC		
	Shunt Trip Coil-2 :	V	230V AC (Refer Note-2) AC		
6.	Duty Cycle of C.B.	O-3min-CO-3min-CO			
7.	Suitability for Cap. Switching	Required			
8.	Surge supressor for Motor Feeder.	Yes			
9.	Provision of earthing				
	Earthing truck	Required			
	Earthing switch	Not Required			
D. Miscellaneous					
1.	Interface with ECS	Required			
2.	Incoming Power Entry	Bus Duct			
3.	Cable Entry	NA			
4.	Separate bolted removable gland palte for cable entry	Reqd.(Gland Plate Drilled at side)			
5.	Cable glands and lugs for cable termination	Included			
6.	Paint shade	RAL-7032			
7.	Windows at the rear side of panels for thermography	Not Required			
MANUFACTURER'S DATA					
A. Switchboards					
1.	Make				
B	13-JAN-2025	ISSUED WITH MR	KANUGUTTA SUMITH	RASHMI SINGH RATHAUR	RASHMI SINGH RATHAUR
Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By

Project	Overall Project Management as MPMC and PMC/EPCM Services for Ethylene Cracker Unit and U&O for BPREP			Client	BPCL	
Unit	Common	Location	Job No.	B957	Unit No.	000
2.	Type designation					
3.	Degree of protection					
4.	Max. overall weight of C.B. panel	Kg				
5.	Overall dimensions of C.B. panel					
	Width	mm				
	Depth	mm				
	Height	mm				
6.	Overall dimensions of dummy /gland palte for cable entry					
	Width	mm				
	Depth	mm				
	Height	mm				
7.	Overall weight and dimensions of largest shipping section					
	Weight	Kg				
	Width	mm				
	Depth	mm				
	Height	mm				
8.	Overall dimensions of each swbd. including all dummy/adaptor/rear extension panels					
	Width	mm				
	Depth	mm				
	Height	mm				
9.	Recommended clearances					
	Front	mm				
	Rear	mm				
	Above	mm				
10.	Shock loading on foundation					
11.	Max. size/no. of cables that can be terminated inside the panel					
	without rear extension panel					
	with rear extension panel					
	size of rear extension panel					
12.	Clearance in air					
	Phase to Phase (min.)	mm				
	Phase to Earth (min.)	mm				
13.	Busbar current rating at design ambient temperature	A				
14.	Busbar (separately for each swbd)					
	(a).Horizontal main busbar size (No. of flats x size of each flat)					
	(b).Horizontal main busbar size as tested at CPRI for full short ckt					
	withstand as per specification requirement (No. of flats x size of each flat)					
	(c).Vertical dropper size (No. of flats x size of each flat)					
15.	Horizontal main busbar/Vertical busbar material					
16.	Insulating material (Busbar supports)					
17.	Earth busbar size					
18.	Earth busbar material					
19.	1 min. power frequency withstand voltage (rms)	kV				
	Over voltage factor for PTs					
20.	Impuse withsatnd voltage (peak)	kV				
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Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By	

 ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)		HV SWITCH BOARD DATA SHEET		Document No. B957-000-16-50-DS-0101 Rev. No. B Page 3 of 4	
Project	Overall Project Management as MPMC and PMC/EPCM Services for Ethylene Cracker Unit and U&O for BPREP			Client	BPCL
Unit	Common	Location		Job No.	B957
				Unit No.	000
	Wave shape of impulse voitage				
21.	1 sec. short ckt. Withstand capacity		kA		
22.	Peak dynamic withsatnd capacity		kA		
23.	Safety Features				
	(a).Heat shrinkable sleeves, rated to				
	withstand the system line to line				
	voltage for one min., provided on busbar				
	(b).Removable FRP shrouds for all busbar				
	joints and tap-off connections provided				
	(c).Arc propagation barrier in busbar				
	compartment provided				
	(d).Breaker service, test and drawn-				
	out position provided				
	(e).Distinct overall lockable door for				
	breaker compartment provided				
	(f).Automatic safety shutter provided				
	(g).Independent pressure release				
	flaps provided for all HV compartments				
	(h).Wire mesh for all louvered				
	openings provided				
	(i).Suitable interlocks to prevent				
	faulty operation as per Cl. 4.4.10				
	of spec. 6-51-0001 provided				
	B. Circuit Breaker				
1.	Type				
	2nd shunt trip coil for VFD feeders				
2.	Make				
3.	Type Designation				
4.	Circuit Breaker mounting in panel				
5.	No. of poles/phase				
6.	Current rating (in free air)		A		
7.	Current rating inside the panel at specified design tempeature		A		
8.	Short time rating (1sec.)		kA		
9.	Symmetrical breaking capapcity		kA		
9.1	% D.C. Component				
10.	Peak making current		kA		
11.	1 min. dry withsatnd voltage (power frequency)		kV		
12.	Duty Cycle				
13.	Total openeing time		m sec.		
14.	Total closing time		m sec.		
15.	Power required for opening		W/VA		
16.	Power required for closing		W/VA		
17.	Power required for spring charging motor		W/VA		
18.	Breaker is trip free				
19.	Closing mechanism				
20.	Provision of manual spring charging provided				
21.	Mechanical Trip PB provided				
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Project	Overall Project Management as MPMC and PMC/EPCM Services for Ethylene Cracker Unit and U&O for BPREP			Client	BPCL
Unit	Common	Location	Job No.	B957	Unit No. 000
22.	Mech. On/Off indicator provided				
23.	Operation counter provided				
24.	Time taken for spring charging	sec.			
25.	No. of aux. contacts and their current ratings				
26.	Interrupter				
	(a).Make				
	(b).Pressure switch for monitoring of SF6 gas pressure provided				
	(c).Re-filling arrangement of SF6				
27.	LOTO (Lock-Out Tag-Out) Provision for mechanical locking arrangement				
28.	Supressor				
	Type designation				
	Make				
27.	Derating reqd. for Cap. Switching				
29.	Earthing System				
30.	Copies of following test cerificates enclosed				
	For each type of offered circuit breaker panel with breake				
	(a).Short Circuit tests (Peak and 1 sec.withstand)				
	(b).Heat run test				
	(c).Internal arc test				
	(d).Impulse and power freq. withstand				
	For each type of offered circuit breaker (in panel)				
	(a).Short Circuit test duties				

Eil Notes

- 1 Numerical Relays shall be provided. However, wherever specifically mentioned in the MR, electromechanical type relays shall also be provided.
2 Vendor shall furnish the dimensions of various types/ratings of swbds., CB panels and dummy/adaptor panels separately.

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एच वी स्विचबोर्डों के लिये निरीक्षण व परीक्षण योजना

INSPECTION AND TEST PLAN FOR HV SWITCHBOARDS UP TO 33KV

4	14.01.2020	Revised and Reissued	MM	RS	RKS	RKT
3	21.11.2013	Revised and Reissued	MJ	RS	SCG	SC
2	15.07.2011	Revised and Reissued	GS	SA	AKC	DM
1	28.09.2007	Revised and Reissued	AKG	PPM	MVKK	VC
0	30.04.2002	Issued for implementation	RG	AKC	AK	GRR
Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	

Abbreviations:

BIS	:	Bureau of Indian Standard	PO	:	Purchase Order
CIMFR	:	Central Institute of Mining & Fuel Research	PESO	:	Petroleum Explosive Safety Organization
ERTL	:	Electronics Regional Test Laboratory	PR	:	Purchase Requisition
FM	:	Factory Mutual	PVC	:	Poly Vinyl Chloride
FLP	:	Flame Proof	QC	:	Quality Control
FRLS	:	Flame retardant low smoke	SF6	:	Sulphur Hexa Fluoride
ITP	:	Inspection and Test Plan	TC	:	Test Certificate
IP	:	Ingress Protection	TPI or TPIA	:	Third Party Inspection Agency
IC	:	Inspection Certification	UL	:	Under writer Laboratories
IEC	:	International Electro technical Commission	VDR	:	Vendor Data Requirement
JEC	:	Japanese Electro technical Committee	XLPE	:	Cross Linked Poly Ethylene
MTC	:	Material Test Certificate			
NEMA	:	National Electrical Manufacturers Association			

Inspection Standards Committee

Convenor :	Mr. RK Singh		
Members:	Mr. Rajesh Sinha Mr. Avdhesh Agrawal	Mr. Chandrasekhar Mr. Deepak Gupta (Project)	Mr R Muthuramalingam (RPO representative)

1.0 SCOPE

This Inspection and Test Plan covers the minimum testing requirements of indoor, draw out type High Voltage Switchboards up to and including 33 KV.

2.0 REFERENCE DOCUMENTS

PO/PR/ Standards referred there in/Job specifications/Approved documents/Relevant BIS/IEC Standards.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	Procedures	--	--	----	--	--	--
2.0	Material Inspection						
2.1	Incoming major Material like Bus Bars, sheet metal, Cable wire (FRLS), instrument transformers, Relays, Breakers, Vacuum Bottles, etc	Visual, Dimensional, Operational checks (as applicable)	100%	MTC's/ Inspection & Test records / Lab Test Records/ Manufacturer's Test Certificates	H	H	R
3.0	In process Inspection						
3.1	Breaker Assembly	Mechanical including spring charging mechanism & time, Breaker opening / closing at normal and worst voltage conditions, Opening / closing time and	100% by Supplier and random by EIL/TPIA	Test Records / Inspection Witness Record	-	H	W #

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TP/A
		simultaneous closing of all poles, Contact resistance measurement, Gas leakage check (for SF6 breakers), Power Frequency Test.					
3.2	Wiring checks	Size, termination, ferruling, continuity, color coding, make, type	100%	Suppliers Test Records	--	H	----
4.0	Final Inspection						
4.1	Switchgear Assembly (Routine test)	- Visual check including layout, Tag plates, Paint shade, Bus marking and sleeving, Joint shrouding, Identification and location of components, safety shutter operation check, verification of partition type, earthing arrangement, wiring checks etc - Dimension check including operational height, Bus bar size, Clearances, Creepage distances, termination height, Compartmentalization; cable gland size, Paint shade, thickness & adhesion check etc.	100%	Test Records / Inspection Witness Record	-	H	H

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
	Switchgear Assembly (Contd.)	• Verification of Bus bar support arrangement with respect to GA drawing and type tested panel drawings and provision for external cable termination. • Bill of material check. • Rack-in and Rack-out of breakers * • Mechanical and electrical interlock checks on test and service position of circuit breaker * • Interchangeability of Truck assembly in identical feeders.* • Pressure switches operation for SF6 breaker. *(as applicable) • Operation check for auxiliary equipment circuits and auxiliary contacts * • Operation checks for all control functions and interlocks as per schematic diagrams in Service position	100%	Test Records / Inspection Witness Record	-	H	H

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
		- Logics and interlock checks on incomers and bus coupler sections as per job specification and approved documents - Relay operation check through primary / secondary injection.* - Measurement of resistance of main circuit. - Communication check between relays and Ethernet switches /Data concentrator / HMI (if applicable)* - HMI operation and functional checks as per separate agreed ITP/FAT(if applicable) - Insulation resistance of main, auxiliary and control circuits before and after High Voltage Test. - Power Frequency voltage withstand test on main, auxiliary and control circuits. - Short time current withstand test					
4.2	Switchgear Assembly (Type Test) %		On each Type/Rating	Test Agency Reports	-	R/H**	R/H**

**INSPECTION AND TEST PLAN
FOR
HV SWITCHBOARDS**

STANDARD SPECIFICATION NO.
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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
		• Impulse and Power Frequency withstand Test • Temperature Rise test • Internal Arc test (in AFLR Condition) • Check for Thermography window (if specified) • Operating sequence test (Duty cycle test) for breaker & endurance test • Degree of protection for panels					
5.0	Painting						
5.1	Painting and Packing	• Visual • Suitable protection to prevent entry of foreign material. • Proper packing to prevent any damage during transportation and storage, as per contract.	100%	Packing list / Supplier's Records	-	H	-
6.0	Documentation and IC						
6.1	Documentation and IC	• Review of Internal Test Reports • IC issuance.	100%	Supplier's Test Records / Inspection Certificate	-	H	H

**INSPECTION AND TEST PLAN
FOR
HV SWITCHBOARDS**

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
6.2	Final Document submission	Compilation of Inspection reports, drawings, etc as per VDR / PR	100%	Final data folder /Completeness certificate	-	H	H

- * Quantum of check is 100% by Supplier & random basis by EIL/TPIA(as applicable)
 ** Witness if called for in job specifications. In such cases specified Type test will be considered as part of routine test.
 # Breaker assembly test can be witnessed during final inspection.
 % Sequence of type testing shall be as per latest IEC.

Legends: H- Hold (Do not proceed without approval, R-Review, RW-Random witness (As specified or 10 % - Samples must include min 1 No of each type),
 W- Witness (Give due notice, work may proceed after scheduled date).

NOTES :-

1. This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable. (Unless otherwise agreed upon).
2. Acceptance Norms for all the activities shall be as per PO/PR/ Standards referred there in/ Job specifications /Approved documents.
3. Supplier has to submit the internal test report for the offered switchboard before the scheduled inspection date.

JOB SPECIFICATION (ELECTRICAL) FOR CENTRIFUGAL COMPRESSOR SPP (MR No. – B957-300-KA-MR-5020)

PROJECT : EPCM SERVICES FOR REFINERY FACILITIES
RELATED TO BPREF- BPCL

CLIENT : M/s BPCL – BINA REFINERY

CONSULTANT : ENGINEERS INDIA LIMITED

EIL JOB NO. : B957

B	23.05.2025	REVISED AND RE-ISSUED WITH MR	SKANU	MKM	RSR
A	28.04.2025	ISSUED WITH MR	SK	MKM	RSR
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

1. GENERAL

- 1.1 The specification defines the basic requirements of the electrical works in vendor's scope for the centrifugal Compressor Package for BPREP Bina Refinery Project. This job specification shall be read in conjunction with EIL standard specifications, data sheets and documents attached with the Purchase Requisition. In case of any conflict amongst various documents enclosed with MR, the most stringent requirement shall govern and Owner/EIL decision in this regard shall be final.
- 1.2 The equipment shall conform to this specification, enclosed data sheets and standard specifications.

2. SCOPE

Vendor's scope shall include sizing, design, engineering, manufacturing, procurement, inspection, testing at manufacturer's works, supply, packing & delivery of complete electrics at site, supervision during erection, testing and commissioning at site, including supply of all commissioning spares, 2 years O&M spares, mandatory spares, special tools & tackles as per the specifications and data sheets enclosed with the requisition. The major electrical scope of work is: -

- 2.1 Main Motors for Compressors as per below table.
- 2.2 Redundant Variable frequency drive along with redundant PLC.
- 2.3 Auxiliary motors, heaters etc.
- 2.4 Local control station for Main Motors and Auxiliaries.
- 2.5 All interconnecting cabling between the equipment supplied by Vendor within the package battery limits (within the field).
- 2.6 Earthing of electrical equipment within the skid and provision for bonding with owner's main plant earth grid (at min. two locations).
- 2.7 Double Compression WP (min. IP-55) & FLP Cable Glands and lugs for Vendor's supplied equipment.
- 2.8 Motor Attachment/fixing bolts, base plates, anchor bolts etc.
- 2.9 All data & drawings as per Vendor data requirements, data sheets, specifications and referenced codes and standards.
- 2.10 Inspection & testing as per the applicable standard specification & inspection test plan attached with the requisition for electrical items.

3. EXCLUSIONS

- 3.1 Supply of 6.6kV circuit breaker feeders for VFDs.
- 3.2 Supply of 415V feeders for auxiliary motors, heaters other misc. electrical loads.
- 3.3 Supply, laying & termination of all power (HV & MV), control and space heater cables from field to Substation.
- 3.4 Earthing grid outside package battery limit.

4. UTILIZATION VOLTAGE

6.6kV TP and 415V TPN power supply as required will be made available by Owner at the incomer of each VFD Panel to be supplied by the Vendor. The arrangement of any other power supply, if required, shall be made by the Vendor. The size of the incoming cable, VFD to output breaker panel, Output breaker panel to motor shall be provided at the time of drawing approval based on the load furnished by the Vendor.

Utilization voltage for motor, aux. heaters, anti-condensation heaters based on their ratings shall be as listed below:

A Voltage and frequency variation

- i). AC System

Voltage	6.6kV / 415V $\pm$ 10%
Frequency	50 Hz $\pm$ 5%
- ii) DC System Voltage

Electrical protection and Control system.	110V $\pm$ 10%
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B Utilization voltage

- i). MV motor voltage ($0.18 \leq kW \leq 132$) 415 V AC except VFD motor
- ii). AC Motors rated below 0.18 kW for process area 240 V AC
- iii). Incomer for VFD for motors rated upto 315kW without bypass 415 V AC TPN
- iv). Incomer for VFD for motors rated above 315kW without bypass 6.6 kV AC TP
- v). Incomer for VFD for motors rated upto 132kW with bypass 415 V AC TPN
- vi). Incomer for VFD for motors rated above 132kW with bypass 6.6 kV AC TP
- vii). Anti-condensation heaters for motors 240 V AC, SPN
- viii). Bulk loads like process Heater etc. 415 V AC TPN

C Utilization voltage for critical supplies

- i). Control supply for VFDs 230 V AC UPS
- ii). Switchgear Protection control power supply 110V DC UPS

5. SPECIAL REQUIREMENT

5.1 VFD shall fulfil the following requirements: -

- 5.1.1 The VFD system having converter input voltage above 1000 shall conform to EIL specification 6-51-0050 and VFD datasheet no. B957-000-16-50-DS-5003.
- 5.1.2 For single large/critical drives with VFD, redundant VFDs (Hot Standby) along with redundant PLC for change over without any common point of failure shall be provided and shall have provision for Auto/Manual change over between the running and standby VFDs without tripping / stopping the motor. Drives for motor

driven ID/FD Fan with only single drive shall be considered as critical drive. Any additional requirement and identification of critical drives shall be done during detailed Engineering and approval on same shall be obtained from Owner/EIL

- 5.1.3 All drives for critical application shall be provided with HMI for trending & diagnostics
- 5.1.4 As dual redundant VFDs are being provided, bypass to VFD is not required.
- 5.1.5 VFD shall limit the starting current to 1.0 times full load current.
- 5.1.6 Owner's incoming feeder breaker shall be provided with 2 nos. trip coils. In case VFD vendor requires under voltage release (in place of second trip coil) or any other safety feature other than two no's shunt trip coils in the upstream Owner's breaker, VFD manufacturer shall get the upstream breaker modified through OEM.
- 5.1.7 Harmonics at the supply side of the drive system shall be restricted within the maximum allowable levels of current and voltage distortion as per recommendations in the latest edition of IEEE-519. The vendor shall perform design calculation for harmonic filter system considering VFD connected to the power system and including the supply of harmonic filters along with all accessories which shall be installed at owner's power system unless otherwise specified. These harmonic studies shall be conducted with maximum and minimum system fault level (details of which shall be provided by Owner during detailed engineering), cable capacitance, system equipment reactance etc. The studies shall highlight but not be limited to maximum load current, expected resonant frequencies, need of harmonic filters, sequence of switching of filters, voltage wave form, rating of equipment/ feeder for feeding filters from owner's switchgear etc
- 5.1.8 Necessary design in VFD shall be considered to avoid drop in the output voltage of VFD. Various parameter i.e., Harmonic content, THD, output voltage/ current etc. at the output of VFD shall be within acceptable limits as per relevant IS/IEC
- 5.1.9 For calculation to limit harmonics within limits as per IEEE 519, system parameters shall be informed during detail engineering. Vendor to provide harmonic spectrum of VFD for harmonic analysis. Following details shall be provided as minimum.
 - Current harmonics at 100% and 50% loading for each harmonic order
 - Voltage harmonics at 100% and 50% loading for each harmonic order
 - Pulse modulation number
 - Phase shift angle
 - Rectifier firing angle
 - Advance angle
 - Commutation reactance in percent of the rated reactance
- 5.1.10 Vendor to furnish detailed harmonic analysis report indicating harmonic current and voltage for each harmonic order
- 5.1.11 Vendor to ensure that while selecting the rating of VFD and its transformers, design margin of 20% is considered over and above the standard design margin considered by the VFD manufacturer. VFD sizing calculation including sizing of input transformer shall be furnished for Owner's review

- 5.1.12 VFDs shall be considered with PLC based control schemes and breaker hard contacts shall be used for interlocking in VFDs
- 5.1.13 The VFD system shall be arranged so that it can be operated in an open circuit mode, disconnected from the motor for start-up adjustments and troubleshooting/maintenance
- 5.1.14 VFDs shall be installed in Air-Conditioned area, however, same shall be suitable for operation in non-air-conditioned environment also
- 5.1.15 MODBUS TCP/IP port shall be provided for communication to HMI / ECS.
- 5.1.16 Requirement of dedicated clean earth for VFD system (if any) shall be suitably indicated by the vendor.
- 5.1.17 The input transformer for the VFD system shall be converter duty type and dry type, VFD Panel mounted only.
- 5.1.18 51G and 64R relays for input transformer of VFD system shall be decided by VFD Manufacturer
- 5.1.19 Complete VFD shall be air cooled type. Water cooled system shall be avoided. Water cooled VFDs, in case unavoidable, shall be closed-circuit water-cooling system (make up water) type as per clause 5.4.2 of EIL specification 6-51-0050
- 5.1.20 The package vendor shall be solely responsible for proper selection of the input transformer, HV Switchboards, VFD and motor for the given load application and the output characteristics of the drive. Sizing, selection & calculation of VFD/motor/transformer/HV switchboards shall be furnished during detailed engineering for Owner's review
- 5.1.21 VFD system shall include line PT and any other hardware along with synchronization panel required for synchronization of output breakers
- 5.1.22 Combined testing of motors and associated VFDs & input/output transformers as a unit shall be carried out at minimum speed required as per process requirement & temperature rise measured to ensure that the same is within permissible limits. This test may not be required in case same make / type / rating of motor & VFD as a unit has been already tested and copy of test certificate will be furnished for EIL/Owner's reference
- 5.1.23 The required provision for the interface with Substation automation system (SAS) or Electrical Control System (ECS) including the details of communication module and data transfer facility, I/O details shall be furnished. The communication interface shall be as per attached ECS I/O list. Communication link shall be with industry standard open protocol i.e., MODBUS/Data Highway Plus/IEC-61850/RS-485 etc. and same shall be coordinated with the interfacing equipment. In case the vendor is using their proprietary software, the interface software for use with Owner's system (software) shall be provided
- 5.1.24 Current Transducer for taking 4-20mA current/power/speed signal to DCS & ECS shall be provided by Vendor in the VFD Panel
- 5.1.25 Fault diagnostic shall be built into the system to supervise the operation and failure of the system. The information regarding failure of any of the system including, shutdown of the system, shall be available for a period of minimum 4 days (96 hours) after a shutdown, even though no supply would be available to the

system. The system may be totally de-energized for maintenance or otherwise. It shall be possible to retrieve the record of events prior to tripping of the system or de-energisation. Auxiliary supply to the system components or to the electronics (firmware) for the diagnostics / display shall be taken care by the manufacturer for this purpose

- 5.1.26 Control supply for VFD shall be 230V AC supplied from UPS installed in the substation. Vendor shall provide control system suitable for 230V AC control supply. Any further auxiliary power supply required by Vendor shall be tapped from 415V incoming power supply provided by Owner. Any control transformer required for the same is also included in vendor's scope
- 5.1.27 240V, 1-Phase power supply for motor and panel space heater shall be provided separately to the VFD. Necessary arrangement for controlling/interfacing these supplies shall be made available in VFD panels. Further distribution & control to motor space heater shall be in VFD panel
- 5.1.28 Joint declaration shall be furnished by Compressor vendor, driven equipment vendor, VFD vendor and motor vendor confirming that driven equipment, VFD and motor compatibility have been verified and ensured for satisfactory operation of the complete system as per contract requirement specifically w.r.t. dv/dt , V_{peak} and V_{THD} (O/P).
- 5.1.29 Effect of long length of cables shall be taken into consideration while sizing / designing VFD including its corresponding effects on motor design.
- 5.1.30 All special cables as required for VFDs based on VFD vendor recommendation shall be supplied by Vendor.
- 5.1.31 Normally drives shall be without ventilating fans. If system demands, provision of ventilation with redundant fans and fan fail alarm to be provided. VFD internal cooling Fans shall be fed from its internal supply only.
- 5.1.32 Diode O-Ring or equivalent based dual supply shall be provided for VFD panels.
- 5.1.33 Comprehensive Post warranty Annual Maintenance Contract (PWAMC) for vendor supplied VFD for a period of 5 years after completion of guarantee period following requirements shall be taken care:
 - I. Vendor shall propose 5 years for VFD comprehensive post warranty annual maintenance contract shall mention the service to be provided, methodology, scope of work and Vendor's responsibility with year wise break up. Placement of this comprehensive AMC will be done after expiry of the guarantee period. In the event of any malfunction of the system hardware / system software, experienced service engineer shall be made available at site within 24 hours on the receipt of such information from Owner.
 - II. The contract shall include supply of maintenance spares, tools & tackles as required. Travel, boarding & lodging of service engineer shall be by Vendor. The quote shall be made year wise up to 5 Years (for VFD). Contract shall include on site stock & shall give cost of each item after expiry of 5 Years CPWAMC.
 - III. The service under Comprehensive Post Warranty Annual Maintenance Contract including supply of spare parts and services shall broadly encompass:
 - Preventive maintenance

- Periodic maintenance
 - Emergency service
 - Software support
- IV. Preventive maintenance: Once in a year, involving complete overhaul of the Electrical Equipment, inspection of hardware and software, fault prediction, inspection of power supply quality, environmental and operating condition checks, calibration checks, major repairs/replacements and detailed reporting. This visit is in addition to visit required for periodic maintenance
- V. Periodic maintenance: Site visits, minimum four to six times in a year, inspection of general healthiness of the system, study and advice on daily maintenance, inspection of hardware and software of Electrical Equipments. If any problem is reported, running of test programs, on line servicing and solving reported problems. Checks shall be conducted on running system i.e.
- On-line sub-systems
 - Power supply checks
 - Others Vendor to mention
- VI. Software maintenance: Maintain existing software to improve and utilize existing application and improve performance of the system. Minor software modifications shall also be covered under this scope
- VII. Emergency service: Any failure shall be on system suppliers' account. In the event of any malfunction of the Electrical Equipment, system hardware/ software during this period, Service Engineer must report at site within 24 hrs. of report of failure with necessary spares. The Electrical Equipment must be brought back within 24 hours after reporting at site

Notes:

1. Vendor to note that while carrying out the Comprehensive Post Warranty Maintenance Contract Activities Owner's engineers may associate with system engineers. On job training of these associated engineers shall be covered under this scope.
 2. All financial aspects of the Post Warranty Maintenance Contract must be listed clearly by the Vendor
- 5.1.34 Vendor to ensure that back-to-back warranty from VFD Vendor is provided/ passed on to BPCL.
- 5.1.35 Thermistors shall be provided in VFD driven motors and the provision for tripping the motor in case of excess temperature shall be considered
- 5.2 **Motor shall fulfill the following requirements:**
- 5.2.1 HV motors (6.6 KV) for DOL start shall conform to EIL Specification 6-51-0031 and HV Motor data sheet no. B957-000-16-50-DS-3101.
- 5.2.2 The pressurized motor shall conform to IS/ IEC 60079-2.

- 5.2.3 HV induction motor shall conform to EIL Specification 6-51-0031 and HV Motor data sheet no. B957-000-16-50-DS-3102 for VFD mode start & run
- 5.2.4 MV motors (<1100V) for DOL start shall conform to EIL Specification 6-51-0064 and MV Motor data sheet no. B957-000-16-50-DS-6401.
- 5.2.5 Motors shall not have dual winding
- 5.2.6 Space heater shall be provided for motors rated 30 kW and above.
- 5.2.7 HV motors shall be provided with starting current limited to 500% of full load current including positive tolerance.
- 5.2.8 All accessories like nuts, bolts, washers, earthing studs etc. shall be made of stainless-steel SS-304.
- 5.2.9 The enclosure type / area classification for motors and their auxiliaries shall be as listed below:

Sl. No.	ITEM NO	Service	Area Classification	Enclosure Type
1.	300-KA-CF-3001	HYDROGEN COMPRESSOR	ZONE-2, IIC, T-3	Ex-p/Ex-d
2.	300-KA-CF-2701	PGH RECYCLE GAS COMPRESSOR	ZONE-2, IIC, T-3	Ex-d
3.	Auxiliary motors.		ZONE-2, IIC, T-3	Ex-d
4.	Auxiliary Heaters, LCP, Junction Box etc.		ZONE-2, IIC, T-3	Ex-d

- 5.2.10 All motors/ other misc. electrical loads shall meet the requirements of latest IS/IEC-60079-1.
- 5.2.11 Motor bearing details shall be indicated in name plate to facilitate operation & maintenance team.
- 5.2.12 Pressurization and purge control panel shall be provided with 230V UPS power supply. All interlocks (status & command) from purge control panel shall be wired to local LCP in field.
- 5.2.13 Terminal box of all the motor shall be suitable for rotation by 90 degrees.
- 5.2.14 Exact cable sizes of power and control cables shall be finalized during detailed engineering. Provisions, as required in Vendor's equipment for termination of the same, shall be made accordingly without any cost & time implications to Owner.
- 5.2.15 Vendor to note that the MV motors supplied shall be of Energy efficient (IE-3) type as a minimum as per IS 12615/IEC 60034-30.
- 5.2.16 Motors installed outdoors shall have FRP canopy for additional weather protection
- 5.2.17 Motors shall be capable for 20 % over speed without danger of mechanical failure
- 5.2.18 All HV Motors shall be provided with temperature transmitters connected to DCS for data logging, trending and DCS trip command generation.
- 5.2.19 Trolley mounted pumps shall be powered from a nearby 5 pin socket supplied by client. Vendor to provide trolley mounted flame proof motors and their flameproof

starters suitable for use in Zone-2, Gas group IIC, Temp class T3, with 30 meters of armored copper conductor trailing cable.

- 5.2.20 The cable entries of all Terminal Boxes of motors, before dispatch from motor manufacturer works, shall be fitted with suitably sized IP-55 Metallic Sealing Plugs to prevent water entry/ingress in motor windings through openings meant for cable entry in terminal boxes at construction site till the time motors are erected and cable terminations are done. Flameproof & weatherproof nickel-plated brass cable glands shall be supplied loose
- 5.2.21 Cable glands to be supplied with the motor shall be of WP (minimum IP-55) suitable for use in Zone-2, Gas group IIC, Temp class T3 and shall meet all the requirement of IS/IEC-60079-0/15. Thread shall be ET type
- 5.2.22 Motor bearing details shall be indicated on motor name plate to facilitate operation & maintenance team
- 5.2.23 HV motors terminal box shall be phase segregated & suitable for cable size provided during detail engineering.
- 5.2.24 Vendor to provide adequate size of motor terminal box to accommodate & terminate Owner's cable sizes and avoid additional intermediate JB for motor termination
- 5.2.25 In case it is not feasible to provide motor terminal box suitable to accommodate owner's cables (indicated above), then separate motor junction box shall be provided by vendor to accommodate owner's cable(s) without any time and cost implication to Owner. The Motor junction box shall be Flameproof type (Ex-d) suitable for the specified gas group and temperature classification. FLP JB shall be supplied with FLP cable glands & lugs and shall meet all the requirement of IS/IEC-60079-0/1. Thread shall be ET type
- 5.2.26 The enclosures of the junction boxes shall be of cast light metal alloy. The Junction Box shall be suitable for outdoor location and shall have minimum IP-55 degree of protection. All accessories like nuts, bolts, washers etc. shall be made of stainless-steel SS-304
- 5.2.27 Lifting lugs shall be provided at motor frame for motor lowering and lifting during maintenance.
- 5.2.28 Cl. 6.4.5 of EIL specification 6-51-0064 is superseded by following:
Motor antifriction bearings on drive and non-drive end shall have greasing facility to lubricate the bearings at site and get the maximum bearing life.
- 5.2.29 There shall be proper provision for carrying out the greasing of NDE/DE side of Vertical HT Motor from ground floor. Longer length of grease pipe shall be made available for Vertical HT Motors with grease nipple at bottom of the pipe.
- 5.2.30 Motors shall be provided with bearing temperature sensors for the condition monitoring if specified elsewhere in MR. Bearing temperature sensors shall be resistance type of temperature measuring device (platinum resistance temperature measuring devices of 100 ohms resistance at 0°C and a temperature co-efficient of 3.85×10^{-3}). These sensors shall be provided for bearings with connections terminating in a common terminal box for winding temperature detectors or a separate terminal box in case winding temperature detector is not

applicable for motor. This is required for hook up with a remote located control / monitoring unit.

5.2.31 Vendor to note that, if there is any requirement of emergency electrical power for the auxiliary equipment supplied with the main motor/pump, same shall be furnished in Electrical load data format.

5.2.32 Cl. 6.2.5 of EIL specification 6-51-0064 is superseded by following:

The terminals, cable lugs, terminal box, cable entries and cable glands shall be suitable for the maximum cables sizes as specified below for 2 poles, 4 pole or 6 pole motors. Motor terminal box shall be provided for the given cable size.

Sl. No	Motor Ratings	Estimated Cable size
1	0.37 KW	1R X 3C X 4 sq.mm.
2	1.1 KW	1R X 3C X 4 sq.mm.
3	1.5 KW	1R X 3C X 6 sq.mm.
4	2.2 KW	1R X 3C X 10 sq.mm.
5	3.7 KW	1R X 3C X 16 sq.mm.
6	5.5 KW	1R X 3C X 35 sq.mm.
7	7.5 KW	1R X 3C X 70 sq.mm.
8	11 KW	1R X 3C X 70 sq.mm.
9	15 KW	1R X 3C X 120 sq.mm.
10	22 KW	1R X 3C X 240 sq.mm.
11	30 KW	2R X 3C X 120 sq.mm.
12	37 KW	2R X 3C X 120 sq.mm.
13	45 KW	2R X 3C X 185 sq.mm.
14	55 KW	3R X 3C X 120 sq.mm.

Notes:

- The cable sizes above are tentative and exact cable sizes of power and control cables shall be finalized during detailed engineering which shall be complied by vendor without any cost and time implication to owner.
- Above cable sizes are estimated based on the assumption of starting power factor = 0.4; cable size may increase in case of starting power factor is more than 0.4 and final cable sizes shall be complied by vendor without any time and cost implication to owner.
- In case, the above cable size is not suitable to be terminated in motor terminal box, suitable junction box (Flameproof type) shall be provided. The junction box shall be suitable for the gas group of the respective motors as specified in clause no. 5.4 above.
Incoming cable of the Junction box: shall be as per the above table
Outgoing cable of the junction box / motor Terminal box cable suitability in case of junction box: shall be informed during detailed engineering.
The required junction box as required shall be provided by vendor without any time & cost implication to owner.
- Cable sizes for motor ratings not covered by the above table shall be informed during detailed engineering which shall be incorporated by vendor without any time and cost implication to owner.

- e) Provisions, as required in Vendor's equipment for termination of cables as per above, shall be made accordingly by vendor without any cost & time implications to Owner.

5.2.33 It is utmost important that size of all cable glands and terminal box to be supplied by the vendor shall match with the Owner's cable sizes. Compliance to same is essential to avoid mismatches at Site and for smooth termination and commissioning of the system without delay on account of this issue. Owner's cable size (i.e., overall dia., dia. over armour and dia. under armour) shall be informed to motor vendor during drawing review stage. The correctness of cable entry and cable glands must be ensured by vendor before dispatch of the same to site. Size of terminals inside motors & LCS w.r.t. cable size to be specifically checked and ensured during inspection. Motor terminal box inside dimensional/ size shall be checked for the suitability/ ease of connections / terminations for designed type of cable size during inspection.

5.2.34 The cable entries of motors, before dispatch from motor manufacturer works, shall be fitted with suitably sized weatherproof (IP 55 minimum) Metallic Sealing Plugs to prevent water entry/ingress inside the motors through openings meant for cable entries at construction site till the time motors are erected and cable termination are carried out.

5.2.35 Cable glands shall be nickel-plated brass cable glands. The cable glands shall be single compression type for indoor equipment & double compression type for outdoor equipment. Cable glands for motor shall be supplied loose. For hazardous area equipment, cable glands shall be flameproof and shall meet all the requirement of IS/IEC-60079-0.

5.2.36 Cable lugs shall be crimping type of following material. All the cable lugs shall be long barrel type. Lugs having sector shaped/ circular barrel shall be used for making connections for cables having sector shaped/ circular geometry of conductor respectively. Lugs shall be as per the following:

S. No.	Description	Cable lug material
1.	Copper conductor cable & copper bus bar/ terminals	Tinned Copper
2.	Copper conductor cable & Aluminium bus bar/ terminals	Bi-metallic (Copper barrel with Aluminium palm)
3.	Aluminium conductor cable & Copper bus bar/ terminals	Bi-metallic (Aluminium barrel with tinned Copper palm)
4.	Aluminium conductor cable & Aluminium bus bar/ terminals	Aluminium

5.2.37 Variation / Clarifications against the standard specification of HV motor 6-51-0031 and MV Motor 6-51-0064, shall be as per the MOU agreed with EIL by respective motor manufacturer. No further deviations to MR requirements shall be entertained.

5.2.38 No technical information about motor is required along with bid. The same shall be reviewed during detailed engineering after order placement. However, during bidding stage the vendor shall categorically confirm to all technical requirements with respect to electrical documents as per MR specifications. If the offered Motor

or any other electrical equipment is found to be not in compliance with the technical requirements during detailed engineering, then alternative equipment shall be offered without any time/cost implication to the purchaser. Decision of EIL will be binding and final. Vendor to confirm the same.

5.3 LCS shall fulfill the following requirements:

- 5.3.1 Flameproof and weatherproof control stations (IP-65) for all motors, emergency stop push motors and emergency push buttons as required for plant operation and safety etc. shall be provided by the vendor.
- 5.3.2 Following minimum electrical facilities shall be provided by Vendor on Local Control Station (LCS):
 - a) Start/Stop push button (Stop Push button shall have provision of putting LOTO locks and padlocks.)
 - c) Field ammeter suitable for 4-20mA signal. Ammeter provided at push-button station shall be 240-degree taut band moving coil type.
 - d) Selector switch (Auto-Off-Manual) shall be provided, as required, as per P&ID & operational requirements
- 5.3.3 LCS for VFD controlled motors, in addition the above requirements, speed raise /lower push buttons, speed indication etc. shall be provided. Ammeters in the each LCS to be calibrated as per current at different speed of VFD before dispatch
- 5.3.4 Any additional hardware / control requirement in LCS as per process requirement / P&ID shall be provided by package vendor.
- 5.3.5 One number emergency stop push button station with ammeter (where applicable) shall be provided near each motor having control not in the vicinity and at grade level for motors located at higher elevation. This push button shall be installed at an accessible place and clearly marked with suitable warning instructions
- 5.3.6 Local control stations installed in outdoor area shall have FRP canopy for additional weather protection

5.4 Output Breaker panel shall fulfil the following requirements:

- 5.4.1 Offered panel shall be placed in substation (S/S-101) switchgear hall and shall meet standard specification 6-51-0001, electrical design basis and datasheets enclosed with tender.
- 5.4.2 Offered HV SWBD shall be placed in substation (S/S-101) switchgear hall and shall be of same configuration and fault level as the main upstream switchboard (SC =40 kA for 1 second & IAC = 40 kA for 1 second).
- 5.4.3 In HV switchgear, horizontal bus bar size in the complete board shall be of same size. Similarly, size of the bus bar from horizontal bus to breaker and breaker to outgoing shall be designed based on breaker rating and not on CT/feeder rating.
- 5.4.4 Bidder has included the supply of one set of recommended tools, tackles and special equipment required for the maintenance of the breakers and panels.
- 5.4.5 Bidder has included supply of breaker withdrawal/ handling trolley & accessories (applicable where cassette mounted breakers are offered). Two numbers such breaker trolleys, 5 nos. each breaker racking/ rack out handle, breaker spring charging handle and fuse puller shall be provided.

- 5.4.6 HV switchboards and breakers shall be type tested and the validity requirements for the type test certificates for switchboards and breakers shall be as per the table given below:

Sr. No.	Type Test	Equipment	Validity
1	Short time current Withstand Capacity	HV Switchboard panel, each type of breaker & bus duct	Upto 10 years from the final bid opening date or design change whichever is earlier
2	Internal Arc Fault	HV Switchboard panel	Till any design change
3	Duty Cycle	Circuit Breaker	Till any design change
4	Impulse voltage withstand test	HV Switchboard panel, each type of breaker & bus duct	Till any design change
5	Heat Run Test	HV Switchboard panel, each type of breaker & bus duct	Upto 5 years from the final bid opening date or design change whichever is earlier

In case the type tests on the offered design of switchboards & breakers do not meet the above criteria, all required type tests shall be conducted by the successful bidder on the offered design of equipment after order finalization without any extra cost and delivery impact.

- 5.4.7 Bidder's scope of supply includes following pressure relief/ gas ducts, as applicable:

"In case bidder/ vendor has considered pressure relief/ gas duct above switchboard for release of gases due to internal arc; vendor shall preferably provide suitable absorbers in the switchboard to prevent the release of harmful gases in the switchgear hall. Alternatively, duct including all accessories/supporting arrangement/sealing material/bends/installation material etc. shall be provided for taking the gases outside the substation to a safe location. Length of duct shall be considered as 10 meters for indoor installation and 5 meters for outdoor installation for each substation (measured from center to center). Bidders to note that for indoor section, 10-meter length shall be in addition to the length of duct required above the HV switchboard. Substation equipment layout shall be furnished during detailed engineering by owner for preparing duct layout by vendor.

- 5.4.8 HV Switchgear shall be provided with online wireless temperature monitoring facility. The passive sensor should be wireless, battery less, dielectrically safe, robust to high voltage, high electromagnetic field, and harsh environment. It should take direct measurement on critical point. This facility shall be interfaced with ECS.

5.4.9 Online Temperature Monitoring System (OTMS) for HV Switchboards at all critical point mentioned below shall be provided for each switchboard and isolating breaker panels.

- a. In each vertical, wireless sensor shall be located as per the following:
 - Each horizontal bus bar terminal/tap-off connection in busbar compartment.
 - Each cable connection points in cable compartment.
 - One sensor per phase of cable connection points shall be considered irrespective of number of runs of cable.
- b. The temperature sensors installed shall be suitable for wireless, with direct contact to hot point, operating range from -25°C to 125 °C. The accuracy shall be as per the following
 $\pm 3^{\circ}\text{C}$ accuracy for 0°C to 80°C range.
 $\pm 4^{\circ}\text{C}$ accuracy for full range (-25°C to 0°C and 80°C to 125 °C)
- c. The system shall allow at least 1 configurable threshold (alarm)
- d. OTMS system shall have the provision to send complete data to SAS/ Owner's ECS for monitoring and investigation. The system shall be online to immediately provide an abnormal temperature alarm (with identification/location of the abnormal temperature) to the owner's operator system.
- e. Complete data of OTMS shall be accessible in the SAS & associated SAS Laptop/ HMI. The protocol for communication shall be either IEC 61850 or MODBUS TCP/IP or MODBUS RTU or other open protocol and shall be decided by vendor.
- f. Complete data of OTMS shall be accessible in the SAS (through switchboard level Ethernet switches) & associated SAS Laptop/ HMI. The protocol for communication shall be either IEC 61850 or MODBUS TCP/IP or MODBUS RTU or other open protocol and shall be decided by Bidder. Accordingly, protocol convertors/gateways at suitable locations as required shall be provided by Bidder for data integration on IEC 61850 protocol from Master Ethernet switch to Owner's ECS system
- g. Online temperature monitoring data shall be available in both owner's ECS as well as Substation Automation System (SAS). OTMS shall be integrated with owner's ECS so that temperature monitoring can be done through owner's ECS.
- h. The following shall be complied for OTMS:
 - No annual re-calibration by the owner shall be required to maintain accuracy.
 - Sensors shall not interfere with the electrical performance of the component and the installation.
 - The thermal (bus bar mounted) sensors shall be battery-less and self-powered with no auxiliary power supply.
 - System shall be suitable to provide the information and capabilities as per the following:
 - o Temperature
 - o Time of measurement

- Provision for location and unique identification of each sensor in the SAS/ Owner's ECS
 - Provision shall be provided for the owner to view the sensors' condition status data on the SAS/ owner's ECS:
 - sensors not paired
 - pairing process failed
 - data error
 - i. communication error
- 5.4.10 Selection, sizing and suitability of all components shall be the Bidder's responsibility. The equipment as required for safe and satisfactory operation shall be considered included in Bidder's scope even if not specifically mentioned.
- 5.4.11 ON/OFF indication shall also be provided on rear side of panel.
- 5.4.12 Auto tripping of HT circuit breaker upon opening rear side cover shall be provided.
- 5.4.13 The back side cable compartment cover of HV switchboard shall not be able to open while the feeder is electrically connected. Breaker shall trip if any person opens the back side cover preferably by mechanical interlock otherwise on electrical interlock. Back side cover shall have on / off LED indication lamp.
- 5.4.14 Each bus section of switchboard shall be provided with independent control supply. Provision for bumpless auto transfer in case of loss of one supply shall be provided. There shall also be provision for manual transfer. Monitoring of failure of supply, availability of source and monitoring auto status shall be provided
- 5.4.15 All the modules shall have stickers (Yellow background with black letters) or letter painting indicating KW, cable size, FLC at front and back for HT and front for LT. A bigger size sticker having list of motor tag nos. and module no. shall be pasted on both side of the panel end covers
- 5.4.16 Interposing relays for all the DI signals from DCS/ PLC in VFD's/ soft starters shall be considered
- 5.4.17 LOTO facility shall be provided for each module
- 5.4.18 Breaker operated direct contacts to be used to the maximum extent for DCS / interlock. If not possible same to be given through bi-stable relays
- 5.4.19 Separate control switch & control fuse for isolation of control supply in all the motor feeders shall be provided. Separate control supply facility from space heater bus for checking module healthiness in TEST position shall not be provided
- 6. MISCELLANEOUS REQUIREMENTS:**
- 6.1 VFD systems shall be sized taking care of input voltage variation (i.e., $\pm 10\%$) and voltage drop within the VFD system and motor cable.
- 6.2 All nuts, bolts, washers, spring washers, grouting bolts, anchor fasteners, etc. necessary for completion of job wherever used shall be of stainless steel SS304.
- 6.3 All Emergency Stop/Stop pushbuttons on LCS/LCP/Switchboard shall be provided with protective covers to avoid accidental operation.
- 6.4 All accessories like nuts, bolts, washers, earthing studs etc. shall be made of stainless-steel SS-304.

- 6.5 All electrical equipment for hazardous areas shall be certified by CIMFR, PTB, Baseefa, UL, FM or equivalent independent testing agency for the service and the area in which it can be used and shall be approved by PESO/CCOE and copies of the same (PESO/ CCOE) shall be furnished during detailed engineering stage which is mandatory as per local rules/regulations. All indigenous flameproof equipment (Type Ex d) shall be manufactured under BIS license.
- 6.6 Bidder/Vendor shall comply to the requirements as per Ministry of Power (GoI) various orders regarding testing of all equipment, components & parts imported for use in the power supply system for cyber security to check for any kind of embedded malware/Trojans/cyber threat and for adherence to Indian Standards. Necessary testing of their equipment/ components at designated labs & obtaining test certificates in line with MOP orders shall be done by Bidder/Vendor.
- 6.7 Vendor to note that, if there is any requirement of emergency electrical power for the auxiliary equipment supplied with the main motor/compressor, same shall be highlighted at the bid stage only.
- 6.8 For HV output breaker panel, please refer attached ECS I/O List with MR and for Redundant VFD system, please refer below tentative ECS I/O list, any updates in below list shall be informed during details engineering:

VFD System (Redundant)						
Di	S	VFD Running - 1			Hardwired	
DI	S	VFD Trip - 1			Hardwired	
DI	S	VFD Ready to start - 1			Hardwired	
Di	S	VFD Running – 2			Hardwired	
DI	S	VFD Trip – 2			Hardwired	
DI	S	VFD Ready to start – 2			Hardwired	
DI	D	PLC Status – 1	Unhealthy	Healthy	Hardwired	
DI	D	PLC Status – 2	Unhealthy	Healthy	Hardwired	
AI	A	Running VFD R phase current			Serial	
AI	A	Running VFD Y phase current			Serial	
AI	A	Running VFD B phase current			Serial	
AI	W	Running VFD 3-Phase Real Power			Serial	
AI	R	Running VFD 3-Phase Reactive Power			Serial	
AI		Running VFD Speed			Serial	
AI	A	Excitation Current Channel-1 (For Sync Motor with excitation system)			Serial	
AI	A	Excitation Current Channel-2 (For Sync Motor with excitation system)			Serial	

- 6.8 Maximum lengths for various cables to be considered for Pump tag- 300-KA-CF-3001 for design of the VFD for motors, as mentioned in the Data sheet no. B957-000-16-50-DS-5003 shall be as listed below:

Cable length between 6.6kV Input Breaker Panel and VFD	:	100m
Cable length between VFD & Output Breaker Panel	:	500m
Cable length between Output Breaker Panel & Motor	:	500m

7 SPARES

- 7.1 Commissioning spares for all electrical equipment are included in Vendor's scope of supply and shall be included in the base price. List of the same shall be furnished with the offer.
- 7.2 For Mandatory spares, refer elsewhere in the MR.
- 7.3 Vendor shall submit a list with unit prices of recommended spares for two years of normal operation for motors. Recommended list of maintenance spares for two years operation shall include the following as a minimum for motors. Vendor shall ensure & quote for the same accordingly.
- a.) Bearing for DE/NDE-one set
 - b.) Terminal box cover with screws
 - c.) Fan
 - d.) Terminal block

8.0 LIST OF ATTACHMENTS

Sr. No.	Document Title	Document No.	Rev.
1.	Data Sheet – HV Motors – DOL	B957-000-16-50-DS-3101	D
2.	Data Sheet – HV Motors – VFD	B957-000-16-50-DS-3102	B
3.	Data Sheet – HV VFD	B957-000-16-50-DS-5003	B
4.	Data Sheet – MV Motors – DOL	B957-000-16-50-DS-6401	D
5.	Data Sheet – Load Data Format	B957-000-16-50-DS-9901	B
6.	ECS I/O List - HV	B957-000-16-50-DS-0107	A
7.	Scheme for dual Redundant VFDs for Induction Motor	B957-000-16-50-DS-0458	B
8.	HV Switchboard Hardware Datasheet	B957-000-16-50-DS-0118	A
9.	Vendor List – Electrical	B957-300-16-50-VL-5020	A
10.	Vendor Data Requirement – Electrical	B957-300-16-50-VR-5020	A
11.	Specification for Medium voltage switchboards	6-51-0001	8
12.	Specification for flameproof type control station	6-51-0006	6
13.	Specification for HV Induction Motors	6-51-0031	6
14.	Specification for HV Variable Frequency drive system	6-51-0050	3
15.	Specification for Energy Efficient MV Induction Motors	6-51-0064	2
16.	ITP- Flameproof Control Station	6-81-1006	5
17.	ITP- HV induction Motors	6-81-1031	5
18.	ITP- HV Variable frequency drive system	6-81-1050	3
19.	ITP- Energy efficient medium voltage motors	6-81-1064	1

Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 13GB		Description : CONTROL STATIONS-FLAME PROOF		
Approved Suppliers				
1	3681	FCG POWER INDUSTRIES PVT LTD	INDIA	
2	K173	KAYSONS TECHNO EQUIPMENTS PVT. LTD.	INDIA	
3	G159	PEPPERL & FUCHS MANUFACTURING (INDIA) PRIVATE LIMITED	INDIA	
4	F036	FLAMEPROOF EQUIPMENTS PVT.LTD	INDIA	
5	F024	FLEXPRO ELECTRICALS PVT LTD	INDIA	
6	S158	SUDHIR SWITCHGEARS PVT LTD	INDIA	
7	B024	BALIGA LIGHTING EQUIPMENTS (P) LIMITED	INDIA	
8	3706	PHOENIX MECANO INDIA PVT. LTD.	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 13MA		Description : JUNCTION BOXES (FLAME PROOF)		
Approved Suppliers				
1	B024	BALIGA LIGHTING EQUIPMENTS (P) LIMITED	INDIA	
2	S158	SUDHIR SWITCHGEARS PVT LTD	INDIA	
3	G159	PEPPERL & FUCHS MANUFACTURING (INDIA) PRIVATE LIMITED	INDIA	
4	R175	R STAHL PVT LTD	INDIA	
5	F024	FLEXPRO ELECTRICALS PVT LTD	INDIA	
6	3681	FCG POWER INDUSTRIES PVT LTD	INDIA	
7	F036	FLAMEPROOF EQUIPMENTS PVT.LTD	INDIA	
8	K173	KAYSONS TECHNO EQUIPMENTS PVT. LTD.	INDIA	
9	3706	PHOENIX MECANO INDIA PVT. LTD.	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14CA		Description : CABLE GLANDS (HAZARDOUS AREA)		
Approved Suppliers				
1	S375	STANDARD METAL INDUSTRIES	INDIA	
2	3681	FCG POWER INDUSTRIES PVT LTD	INDIA	
3	4187	SIGMA INDUSTRIES	INDIA	
4	3704	METAL CRAFT INDUSTRIES	INDIA	
5	C205	COMET INDUSTRIES	INDIA	
6	S158	SUDHIR SWITCHGEARS PVT LTD	INDIA	
7	F036	FLAMEPROOF EQUIPMENTS PVT.LTD	INDIA	
8	B024	BALIGA LIGHTING EQUIPMENTS (P) LIMITED	INDIA	
9	4244	METALMECH ENGINEERING	INDIA	
10	C195	COMET BRASS PRODUCTS	INDIA	
11	3890	AKSHAR BRASS INDUSTRIES	INDIA	
12	F024	FLEXPRO ELECTRICALS PVT LTD	INDIA	
13	K173	KAYSONS TECHNO EQUIPMENTS PVT. LTD.	INDIA	
14	27421	CMP PRODUCTS LIMITED	UNITED KINGDOM	

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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14CF		Description : CONTROL SWITCHES / SELECTOR SWITCHES		
Approved Suppliers				
1	R159	RELIABLE ELECTRONIC COMPONENTS PVT LTD	INDIA	
2	S373	SWITRON DEVICES	INDIA	
3	K143	KAYCEE INDUSTRIES LTD.	INDIA	
4	S003	SIEMENS LIMITED	INDIA	
5	L103	SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED	INDIA	
6	H142	HOTLINE SWITCHGEAR & CONTROLS	INDIA	
7	4002	P.P. INDUSTRIES	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14EA		Description : EARTH LEAKAGE CIRCUIT BREAKER		
Approved Suppliers				
1	G147	GE INDIA INDUSTRIAL PVT LTD	INDIA	
2	3726	NOVATEUR ELECTRICAL & DIGITAL SYSTEMS PVT. LTD.	INDIA	
3	A372	ABB INDIA LTD	INDIA	
4	L071	LEGRAND (INDIA) PVT. LTD (FORM. M-006)	INDIA	
5	S003	SIEMENS LIMITED	INDIA	
6	S450	SCHNEIDER ELECTRIC INDIA PVT LTD	INDIA	
7	3824	HAVELLS INDIA LIMITED	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14FA		Description : FUSES		
Approved Suppliers				
1	G147	GE INDIA INDUSTRIAL PVT LTD	INDIA	
2	S003	SIEMENS LIMITED	INDIA	
3	L103	SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED	INDIA	
4	I013	NOVATEUR ELECTRICAL & DIGITAL SYSTEMS P	INDIA	
5	C194	EATON POWER QUALITY PRIVATE LIMITED	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14HA		Description : HEAVY DUTY SWITCHES		
Approved Suppliers				
1	S003	SIEMENS LIMITED	INDIA	
2	L103	SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED	INDIA	
3	3790	C & S ELECTRIC LTD	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14MA		Description : MCB		
Approved Suppliers				
1	S393	STANDARD ELECTRICALS LTD	INDIA	
2	3793	C & S ELECTRIC LTD	INDIA	
3	3726	NOVATEUR ELECTRICAL & DIGITAL SYSTEMS PVT. LTD.	INDIA	
4	S003	SIEMENS LIMITED	INDIA	
5	L071	LEGRAND (INDIA) PVT. LTD (FORM. M-006)	INDIA	
6	I168	INDIANA CURRENT CONTROL LTD	INDIA	
7	S450	SCHNEIDER ELECTRIC INDIA PVT LTD	INDIA	
8	3888	POLYCAB INDIA LIMITED	INDIA	
9	3824	HAVELLS INDIA LIMITED	INDIA	
10	A372	ABB INDIA LTD	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14MB		Description : MCCB		
Approved Suppliers				
1	G147	GE INDIA INDUSTRIAL PVT LTD	INDIA	
2	S450A	SCHNEIDER ELECTRIC INDIA P LTD-HYDERABAD	INDIA	
3	S003	SIEMENS LIMITED	INDIA	
4	A200B	ABB INDIA LTD	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14MC		Description : METERS		
Approved Suppliers				
1	M239	MECO INSTRUMENTS PVT LTD	INDIA	
2	S141	SECURE METERS LIMITED	INDIA	
3	A028A	AUTOMATIC ELECTRIC LTD.	INDIA	
4	N130	NIPPEN ELECTRICAL INSTRUMENTS CO.	INDIA	
5	R042	RISHABH INSTRUMENTS LIMITED	INDIA	
6	4233	ELMEASURE INDIA PRIVATE LIMITED	INDIA	
7	3901	NEWTEK ELECTRICALS	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14PB		Description : PUSH BUTTON AND INDICATING LAMPS		
Approved Suppliers				
1	S003	SIEMENS LIMITED	INDIA	
2	P291	PRECIFINE PRODUCTS PVT. LTD.	INDIA	
3	S365	SHRI TULSI SWITCHGEARS PVT LTD	INDIA	
4	4002	P.P. INDUSTRIES	INDIA	
5	S450A	SCHNEIDER ELECTRIC INDIA P LTD-HYDERABAD	INDIA	
6	3791	C & S ELECTRIC LTD	INDIA	
7	H142	HOTLINE SWITCHGEAR & CONTROLS	INDIA	
8	T166	TEKNIC ELECTRIC (I) PVT. LTD.	INDIA	
9	B002	BCH ELECTRIC LTD	INDIA	
10	E173	ESSEN DEINKI	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14SA		Description : FUSE SWITCH COMBINATION		
Approved Suppliers				
1	3825	HAVELLS INDIA LIMITED	INDIA	
2	S393	STANDARD ELECTRICALS LTD	INDIA	
3	L103	SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED	INDIA	
4	S003	SIEMENS LIMITED	INDIA	
5	3790	C & S ELECTRIC LTD	INDIA	
6	I013	NOVATEUR ELECTRICAL & DIGITAL SYSTEMS P	INDIA	
7	G147	GE INDIA INDUSTRIAL PVT LTD	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14TA		Description : TIMERS		
Approved Suppliers				
1	E151	ELECTRONIC AUTOMATION PVT LTD	INDIA	
2	B002	BCH ELECTRIC LTD	INDIA	
3	L103	SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED	INDIA	
4	S003	SIEMENS LIMITED	INDIA	



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Additional BPCL Vendor List for Electrical Items (Refer Notes as per Vendor List Preamble)

	SUPPLIER CODE	SUPPLIER NAME	COUNTRY	HOLIDAY DESCRIPTION
Item Code: 13BD Description: RELAY & CONTROL PANEL				
1	BPCL VC 120295	R.STAHL (P) LTD.	INDIA	
1	BPCL VC 120325	ABB INDIA LIMITED	INDIA	
Item Code: 13HC Description: BATTERIES-LEAD ACID (VRLA)				
2	BPCL VC 138626	IGA TECH INDUSTRIAL ELECTRONICS	INDIA	
2	BPCL VC 161946	CUMMINS SALES & SERVICE PVT LTD.	INDIA	
Item Code: 13HD Description: BATTERIES-NICKLE CADMIUM				
3	BPCL VC 312982	SUN BATTERY SHOPPE	INDIA	
Item Code: 13KA Description: TRANSFORMERS-POWER-ABOVE 5MVA				
4	BPCL VC 139893	EMCO LIMITED	INDIA	
4	BPCL VC 101407	RAYCHEM RPG PRIVATE LIMITED	INDIA	
Item Code: 13KB Description: TRANSFORMERS-DISTRIBUTION-UPTO 5MVA				
5	BPCL VC 139893	EMCO LIMITED	INDIA	
5	BPCL VC 100270	BHARAT BIJLEE LIMITED	INDIA	
Item Code: 13LA Description: LIGHTING FIXTURE & ACCESSORIES-HAZARDOUS				
6	BPCL VC 132472	PYROTECH ELECTRONICS PRIVATE LIMITED	INDIA	
6	BPCL VC 168748	WM ENERGY & LIGHTING PRIVATE LIMITED	INDIA	
6	BPCL VC 120295	R.STAHL (P) LTD.	INDIA	
6	BPCL VC 162049	INDUSTRIAL ELECTRO CONTROLS	INDIA	
Item Code: 13LD Description: HIGH MAST LIGHTING SYSTEM				
7	BPCL VC 171084	CONTRACTING SYNDICATE	INDIA	
7	BPCL VC 300456	CHASHMITA ENGINEERS PRIVATE LIMITED	INDIA	
Item Code: 13MA Description: JUNCTION BOXES (FLAME PROOF)				
8	BPCL VC 162049	INDUSTRIAL ELECTRO CONTROLS	INDIA	
Item Code: 13NC Description: EPABX SYSTEM				
9	BPCL VC 167774	ASCENT NETWORKS PRIVATE LTD	INDIA	

Item Code: 13PA Description: CAPACITORS-HIGH VOLTAGE				
10	BPCL VC 120325	ABB INDIA LIMITED	INDIA	
Item Code: 14BB Description: BUS DUCTS (MV)				
11	BPCL VC 333082	CASYON ENGINEERS AND CONSULTANTS	INDIA	
Item Code: 14CB Description: CABLE TERMINATION & JOINTING KIT				
12	BPCL VC 300990	TRANS ELECTRICALS (33 KV UE END only)	INDIA	
Item Code: 14HB Description: HEAT TRACERS				
13	BPCL VC 101407	RAYCHEM RPG PRIVATE LIMITED	INDIA	

TYPICAL ECS & SCAP I/O LIST FOR ELECTRICAL CONTROL SYSTEM HV SWITCHBOARD

PROJECT : BPREP PROJECT, BINA REFINERY
OWNER : M/s BPCL
EPMC : ENGINEERS INDIA LTD.

A	05-11-2024	ISSUED WITH MR/TENDER	SK	MKM	RSR
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

This ECS I/O list is applicable for the 6.6kV HV Switchgear in substations

ECS I/O List

Type	Pt type	Description	Set condition	Reset condition	Interface	Remarks
INCOMER FROM TRANSFORMER						
DI	S	Ready to close			RELAY LAN	
DI	S	Synch. OK			RELAY LAN	
DI	D	Over Current			RELAY LAN	
DI	D	Earth Fault			RELAY LAN	
DI	D	51G Operated			RELAY LAN	
DI	D	Under Voltage			RELAY LAN	
DI	D	Reverse BLOCKING activated			RELAY LAN	
DI	D	64R Operated			RELAY LAN	
AI	A	R phase current			RELAY LAN	
AI	A	Y phase current			RELAY LAN	
AI	A	B phase current			RELAY LAN	
AI	W	3-Phase Real Power			RELAY LAN	
AI	R	3-Phase Reactive Power			RELAY LAN	
AI		Power Factor			RELAY LAN	
AI		Frequency			RELAY LAN	
DI	S	CB in service &	Closed	Not closed	HARDWIRED	
DI	S	CB in service &	Open	Not open	HARDWIRED	
DI	D	Relay 86	Operated	Reset	HARDWIRED	
DI	D	Relay 95	Operated	Reset	RELAY LAN	
DI	D	Trip on under voltage	Activated	Reset	RELAY LAN	
DI	D	Numerical Relays	Unhealthy	Healthy	RELAY LAN	
DO	C	Trip from ECS	Activated	Reset	HARDWIRED	
DO	C	Close Inhibit (From ECS)	Operated	Reset	HARDWIRED	
DI	D	Trafo Trouble Alarm (Buch., OTI,WTI)			RELAY LAN	
DI	D	Trafo Trouble Trip (Buch., OTI,WTI)			RELAY LAN	
AI	T	Oil Temperature			HARDWIRED	4-20mA through transducers in Trafo MB
AI	T	Winding Temperature			HARDWIRED	
DI	D	Transformer Differential	Operated=1		RELAY LAN	87T
DI	D	Over Temperature monitoring system	Operated	Reset	HARDWIRED	
INCOMER FROM ANOTHER SWITCHBOARD						
AI	A	R phase current			RELAY LAN	
AI	A	Y phase current			RELAY LAN	
AI	A	B phase current			RELAY LAN	
AI	W	3-Phase Real Power			RELAY LAN	
AI	R	3-Phase Reactive Power			RELAY LAN	

Type	Pt type	Description	Set condition	Reset condition	Interface	Remarks
AI		Power Factor			RELAY LAN	
AI		Frequency			RELAY LAN	
DI	S	CB in service &	Closed	Not closed	HARDWIRED	
DI	S	CB in service &	Open	Not open	HARDWIRED	
DI	D	Relay 86	Operated	Reset	HARDWIRED	
DI	D	Relay 95	Operated	Reset	RELAY LAN	
DI	D	Trip on undervoltage	Activated	Reset	RELAY LAN	
DI	D	Numerical Relays	Unhealthy	Healthy	RELAY LAN	
DO	C	Trip from ECS	Activated	Reset	HARDWIRED	
DO	C	Close Inhibit (From ECS)	Operated	Reset	HARDWIRED	
DI	D	Feeder Differential	Operated=1		RELAY LAN	87F
DI	D	Over Temperature monitoring system	Operated	Reset	HARDWIRED	
LINE PT						
AI	V	R-Y Line Voltage			RELAY LAN	
AI	V	Y-B Line Voltage			RELAY LAN	
AI	V	R-B Line Voltage			RELAY LAN	
DI	D	Line PT Secondary MCB	Tripped=1		HARDWIRED	
BUS COUPLER						
AI	A	R phase current			RELAY LAN	
AI	A	Y phase current			RELAY LAN	
AI	A	B phase current			RELAY LAN	
AI	W	3-Phase Real Power (Bi-directional)			RELAY LAN	
AI	R	3-Phase Reactive Power			RELAY LAN	
AI		Power Factor			RELAY LAN	
DI	S	CB in service &	Closed	Not closed	HARDWIRED	
DI	S	CB in service &	Open	Not open	HARDWIRED	
DI	D	Relay 86	Operated	Reset	HARDWIRED	
DI	D	Relay 95	Operated	Reset	RELAY LAN	
DI	D	Trip on undervoltage	Activated	Reset	RELAY LAN	
DI	D	Numerical Relays	Unhealthy	Healthy	RELAY LAN	
DO	C	Trip from ECS	Activated	Reset	HARDWIRED	
DO	C	Close Inhibit (From ECS)	Operated	Reset	HARDWIRED	
DI	D	Auto-changeover	Blocked	Not blocked	HARDWIRED	
DI	S	Switchboard (A-I-M selector switch)	Auto		HARDWIRED	
DI	S	Switchboard (A-I-M selector switch)	Independent		HARDWIRED	
DI	S	Switchboard (A-I-M selector switch)	Manual		HARDWIRED	
DI	D	AC control supply #1	Failed	Healthy	HARDWIRED	

Type	Pt type	Description	Set condition	Reset condition	Interface	Remarks
DI	D	AC control supply #2	Failed	Healthy	HARDWIRED	
DI	D	DC control supply #1	Failed	Healthy	HARDWIRED	
DI	D	DC control supply #2	Failed	Healthy	HARDWIRED	
DI	S	Ready to close			RELAY LAN	
DI	S	Synch. OK			RELAY LAN	
DI	D	Over Current / Earth Fault			RELAY LAN	
DI	D	Auto-changeover	Blocked	Not blocked	RELAY LAN	
DI	S	I/C-1 Under Voltage			RELAY LAN	
DI	S	I/C-2 Under Voltage			RELAY LAN	
DI	D	Reverse BLOCKING activated			RELAY LAN	
OUTGOING TRANSFORMER FEEDER						
AI	A	R phase current			RELAY LAN	
AI	A	Y phase current			RELAY LAN	
AI	A	B phase current			RELAY LAN	
AI	W	3-Phase Real Power			RELAY LAN	
AI	R	3-Phase Reactive Power			RELAY LAN	
AI		Power Factor			RELAY LAN	
AI		Frequency			RELAY LAN	
DI	S	CB in service &	Closed	Not closed	HARDWIRED	
DI	S	CB in service &	Open	Not open	HARDWIRED	
DI	D	Relay 86	Operated	Reset	HARDWIRED	
DI	D	Relay 95	Operated	Reset	RELAY LAN	
DI	D	Trip on undervoltage	Activated	Reset	RELAY LAN	
DI	D	Numerical Relay	Unhealthy	Healthy	RELAY LAN	
DO	C	Trip from ECS	Activated	Reset	HARDWIRED	
DO	C	Close Inhibit (From ECS)	Operated	Reset	HARDWIRED	
DI	D	Transformer Trouble	Operated=1		RELAY LAN	63TX, 51G, 64R
DO	C	Outgoing trafo fdr re-closing	Activated	Reset	HARDWIRED	
DI	S	Ready to close			RELAY LAN	
DI	D	Over Current			RELAY LAN	
DI	D	Earth Fault			RELAY LAN	
DI	D	Trafo Trouble Alarm (Buch., OTI,WTI)			RELAY LAN	
DI	D	Trafo Trouble Trip (Buch., OTI,WTI)			RELAY LAN	
DI	D	64R from Downstream			RELAY LAN	
DI	D	Reverse BLOCKING activated			RELAY LAN	
DI	D	51G from Downstream			RELAY LAN	
OUTGOING PLANT FEEDER						
AI	A	R phase current			RELAY LAN	

Type	Pt type	Description	Set condition	Reset condition	Interface	Remarks
AI	A	Y phase current			RELAY LAN	
AI	A	B phase current			RELAY LAN	
AI	W	3-Phase Real Power			RELAY LAN	
AI	R	3-Phase Reactive Power			RELAY LAN	
AI		Power Factor			RELAY LAN	
DI	S	CB in service &	Closed	Not closed	HARDWIRED	
DI	S	CB in service &	Open	Not open	HARDWIRED	
DI	D	Relay 86	Operated	Reset	HARDWIRED	
DI	D	Relay 95	Operated	Reset	RELAY LAN	
DI	D	Trip on under voltage	Activated	Reset	RELAY LAN	
DI	D	Numerical Relays	Unhealthy	Healthy	RELAY LAN	
DO	C	Trip from ECS	Activated	Reset	HARDWIRED	
DI	D	Feeder Differential	Operated=1		RELAY LAN	
DI	S	Ready to close			RELAY LAN	
DI	D	Over Current			RELAY LAN	
DI	D	Earth Fault			RELAY LAN	
DI	D	Reverse BLOCKING activated			RELAY LAN	
DI	D	Line Differential Operated			RELAY LAN	
OUTGOING CAPACITOR FEEDER						
AI	A	R phase current			RELAY LAN	
AI	A	Y phase current			RELAY LAN	
AI	A	B phase current			RELAY LAN	
AI	R	3-Phase Reactive Power			RELAY LAN	
AI	R	3-Phase Reactive Power			RELAY LAN	
AI		Power Factor			RELAY LAN	
DI	S	CB in service &	Closed	Not closed	HARDWIRED	
DI	S	CB in service &	Open	Not open	HARDWIRED	
DI	D	Relay 86	Operated	Reset	HARDWIRED	
DI	D	Relay 95	Operated	Reset	RELAY LAN	
DI	D	Trip on under voltage	Activated	Reset	RELAY LAN	
DI	D	Numerical Relay	Unhealthy	Healthy	RELAY LAN	
DO	C	Close from ECS	Activated	Reset	HARDWIRED	
DO	C	Trip from ECS	Activated	Reset	HARDWIRED	
DI	S	Local / ECS Selector Switch in	LOCAL	Not_Local	HARDWIRED	
DI	S	Local / ECS Selector Switch in	ECS	Not_ECS	HARDWIRED	
DI	S	Ready to close			RELAY LAN	
DI	D	Over Current			RELAY LAN	
DI	D	Earth Fault			RELAY LAN	
DI	D	Over Voltage			RELAY LAN	
DI	D	Under Voltage			RELAY LAN	

Type	Pt type	Description	Set condition	Reset condition	Interface	Remarks
DI	D	Reverse BLOCKING activated			RELAY LAN	
OUTGOING MOTOR FEEDER						
DI	D	Motor Differential Operated			RELAY LAN	Applicable for motors $\geq 1500\text{kW}$
AI	A	R phase current			RELAY LAN	
AI	A	Y phase current			RELAY LAN	
AI	A	B phase current			RELAY LAN	
AI	W	3-Phase Real Power			RELAY LAN	
AI	R	3-Phase Reactive Power			RELAY LAN	
AI		Power Factor			RELAY LAN	
DI	S	CB in service &	Closed	Not closed	HARDWIRED	
DI	S	CB in service &	Open	Not open	HARDWIRED	
DI	D	Relay 86	Operated	Reset	HARDWIRED	
DI	D	Relay 95	Operated	Reset	RELAY LAN	
DI	D	Trip on under voltage	Activated	Reset	RELAY LAN	
DI	D	Numerical Relays	Unhealthy	Healthy	RELAY LAN	
DO	C	Trip from ECS	Activated	Reset	HARDWIRED	
DO	C	Close Inhibit (From ECS)	Operated	Reset	HARDWIRED	
DI	D	Motor Trip from Process	Operated=1		HARDWIRED	
DI	S	Ready to close			RELAY LAN	
DI	D	49T/50/50LR			RELAY LAN	
DI	D	Earth Fault			RELAY LAN	
DI	D	Unbalance Trip			RELAY LAN	
DI	D	Under Voltage Trip			RELAY LAN	
DI	S	Re-Acceleration			RELAY LAN	
DI	D	Reverse BLOCKING activated			RELAY LAN	
DI	D	Process Trip			RELAY LAN	
BUS PT						
AI	V	R-Y Line Voltage			RELAY LAN	
AI	V	Y-B Line Voltage			RELAY LAN	
AI	V	R-B Line Voltage			RELAY LAN	
DI	D	Bus PT Secondary MCB	Tripped=1		HARDWIRED	
DI	S	Dead Bus (<40%)			RELAY LAN	
DI	D	Under Voltage (<80%)			RELAY LAN	
DI	D	BPT not in Service / PT MCB Unhealthy			RELAY LAN	
DI	D	UF & df/dt Signal	Operated	Reset	Hardwired (4 Nos)	
OUTGOING VFD TRANSFORMER FEEDER						
AI	A	R phase current			RELAY LAN	

Type	Pt type	Description	Set condition	Reset condition	Interface	Remarks
AI	A	Y phase current			RELAY LAN	
AI	A	B phase current			RELAY LAN	
AI	W	3-Phase Real Power			RELAY LAN	
AI	R	3-Phase Reactive Power			RELAY LAN	
AI		Power Factor			RELAY LAN	
DI	S	CB in service &	Closed	Not closed	HARDWIRED	
DI	S	CB in service &	Open	Not open	HARDWIRED	
DI	D	Relay 86	Operated	Reset	HARDWIRED	
DI	D	Relay 95	Operated	Reset	RELAY LAN	
DI	D	Trip on under voltage	Activated	Reset	RELAY LAN	
DI	D	Numerical Relay	Unhealthy	Healthy	RELAY LAN	
DO	C	Trip from ECS	Activated	Reset	HARDWIRED	
DO	C	Close Inhibit (From ECS)	Operated	Reset	HARDWIRED	
DI	D	Transformer Trouble	Operated=1		RELAY LAN	63TX, 51G, 64R
DI	S	Ready to close			RELAY LAN	
DI	D	Over Current			RELAY LAN	
DI	D	Earth Fault			RELAY LAN	
DI	D	Trafo Trouble Alarm (Buch., OTI, WTI)			RELAY LAN	
DI	D	Trafo Trouble Trip (Buch., OTI, WTI)			RELAY LAN	
DI	D	Trip from VFD			RELAY LAN	
DI	D	Reverse BLOCKING activated			RELAY LAN	
ISOLATING BREAKER PANEL						
AI	W	3-Phase Real Power			RELAY LAN	
AI	R	3-Phase Reactive Power			RELAY LAN	
AI		Power Factor			RELAY LAN	
DI	D	Line PT Secondary MCB	Tripped=1		HARDWIRED	
DI	S	CB in service &	Closed	Not closed	HARDWIRED	
DI	S	CB in service &	Open	Not open	HARDWIRED	
DI	D	Relay 86	Operated	Reset	HARDWIRED	
DI	D	Relay 95	Operated	Reset	RELAY LAN	
DI	D	Trip on under voltage	Activated	Reset	RELAY LAN	
DI	D	Numerical Relays	Unhealthy	Healthy	RELAY LAN	
DO	C	Trip from ECS	Activated	Reset	HARDWIRED	
DI	D	Feeder Differential	Operated=1		RELAY LAN	
DI	D	Transformer Trouble	Operated=1		RELAY LAN	63TX, 51G, 64R
DI	D	Trafo Trouble Alarm (Buch., OTI, WTI)	Operated=1		RELAY LAN	
DI	D	Trafo Trouble Trip (Buch., OTI, WTI)	Operated=1		RELAY LAN	
VFD TIE FEEDER						

Type	Pt type	Description	Set condition	Reset condition	Interface	Remarks
DI	S	CB in service &	Closed	Not closed	HARDWIRED	
DI	S	CB in service &	Open	Not open	HARDWIRED	
DI	D	Trip Circuit Supervision	Unhealthy	Healthy	HARDWIRED	

Notes

- 1.0 Acquisition of input/output (I/O) signals as hardwired or software:
 - a) All numerical relays shall be connected to ECS-RTU. ECS shall acquire relay and metering status I/O signals of the relays. These I/O signals have been indicated as "relay and metering LAN" in the typical I/O list above.
 - b) All other I/Os shall be acquired hardwired and have been indicated as "hardwired" in the typical I/O list above. All hardwired signals shall be wired and terminated in respective panels.
 - c) In case any of these data cannot be acquired over the relay LAN, these signals have to be provided as hardwired. For requirement of numerical relays, refer Electrical part of contract document.
- 2.0 This I/O list is indicative only. Any other I/O required for meeting the contract requirements shall be identified and provided by CONTRACTOR.
- 3.0 Transformer oil temperature and transformer winding temperature shall be acquired hardwired from 66kV power transformers only. These I/Os shall be acquired as a 4-20 mA signal from the transformer.

Guidelines for ECS I/O Interface Design

Analogue Input Signals

Signal transducers for hard-wired analogue inputs shall have accuracy class 0.1 for the range 0-120%. All transducers shall be externally-powered types. External power supply shall be 230V AC UPS.

For all measurements for I, V, MW, MVAR, Hz, obtained on the relay and metering LAN, maximum possible accuracy shall be ensured

Digital Input Signals

Alarm (D)

Alarm is a signal which requires operator to be alerted such as VT circuit MCB (closed, open), relays 86 & 95 (operated, reset), auto-changeover (blocked, not blocked), DC control supply (healthy, failed), line voltage (unhealthy, healthy), bus voltage (unhealthy, healthy), motor trip from process, under-voltage trip. This shall be hardwired / on relay LAN as specified.

For hardwired signal, potential free contacts of rating 1 A, 110V DC or 240 V AC, make to alarm (NO) preferred. CONTRACTOR shall specifically indicate if NC contact is being provided in place of NO contact.

Generally a hardwired alarm point is put under "sequence of event" monitoring

Status (S)

For hardwired signal, potential free contacts of rating 1 A, 110V DC or 240 V AC, make to alarm (NO) required

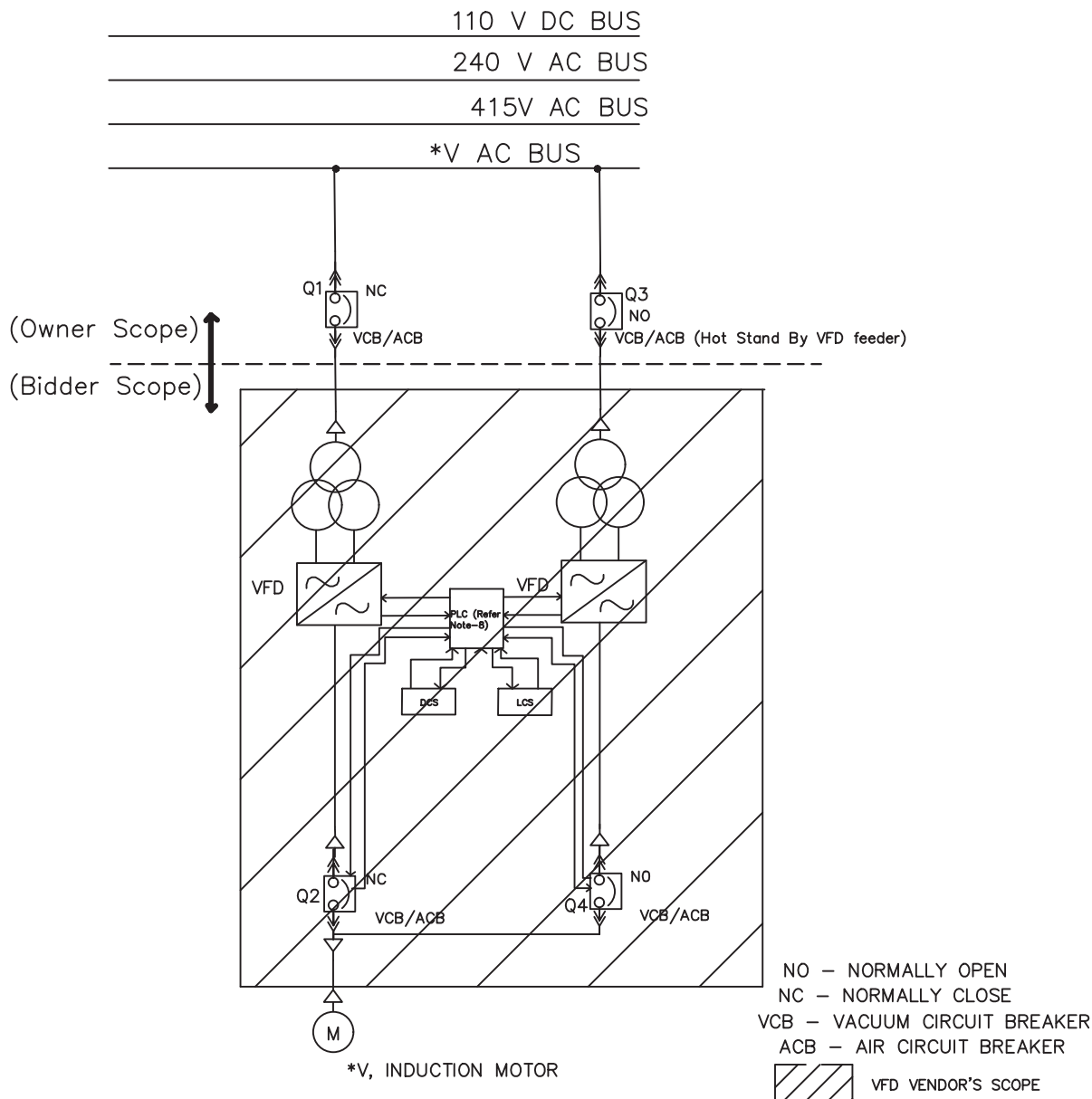
Digital Output Signals

Command (C)

Hardwired through potential free changeover type contact of interposing relay, contact rating 5 A, 240 V AC and/or 4 A, 110V DC. Coil rating shall be 24 V DC

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PROJECT:	BPREP PROJECT	REV	DATE	PURPOSE	BY	CHKD	APPRV
CLIENT: M/s BPCL-BINA		B	02.04.2025	REVISED & ISSUED WITH MR/TENDER	SK	RSR	RSR
		A	05.11.2024	ISSUED WITH MR/TENDER	SK	RSR	RSR



NOTES:

1. THE SCHEME SHOWN ABOVE IS INDICATIVE. EQUIPMENT DETAILS SHALL BE DECIDED BY VFD VENDOR BASED ON OFFERED VARIABLE FREQUENCY DRIVE DESIGN AND OVERALL SYSTEM OPTIMIZATION TO MEET START-UP & NORMAL OPERATION REQUIREMENTS AS PER MR/TENDER SPECIFICATIONS.
2. FOR THE OTHER REQUIREMENTS OF RELAYS AND METERS, REFER JOB SPECIFICATION.
3. ALL PROTECTIVE RELAYS REQUIRED FOR MOTOR PROTECTION SHALL BE PROVIDED BY VFD VENDOR IN THE VFD.
4. VFD VENDOR TO NOTE THAT INCOMING POWER SUPPLY (6.6kV/415V) AND CONTROL SUPPLY SHALL BE PROVIDED BY OWNER AS PER JOB SPECIFICATION.
5. THE OFFERED SYSTEM SHALL BE SUITABLE FOR SYNCHRONIZED TRANSFER OF POWER SUPPLY TO MOTOR FROM WORKING VFD TO HOT STANDBY VFD WITHOUT INTERRUPTION OF POWER SUPPLY TO THE RUNNING MOTOR (BUMPLESS TRANSFER). ALL SYNCHRONIZING EQUIPMENTS AND FACILITIES (AS REQUIRED) i.e PLC etc. FOR SYNCHRONIZATION, SUITABLE HARDWARE (INCLUDING ALL CTs, PTs etc.) & SOFTWARES REQUIRED FOR SATISFACTORY OPERATION OF THIS SYSTEM AS PER THE MR REQUIREMENT SHALL BE PROVIDED BY THE VFD VENDOR. TOTAL OPERATIONAL SCHEME/ LOGIC SHALL BE DEVELOPED BY CONTRACTOR DURING DETAILED ENGINEERING FOR OWNER'S APPROVAL.
6. ALL NECESSARY INTERLOCKS, SCHEMES AS REQUIRED AMONGST BREAKER NO. Q1, Q2, Q3 & Q4 SHALL BE AS PER THE OPERATING PHILOSOPHY FOR WORKING VFD AND HOT STANDBY VFD MODE OF OPERATION. NECESSARY SCHEME SHALL BE DEVELOPED BY THE VFD VENDOR FOR OWNER'S APPROVAL DURING DETAIL ENGINEERING FOR SAFE AND RELIABLE OPERATION.
7. ALL PROTECTIVE RELAYS SHALL BE NUMERICAL TYPE OF APPROVED MAKES. METERING SHALL BE A PART OF NUMERICAL RELAY.
8. REDUNDANT PLC SHALL BE PROVIDED BY VENDOR FOR CONTROL / CHANGEOVER.



ENGINEERS INDIA LIMITED
NEW DELHI

**SCHEME FOR DUAL REDUNDANT
VFDs FOR INDUCTION MOTOR**

DATA SHEET

B957-000-16-50-DS-0458
Sht.1 OF 1

REV

B

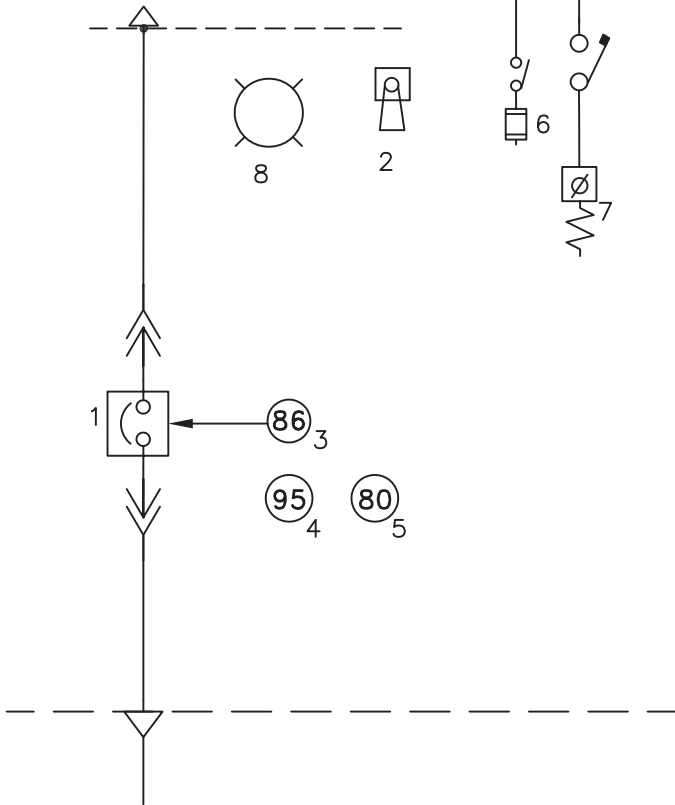
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PROJECT: MPCM & EPCM FOR BPREP CLIENT: M/S BPCL BINA	REV	DATE	PURPOSE	BY	CHKD	APPRV
	A	06.11.24	ISSUED WITH MR/TENDER	SK	RSR	RSR

D.C CONTROL BUS (110 V)

240V AC AUX. CKT BUS

FROM VFD



EQUIPMENT DATA

ITEM NO	NEMA NO.	QTY.	DESCRIPTION
1	52	1	VACUUM CIRCUIT BREAKER
2	-	1	BREAKER CONTROL SWITCH CLOSE-NEUTRAL-TRIP (SPRING RETURN TO NEUTRAL)
3	86	1	TRIPPING RELAY (ELECTROMECHANICAL TYPE)
4	95	1	TRIP CKT SUPERVISION RELAY
5	80	1	CONTROL SUPPLY SUPERVISION RELAY
6	-	1	DP. SWITCH WITH FUSE FOR D.C. CONTROL SUPPLY
7	-	1	PANEL SPACE HEATER WITH SWITCH AND THERMOSTAT
8	-	AS REQD	CLUSTER LED TYPE INDICATING LAMPS
9	-	1	CUBICLE LAMP (CFL) WITH SWITCH AND FUSE

NOTES:

1. ANTIPUMPING RELAY USED, IF ANY, SHALL BE CONSIDERED AS PART OF BREAKER MECHANISM.
2. THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN JOB SPECIFICATION SHALL BE IN VENDOR'S SCOPE..
3. FOR THE OTHER REQUIREMENTS OF RELAYS AND METERS, REFER JOB SPECIFICATION.
4. FOR THE REQUIREMENTS OF ECS INTERFACE, REFER I/O LIST ENCLOSED SEPARATELY IN M.R/TENDER
5. VA BURDEN OF PT SHALL BE DECIDED BY THE VENDOR/CONTRACTOR.
6. THERE SHALL BE ONE COMMON CONTROL SWITCH FOR ALL CONTROL SUPPLY FEEDER. SEPARATE FUSES FOR FOLLOWING BRANCH CIRCUIT SHALL BE PROVIDED:
 - SPRING CHARGING CIRCUIT
 - CLOSING CIRCUIT
 - TRIPPING, CONTACT MULTIPLIER & DIGITAL INPUT CIRCUIT
 - INDICATION CIRCUIT



ENGINEERS INDIA LIMITED
NEW DELHI

HV SWITCHBOARD
HARDWARE DATA SHEET
(VCB 0/P-2, 4 OF VFD)

DATA SHEET

REV

B957-000-16-50-DS-0118
Sht.1 OF 1

A

ANNEXURE-I TO MR TOPSHEET (B957-300-KA-MR-5020)

Note-1: Bidders shall provide mandatory spares as listed in Mandatory spare parts list (Doc. No. B957-300-80-42-SL-5020) forming part of inquiry document.

Note-2: Bidders are required to submit a list of commissioning spares (as recommended by them) along with the offer, which shall be supplied along with the compressor package. Any spares consumed over and above the spares supplied along with the compressor package, shall be furnished by the Compressor Bidders at the time of commissioning without any time/cost implication to the purchaser. Any un-used spare(s) shall be retained at purchaser's end without any cost implication. The prices of the same shall be included in base price of compressor package.

Note-3: Bidders are required to submit a list of special tools and tackles (as recommended by them) along with the offer which shall be supplied along with the compressor package. If no special tools/tackles are required for normal operation and maintenance of compressor package, the same shall be categorically indicated in the bid. The prices of the same shall be included in base price of compressor package.

Note-4: Bidders shall provide quotation of two years normal operation and maintenance spares for each compressor package. The same shall at-least contain the spares as specified in Document no. B957-300-80-42-OM-5020 forming part of Inquiry.

Note-5: The Bidder shall provide his services for supervision during erection, commissioning & field trial testing of each compressor package. Electrical & Instrumentation sub-Bidder's engineers shall also be present along with Bidder's erection, commissioning & testing engineers, as required. For each compressor package, the supervisory cost of **300 man-days** shall be considered for the purpose of commercial comparison. The bidder shall indicate the cost of providing the above services on per diem basis. Per-diem rates, as quoted by the bidder, shall be the basis of payment, however the actual payment for supervision services shall be based on actual man-days consumed at site.

Note-6: The successful bidder shall share the best maintenance practices with the Purchaser and shall conduct on-site training to the Purchaser team to familiarize on operation & maintenance aspects of the complete compressor package(s) considering a total of **15 days at site**. Bidder shall indicate in his proposal the cost for providing the above services on per-diem basis for site. Payment shall be done on the basis of actual days consumed. Also refer Electrical and Instrumentation specifications for customer training purposes.

Note-7: Bidder shall provide the lumpsum quotation of Comprehensive Post warranty Annual Maintenance contract for Dual redundant VFDs (as applicable for each package) in price breakup as below:

Applicable
for VCB also.

S. No.	Item description	Quoted price
1.	Comprehensive Post warranty Annual Maintenance Contract (PWAMC) for Main VFD- 1 (for a period of 5 years after completion of guarantee period)	
a.	PWAMC for VFD-1 for 1st year	
b.	PWAMC for VFD-1 for 2 nd year	
c.	PWAMC for VFD-1 for 3 rd year	
d.	PWAMC for VFD-1 for 4 th year	
e.	PWAMC for VFD-1 for 5 th year	

ANNEXURE-I TO MR TOPSHEET (B957-300-KA-MR-5020)

S. No.	Item description	Quoted price
2.	Comprehensive Post warranty Annual Maintenance Contract (PWAMC) for Main VFD- 2 (for a period of 5 years after completion of guarantee period)	
a.	PWAMC for VFD-2 for 1 st year	
b.	PWAMC for VFD-2 for 2 nd year	
c.	PWAMC for VFD-2 for 3 rd year	
d.	PWAMC for VFD-2 for 4 th year	
e.	PWAMC for VFD-2 for 5 th year	

Note-8: Bidder shall provide the quotation of carry out the 3-D modelling of complete compressor package as per Piping specifications forming part of Inquiry.

Note-9: The bidder shall participate during HAZOP study of the compressor package. The bidder shall indicate the cost of providing the above services on per diem basis considering **Two days / compressor package**. Per-diem rates, as quoted by the bidder, shall be the basis of payment, however the actual payment for HAZOP participation shall be based on actual man-days participated by bidder. Any suggestions/modifications raised during the HAZOP review shall be implemented by Bidder without any time/cost implication to the purchaser. Also refer to Job specifications.

Note-10: Bidder shall provide the quotation of Hardware (Hot Gas Bypass valve(s), NRV etc.) along with necessary instrumentation & logic implementation; arising as an output of dynamic simulation study. The same shall be ordered by Client, as per requirements.

Pre-Qualification Criteria

Item: 400A, 6.6 kV VCB Panel Switchboard for VFD System

Project: BPCL- BINA, DCU Off Gas Compressor

Customer: Bharat Petroleum Corporation Ltd. (BPCL)

Consultant: Engineers India Ltd. (EIL)

1. The vendor shall be an Original Equipment Manufacturer (OEM) of VCB Panels. Only the OEM can submit offers.
2. The vendor should have designed, engineered, manufactured, type tested or got type tested (as per IEC/equivalent), supplied 400A, 6.6kV or higher rating VCB panels as on 01.05.2026. Vendor to furnish necessary supporting documents. The Reference List of supplies made giving the ratings, year of supply, application and details of the customers etc. to be provided along with the offer.
3. The vendor shall be an EIL approved Vendor for Indoor HV Switchboard with VCB. Technical clearance of Vendor's offer will be based on Customer/EIL acceptance of OEM Credentials (does not apply to approved vendors for this project).
4. The vendor or their authorized service representatives shall have trained engineers for supervision of testing and commissioning & service for the offered equipment and shall be in a position to provide prompt after sales service and spares support for our installations. This service network shall necessarily be available in India.
5. The vendor shall be in a position to undertake AMC or provide service support for the equipment supplied, after the expiry of the warranty / guarantee period either directly or through a service representative.

Note:

- a. Vendor must furnish all necessary supporting documents, as required, along with the bid to satisfy Pre-Qualification criteria as specified above.
- b. The Pre-Qualification criteria are mandatory requirements and the technical bids will be cleared only when the Pre-Qualification criteria are accepted by end customer.

Checklist for Pre-Qualification Criteria:

Sl. No.	Vendor Confirmation to the points above	Reference of documents attached
1	Yes / No	
2	Yes / No	
3	Yes / No	
4	Yes / No	
5	Yes / No	



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PURCHASE SPECIFICATION
GROUP: CE ENGG./DRIVES

P.S NO. : PS/445/3167

REV. NO : 01

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REVISION HISTORY SHEET

REV. NO.	DATE	NATURE OF CHANGE	REASONS	PREPARED BY	APPROVED BY
00	08-05-2026	FIRST ISSUE	-----	KD	GD
01	26-05-2026	MINOR CHANGES	-----	KD	GD

REVISION 01

APPROVED BY

GITESH DAS

PREPARED BY

ISSUED BY

DATE

KAMALINI DEY

CE ENGG / DRIVES

26-05-2026



A4 – 10

PURCHASE SPECIFICATION

GROUP: CE ENGG./DRIVES

P.S NO. : PS/445/3167

REV. NO : 01

PAGE 01 OF 16

TECHNICAL SPECIFICATION FOR VACUUM CIRCUIT BREAKERS IN METAL ENCLOSED PANELS

1. Project Details

Sl. No.	Parameter	Specification
1	Project Title	Delayed Coker Unit (DCU) Revamp, Off Gas Compressor (OGC) Project
2	Customer	Bharat Petroleum Corporation Ltd. (BPCL)
3	Consultant	M/s ENGINEERS INDIA LTD. (EIL)
4	Project Location	BPCL-Bina Refinery, Madhya Pradesh, India

2. Environment Specifications

Sl. No.	Parameter	Specification
1	Maximum Ambient Temperature	48°C
2	Minimum Ambient Temperature	1.1°C
3	Equipment Design Temperature (IS-9676)	45°C
4	Relative Humidity	86%
5	Altitude above mean sea Level	Less than 1000m above mean sea level
6	Location of VCB Panels	Indoor
7	Seismic Zone	As per IS:1893
8	Site Environment	Humid & Corrosive

3. Input Data

Sl. No.	Parameter	Specification
1	System Voltage / Frequency / Phase	6.6kV / 50Hz / 3
2	Voltage Variation	± 10 %
3	Frequency Variation	± 5 %

REVISION 01

APPROVED BY

GITESH DAS

PREPARED BY

ISSUED BY

DATE

KAMALINI DEY

CE ENGG. /DRIVES

26-05-2026

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4	Combined Voltage and Frequency Variation	$\pm 10 \%$
5	Fault Level	40 kA for 1 Sec
6	Application	Switchboard with 3 Numbers (400 Amp) Vacuum Circuit Breakers Q1, Q2 & Q3 as shown in attached SLD.

4. VCB Specifications

Sl. No.	Parameter	Specification
1	Rated Voltage	6.6kV
2	Rated Current	400A
3a	Rated Short Time Current Rating	40kA RMS for 1 Second
3b	IAC Rating	As per attached EIL specifications/ datasheet (40kA for 1 sec)
4	Power frequency Withstand / Impulse Withstand	20kV / 60kV peak
5	Reference Standard	As per attached EIL specification for HV Switchboards
6	Type of Circuit Breaker	Truck mounted withdrawable type with wheels. 3-pole version with individual vacuum interrupter for each phase. If cassette type VCBs are being provided, then Breaker Transport trolleys shall be supplied.
7	Closing / Opening Mechanism	Through spring charged electric motor mechanism; with a provision for manual spring charging through crank handle to be provided as standby. Provision for closing and tripping circuit breaker from remote through contacts and from local by Trip-Neutral-Close (T-N-C) switch to be provided. Lockable Local/Remote Switch and Emergency Push Button shall be provided. Two numbers of 110V DC feeders (redundant) & 1 no. of 240V AC feeder shall be provided by customer for the complete Switchboard. Building up necessary redundancy with auto changeover arrangement for 110V DC and internal



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		distribution is in Vendor's scope. 240V AC Supply for space heater/ lighting. Closing Coil and Spring Charging Motor in all 3 VCBs are with 110 V DC supply. Mechanism shall be trip free type. Anti-Pumping circuit/mechanism shall be incorporated. Tripping coil for VCBs Q2 and Q3 shall be of 110V DC Supply. Tripping coil for VCB Q1 – Please refer Clause 4(18) (u) in page 8 of 15 of this Specification.
8	VCB Panel Construction	a) Vacuum Circuit Breaker panel should be as per attached EIL Specification for HV Switchboard, EIL Datasheet of HV Switchboard and other documents/specifications as per attached list. b) Base channel of height 100 mm suitable for tack welding to the MS insert embedded in the floor shall be provided. c) Cutout to be given on door with toughened glass with beading to view contacts from the outside. d) A separate metering chamber with partitions shall be provided to house protective relays, meters, indicating lamps, switches, transducers etc. e) Neoprene rubber gaskets to be provided on bolt-on covers, doors, cable gland plates and all other places wherever found necessary. f) Each compartment like circuit breaker compartment, cable compartment etc. shall be provided with an explosion vent. g) Height of metal clad enclosure must be at least 2300 mm from the finished floor. See fig. 2 for typical sizes and arrangement of panels.
9	Class of Protection	Degree of Protection of Circuit Breaker panels shall be IP4X (minimum) as per IEC:60529.
10	Termination Arrangement	All Incoming and Outgoing cable entries for Power and Control cables shall be from Bottom only. Details of Power Cable Terminations is in figure-2. The power terminals shall be at least 600 mm from the cable gland plate to facilitate termination. Tentative arrangement has been indicated in figure-2. Vendor to provide their proposed panel arrangement.



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10	Termination Arrangement	For Power Cables and control cables, undrilled, detachable gland plates of sufficient size & thickness (3 mm minimum) Aluminium gland plate to be provided. Gland plate shall be of sufficient strength to handle all the cables. VCBs busbar terminals shall be suitable for termination of cables as shown in figure-1.
11	Cable Accessories	Double Compression type, Nickel plated brass cable glands (flameproof) to be supplied by the vendor for Incoming and Outgoing cables. HT power cable size selected for Q1 VCB is 1R x 3C x 240 sq.mm and Q3 VCB is 1R x 3C x 240 sq.mm., 6.6 kV, Al cable. However, exact cable sizes shall be confirmed during drawing approval stage. HT Cables and Cable Termination Kits are not in vendor's scope of supply. Cable Glands for all HT cable terminations shall be supplied along with the VCB Panels.
12	Painting	2 Coats of Primer and 2 Coats of Finish Paint to be given for all surfaces of enclosure. Paint shall be Epoxy Based with Powder Coated Finish. Paint: Paint colour shall be RAL-7032. Paint Thickness: 100 Microns (minimum). Exact paint shade will be confirmed during detailed engineering. Note - Vendor shall supply final paint (1 litre per switchboard) in non-returnable container for final touch up at site as per Cl. No. 5.11.4 of EIL Specification for HV Switchboard.
13	Main Bus bars	For bus bar specification, refer attached Cl. No. 5.3 of EIL specification for HV Switchboards. Shorting of Incoming and Outgoing terminations shall be as shown in Figures 1 and 2.
14	Earth Bus bars	For the Earth bus bar specification, refer attached EIL specification for HV Switchboards.



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Features

- a) For auxiliary wiring and terminals, refer attached EIL specification for HV Switchboards.
- b) All hardware shall be corrosion-resistant. All joints and connections of the panel members shall be made by zinc-passivated high-quality Grade 8.8 or superior steel bolts, nuts and washers, secured against loosening.
- c) Facility for locking of VCB panel doors shall be provided.
- d) **All components/items shall be as per attached EIL's Master Vendor List.**
- e) Elmex type TBs CATDM4 to be provided for CT circuits to facilitate testing.
- f) Detachable type Operating Handle
- g) Mechanical ON/OFF Position Indicator on enclosure front.
- h) 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.
- i) Plugs and Sockets for low voltage wiring.
- j) Manual Spring charging port with indicator.
- k) Drawout Lever
- l) Interlock Lever
- m) Operation Counter
- n) Handle for spring charging
- o) Spring charging motor with its protection circuit.
- p) Anti pumping relay and associated circuit
- q) Isolating contact in motor circuit when manual closing handle is inserted.
- r) Suitable rating Surge Arrestors to be provided for all VCBs.
- s) Atleast 10% spare terminals for each type of TB's and space for adding another 10% spare terminals shall also be available.
- t) LOTO arrangement shall be provided for breaker.
- u) Line PT (if applicable as per BOM) provided shall be withdrawable in line with EIL Standard Specification clause no. 6.1.12.



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16	Gasducts	Refer Cl. No. 5.4.7 of attached EIL Job Specification (Electrical). Vendor shall consider additional duct length, if required, to meet the requirements of the type-tested design.
17	Safety Interlocks	The following minimum safety interlocks are to be provided. i. The truck cannot be moved from either Test to Service position or vice versa, when Circuit Breaker is "ON". ii. The Circuit Breaker cannot be switched "ON" when truck is in any position between Test and Service positions. iii. The front part of the VCB shall have a locking facility. iv. There shall be no approach to high voltage points when the front door is open and Circuit Breaker is in "SERVICE" position. v. Interlock to be built such that VFD Input Breaker(Q1) & VFD Output Breaker(Q2) shall not switch ON if VFD Bypass Breaker(Q3) is in ON position or vice versa. vi. Rear door interlock shall be provided as per Cl. No. 5.4.12 of EIL Job Specification (Electrical). vii. Any other safety interlocks as may be required shall be provided for safe operation and maintenance. Refer Cl. No. 5.4.5 of attached EIL Job Specification (Electrical).
18	Accessories (as per BOM)	a) Current Transformers shall be as per attached EIL specifications. Dual Core Resin Cast Current Transformer with bar primary. The bar primary shall be capable of carrying 40kA for 1 sec during fault. Working Voltage: 7.2kV, Insulation Class: B. Core 1: 15VA, Class 1.0 Metering, XXX/1A Core 2: 15VA, Class 5P10 Protection, XXX/1A All CT connections to be taken through Elmex make (or as per customer sub-vendor list) TBs with links – Type CATDM4.



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Accessories (as per BOM)

- b) Potential Transformers shall be as per attached EIL specifications. 3 phase drawout Cast Resin Potential Transformer with Fuses, Insulation Class: B. Vector Group to be selected based on bus PT vector group. Primary 7.2 kV L-L RMS; Secondary 110V L-L RMS. Fuses to be integral with PT. LV neutral of the PT shall be insulated to full line voltage. PT secondary R, Y, B, n connections to be brought out to external terminals for remote measurements.
- c) Analog Ammeter. Input 0-1A fed from Core 1 of CTs above. Accuracy Class: 1.0, Scale 0-xxxA. Other details shall be as per EIL specifications. Auxiliary Supply: 110V DC.
- d) Analog Voltmeter. Scale 0-7200V. Input 0-110V fed from PTs above. Other details shall be as per EIL specifications. Auxiliary Supply: 110V DC.
- e) Ammeter Selector Switch (4 position).
- f) Voltmeter Selector Switch (4 position).
- g) High Speed Tripping Relay – VAJH23. Coil Voltage 110V DC. Flag – Hand Reset, Flush mounting type.
- h) Motor protection relay for Bypass breaker (Q3) – Numerical type fed from CTs & PTs above : Flush mounting, Auxiliary supply : 110V DC. The relay shall also include under voltage protection.
- i) Trip Circuit Supervision Relay – VAX31, Contacts 1NO+2NC, 110V DC supply. 1NO+2NC Contacts to be wired to TBs for external signalling. Flush mounting type. Other details shall be as per EIL specifications.
- j) “Trip-Neutral-Close” Switch .– 6 pole
- k) “Local-Remote” Switch – 8 pole lockable
- l) “Emergency Trip” – Push Button, 2NO+2NC, Mushroom Type, Lockable – Twist to Release.
- m) Limit Switch for Door Interlock to be provided. Contacts to be wired to TBs.
- n) Each Circuit breaker will be provided with following indicating lamps:
 - i) Indicating Lamp "ON" - Red,
 - ii) Indicating Lamp "OFF" - Green,
 - iii) Indicating Lamp and Push Button “TRIP CIRCUIT



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Accessories (as per BOM)

TEST"-White

- iv) Indicating Lamp "SPRING CHARGED" - Blue,
- v) Indicating Lamp "AUTO TRIP" – Amber
- vi) Indicating Lamp – Phase Indication "R", "Y", "B" - Red, Yellow, Blue
- vii) Indicating Lamp "TRIP CKT HEALTHY" – White
- viii) Indicating Lamp "SPARE" – Amber

Details of connection and wiring will be discussed and finalized during detailed engineering. For indicating Lamps, refer clause no. 6.6.4 of EIL specification for HV Switchboards.

- o) Auxiliary Contactor for contact multiplication and interlocking 4NO+4NC, 110V DC coil Interlocking Scheme to be finalized during detailed engineering,
- p) Space Heater with Thermostat, MCB for Space heater: Refer EIL specification for HV Switchboards. Rating: 230V AC
- q) Covered CFL illumination lamp with ON/OFF switch & MCB, Rating: 230V AC
- r) Switch socket unit for each panel
- s) Dual O/P transducer for 4-20 mA Current feedback to
 - i) DCS / LCS
 - ii) Spare
- t) One set of accessories consisting 1 no. each of slow closing handle, spring charging handle, lever's used for providing status of test mode and service mode & Wedge shaped platform shall be supplied loose alongwith switchboard.
- u) VFD Input Breaker (Q1) shall be provided with 1 No. shunt trip coil and with under voltage release. However, in case it is not possible to provide under voltage release in the standard design, as an alternative, two shunt trip coils shall be provided of different voltages. One shunt trip coil shall be suitable for switchgear DC control supply (110V DC) while second shunt trip coil suitable for external AC control supply (240V AC). The control supply voltage level shall be as per EIL datasheet.



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19	OTMS(Online Temperature Monitoring System)	Switchboard shall be provided with online wireless temperature monitoring facility(OTMS). The passive sensor should be wireless, battery less, dielectrically safe, robust to high voltage, high electromagnetic field, and harsh environment. It should take direct measurement on critical point. This facility shall be interfaced with ECS. For detailed spec. refer Cl. No. 5.4.9 of EIL Job Spec. Electrical attached. Approved vendors for OTMS shall be Schneider/ABB/Rugged or Equivalent.
Note: 1. VCB vendor should decide VA rating of PT during detail engineering. 2. For detailed specification of CT & PT, please refer EIL specification/ datasheet. 3. CTs and PTs shall be suitable for variable frequency operation. 4. Make of items: As per attached EIL master vendor list.		
20	Identification of Panel	a) An Identification Plate has to be fixed on the front and rear of the Panel. The rear side identification plate shall be fixed on the panel frame and not on removable covers. Inscription details will be Input VCB (Q1), Output VCB (Q2) and Bypass VCB (Q3) as shown in Figure-1. b) Cable Identification Plates screwed on edge of cable gland plate indicating the source and destination of incoming and outgoing cables to be provided. Details will be provided during detailed engineering.
21	Relay Settings	Vendor has to submit relay settings calculations for the numerical relays during detailed engineering stage. The calculations shall be supported by e-Tap calculations/simulations including co-ordination curves of relays. Details required for relay settings like motor datasheet, upstream breaker details etc. shall be shared during detailed engg. stage. Vendor has to depute service person to Site for modifications of relay settings (if required). Charges for the same shall be same as that of erection supervision and commissioning charges.
22	Routine Tests	All routine tests shall be conducted and type test reports shall be submitted as per attached EIL ITP for HV Switchboards (6-81-1001 Rev. 4) and EIL Datasheet for HV Switchboard (B957-000-16-50-DS-0101 Rev. B).



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23	Type tests	Type Test certificates (not more than 10 Years old from 01.05.2026) to be furnished for similar switchboard in line with attached Job Specification Electrical, EIL HV
	Type tests	Switchboard Datasheet and EIL ITP. Vendor shall furnish back up documents to establish that no major change has been introduced in the basic design/ technology/ material/ mechanical construction/ functionalities of equipment/performance characteristic / manufacturing process of the equipment. If valid type test certificates as above are not available, vendor shall conduct type tests without any cost implication to BHEL- EDN.
24	Quality Plan	Vendor should submit ITP for BHEL / Customer Approval as per Customer ITP. Customer Approved Quality Plan / Requirements will have to be adhered to during design / manufacture /material procurement / testing and despatch.
25	Inspection	Final Inspection: BHEL / Customer / Customer representative /Third Party Inspector (TPI) will be present at manufacturer's works for witnessing of final testing. This is to be incorporated in the Quality Plan. Hiring of Third Party Inspector (TPI) shall be in Customer scope.
26	Packing	Packing shall be suitable for storage in areas with heavy rains and high ambient temperature as per EIL Specification for HV Switchboards cl. 8.0 & attached packing instructions.

5. Confirmations / Deviations to Specifications

Point-wise confirmation to this specification & EIL Specification to be given along with offer. Deviations, if any, shall be indicated separately. If there are no deviations to specifications, vendor shall mention the same explicitly. A reply from vendor stating that "Equipment will generally meet the specifications" will not be accepted by BHEL. Clause-wise Confirmation / Clarifications of all Clauses in this Specification, Customer specifications/documents and ITPs shall be furnished in the format below. This is mandatory. Deviations furnished below ONLY will be considered by BHEL. Deviations mentioned elsewhere will not be allowed. BHEL has right to not accept the deviations mentioned by Vendor.

Point No.	Page No	Confirmation / Clarification / Information / Deviation	Details	Remarks, if any



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6. SPARES:

A	Mandatory Spares:	Supplier should quote item wise price for the spare list attached. Unpriced List of Spares quoted for shall be provided in the Technical Offer. Bidder shall supply these spares along with main equipment.
B	Recommended spares for 2 years:	Supplier should quote item wise price for the recommended 2 years O&M spare list attached. These prices shall remain valid up to 2 years validity beyond the contractual completion/delivery period of order. Order of recommended two years operation and maintenance spares may be placed by BPCL/EIL/BHEL separately, if required. BHEL/BPCL reserves the right to select and order any of the spares out of above list within the validity period.

Sl. No.	Parameter	Qty. Mandatory Spares	Qty. Recommended Spares for 2 years
1	Closing coil	1 no. of each rating & type	1 no. of each rating & type
2	Shunt trip coil	1 no. of each rating & type	1 no. of each rating & type
3	Control fuses / MCB (all type & rating)	10 nos. of each rating & type	10 nos. of each rating & type
4	Breaker finger jaws	1 set of each rating & type	1 set of each rating & type
5	Indicating lamp covers	5 nos. of each colour	5 nos. of each colour
6	Indicating lamps	20% or 3 nos. (min) which ever is more	20% or 3 nos. (min) which ever is more
7	Ethernet switch	1 no. each type	1 no. each type
8	Spring charging motor	1 no. each type	1 no. each type
9	Numerical protection relays	1 no. each type	1 no. each type

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7. Bill of Material (in Nos.):

Sl.	Item	Feeder PT	VFD I/P (Q1)	VFD O/P (Q2)	BYPASS (Q3)
1	7.2 kV VCB	-	1	1	1
2	CT – XXX/1A – dual core	-	1	-	1
3	Ammeter 0 – XXXA with ASS	-	1	-	1
4	PT 7.2 kV/110V L-L with Fuses	1	-	-	-
5	Voltmeter 0-6600V with VSS	1	-	-	-
6	Indicating Lamps and Push Buttons (*)	1 Set	1 Set	1 Set	1 Set
7	High Speed Tripping Relay VAJH23	-	1	1	1
8	Trip Circuit Supervision Relay VAX31	-	1	1	1
9	Auxiliary Contactor 4NO+4NC (*)	-	6*	6*	6*
10	T-N-C Switch – 8 Pole – ODS	-	1	1	1
11	Local-Remote switch- 8 pole	-	1	1	1
12	Emergency Trip PB – 2NO+2NC	-	1	1	1
13	Limit Switch	-	1	1	1
14	Space Heater	-	1	1	1
15	Illumination Lamps	-	1	1	1
16	Switch socket	-	1	1	1
17	Surge Arrester	-	-	-	1 Set
18	Dual O/P transducer	-	1		1
19	Numerical Relay (O/C & E/F)	-	1	-	-
20	Numerical Relay (Motor protection)	-	-	-	1
21	Earthing Truck (Feeder & Bus)	-	1		
22	Breaker Handling trolley (for Cassette type Breaker only)	-	1		
23	Ethernet Switch*	-	1 Set		
24	OTMS System	-	1 Set		

Note:

- 1) * As per requirement.
(Vendor to consider same as per logic requirement during detailed engineering stage, without any price implication).
- 2) Only major relays, meters and controls are indicated in BOM. Any other auxiliary relays, timers, switches, contactors, indications etc. as required while implementing the control schematics or felt necessary for safe operation, even if these are not specifically mentioned, shall be supplied without any time and price implications.



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8. Scope of Supply & Services

Sl. No.	Item	Quantity
1	400A, 6.6kV Switchboard (consisting of Q1, Q2 & Q3 VCBs)	1 No.
2	Breaker Earthing Truck (Feeder & Bus)	1 No.
3	Accessories for cables and Breaker	1 Set
4	Mandatory Spares	1 Set
5	Erection Supervision & Commissioning charges including relay setting charges at site (<i>Vendor to quote lumpsum charges for 7 mandays which shall be considered for bid evaluation</i>)*	1 Lot
6	PWAMC charges for VCBs **	01 Lot (Lumpsum)
7	Recommended Spares for 2 Years (optional for Ordering)***	1 Set

Note:

* Payment shall be made for actual man-days consumed with per man-day charges calculated on the basis of the lump sum charges quoted above. Lump sum charges quoted shall include travelling, boarding and lodging expenses.

**Comprehensive Post Warranty Annual Maintenance Contract (PWAMC) for Bidder supplied Switchgear for a period of 5 years after completion of guarantee period. Breakup shall be furnished in EIL Format attached. Charges quoted shall include travelling, boarding and lodging expenses.

*** These shall be considered for Bid evaluation.

9. Data sheet

Data sheet is to be filled up by the Vendor as per customer format and submitted as a part of the Technical Bid and Final Version during Drawing Approval stage.



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10. Documentation

S.No.	Parameter	Specification
1	Attached Documents	a) EIL Specification for HV Switchboards, 6-51-0001 Rev. 08 b) EIL Datasheet for HV Switchboard, B957-000-16-50-DS-0101 Rev. B c) EIL ITP for HV Switchboards, 6-81-1001, Rev. 4 d) BHEL SLD of VFD System, 3-674-00-52-004 Rev. 01 e) EIL Job Specification for Elec., B957-300-16-50-SP-5030, Rev. D f) Hardware datasheet - for VCB output breaker, B957-000-16-50-DS-0118 Rev.A g) Format of Test reports of HV switchgear with VCB, B957-000-16-50-DS-9903, Rev. A h) Extract of EIL's Vendor List B957-16-51-VL-5030 Rev.B i) ECS I/O list j) PWCAMC Details, Annexure-I to B957-300-KA-MR-5030 k) Pre qualification criteria
2	Technical (unpriced) and Commercial (priced) Bids – For Evaluation	Refer “Scope of Supply and Services”(Sl. No. 8) for Unpriced and Priced bid.
3	Technical Information required along with Offer	a) OGA Drawing of VCB Panels, Weight b) Technical Catalogue of VCB being offered (including details of Safety Interlocks provided) c) Confirmation / Clarification / Information / Deviation List to Customer /EIL/ BHEL Specification as per Point 5 above. d) Filled up Data Sheet as per Point 9 above. e) Confirmation / Deviation to Customer/BHEL Specifications.
4	Information required for Approval after Placement of Purchase Order	a) OGA Drawing & Schematic diagram b) Technical Catalogue of VCB being offered, including details of Safety Interlocks provided. c) Filled up Data Sheet as per Point no. 9 above d) Bill of Materials e) Quality Plan, Test Protocol for Routine Tests f) Type test certificates as per EIL specification g) CT, PT, busbar sizing calculation.
5	Information Required along with Supply. Maintenance Manuals and Documentation	Soft copies of Erection, Commissioning and Maintenance Manuals along with Final Drawings and Documentation, Test and Guarantee Certificates, Complete Bill of Material, Operation and maintenance Manual for equipment supplied.

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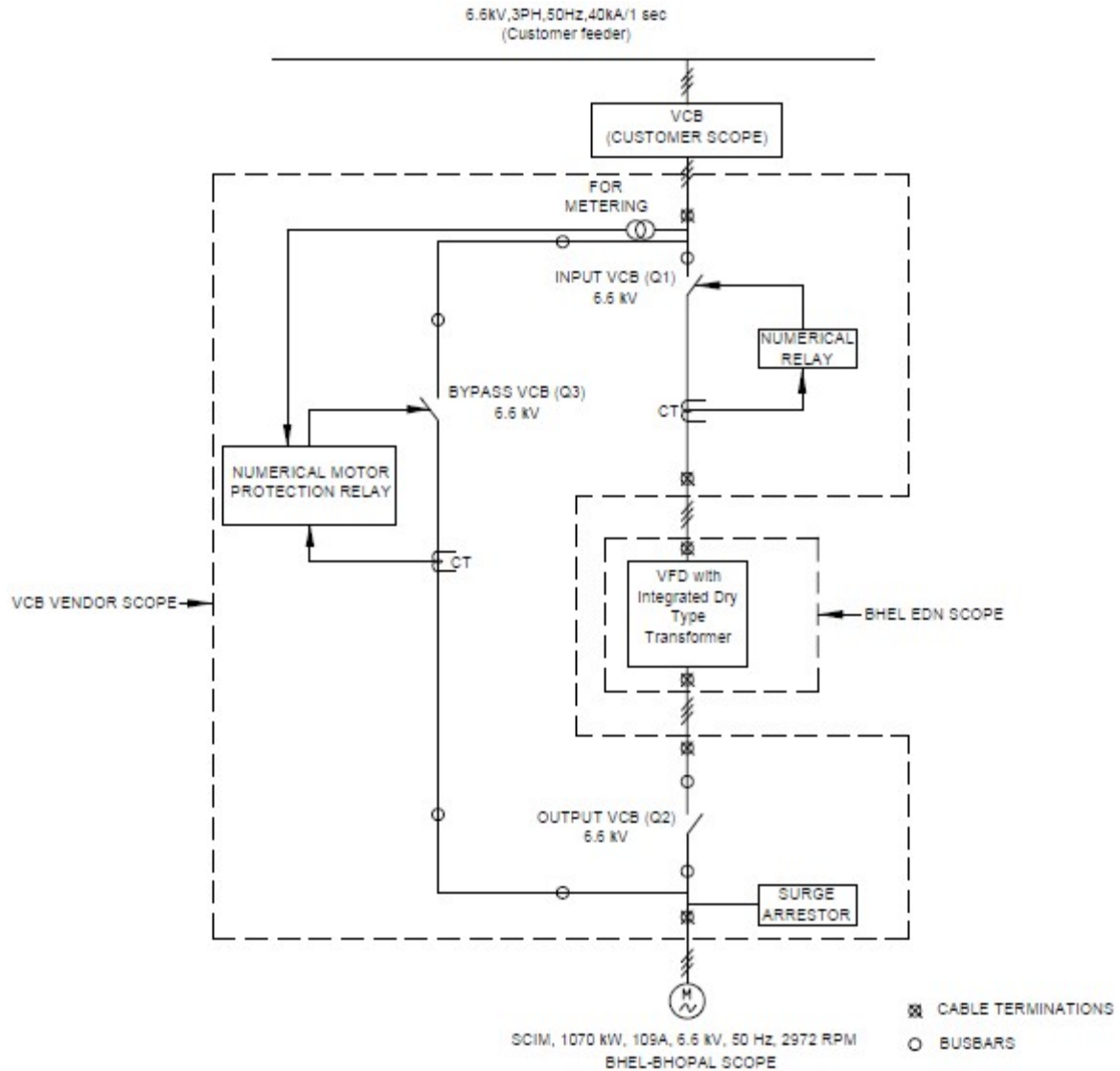
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NOTE:

- 1) INPUT TERMINALS OF Q1 & Q2 TO BE SHORTED INTERNALLY BY BUSBARS
- 2) OUTPUT TERMINALS OF Q2 & Q3 TO BE SHORTED INTERNALLY BY BUSBARS
- 3) CABLE TERMINATIONS SHALL BE SUITABLE FOR CABLE SIZES SHOWN IN SLD DWG NO: 3-674-00-52-004

FIGURE 1 - SINGLE LINE DIAGRAM



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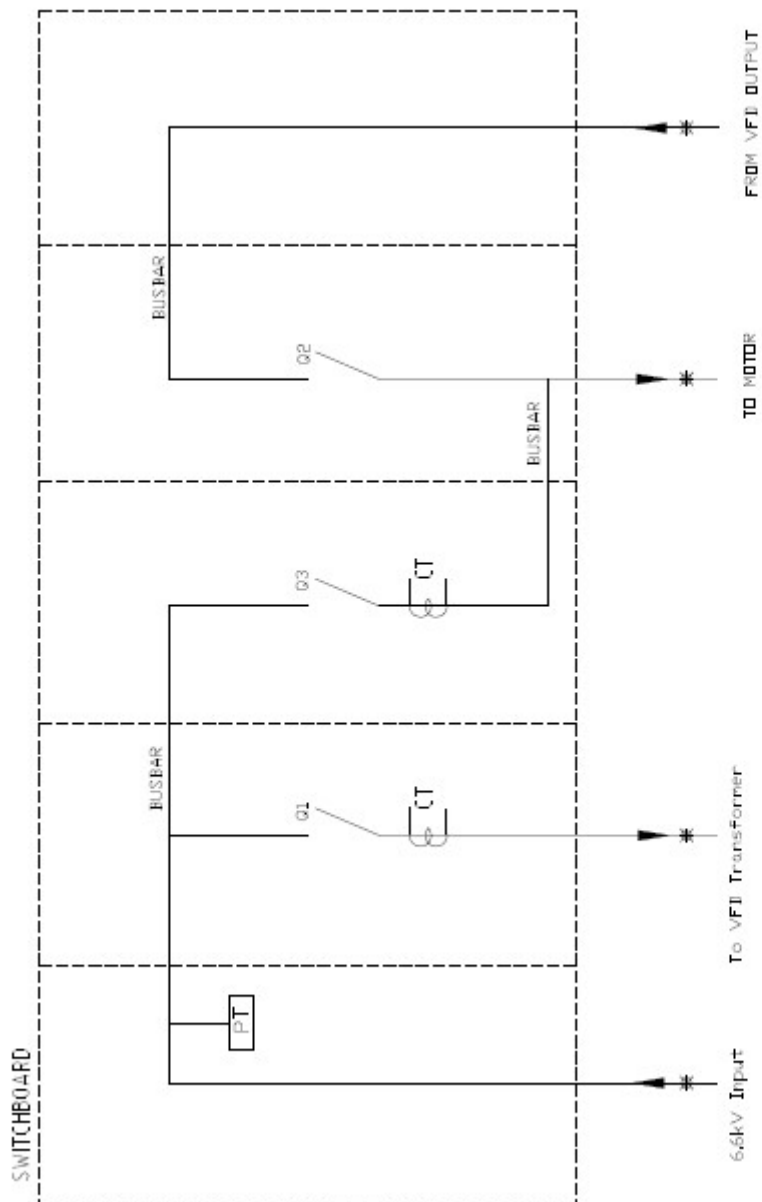
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* CABLE TERMINATIONS (cable sizes will be confirmed during detailed Engineering)

NOTE: The number of cables shown is indicative. Vendor to indicate the optimum number of cables based on the quantities of components required.

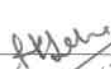
FIGURE 2 - SWITCHBOARD CONFIGURATION



- | MODE | LCS
L/R SW. POS. | VFD
A/M SW. POS. | START/ STOP
CTRL | SPEED
REFERENCE |
|----------------|---------------------|---------------------|---------------------|-------------------------|
| VFD
MODE | LOCAL | AUTO/
MANUAL | LCS | LCS SPEED IN
DEC. PB |
| | REMOTE | MANUAL | VFD | VFD PANEL |
| | REMOTE | AUTO | DCS
(STOP ONLY) | DCS
(4-20mA) |
| BYPASS
MODE | LOCAL | -NA- | LCS | -NA- |
| | REMOTE | -NA- | DCS
(STOP ONLY) | -NA- |

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उच्च वोल्टेज स्विचबोर्डों के लिए मानक विनिर्देश SPECIFICATION FOR MEDIUM VOLTAGE SWITCHBOARDS

8.	20.11.2024	REVISED & ISSUED AS STANDARD SPECIFICATION	 VB/MKM	 RKS	 HK	 MN
7.	10.01.2019	REVISED & ISSUED AS STANDARD SPECIFICATION	VB	HK	BRB	RKT
6.	15.10.2013	REVISED & ISSUED AS STANDARD SPECIFICATION	VB	HK	UAP/JMS	SC
5.	28.04.2010	REVISED & ISSUED AS STANDARD SPECIFICATION	HK	SA	NS/JMS	ND
4.	03.03.2005	REVISED & ISSUED AS STANDARD SPECIFICATION	RM	AKT	AAN	SKG
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

Abbreviations:

A	Ampere
AC	Alternating Current
BIS	Bureau of Indian Standards
BS	British Standard
CNT	Close-Neutral-Trip
CEA	Central Electricity Authority
CPRI	Central Power Research Institute
CRCA	Cold Rolled Cold Annealed
CT	Current Transformer
DC	Direct Current
EPDM	Ethylene Propylene Diene Monomer
FBT	Fast Bus Transfer
FRP	Fiber Reinforced Polyester
MV	Medium Voltage
Hz	Hertz
IAC	Internal Arc Classification
IEC	International Electro-Technical Commission
IEEE	Institute of Electrical & Electronics Engineer
IP	Ingress Protection
kV	Kilo Volt
kW	Kilo Watt
kWH	Kilo Watt Hour
LED	Light Emitting Diode
LOTO	Lock-Out Tag-Out
LSC	Loss of Service Continuity
MCB	Miniature Circuit Breaker
MCC	Motor Control Center
MCCB	Moulded Case Circuit Breaker
NEMA	National Electrical Manufacturers Association
NO	Normally Open Contact
NC	Normally Close Contact
OTMS	Online Temperature Monitoring System
PO	Purchase Order
PT	Potential Transformer
PU	Polyurethane
p.u.	Per unit
PVC	Poly Vinyl Chloride
RAL	Reichs-Ausschuss für Lieferbedingungen
SF ₆	Sulphur Hexafluoride
SWG	Standard Wire Gauge
VCB	Vacuum Circuit Breaker
VDE	Verband Deutscher Elektrotechniker
VFD	Variable Frequency Drive
VT	Voltage Transformer
XLPE	Cross linked Poly Ethylene

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1.0 SCOPE

This specification covers the design, manufacture, testing, packing and supply of indoor, drawout type Medium Voltage Switchboards >1 kV up to and including 33 kV, incorporating Vacuum or SF₆ 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, unless otherwise specified:

IS: 1248	Direct acting indicating analogue electrical measuring instruments and their accessories
IS: 2071	High Voltage Test Technique
IS: 2544	Porcelain post-insulators for systems with nominal voltage greater than 1000V
IS: 2705-1	Current transformers specification: Part 1 General Requirements
IS: 3618	Specification for phosphate treatment of iron and steel for protection against corrosion
IS: 5082	Wrought aluminium and aluminium alloy bars, rods, tubes, sections, plates and sheets for electrical applications
IS: 5578	Guide for marking of insulated conductors
IS: 6005	Code of practice for phosphating of iron and steel
IS: 16227	Instrument transformers
IS: 11353/	
IEC 60445	Basic and safety principles for man-machine interface marking and identification - identification of equipment terminals conductor terminations and conductors
IS: 13703-4	Specification for low - voltage fuses for voltages not exceeding 1000V AC or 1500V DC : supplementary requirements for fuse links for the protection of semiconductor devices
IEC 60282-1	High voltage fuses – Current Limiting fuses
IS/IEC 60168	Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1000 V
IS/ IEC 60529	Degree of Protection provided by Enclosure
IS/IEC 62271	High Voltage Switchgear and Controlgear (Part 1, 100, 102, 103, 105, 106, 200, 201, 301)
IEC 62271	High Voltage Switchgear and Controlgear

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

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

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

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

3.0 GENERAL REQUIREMENTS

3.1 The offered equipment shall be brand new with state of art technology and proven track record of the manufacturer of similar product. No equipment without mandatory type test shall be offered.

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

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

4.0 SITE CONDITIONS

- 4.1 The switchboards shall be suitable for installation and satisfactory operation in an air conditioned/ pressurised sub-station or in a substation with restricted natural air ventilation or in a covered shed/ enclosed electrical room (e-room) in a tropical, humid and corrosive atmosphere.
- 4.2 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.
- 4.3 All equipments described in this specification are intended for continuous duty operation, as per nameplate rating under the specified ambient conditions, unless indicated otherwise.

5.0 DESIGN AND FABRICATION REQUIREMENTS

5.1 Enclosure and Protection

- 5.1.1 The Medium 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, 2mm (14 SWG) CRCA sheet steel shall be used for all front and rear doors and covers, and 1.6mm (16 SWG) CRCA sheet steel for inter-panel partitions. Wherever required, stiffeners shall be provided to increase stiffness of large size doors and covers.
- As an alternative to CRCA, Aluzinc/pre-galvanised sheet steel can also be provided for internal inter-panel partitions only. However, all external surface shall be of CRCA with specified paint shade.
- 5.1.2 Vertical panels shall be assembled to form a continuous line-up of uniform height both for HV chamber as well as control chamber. Rear extension panels shall also be of full height. However, HV chamber height can be different from control chamber height.
- 5.1.3 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 1mm. Design of louvers/ opening shall be such that the arc does not come out in case of internal arc. The same shall be type tested for internal arc, as specified. The enclosure shall have complete protection against approach to live parts or contact with internal moving parts (IP-4X) as per IS/IEC: 60529.
- 5.1.4 All openings, covers and doors shall be provided with suitable Neoprene/ XLPE/ EPDM gaskets around the perimeter to make the switchboard dust and vermin proof.
- 5.1.5 Each unit of the switchgear shall have necessary internal sheet metal barriers to form separate compartments for circuit breaker, busbars, instruments and relays, cable connections etc. Compartments for cable connections shall allow cable termination and connection work with the switchgear energised. Suitable interlock shall be provided such that cable compartment can be opened only when earth switch is ON or Earthing truck is inserted.
- 5.1.6 The panel shall be internal arc tested as per IS/IEC 62271-200 requirements for full short circuit current and for a duration of 0.5 second (minimum) unless specified otherwise in job specification/ datasheet and shall be qualified to comply with all the 5 criteria as per IS/IEC 62271-200. 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 internal arc classification (IAC) as per IS/IEC 62271-200 for the short circuit current and duration as specified. IAC test shall be conducted on the offered panel variants such as smallest width panel, panel with louvers, panel with thermography window and any other variants (as applicable) as per job requirements. The panel shall also be AFLR tested as per IS/IEC 62271-200 requirements.

For panels having busduct entry in place of cable entry, busduct interface with panel shall be such that it does not interfere with the IAC type tested design of panel. Separate rear extension panel shall be provided for the Busduct entry. Wall through bushings shall be provided at interface point between busduct and panel.

In case vendor has considered pressure relief/ gas duct above switchboard for release of gases due to internal arc; vendor shall preferably provide suitable absorbers in the switchboard to prevent the release of harmful gases in the switchgear hall. Alternatively, duct including all accessories/supporting arrangement/sealing material/bends/installation material etc. shall be provided for evacuating harmful gases. The offered arrangement of pressure relief/ gas duct shall be as per type tested design.

- 5.1.7 All identical equipment and corresponding parts shall be fully interchangeable.
- 5.1.8 Safety barriers / shutters shall be provided to permit personnel to work safely within an empty compartment with the bus bars energised. Loss of Service Continuity (LSC) category of the switchgear shall be LSC2B as per IS/IEC-62271-200.
- 5.1.9 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.
- 5.1.10 The drawout carriage on the switchboard shall have three positions: "Service", "Test" and "Drawout" viz:
 - "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.
 - "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.
 - "Draw out" Position - both power and control circuits shall be disconnected in this position. Alternatively, "Test Position" with the secondary control circuit disconnected may be provided in lieu of "Draw out Position"

Circuit breaker operation shall be possible only in "Service" and "Test" positions. The circuit breaker shall be lockable in "Test" / "Draw-out" positions. Automatic safety shutters shall be provided to ensure the inaccessibility of all live parts after the carriage is drawn out.

There shall be a distinct overall door for the breaker compartment, which can be closed with the carriage in drawout position and it shall be lockable type.

- 5.1.11 All circuit breaker modules of the same rating shall be inter-changeable. Suitable interlocks shall be provided to prevent the following operations:
 - "Plugging in" or "drawing out" of a closed breaker.
 - "Plugging in" a breaker with the earthing isolator closed.
 - "Closing" of the earthing isolator with the breaker "plugged in".
 - Pulling out the auxiliary circuit plug with the breaker in the service position. Pushing in the breaker to the service position, with the auxiliary circuit plug not in position.

Additionally, the following shall also be provided:

- All operations such as breaker rack-in, breaker rack-out, breaker On/Off, spring charging, earth switch On/Off etc. shall be possible only with panel door closed.
- Pad locking arrangement shall be provided for rack in operation of breaker as well as for the panel door meeting LOTO requirements.

LOTO arrangement shall include provision for the following:

- a) Provision for hooking lockout devices by multiple lock arrangement to prevent opening of panel door and racking-in of circuit breaker.
 - b) Provision for attaching tag-out device for warning against energisation and to provide information regarding date of isolation, agency working on the equipment, etc.
 - c) Provision for Hasp such that the same shall be put-in and closed in the locking arrangement of the breaker/switch and panel door.
- 5.1.12 All hardware shall be corrosion-resistant. All joints and connections of the panel members shall be made by zinc-passivated high-quality Grade 8.8 or superior steel bolts, nuts and washers, secured against loosening.
 - 5.1.13 Suitable eyebolts/ lifting clamps shall be provided for the lifting of the panel/shipping section. The bolts, when removed shall not leave any opening in the panels.
 - 5.1.14 If specified in job specifications/datasheet/Tender, light/ arc/ pressure based sensors with controller shall be provided to quickly detect internal arc and immediately initiate tripping action.
 - 5.1.15 Thermography window for infrared electrical inspection shall be provided if specified in job specifications/datasheet/Tender. The switchgear with thermo-graphy window shall be type tested and certified for internal arc faults as per IS/IEC 62271-200 requirements. In case IAC test report with thermography window is not available, IAC test report to be submitted for the panel along with internal arc withstand capability report for the material used for thermography window.
 - 5.1.16 MV Switchgear shall be provided with online wireless temperature monitoring facility if specified in job specifications/datasheet/Tender. The passive sensor shall be wireless, battery less, dielectrically safe, robust to high voltage, high electromagnetic field, and harsh environment. It shall take direct measurement of temperature from critical points. This facility shall be interfaced with Substation Automation System/ ECS.

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

5.2 Accessibility

- 5.2.1 All relays, metering, and control components shall be mounted on the panel front only. However, auxiliary contact multiplier relays with auto reset can be mounted inside the panel.
- 5.2.2 The switchgear shall be considered to be accessible to authorized personnel having access all around and shall be tested for following type of accessibility as per IS/IEC 62271-200:

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

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

5.3 Bus Bar

- 5.3.1 The switchboard shall comprise of 3-phase bus bars which shall extend through all units of the switchgear line-up. The main bus bars shall have uniform cross-section throughout their length and shall be sized to carry continuously the rated current specified in the data sheet.
- 5.3.2 Bus bars shall be of high conductivity electrolytic aluminium or copper supported on insulators made of non-hygroscopic, non-inflammable material with tracking index equal to or more than that defined in Indian standards. Self supporting busbars can also be accepted provided the same is type tested design.
- 5.3.3 Bus bars shall be housed in a separate chamber and shall be accessible for inspection. Wire guards /cover shall be provided inside the enclosure to avoid accidental contact when the cover is removed.
- 5.3.4 Both bus bars and the supports shall be adequately sized and braced to withstand the specified short-circuit current for 1 second. Dynamic stresses shall be calculated on the basis of the specified peak short-circuit current. All bus bars supports shall be of non-carbonising material, resistant to acids and alkalies.
- 5.3.5 Bus bars shall be insulated by using heat-shrinkable sleeves or glass fibre tubes suitable for withstanding heat under worst operating condition as per type tested design. The sleeves/ tubes shall be rated to withstand the system line-to-line voltage for 1 minute. This shall be verified by a type test in which the line voltage will be applied between the sleeved/ tubed main bus bar and an aluminium foil wrapped closely around the insulation over a length of at least 500mm.
- 5.3.6 All bus bar joints and all tap-off connections from the main horizontal bus bars shall be provided with removable FRP/PU/PVC/EPDM/Nylon shrouds. The material of the shrouds shall be flame retardant (FR).
- 5.3.7 Bus bars shall be prominently marked with Red, Yellow and Blue colour rings/ stickers for easy phase identification at regular interval and at every power tap off point.
- 5.3.8 The thermal design of the bus bars shall be based on installation of the switchgear in poorly ventilated conditions. The cooling air volume shall take into account only the bus bar enclosure.
- 5.3.9 The hot spot temperature of busbars, including joints, at design ambient temperature shall not exceed 100°C under normal operating conditions while for silver plated joints, the allowable maximum temperature shall be 115°C in line with IS/IEC-62271-1.
- 5.3.10 Only zinc passivated high tensile strength high-quality Grade 8.8 or superior steel bolts, nuts and washers shall be used for all busbar joints and supports. Also, instruction label for torque tightening of busbar coupling shall be provided on switchboard.
- 5.3.11 The current rating as defined for switchboard and components in data sheet/job specification are for design ambient temperature at site conditions and for being inside the cubicle at fully loaded condition. The vendor shall suitably derate the nominal rating to suit the above condition.

5.4 HV Power Connections

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

- 5.4.2 The switchboard shall be supplied complete with supports for clamping outgoing and incoming cables. The head-room available between cable gland plate and terminal lugs shall not be less than 600 mm for switchgear up to 11 kV, and 900 mm for 22 and 33 kV cables.
- 5.4.3 In case, the standard panel depth cannot accommodate the specified number of cables, a rear extension panel of full height shall be provided. An earth strip shall also be brought to this extension panel.
- 5.4.4 Unless otherwise specified, all power cables shall enter the switchboard from the bottom.

5.5 Auxiliary Wiring and Terminals

- 5.5.1 Inside the cubicles, the wiring for control, signalling, protection and instrument circuits shall be done with BIS approved, PVC/XLPE insulated, flame retardant low smoke (FRLS) type, copper conductor wire. The insulation grade shall be 660 V. FRLS shall be embossed on the inter-panel wires.
The wiring shall preferably be enclosed in FRLS plastic channels or neatly bunched together. Wiring between HV breakers or cable compartments to relay and metering compartments shall be routed through FRLS flexible conduits. FRLS shall also be embossed on the plastic channels/ flexible conduits. However, as an alternative to FRLS embossing, manufacturer compliance for FRLS plastic channels/ flexible conduits in form of certification can also be accepted.
- 5.5.2 A minimum of 10% spare terminals shall be provided on each terminal block. Conductors shall be terminated with adequately sized compression-type lugs for connection to equipment terminals and strips. Stranded conductors shall be soldered at the ends/ crimped with suitable lugs before connections are made to the terminals. Sufficient terminals shall be provided on each terminal block to ensure that not more than one outgoing wire is connected per terminal. Terminal strips shall preferably be separated from power circuits by metal barriers or enclosures. All spare contacts of auxiliary relays, timers, etc shall be wired up to the terminals.
- 5.5.3 Each wire shall be identified at both ends by correctly sized PVC ferrules. Shorting links shall be provided for all CT terminals.
- 5.5.4 XLPE/ PVC insulated copper conductor of cross section 1.5 mm^2 may normally be used provided the control fuse rating is 10A or less. For 16A control fuse circuit 2.5 mm^2 copper conductors shall be used. Each wire shall be terminated at a separate terminal. CT Circuit wiring shall be done with 2.5 mm^2 copper conductors. Shorting links / suitable shorting arrangement for shorting CT secondary shall be provided.
- 5.5.5 Unless otherwise specified, all control cables shall enter the switchboard from the bottom.
- 5.5.6 Supporting facilities shall be provided for clamping the control cables.
- 5.5.7 All inter-panel control wiring within each shipping section shall be by switchgear vendor. The inter-panel wiring shall be taken through PVC sleeves or suitable grommets. For inter-panel wiring between the shipping sections, wires in rolls of the required length, connected at one point, shall be supplied with the panel for connection at site.

5.6 Control and Indication

- 5.6.1 Breaker tripping, closing and spring charging devices shall be fed with DC control power supply. The rated DC voltage shall be as specified in the data sheet. The power supply for breaker opening, closing and indication devices shall be arranged as follows:
- One DC feeder shall be provided for each bus section. The bus coupler panel may be fed from any of the two supplies.
 - One separate, single-phase power supply shall be provided for each bus section for feeding space heaters, etc. Supply voltage shall be 240 V AC, unless otherwise specified.

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

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

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

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

5.7 Earthing Connections

All cubicles shall be connected to an earth bus bar running throughout the length of the switchboard. The minimum earth bus bar size shall be 30 x 6 mm² copper up to short-circuit withstand capacity of 31.5 kA and 50 x 6 mm² copper for a short-circuit withstand capacity above 31.5 kA and upto 40 kA. All doors and movable parts shall be connected to the earth bus with flexible copper connections. Provision shall be made to connect the earthing bus bar to the plant earthing grid at two ends. All non current-carrying metallic parts of the equipment and components shall be earthed. The earth bus shall be brought back to the cable compartment, and earthing bolts shall be provided to ground cable armour. The mating surfaces of all bolted parts shall be zinc passivated to ensure continuity between them.

5.8 Space Heaters

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

5.9 Panel Supporting Frame

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

5.10 Nameplates

- 5.10.1 The switchgear shall be provided with durable and clearly legible nameplate in accordance with Table-1 of IS/IEC 62271-200 requirements.
- 5.10.2 A nameplate with the switchboard designation shall be fixed at the top of the central panel. A separate nameplate giving details for each feeder compartment of all panels shall be provided. Danger plate (Red) shall be provided at the front and rear for each panel.
- 5.10.3 The nameplates for feeder compartments shall be in two parts. One part shall have necessary details pertaining to the compartment's number of vertical panel of the switchboards. The other parts shall be removable and shall contain all details regarding the feeder number for drives/equipment controlled by the particular module as per approved single line diagram.
- 5.10.4 Blank nameplates shall be provided for all spare and vacant modules.
- 5.10.5 Nameplate or polyester adhesive stickers shall be provided for each equipment mounted inside the switchboard. Special warning plates shall be provided on removable covers or doors giving access to cable terminals and bus bars.

- 5.10.6 Special warning labels shall be provided inside the switchboards also, wherever considered necessary. Identification tags shall be provided inside the panels matching with those shown on the circuit diagram.
- 5.10.7 Engraved nameplates shall preferably be of 3- ply (Black-White-Black) lamicoid sheets or anodised aluminium. However back engraved perspex sheet nameplates may also be acceptable. Nameplates shall be fastened by screws and not by adhesives.

5.11 Painting

- 5.11.1 All metal surfaces shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. Alternately, supplier's standard paint procedure as per their ISO standard is also acceptable. The under surface shall be made free from all imperfections before undertaking the finishing coat.
- 5.11.2 After preparation of the under surface, the switchboard shall be spray painted with two coats of epoxy based final paint or shall be powder coated.
- 5.11.3 Colour shade of final paint shall be as RAL 7032 unless specified otherwise.
- 5.11.4 The finished panels shall be dried in stoving ovens in dust free atmosphere. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint etc. Vendor shall supply final paint (1 litre per switchboard) in non-returnable container for final touch up at site.
- 5.11.5 All unpainted steel parts shall be Zinc passivated or suitably treated to prevent rust formation. If these parts are moving elements then they shall be greased. Aluzinc/ pre-galvanised sheet, wherever provided, need not be painted.

6.0 SWITCHBOARD COMPONENTS

6.1 Circuit Breakers

- 6.1.1 Vacuum or SF₆ circuit breakers shall be used in the switchboard. The exact type and rating of breakers shall be as indicated in the data sheet. Breaker transport trolleys required for cassette-mounted breakers shall be provided for each switchboard. Number of trolleys to be provided shall be as per data sheet.
- 6.1.2 Vacuum circuit breakers shall be designed to have low switching-over voltage levels and with a long switching life. The interrupter shall be leak-free. The VCB shall be type tested with the offered make & model of vacuum interrupter.
- 6.1.3 In case of SF₆ circuit breaker, each pole shall be provided with a pressure switch to monitor the gas pressure with local indication / lockout, and remote annunciation in the event of SF₆ gas leakage.
- 6.1.4 The breakers shall have at least 6 normally open (NO) and 6 normally closed (NC) spare auxiliary contacts for purchaser's use. If these are not available, auxiliary relays shall be used to multiply the auxiliary contacts of the breakers.
- 6.1.5 The breakers shall have a motor-operated, spring-charging mechanism. It shall also be possible to charge the springs manually. The closing spring shall get re-charged (for subsequent closing) soon after a closing shot and prior to breaker tripping. In case the limit switch fails to cut out the spring-charging motor with the springs fully charged, the motor shall be automatically de-coupled or else positive isolation (at both ends) of power supply to spring charging motor shall be ensured. The control circuit shall be suitable for local as well as remote control. Breakers shall be trip-free and shall have an anti-pumping device. The breaker operating duty shall be O-3min.-CO-3min.-CO, unless otherwise agreed.

6.1.6 Operating Mechanism

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

- 6.1.7 Circuit breaker trip and closing coils, in case of electrically operated breakers, and trip coil in case of mechanically operated breakers and circuit breaker indication shall be suitable for satisfactory operation on a control supply system indicated in data sheets/job specification. Additional second shunt trip coil (operating on different control voltage supply) shall also be provided if specified in job specifications/datasheet/Tender.
- 6.1.8 All circuit breakers shall be provided with mechanically operated emergency trip device. This device shall be available on the front of the panel. Mechanically operated 'closing' device shall be provided for all breakers. However mechanical closing shall be inhibited for all circuit breakers in service position.
- 6.1.9 The breakers shall be provided with anti pumping & trip free feature. Each breaker shall be also provided with an operation counter.
- 6.1.10 For all HV VFD outgoing feeders, breaker shall be provided with one no. shunt trip coil and with undervoltage release. As an alternative, two shunt trip coils can be also provided. One shunt trip coil shall be suitable for switchgear DC control supply while second shunt trip coil shall be suitable for external AC control supply. The control supply voltage level shall be as specified in data sheet.
- 6.1.11 Metal Oxide surge suppressors shall be provided on all outgoing vacuum circuit breakers to limit the over voltage to a maximum of 2.2 p.u. rated peak line to earth voltage. Sizing calculations for surge suppressor shall be provided post order.
- 6.1.12 Line PT shall be mounted in a separate drawout carriage having separate arrangement for rack-in/rack-out which will be independent of breaker. For cassette type breaker, line PT can be housed in the same vertical panel housing breaker. In case of truck mounted breaker, line PT

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

- 6.1.13 The complete breaker assembly should have inter-changeability with breakers of identical ratings.
- 6.1.14 The switchgear shall be supplied in single tier arrangement i.e. one circuit breaker in one vertical panel. For switchgears specified with double tier circuit breaker arrangement, the outgoing feeder breakers shall have double tier arrangement and incomer breakers with Line/bus PT shall be housed in one vertical panel. In double tier arrangement, sheet steel partitions shall be provided for each compartment. Compartmentalization shall be such that maintenance of one breaker is possible without disturbing the adjacent breaker compartment. Suitable trolley(s) shall be supplied for drawing out the breakers in upper tier. The maximum height of the operating handle/switches/reset knobs/pushbuttons shall not exceed 1900 mm and minimum height shall not be below 300 mm.
- 6.1.15 An integral earthing system, or a separate earthing carriage/truck, shall be provided. In case of a separate earthing carriage, the necessary trolleys for bus-side and cable-side earthing shall be supplied. After withdrawing the circuit breaker, this can be inserted to facilitate earthing of cables and bus bars. Earthing truck shall be complete with the PT and voltmeter giving audio-visual indication and solenoid interlock to prevent closing of bus side earthing truck on live busbars. In case voltmeter cannot be provided suitable voltage detecting system shall be provided. Suitable interlock shall also be provided for Earthing switch. Earthing truck/earthing switch operation shall be only with door closed.
- Integral earthing switch shall be suitable for short time withstand current and peak withstand current rating equal to the corresponding breaker withstand rating.
- 6.1.16 Number and type of earthing trucks shall be as specified elsewhere.
- 6.1.17 Circuit breaker electrical endurance shall be class E2 and mechanical endurance shall be class M2 as per IS/IEC-62271-100. Probability of restrike during capacitive current breaking shall be of class C1 as per IS/IEC-62271-100 except for capacitor feeders which shall be of class C2 as per IS/IEC-62271-100.

6.2 Fuse Contactor Units

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

Fuse contactors shall be fully drawable type.

Contactors shall comply with IS/IEC-60470 and shall be suitable for intermittent duty class 0.1 as well as for uninterrupted duties.

The minimum short circuit breaking capacity of the contactor shall be at least 6 kA at rated voltage.

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

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

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

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

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

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

6.3 Instrument Transformers

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

6.3.1 Current transformer

- i) Current transformers shall conform to IS: 2705 Part-1 and IS:16227 Part-1 & 2. The short-time current rating shall be equal to that of the switchboard. They shall be mounted on the stationary part of the switchboard. The CT ratings shall be as shown in the data sheet. Protective CTs shall have an accuracy class of 5P and an accuracy limit factor greater than 10. CTs for instruments shall have an accuracy class of 1.0 and an accuracy limit factor less than 5.0. For numerical relays having protection and metering functions, dual rated CT shall be provided suitable for protection class and metering class. One leg of the CTs shall be earthed. Separate CTs shall be provided for each of Differential protections such as transformer, line, bus, motor, Restricted Earth fault protection, etc. However, common CT having separate cores for any differential and Restricted Earth fault protection is acceptable.
- ii) All CTs shall be star connected. Interposing CT (ICT) shall be provided (if required) for differential protection of transformers having star-delta connection.
- iii) Proper access to each set of CTs shall be provided for repair / maintenance.
- iv) Core Balance Current Transformer shall be provided in motor feeders for sensitive earth fault protection, if specified in job specifications/datasheet/Tender.

6.3.2 Potential transformer

- i) The potential transformers shall conform to IS: 16227-1 & 16227-3. The potential transformers shall be of drawout-type, and shall be provided with 4 pole miniature circuit breakers with auxiliary contacts on the secondary side.
- ii) The drawout mechanism shall disconnect the PT from the busbars. The primary connection shall be disconnected before the PT becomes accessible. Neutral point of the star connected PTs both on the primary and secondary sides shall be earthed.
- iii) The PTs shall have an over-voltage factor of 1.2 continuous and 1.9 for 30 seconds, and an accuracy class of 1.0 from 10% to 120% of normal voltage. PT selected shall be compatible with system grounding. Also precaution shall be provided to mitigate the problem of ferroresonance.
- iv) The primary rated voltage shall be equal to the rated voltage V of the system, or $V/\sqrt{3}$, if the PT is connected between phase and neutral.
- v) If not otherwise specified, the secondary voltage shall be 110 V, or $110/\sqrt{3}$ V. The burden and class of accuracy shall be as specified in data sheets. For directional relays, either a 3-phase 5-limb PT, or 3 single-phase PTs with secondary windings connected in open delta shall be provided.

6.4 Measuring Instruments

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

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

6.4.1 Ammeters and voltmeters

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

6.4.2 kW / kWh meters

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

6.4.3 Frequency meters

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

6.4.4 Power factor meters

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

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

6.5 Relays

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

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

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

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

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

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

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

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

6.6 Auxiliary Equipment

6.6.1 Auxiliary relays and contactors:

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

6.6.2 Control Switches:

- i) All control switches shall be rotary type, having a cam-operated contact mechanism otherwise stated. Circuit breaker control switches shall be 3-position CNT, spring return to neutral from both Close and Trip positions. They shall have pistol-grip handles and shall be lockable.
- ii) Ammeter selector switches shall have a make-before-break feature on its contacts. The selector switch shall generally have four positions, three positions for reading 3-phase currents and the fourth position for OFF. The voltmeter selector switch shall also have four positions, three positions shall be used to measure phase-to-phase voltages and the fourth position shall be for OFF.

6.6.3 Timers:

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

6.6.4 Indicating Lamps:

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

7.0 INSPECTION, TESTING AND ACCEPTANCE

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

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

8.0 PACKING AND DESPATCH

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

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

Project	Overall Project Management as MPMC and PMC/EPCM Services for Ethylene Cracker Unit and U&O for BPREP			Client	BPCL
Unit	Common	Location		Job No.	B957
				Unit No.	000
PURCHASER'S DATA					
A. Site Conditions					
1.	Maximum Ambient Temperature	°C	48		
2.	Minimum Ambient Temperature	°C	1.1		
3.	Design Ambient Temperature	°C	45		
4.	Relative Humidity	%	86		
5.	Altitude Above MSL	mm	<1000		
6.	Environment		Hot, humid & corrosive		
B. Operating Conditions					
1.	Voltage	kV	By Vendor +/- 10 %		
2.	Frequency	Hz	50+/-5%		
3.	No of phases		Three		
4.	System fault level	kA	40		
5.	System earthing		Resistance Earthing		
6.	Auxiliary supply				
	AC	V	240 +/- 5 %		
	DC	V	110 +/- 10 % DC		
C. Electrical Data					
1.	Busbar current rating (inside panel at design temp.)		By Vendor		
2.	1 sec. Short Circuit withstand capacity	kA	40		
3.	System Breaking capacity	kA	40		
	% D.C. Component		As per IEC		
4.	System making capacity	kA(peak)	100		
5.	Type of Circuit Breaker		VCB		
	Shunt Trip Coil-1 :	V	110 DC		
	Shunt Trip Coil-2 :	V	230V AC (Refer Note-2) AC		
6.	Duty Cycle of C.B.		O-3min-CO-3min-CO		
7.	Suitability for Cap. Switching		Required		
8.	Surge supressor for Motor Feeder.		Yes		
9.	Provision of earthing				
	Earthing truck		Required		
	Earthing switch		Not Required		
D. Miscellaneous					
1.	Interface with ECS		Required		
2.	Incoming Power Entry		Bus Duct		
3.	Cable Entry		NA		
4.	Separate bolted removable gland palte for cable entry		Reqd.(Gland Plate Drilled at side)		
5.	Cable glands and lugs for cable termination		Included		
6.	Paint shade		RAL-7032		
7.	Windows at the rear side of panels for thermography		Not Required		
MANUFACTURER'S DATA					
A. Switchboards					
1.	Make				
B	13-JAN-2025	ISSUED WITH MR	KANUGUTTA SUMITH	RASHMI SINGH RATHAUR	RASHMI SINGH RATHAUR
Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By

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Unit	Common	Location		Job No.	B957
				Unit No.	000
2.	Type designation				
3.	Degree of protection				
4.	Max. overall weight of C.B. panel	Kg			
5.	Overall dimensions of C.B. panel				
	Width	mm			
	Depth	mm			
	Height	mm			
6.	Overall dimensions of dummy /gland palte for cable entry				
	Width	mm			
	Depth	mm			
	Height	mm			
7.	Overall weight and dimensions of largest shipping section				
	Weight	Kg			
	Width	mm			
	Depth	mm			
	Height	mm			
8.	Overall dimensions of each swbd. including all dummy/adaptor/rear extension panels				
	Width	mm			
	Depth	mm			
	Height	mm			
9.	Recommended clearances				
	Front	mm			
	Rear	mm			
	Above	mm			
10.	Shock loading on foundation				
11.	Max. size/no. of cables that can be terminated inside the panel				
	without rear extension panel				
	with rear extension panel				
	size of rear extension panel				
12.	Clearance in air				
	Phase to Phase (min.)	mm			
	Phase to Earth (min.)	mm			
13.	Busbar current rating at design ambient temperature	A			
14.	Busbar (separately for each swbd)				
	(a).Horizontal main busbar size (No. of flats x size of each flat)				
	(b).Horizontal main busbar size as tested at CPRI for full short ckt withstand as per specification requirement (No. of flats x size of each flat)				
	(c).Vertical dropper size (No. of flats x size of each flat)				
15.	Horizontal main busbar/Vertical busbar material				
16.	Insulating material (Busbar supports)				
17.	Earth busbar size				
18.	Earth busbar material				
19.	1 min. power frequency withstand voltage (rms)	kV			
	Over voltage factor for PTs				
20.	Impuse withsatnd voltage (peak)	kV			
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Unit	Common	Location		Job No.	B957
				Unit No.	000
	Wave shape of impulse voltage				
21.	1 sec. short ckt. Withstand capacity	kA			
22.	Peak dynamic withstand capacity	kA			
23.	Safety Features				
	(a).Heat shrinkable sleeves, rated to withstand the system line to line voltage for one min., provided on busbar				
	(b).Removable FRP shrouds for all busbar joints and tap-off connections provided				
	(c).Arc propagation barrier in busbar compartment provided				
	(d).Breaker service, test and drawn-out position provided				
	(e).Distinct overall lockable door for breaker compartment provided				
	(f).Automatic safety shutter provided				
	(g).Independent pressure release flaps provided for all HV compartments				
	(h).Wire mesh for all louvered openings provided				
	(i).Suitable interlocks to prevent faulty operation as per Cl. 4.4.10 of spec. 6-51-0001 provided				
	B. Circuit Breaker				
1.	Type				
	2nd shunt trip coil for VFD feeders				
2.	Make				
3.	Type Designation				
4.	Circuit Breaker mounting in panel				
5.	No. of poles/phase				
6.	Current rating (in free air)	A			
7.	Current rating inside the panel at specified design temperature	A			
8.	Short time rating (1sec.)	kA			
9.	Symmetrical breaking capacity	kA			
9.1	% D.C. Component				
10.	Peak making current	kA			
11.	1 min. dry withstand voltage (power frequency)	kV			
12.	Duty Cycle				
13.	Total opening time	m sec.			
14.	Total closing time	m sec.			
15.	Power required for opening	W/VA			
16.	Power required for closing	W/VA			
17.	Power required for spring charging motor	W/VA			
18.	Breaker is trip free				
19.	Closing mechanism				
20.	Provision of manual spring charging provided				
21.	Mechanical Trip PB provided				
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Unit	Common	Location		Job No.	B957
				Unit No.	000
22.	Mech. On/Off indicator provided				
23.	Operation counter provided				
24.	Time taken for spring charging	sec.			
25.	No. of aux. contacts and their current ratings				
26.	Interrupter				
	(a).Make				
	(b).Pressure switch for monitoring of SF6 gas pressure provided				
	(c).Re-filling arrangement of SF6				
27.	LOTO (Lock-Out Tag-Out) Provision for mechanical locking arrangement				
28.	Supressor				
	Type designation				
	Make				
27.	Derating reqd. for Cap. Switching				
29.	Earthing System				
30.	Copies of following test certificates enclosed				
	For each type of offered circuit breaker panel with breake				
	(a).Short Circuit tests (Peak and 1 sec.withstand)				
	(b).Heat run test				
	(c).Internal arc test				
	(d).Impulse and power freq. withstand				
	For each type of offered circuit breaker (in panel)				
	(a).Short Circuit test duties				

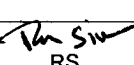
Eil Notes

- Numerical Relays shall be provided. However, wherever specifically mentioned in the MR, electromechanical type relays shall also be provided.
- Vendor shall furnish the dimensins of various types/ratings of swbds., CB panels and dummy/adaptor panels separately.

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एच वी स्विचबोर्डों के लिये निरीक्षण व परीक्षण योजना

INSPECTION AND TEST PLAN FOR HV SWITCHBOARDS UP TO 33KV

4	14 01 2020	Revised and Reissued	 MM	 RS	 RKS	 RKT
3	21 11 2013	Revised and Reissued	MJ	RS	SCG	SC
2	15 07 2011	Revised and Reissued	GS	SA	AKC	DM
1	28 09 2007	Revised and Reissued	AKG	PPM	MVKK	VC
0	30 04 2002	Issued for implementation	RG	AKC	AK	GRR
Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
						Approved by

Abbreviations:

BIS	:	Bureau of Indian Standard
CIMFR	:	Central Institute of Mining & Fuel Research
ERTL	:	Electronics Regional Test Laboratory
FM	:	Factory Mutual
FLP	:	Flame Proof
FRLS	:	Flame retardant low smoke
ITP	:	Inspection and Test Plan
IP	:	Ingress Protection
IC	:	Inspection Certification
IEC	:	International Electro technical Commission
JEC	:	Japanese Electro technical Committee
MTC	:	Material Test Certificate
NEMA	:	National Electrical Manufacturers Association

PO	:	Purchase Order
PESO	:	Petroleum Explosive Safety Organization
PR	:	Purchase Requisition
PVC	:	Poly Vinyl Chloride
QC	:	Quality Control
SF6	:	Sulphur Hexa Floride
TC	:	Test Certificate
TPI or TPIA	:	Third Party Inspection Agency
UL	:	Under writer Laboratories
VDR	:	Vendor Data Requirement
XLPE	:	Cross Linked Poly Ethylene

Inspection Standards Committee

Convenor : Mr. RK Singh

Members: Mr. Rajesh Sinha Mr. Himangshu Pal Mr. Chandrasekhar Mr R Muthuramalingam (RPO representative)
Mr. Avdhesh Agrawal Mr. Mahendra Mittal Mr. Deepak Gupta (Project)

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1.0 SCOPE

This Inspection and Test Plan covers the minimum testing requirements of indoor, draw out type High Voltage Switchboards up to and including 33 KV.

2.0 REFERENCE DOCUMENTS

PO/PR/ Standards referred there in/Job specifications/Approved documents/Relevant BIS/IEC Standards.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	Procedures	--	--	----	--	--	--
2.0	Material Inspection						
2.1	Incoming major Material like Bus Bars, sheet metal, Cable wire (FRLS), instrument transformers, Relays, Breakers, Vacuum Bottles, etc	Visual, Dimensional, Operational checks (as applicable)	100%	MTC's/ Inspection & Test records / Lab Test Records/ Manufacturer's Test Certificates	H	H	R
3.0	In process Inspection						
3.1	Breaker Assembly	Mechanical Operation including spring charging mechanism & time, Breaker opening / closing at normal and worst voltage conditions, Opening / closing time and	100% by Supplier and random by EIL/TPIA	Test Records / Inspection Witness Record	-	H	W #

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
		simultaneous closing of all poles, Contact resistance measurement, Gas leakage check (for SF6 breakers), Power Frequency Test.					
3.2	Wiring checks	Size, termination, ferruling, continuity, color coding, make, type	100%	Suppliers Test Records	--	H	----
4.0	Final Inspection						
4.1	Switchgear Assembly (Routine test)	- Visual check including layout, Tag plates, Paint shade, Bus marking and sleeving, Joint shrouding, Identification and location of components, safety shutter operation check, verification of partition type, earthing arrangement, wiring checks etc - Dimension check including operational height, Bus bar size, Clearances, Creepage distances, termination height, Compartmentalization; cable gland size, Paint shade, thickness & adhesion check etc.	100%	Test Records / Inspection Witness Record	-	H	H

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
	Switchgear Assembly (Contd.)	• Verification of Bus bar support arrangement with respect to GA drawing and type tested panel drawings and provision for external cable termination. • Bill of material check. • Rack-in and Rack-out of breakers * • Mechanical and electrical interlock checks on test and service position of circuit breaker * • Interchangeability of Truck assembly in identical feeders.* • Pressure switches operation for SF6 breaker. *(as applicable) • Operation check for auxiliary equipment circuits and auxiliary contacts * • Operation checks for all control functions and interlocks as per schematic diagrams in Service position	100%	Test Records / Inspection Witness Record	-	H	H

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
		- Logics and interlock checks on incomers and bus coupler sections as per job specification and approved documents - Relay operation check through primary / secondary injection.* - Measurement of resistance of main circuit. - Communication check between relays and Ethernet switches /Data concentrator / HMI (if applicable)* - HMI operation and functional checks as per separate agreed ITP/FAT(if applicable) - Insulation resistance of main, auxiliary and control circuits before and after High Voltage Test. - Power Frequency voltage withstand test on main, auxiliary and control circuits.					
4.2	Switchgear Assembly (Type Test) %	Short time current withstand test	On each Type/Rating	Test Agency Reports	-	R/H**	R/H**

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
		• Impulse and Power Frequency withstand Test • Temperature Rise test • Internal Arc test (in AFLR Condition) • Check for Themography window (if specified) • Operating sequence test (Duty cycle test) for breaker & endurance test • Degree of protection for panels					
5.0	Painting						
5.1	Painting and Packing	• Visual • Suitable protection to prevent entry of foreign material. • Proper packing to prevent any damage during transportation and storage, as per contract.	100%	Packing list / Supplier's Records	-	H	-
6.0	Documentation and IC						
6.1	Documentation and IC	• Review of Internal Test Reports • IC issuance.	100%	Supplier's Test Records / Inspection Certificate	-	H	H

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
6.2	Final Document submission	Compilation of Inspection reports, drawings, etc as per VDR / PR	100%	Final data folder /Completeness certificate	-	H	H

- * Quantum of check is 100% by Supplier & random basis by EIL/TPIA(as applicable)
- ** Witness if called for in job specifications. In such cases specified Type test will be considered as part of routine test.
- # Breaker assembly test can be witnessed during final inspection.
- % Sequence of type testing shall be as per latest IEC.

Legends: H- Hold (Do not proceed without approval, R-Review, RW-Random witness (As specified or 10 % - Samples must include min 1 No of each type), W- Witness (Give due notice, work may proceed after scheduled date).

NOTES :-

1. This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable. (Unless otherwise agreed upon).
2. Acceptance Norms for all the activities shall be as per PO/PR/ Standards referred there in/ Job specifications /Approved documents.
3. Supplier has to submit the internal test report for the offered switchboard before the scheduled inspection date.



- | MODE | LCS
L/R SW. POS. | VFD
A/M SW. POS. | START/ STOP
CTRL | SPEED
REFERENCE |
|----------------|---------------------|---------------------|---------------------|--------------------------|
| VFD
MODE | LOCAL | AUTO/
MANUAL | LCS | LCS SPEED INC
DEC. PB |
| | REMOTE | MANUAL | VFD | VFD PANEL |
| | REMOTE | AUTO | DCS
(STOP ONLY) | DCS
(4-20mA) |
| BYPASS
MODE | LOCAL | -NA- | LCS | -NA- |
| | REMOTE | -NA- | DCS
(STOP ONLY) | -NA- |

4

JOB SPECIFICATION (ELECTRICAL) FOR COMPRESSOR- CENTRIFUGAL (SPECIAL PURPOSE PROCESS)

(MR No. – B957-300-KA-MR-5030)

PROJECT : OVERALL PROJECT MANAGEMENT AS MPMC
AND PMC/EPCM SERVICES FOR ETHYLENE
CRACKER UNIT AND U&O FOR BPREP.

CLIENT : M/s BPCL – BINA REFINERY

CONSULTANT : ENGINEERS INDIA LIMITED

EIL JOB NO. : B957

D	20.08.2025	REVISED AND RE-ISSUED WITH MR	SONALI	SK	RSR
C	12.08.2025	REVISED AND RE-ISSUED WITH MR	SONALI	SK	RSR
B	03.06.2025	REVISED AND RE-ISSUED WITH MR	SONALI	SK	RSR
A	02.06.2025	ISSUED WITH MR	SONALI	SK	RSR
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

1. GENERAL

- 1.1 The specification defines the basic requirements of the electrical works in vendor's scope for the Compressor- centrifugal SPP for BPREP Bina Refinery Project. This job specification shall be read in conjunction with EIL standard specifications, data sheets and documents attached with the Material Requisition. In case of any conflict amongst various documents enclosed with MR, the most stringent requirement shall govern and Owner/EIL decision in this regard shall be final.
- 1.2 The equipment shall conform to this specification, enclosed data sheets and standard specifications.

2. SCOPE

Vendor's scope shall include sizing, design, engineering, manufacturing, procurement, inspection, testing at manufacturer's works, supply, packing & delivery of complete electrics at site, supervision during erection, testing and commissioning at site, including supply of all commissioning spares, 2 years O&M spares, mandatory spares, special tools & tackles as per the specifications and data sheets enclosed with the requisition. The major electrical scope of work is: -

- 2.1 Main Motors for pumps as per below table.
- 2.2 Redundant Variable frequency drive along with redundant PLC (As applicable)
- 2.3 Auxiliary motors, heaters etc.
- 2.4 Local Control Station (flameproof) for all motors.
- 2.5 All interconnecting cabling between the equipment supplied by Vendor within the package battery limits (within the field).
- 2.6 Earthing of electrical equipment within the skid and provision for bonding with owner's main plant earth grid (at min. two locations).
- 2.7 Double Compression WP (min. IP-55) & FLP Cable Glands and lugs for Vendor's supplied equipment.
- 2.8 Motor Attachment/fixing bolts, base plates, anchor bolts etc.
- 2.9 All data & drawings as per Vendor data requirements, data sheets, specifications and referenced codes and standards.
- 2.10 Inspection & testing as per the applicable standard specification & inspection test plan attached with the requisition for electrical items.

3. EXCLUSIONS

- 3.1 Supply of 6.6kV feeders for VFDs/DOL starters of HV Motors.
- 3.2 Supply of 415V feeders for auxiliary motors, heaters other misc. electrical loads.
- 3.3 Supply, laying & termination of all power (HV & MV), control and space heater cables from field to Substation.
- 3.4 Earthing grid outside package battery limit.

4. UTILIZATION VOLTAGE

6.6kV TP and 415V TPN power supply as required will be made available by Owner at the incomer of each VFD Panel to be supplied by the Vendor. The arrangement of any other power supply, if required, shall be made by the Vendor. The size of the incoming cable, VFD to output breaker panel, Output breaker panel to motor shall be provided at the time of drawing approval based on the load furnished by the Vendor.

Utilization voltage for motor, aux. heaters, anti-condensation heaters based on their ratings shall be as listed below:

A Voltage and frequency variation

- i). AC System

Voltage

6.6kV / 415V $\pm$ 10%

Frequency	50 Hz $\pm$ 5%
ii) DC System Voltage	
Electrical protection and Control system.	110V $\pm$ 10%

B Utilization voltage

- | | | |
|--------|---|---------------------------|
| i). | MV motor voltage ($0.18 \leq kW \leq 132$) | 415 V AC except VFD motor |
| ii). | AC Motors rated below 0.18 kW for process area | 240 V AC |
| iii). | Incomer for VFD for motors rated up to 315kW without bypass | 415 V AC TPN |
| iv). | Incomer for VFD for motors rated above 315kW and up to 700kW without bypass | 690 V AC TP |
| v). | Incomer for VFD for motors rated above 700Kw without bypass | 6.6 KV AC TP |
| vi). | Incomer for VFD for motors rated up to 132kW with bypass | 415 V AC TPN |
| vii). | Incomer for VFD for motors rated above 132kW with bypass | 6.6 kV AC TP |
| viii). | Anti-condensation heaters for motors | 240 V AC, SPN |
| ix). | Bulk loads like process Heater etc. | 415 V AC TPN |

C Utilization voltage for critical supplies

- | | | |
|------|--|--------------|
| i). | Control supply for VFDs | 230 V AC UPS |
| ii). | Switchgear Protection control power supply | 110V DC UPS |

FOR DOL:

- | | | | |
|-----|--------------------------------|---|---------------------------------|
| a.) | Motors rated above 132kW (DOL) | : | 6600V $\pm$ 10%, 50 Hz $\pm$ 5% |
| b.) | Motors rated up to 132kW (DOL) | : | 415V $\pm$ 10%, 50 Hz $\pm$ 5% |
| c.) | Aux. Heaters | : | 415V $\pm$ 10%, 50 Hz $\pm$ 5% |
| d.) | Anti-condensation heaters | : | 240V $\pm$ 10%, 50 Hz $\pm$ 5% |

5. SPECIAL REQUIREMENT

5.1 VFD shall fulfil the following requirements: -

- 5.1.1 The VFD system having converter input voltage above 1000 shall conform to EIL specification 6-51-0050 and VFD datasheet no. B957-000-16-50-DS-5003.
- 5.1.2 For single large/critical drives with VFD, redundant VFDs (Hot Standby) along with redundant PLC for change over without any common point of failure shall be provided and shall have provision for Auto/Manual change over between the running and standby VFDs without tripping / stopping the motor. Drives for motor driven ID/FD Fan with only single drive shall be considered as critical drive. Any additional requirement and identification of critical drives shall be done during detailed Engineering and approval on same shall be obtained from Owner/EIL
- 5.1.3 All drives for critical application shall be provided with HMI for trending & diagnostics
- 5.1.4 As dual redundant VFDs are being provided, bypass to VFD is not required.
- 5.1.5 VFD shall limit the starting current to 1.0 times full load current.
- 5.1.6 Owner's incoming feeder breaker shall be provided with 2 nos. trip coils. In case VFD vendor requires under voltage release (in place of second trip coil) or any other safety feature other

than two no's shunt trip coils in the upstream Owner's breaker, VFD manufacturer shall get the upstream breaker modified through OEM.

- 5.1.7 Harmonics at the supply side of the drive system shall be restricted within the maximum allowable levels of current and voltage distortion as per recommendations in the latest edition of IEEE-519. The vendor shall perform design calculation for harmonic filter system considering VFD connected to the power system and including the supply of harmonic filters along with all accessories which shall be installed at owner's power system unless otherwise specified. These harmonic studies shall be conducted with maximum and minimum system fault level (details of which shall be provided by Owner during detailed engineering), cable capacitance, system equipment reactance etc. The studies shall highlight but not be limited to maximum load current, expected resonant frequencies, need of harmonic filters, sequence of switching of filters, voltage wave form, rating of equipment/ feeder for feeding filters from owner's switchgear etc
- 5.1.8 Necessary design in VFD shall be considered to avoid drop in the output voltage of VFD. Various parameter i.e., Harmonic content, THD, output voltage/ current etc. at the output of VFD shall be within acceptable limits as per relevant IS/IEC
- 5.1.9 For calculation to limit harmonics within limits as per IEEE 519, system parameters shall be informed during detail engineering. Vendor to provide harmonic spectrum of VFD for harmonic analysis. Following details shall be provided as minimum.
- Current harmonics at 100% and 50% loading for each harmonic order
 - Voltage harmonics at 100% and 50% loading for each harmonic order
 - Pulse modulation number
 - Phase shift angle
 - Rectifier firing angle
 - Advance angle
 - Commutation reactance in percent of the rated reactance
- 5.1.10 Vendor to furnish detailed harmonic analysis report indicating harmonic current and voltage for each harmonic order
- 5.1.11 Vendor to ensure that while selecting the rating of VFD and its transformers, design margin of 20% is considered over and above the standard design margin considered by the VFD manufacturer. VFD sizing calculation including sizing of input transformer shall be furnished for Owner's review
- 5.1.12 VFDs shall be considered with PLC based control schemes and breaker hard contacts shall be used for interlocking in VFDs
- 5.1.13 The VFD system shall be arranged so that it can be operated in an open circuit mode, disconnected from the motor for start-up adjustments and troubleshooting/ maintenance
- 5.1.14 VFDs shall be installed in Air-Conditioned area, however, same shall be suitable for operation in non-air-conditioned environment also
- 5.1.15 MODBUS TCP/IP port shall be provided for communication to HMI / ECS.
- 5.1.16 Requirement of dedicated clean earth for VFD system (if any) shall be suitably indicated by the vendor.
- 5.1.17 The input transformer for the VFD system shall be converter duty type and dry type, VFD Panel mounted only.
- 5.1.18 51G and 64R relays for input transformer of VFD system shall be decided by VFD Manufacturer
- 5.1.19 Complete VFD shall be air cooled type. Water cooled system shall be avoided. Water cooled VFDs, in case unavoidable, shall be closed-circuit water-cooling system (make up water) type as per clause 5.4.2 of EIL specification 6-51-0050

- 5.1.20 The package vendor shall be solely responsible for proper selection of the input transformer, HV Switchboards, VFD and motor for the given load application and the output characteristics of the drive. Sizing, selection & calculation of VFD/motor/transformer/HV switchboards shall be furnished during detailed engineering for Owner's review
- 5.1.21 VFD system shall include line PT and any other hardware along with synchronization panel required for synchronization of output breakers
- 5.1.22 Combined testing is not required for motors operating above 690V.
However, in all cases (irrespective of voltage rating), the hazardous area type test certificate for the motor must explicitly state that the motor is suitable for operation with a VFD. Additionally, all necessary protective measures and provisions, as specified in the relevant IEC 60079 standard series, shall be incorporated
- 5.1.23 The required provision for the interface with Substation automation system (SAS) or Electrical Control System (ECS) including the details of communication module and data transfer facility, I/O details shall be furnished. The communication interface shall be as per attached ECS I/O list. Communication link shall be with industry standard open protocol i.e., MODBUS/Data Highway Plus/IEC-61850/ RS-485 etc. and same shall be coordinated with the interfacing equipment. In case the vendor is using their proprietary software, the interface software for use with Owner's system (software) shall be provided
- 5.1.24 Current Transducer for taking 4-20mA current/power/speed signal to DCS & ECS shall be provided by Vendor in the VFD Panel
- 5.1.25 Fault diagnostic shall be built into the system to supervise the operation and failure of the system. The information regarding failure of any of the system including, shutdown of the system, shall be available for a period of minimum 4 days (96 hours) after a shutdown, even though no supply would be available to the system. The system may be totally de-energized for maintenance or otherwise. It shall be possible to retrieve the record of events prior to tripping of the system or de-energisation. Auxiliary supply to the system components or to the electronics (firmware) for the diagnostics / display shall be taken care by the manufacturer for this purpose.
- 5.1.26 Control supply for VFD shall be 230V AC supplied from UPS installed in the substation. Vendor shall provide control system suitable for 230V AC control supply. Any further auxiliary power supply required by Vendor shall be tapped from 415V incoming power supply provided by Owner. Any control transformer required for the same is also included in vendor's scope
- 5.1.27 240V, 1-Phase power supply for motor and panel space heater shall be provided separately to the VFD. Necessary arrangement for controlling/interfacing these supplies shall be made available in VFD panels. Further distribution & control to motor space heater shall be in VFD panel
- 5.1.28 Joint declaration shall be furnished by Compressor vendor, driven equipment vendor, VFD vendor and motor vendor confirming that driven equipment, VFD and motor compatibility have been verified and ensured for satisfactory operation of the complete system as per contract requirement specifically w.r.t. dv/dt, Vpeak and VTHD (O/P).
- 5.1.29 Effect of long length of cables shall be taken into consideration while sizing / designing VFD including its corresponding effects on motor design.
- 5.1.30 All special cables as required for VFDs based on VFD vendor recommendation shall be supplied by Vendor.
- 5.1.31 Normally drives shall be without ventilating fans. If system demands, provision of ventilation with redundant fans and fan fail alarm to be provided. VFD internal cooling Fans shall be fed from its internal supply only.
- 5.1.32 Diode O-Ring or equivalent based dual supply shall be provided for VFD panels.
- 5.1.33 Comprehensive Post warranty Annual Maintenance Contract (CPWAMC) for vendor supplied VFD for a period of 5 years after completion of guarantee period following requirements shall be taken care:

1. Vendor shall propose 5 years comprehensive post warranty annual maintenance contract shall mention the service to be provided, methodology, scope of work and Vendor's responsibility with year wise break up. Placement of this comprehensive AMC will be done after expiry of the guarantee period. In the event of any malfunction of the system hardware / system software, experienced service engineer shall be made available at site within 24 hours on the receipt of such information from Owner.
2. The contract shall include supply of maintenance spares, tools & tackles as required. Travel, boarding & lodging of service engineer shall be by Vendor. The quote shall be made year wise up to 5 Years. Contract shall include on site stock & shall give cost of each item after expiry of 5 Years CPWAMC.
3. The service under Comprehensive Post Warranty Annual Maintenance Contract including supply of spare parts and services shall broadly encompass:
 - a. Preventive maintenance
 - b. Periodic maintenance
 - c. Emergency service
 - d. Software support

Service support shall be strengthened to ensure timely restoration of equipment and minimize downtime.

4. **Preventive maintenance:** Once in a year, involving complete overhaul of the Electrical Equipment, inspection of hardware and software, fault prediction, inspection of power supply quality, environmental and operating condition checks, calibration checks, major repairs/replacements and detailed reporting. This visit is in addition to visit required for periodic maintenance.
5. **Periodic maintenance:** Site visits, minimum four to six times in a year, inspection of general healthiness of the system, study and advice on daily maintenance, inspection of hardware and software of Electrical Equipment. If any problem is reported, running of test programs, on-line servicing and solving reported problems. Checks shall be conducted on running system i.e.
 - a. On-line sub-systems
 - b. Power supply checks
 - c. Others Vendor to mention
6. **Software maintenance:** Maintain existing software to improve and utilize existing application and improve performance of the system. Minor software modifications shall also be covered under this scope.
7. **Emergency service:** Any failure shall be on system suppliers' account. In the event of any malfunction of the Electrical Equipment, online support shall be provided immediately or within a maximum period of 4 hours from the time of failure notification. Service Engineer must report at site within 24 hrs. of report of failure with necessary spares. The Electrical Equipment must be brought back within 24 hours after reporting at site.

Notes:

- a) Vendor to note that while carrying out the Comprehensive Post Warranty Maintenance Contract Activities Owner's engineers may associate with system engineers. On job training of these associated engineers shall be covered under this scope
- b) All financial aspects of the Post Warranty Maintenance Contract must be listed clearly by the Vendor

- 5.1.34 Vendor to ensure that back-to-back warranty from VFD Vendor is provided/ passed on to BPCL.
- 5.1.35 Thermistors shall be provided in VFD driven motors and the provision for tripping the motor in case of excess temperature shall be considered.

5.2 **Motors shall fulfil the following requirements:** -

- 5.2.1 HV motors (6.6 KV) start shall conform to EIL Specification 6-51-0031 and HV Motor data sheet no. B957-000-16-50-DS-3101 for DOL and B957-000-16-50-DS-3102 for VFD mode start & run.
- 5.2.2 MV motors (<1100V) for DOL start shall conform to EIL Specification 6-51-0064 and MV Motor data sheet no. B957-000-16-50-DS-6401.
- 5.2.3 Motors shall not have dual winding
- 5.2.4 Space heater shall be provided for motors rated 30 kW and above.
- 5.2.5 HV motors shall be provided with starting current limited to 500% of full load current including positive tolerance.
- 5.2.6 All accessories like nuts, bolts, washers, earthing studs etc. shall be made of stainless-steel SS-304
- 5.2.7 Negative Sequence withstand characteristics of the offered motor shall be furnished by the vendor during drawing review stage.
- 5.2.8 The enclosure type / area classification for motors and their auxiliaries shall be as listed below:

Sl. No.	Tag no.	Service	Area classification	Enclosure Type
1.	300-KA-CF-2401	DCU OFF GAS COMPRESSOR	ZONE-2 IIA/IIB T3	Ex-d
2.	Auxiliary motors for Electrical motor driven pumps.			Ex-d
3.	Auxiliary heaters, Junction Box etc. for Electrical motor driven pumps.			Ex-d

- 5.2.9 All motors/ other misc. electrical loads shall meet the requirements of latest IS/IEC-60079-1.
- 5.2.10 For outdoor motor, separate FRP type canopy shall be provided.
- 5.2.11 Motor bearing details shall be indicated in name plate to facilitate operation & maintenance team.
- 5.2.12 Trolley mounted pumps(if applicable) shall be powered from a nearby 5 pin socket supplied by client. Vendor to provide trolley mounted flame proof motors and their flameproof starters suitable for use in Zone-2, Gas group IIA/IIB, Temp class T3, with 30 meters of armored copper conductor trailing cable.
- 5.2.13 The trolley mounted pumps shall be complete with integral starters; connection between motor & starter shall be through armored copper conductor cable and shall have motor protections, other hardware & basic control/indications as shown in the data sheet B957-000-16-50-DS-0205
- 5.2.14 Bidder to note that all 415V MV motors supplied shall be of Energy efficient IE3 class as as a minimum as per IS 12615/IEC 60034-30.
- 5.2.15 Motors shall be capable for 20 % over speed without danger of mechanical failure.
- 5.2.16 All HV Motors shall be provided with temperature transmitters connected to DCS for data logging, trending and DCS trip command generation
- 5.2.17 The cable entries of all terminal boxes of motors, before dispatch from motor manufacturer works, shall be fitted with suitably sized Metallic Sealing Plugs to prevent water entry/ingress in motor windings through openings meant for cable entry in terminal boxes at construction site till the time motors are erected and cable terminations are done. Flameproof & weatherproof nickel-plated brass cable glands shall be supplied loose.
- 5.2.18 Cable glands to be supplied with the motor shall be of WP (minimum IP-55) suitable for use in Zone-2, Gas group IIC, Temp class T3 and shall meet all the requirement of IS/IEC-60079-0/15. Thread shall be ET type

- 5.2.19 Vendor to provide adequate size of motor terminal box to accommodate & terminate Owner's cable sizes and avoid additional intermediate JB for motor termination
- 5.2.20 In case it is not feasible to provide motor terminal box suitable to accommodate owner's cables (indicated above), then separate motor junction box shall be provided by vendor to accommodate owner's cable(s) without any time and cost implication to Owner. The Motor junction box shall be Flameproof type (Ex-d) suitable for the specified gas group and temperature classification. FLP JB shall be supplied with FLP cable glands & lugs and shall meet all the requirement of IS/IEC-60079-0/1. Thread shall be ET type
- 5.2.21 The enclosures of the junction boxes shall be of cast light metal alloy. The Junction Box shall be suitable for outdoor location and shall have minimum IP-55 degree of protection. All accessories like nuts, bolts, washers etc. shall be made of stainless-steel SS-304
- 5.2.22 Bidder to note that the control cables used shall be 2.5 sq. mm multi-stranded conductor, twisted pair, and individual and overall shielded, XLPE insulated type shielded cables
- 5.2.23 Terminal box of all the 415V motor shall be suitable for rotation by 90 degrees.
- 5.2.24 Tentative cable size for 6.6kV motors shall be min. 2 runs x 3C x 240 sq.mm. (For rating > 1400kW) and min. 1 run x 3C x 240 sq.mm (for rating <= 1400 kW) 6.6kV (UE) grade, Al conductor XLPE insulated cable. However exact number of runs and size shall depend on the motor details such as ratings, FLC, efficiency, power factor etc. accordingly the exact number of runs shall be confirmed during detail engineering. Provisions, as required in Vendor's equipment for termination of the same, shall be made accordingly without any cost & time implications to Owner. Vendor to note that the MV motors supplied shall be of Energy efficient (IE-3) type as a minimum as per IS 12615/IEC 60034-30.
- 5.2.25 Lifting lugs shall be provided at motor frame for motor lowering and lifting during maintenance.
- 5.2.26 All push button stations shall be provided with 2 nos earthing lugs/studs.
- 5.2.27 All Hazardous area equipment shall have hazardous area test certificates and approvals as per following:
1. For Indigenous manufactured hazardous area equipment:
For all electrical items manufactured in India, the testing shall be carried out & test report issued by Indian test laboratory recognized by the Chief Controller of Explosives shall be furnished. For Ex protection Electric Apparatus having flameproof type protection, a copy of valid BIS license shall be furnished.
Alternatively, IECEx Certificate of Conformity, valid copy of IECEx Quality Assessment Report (summary) and IECEx Test Report shall be furnished.
 2. For Imported hazardous area equipment:
For all electrical items manufactured outside India, test report issued by Indian test laboratory recognized by the Chief Controller of Explosives shall be furnished during offer stage. For Ex protection Electric Apparatus having flameproof type protection, a copy of valid BIS license shall be furnished.
 - As an alternative option-1 to this, IECEx Certificate of Conformity, valid copy of IECEx Quality Assessment Report (summary) and IECEx Test Report shall be furnished.
 - As an alternative option-2 to this, EU Type Examination Certificate, which is applicable for manufacturers having manufacturing locations in countries covered under the European Union, valid copy of Production Quality Assessment / Assurance Notification shall be furnished.
 - All equipment i.e., Indigenous & imported, shall also have valid statutory approvals, as applicable for the specified location and marking as per IS/IEC 60079 and as required by statutory authorities. For installations in India, PESO approval letter shall be provided.

Bidder shall furnish copy of valid type test reports, PESO approval letter and BIS license (as applicable).

- 5.2.28 Cl. 6.4.5 of EIL specification 6-51-0064 is superseded by following:

Motor antifriction bearings on drive and non-drive end shall have greasing facility to lubricate the bearings at site and get the maximum bearing life.

- 5.2.29 There shall be proper provision for carrying out the greasing of NDE/DE side of AFC/Vertical HT Motor from ground floor. Longer length of grease pipe shall be made available for AFC/Vertical HT Motors with grease nipple at bottom of the pipe.
- 5.2.30 Motors shall be provided with bearing temperature sensors for the condition monitoring if specified elsewhere in MR. Bearing temperature sensors shall be resistance type of temperature measuring device (platinum resistance temperature measuring devices of 100 ohms resistance at 0°C and a temperature co-efficient of 3.85×10^{-3}). These sensors shall be provided for bearings with connections terminating in a common terminal box for winding temperature detectors or a separate terminal box in case winding temperature detector is not applicable for motor. This is required for hook up with a remote located control / monitoring unit.
- 5.2.31 Vendor to note that, if there is any requirement of emergency electrical power for the auxiliary equipment supplied with the main motor/pump, same shall be furnished in Electrical load data format.
- 5.2.32 Cl. 6.2.5 of EIL specification 6-51-0064 is superseded by following:

The terminals, cable lugs, terminal box, cable entries and cable glands shall be suitable for the maximum cables sizes as specified below for 2 poles, 4 pole or 6 pole motors. Motor terminal box shall be provided for the given cable size.

Sl. No	Motor Ratings	Estimated Cable size
	0.75 KW	1R X 3C X 4 sq.mm.
1	2.2 KW	1R X 3C X 10 sq.mm.
2	3.7 KW	1R X 3C X 16 sq.mm.
3	5.5 KW	1R X 3C X 50 sq.mm.
4	7.5 KW	1R X 3C X 70 sq.mm.
5	11 KW	1R X 3C X 95 sq.mm.
6	15 KW	1R X 3C X 120 sq.mm.
7	18.5 KW	1R X 3C X 185 sq.mm.
8	22 KW	1R X 3C X 240 sq.mm.
9	30 KW	2R X 3C X 150 sq.mm.

Notes:

- The cable sizes above are tentative and exact cable sizes of power and control cables shall be finalized during detailed engineering which shall be complied by vendor without any cost and time implication to owner.
 - Above cable sizes are estimated based on the assumption of starting power factor = 0.4; cable size may increase in case of starting power factor is more than 0.4 and final cable sizes shall be complied by vendor without any time and cost implication to owner.
 - In case, the above cable size is not suitable to be terminated in motor terminal box, suitable junction box (Flameproof type) shall be provided. The junction box shall be suitable for the gas group of the respective motors as specified in clause no. 5.5 above.
Incoming cable of the Junction box: shall be as per the above table
Outgoing cable of the junction box / motor Terminal box cable suitability in case of junction box: shall be informed during detailed engineering.
The required junction box as required shall be provided by vendor without any time & cost implication to owner.
 - Cable sizes for motor ratings not covered by the above table shall be informed during detailed engineering which shall be incorporated by vendor without any time and cost implication to owner.
 - Provisions, as required in Vendor's equipment for termination of cables as per above, shall be made accordingly by vendor without any cost & time implications to Owner.
- 5.2.33 It is utmost important that size of all cable glands and terminal box to be supplied by the vendor shall match with the Owner's cable sizes. Compliance to same is essential to avoid mismatches at Site and for smooth termination and commissioning of the system without delay on account of this issue. Owner's cable size (i.e., overall dia., dia. over armour and dia. under armour) shall be informed to motor vendor during drawing review stage. The correctness of cable entry and cable glands must be ensured by vendor before dispatch of the same to site.

Size of terminals inside motors w.r.t. cable size to be specifically checked and ensured during inspection. Motor terminal box inside dimensional/ size shall be checked for the suitability/ ease of connections / terminations for designed type of cable size during inspection.

- 5.2.34 The cable entries of motors, before dispatch from motor manufacturer works, shall be fitted with suitably sized weatherproof (IP 55 minimum) Metallic Sealing Plugs to prevent water entry/ingress inside the motors through openings meant for cable entries at construction site till the time motors are erected and cable termination are carried out.
- 5.2.35 Cable glands shall be nickel-plated brass cable glands. The cable glands shall be single compression type for indoor equipment & double compression type for outdoor equipment. Cable glands for motor shall be supplied loose. For hazardous area equipment, cable glands shall be flameproof and shall meet all the requirement of IS/IEC-60079-0.
- 5.2.36 Cable lugs shall be crimping type of following material. All the cable lugs shall be long barrel type. Lugs having sector shaped/ circular barrel shall be used for making connections for cables having sector shaped/ circular geometry of conductor respectively. Lugs shall be as per the following:

S. No.	Description	Cable lug material
1.	Copper conductor cable & copper bus bar/ terminals	Tinned Copper
2.	Copper conductor cable & Aluminium bus bar/ terminals	Bi-metallic (Copper barrel with Aluminium palm)
3.	Aluminium conductor cable & Copper bus bar/ terminals	Bi-metallic (Aluminium barrel with tinned Copper palm)
4.	Aluminium conductor cable & Aluminium bus bar/ terminals	Aluminium

- 5.2.37 Variation / Clarifications against the standard specification of HV motor 6-51-0031 and MV Motor 6-51-0064, shall be as per the MOU agreed with EIL by respective motor manufacturer. No further deviations to MR requirements shall be entertained.
- 5.2.38 No technical information about motor is required along with bid. The same shall be reviewed during detailed engineering after order placement. However, during bidding stage the vendor shall categorically confirm to all technical requirements with respect to electrical documents as per Tender specifications. If the offered Motor or any other electrical equipment is found to be not in compliance with the technical requirements during detailed engineering, then alternative equipment shall be offered without any time/cost implication to the purchaser. Decision of EIL will be binding and final. Vendor to confirm the same.

5.3 LCS shall fulfill the following requirements:

- 5.3.1 Flameproof and weatherproof control stations (IP-65) for all motors, emergency stop push motors and emergency push buttons as required for plant operation and safety etc. shall be provided by the vendor.
- 5.3.2 Following minimum electrical facilities shall be provided by Vendor on Local Control Station (LCS):
- Start/Stop push button (Stop Push button shall have provision of putting LOTO locks and padlocks.)
 - Field ammeter suitable for 4-20mA signal. Ammeter provided at push-button station shall be 240-degree taut band moving coil type.
 - Selector switch (Auto-Off-Manual) shall be provided, as required, as per P&ID & operational requirements
- 5.3.3 LCS for VFD controlled motors, in addition the above requirements, speed raise /lower push buttons, speed indication etc. shall be provided. Ammeters in the each LCS to be calibrated as per current at different speed of VFD before dispatch
- 5.3.4 Any additional hardware / control requirement in LCS as per process requirement / P&ID shall be provided by package vendor.

5.3.5 One number emergency stop push button station with ammeter (where applicable) shall be provided near each motor having control not in the vicinity and at grade level for motors located at higher elevation. This push button shall be installed at an accessible place and clearly marked with suitable warning instructions

5.3.6 Local control stations installed in outdoor area shall have FRP canopy for additional weather protection

5.4 Output Breaker panel shall fulfil the following requirements:

5.4.1 Offered panel shall be placed in substation (S/S-101) switchgear hall and shall meet standard specification 6-51-0001, electrical design basis and datasheets enclosed with tender.

5.4.2 Offered HV SWBD shall be placed in substation (S/S-101) switchgear hall and shall be of same configuration and fault level as the main upstream switchboard (SC =40 kA for 1 second & IAC = 40 kA for 1 second).

5.4.3 In HV switchgear, horizontal bus bar size in the complete board shall be of same size. Similarly, size of the bus bar from horizontal bus to breaker and breaker to outgoing shall be designed based on breaker rating and not on CT/feeder rating.

5.4.4 Bidder has included the supply of one set of recommended tools, tackles and special equipment required for the maintenance of the breakers and panels.

5.4.5 Bidder has included supply of breaker withdrawal/ handling trolley & accessories (applicable where cassette mounted breakers are offered). Two numbers such breaker trolleys, 5 nos. each breaker racking/ rack out handle, breaker spring charging handle and fuse puller shall be provided.

5.4.6 HV switchboards and breakers shall be type tested and the validity requirements for the type test certificates for switchboards and breakers shall be as per the table given below:

Sr. No.	Type Test	Equipment	Validity
1	Short time current Withstand Capacity	HV Switchboard panel, each type of breaker & bus duct	Up to 10 years from the final bid opening date or design change whichever is earlier
2	Internal Arc Fault	HV Switchboard panel	Till any design change
3	Duty Cycle	Circuit Breaker	Till any design change
4	Impulse voltage withstand test	HV Switchboard panel, each type of breaker & bus duct	Till any design change
5	Heat Run Test	HV Switchboard panel, each type of breaker & bus duct	Up to 10 years from the final bid opening date or design change whichever is earlier

In case the type tests on the offered design of switchboards & breakers do not meet the above criteria, all required type tests shall be conducted by the successful bidder on the offered design of equipment after order finalization without any extra cost and delivery impact.

5.4.7 Bidder's scope of supply includes following pressure relief/ gas ducts, as applicable:

"In case bidder/ vendor has considered pressure relief/ gas duct above switchboard for release of gases due to internal arc; vendor shall preferably provide suitable absorbers in the switchboard to prevent the release of harmful gases in the switchgear hall. Alternatively, duct including all accessories/supporting arrangement/sealing material/bends/installation material etc. shall be provided for taking the gases outside the substation to a safe location. Length of duct shall be considered as 10 meters for indoor installation and 5 meters for outdoor installation for each substation (measured from center to center). Bidders to note that for indoor section, 10-meter length shall be in addition to the length of duct required above the HV switchboard. Substation equipment layout shall be furnished during detailed engineering by owner for preparing duct layout by vendor.

5.4.8 HV Switchgear shall be provided with online wireless temperature monitoring facility. The passive sensor should be wireless, battery less, dielectrically safe, robust to high voltage, high

electromagnetic field, and harsh environment. It should take direct measurement on critical point. This facility shall be interfaced with ECS.

5.4.9 Online Temperature Monitoring System (OTMS) for HV Switchboards at all critical point mentioned below shall be provided for each switchboard and isolating breaker panels.

- a. In each vertical, wireless sensor shall be located as per the following:
 - Each horizontal bus bar terminal/tap-off connection in busbar compartment.
 - Each cable connection points in cable compartment.
 - One sensor per phase of cable connection points shall be considered irrespective of number of runs of cable.
- b. The temperature sensors installed shall be suitable for wireless, with direct contact to hot point, operating range from -25°C to 125 °C. The accuracy shall be as per the following
± 3°C accuracy for 0°C to 80 °C range.
± 4°C accuracy for full range (-25°C to 0°C and 80°C to 125 °C)
- c. The system shall allow at least 1 configurable threshold (alarm)
- d. OTMS system shall have the provision to send complete data to SAS/ Owner's ECS for monitoring and investigation. The system shall be online to immediately provide an abnormal temperature alarm (with identification/location of the abnormal temperature) to the owner's operator system.
- e. Complete data of OTMS shall be accessible in the SAS & associated SAS Laptop/ HMI. The protocol for communication shall be either IEC 61850 or MODBUS TCP/IP or MODBUS RTU or other open protocol and shall be decided by vendor.
- f. Complete data of OTMS shall be accessible in the SAS (through switchboard level Ethernet switches) & associated SAS Laptop/ HMI. The protocol for communication shall be either IEC 61850 or MODBUS TCP/IP or MODBUS RTU or other open protocol and shall be decided by Bidder. Accordingly, protocol convertors/gateways at suitable locations as required shall be provided by Bidder for data integration on IEC 61850 protocol from Master Ethernet switch to Owner's ECS system
- g. Online temperature monitoring data shall be available in both owner's ECS as well as Substation Automation System (SAS). OTMS shall be integrated with owner's ECS so that temperature monitoring can be done through owner's ECS.
- h. The following shall be complied for OTMS:
 - No annual re-calibration by the owner shall be required to maintain accuracy.
 - Sensors shall not interfere with the electrical performance of the component and the installation.
 - The thermal (bus bar mounted) sensors shall be battery-less and self-powered with no auxiliary power supply.
 - System shall be suitable to provide the information and capabilities as per the following:
 - o Temperature
 - o Time of measurement
 - o Provision for location and unique identification of each sensor in the SAS/ Owner's ECS
 - Provision shall be provided for the owner to view the sensors' condition status data on the SAS/ owner's ECS:
 - o sensors not paired
 - o pairing process failed
 - o data error
- i. communication error

5.4.10 Selection, sizing and suitability of all components shall be the Bidder's responsibility. The equipment as required for safe and satisfactory operation shall be considered included in Bidder's scope even if not specifically mentioned.

5.4.11 ON/OFF indication shall also be provided on rear side of panel.

5.4.12 Auto tripping of HT circuit breaker upon opening rear side cover shall be provided.

- 5.4.13 The back side cable compartment cover of HV switchboard shall not be able to open while the feeder is electrically connected. Breaker shall trip if any person opens the back side cover preferably by mechanical interlock otherwise on electrical interlock. Back side cover shall have on / off LED indication lamp.
- 5.4.14 Each bus section of switchboard shall be provided with independent control supply. Provision for bump less auto transfer in case of loss of one supply shall be provided. There shall also be provision for manual transfer. Monitoring of failure of supply, availability of source and monitoring auto status shall be provided
- 5.4.15 All the modules shall have stickers (Yellow background with black letters) or letter painting indicating KW, cable size, FLC at front and back for HT and front for LT. A bigger size sticker having list of motor tag nos. and module no. shall be pasted on both side of the panel end covers
- 5.4.16 Interposing relays for all the DI signals from DCS/ PLC in VFD"s/ soft starters shall be considered
- 5.4.17 LOTO facility shall be provided for each module
- 5.4.18 Breaker operated direct contacts to be used to the maximum extent for DCS / interlock. If not possible same to be given through bi-stable relays
- 5.4.19 Separate control switch & control fuse for isolation of control supply in all the motor feeders shall be provided. Separate control supply facility from space heater bus for checking module healthiness in TEST position shall not be provided

6. MISCELLANEOUS REQUIREMENTS:

- 6.1 VFD systems shall be sized taking care of input voltage variation (i.e., $\pm 10\%$) and voltage drop within the VFD system and motor cable.
- 6.2 All nuts, bolts, washers, spring washers, grouting bolts, anchor fasteners, etc. necessary for completion of job wherever used shall be of stainless steel SS304.
- 6.3 All Emergency Stop/Stop pushbuttons on LCS/LCP/Switchboard shall be provided with protective covers to avoid accidental operation.
- 6.4 All accessories like nuts, bolts, washers, earthing studs etc. shall be made of stainless-steel SS-304.
- 6.5 All electrical equipment for hazardous areas shall be certified by CIMFR, PTB, Baseefa, UL, FM or equivalent independent testing agency for the service and the area in which it can be used and shall be approved by PESO/CCOE and copies of the same (PESO/ CCOE) shall be furnished during detailed engineering stage which is mandatory as per local rules/regulations. All indigenous flameproof equipment (Type Ex d) shall be manufactured under BIS license.
- 6.6 Bidder/Vendor shall comply to the requirements as per Ministry of Power (GoI) various orders regarding testing of all equipment, components & parts imported for use in the power supply system for cyber security to check for any kind of embedded malware/Trojans/cyber threat and for adherence to Indian Standards. Necessary testing of their equipment/ components at designated labs & obtaining test certificates in line with MOP orders shall be done by Bidder/Vendor.
- 6.7 Vendor to note that, if there is any requirement of emergency electrical power for the auxiliary equipment supplied with the main motor/compressor, same shall be highlighted at the bid stage only.
- 6.8 For HV output breaker panel, please refer attached ECS I/O List with MR and for Redundant VFD system, please refer below tentative ECS I/O list, any updates in below list shall be informed during details engineering:

VFD System (Redundant)					
Di	S	VFD Running - 1			Hardwired
DI	S	VFD Trip - 1			Hardwired

DI	S	VFD Ready to start - 1			Hardwired	
DI	S	VFD Running – 2			Hardwired	
DI	S	VFD Trip – 2			Hardwired	
DI	S	VFD Ready to start – 2			Hardwired	
DI	D	PLC Status – 1	Unhealthy	Healthy	Hardwired	
DI	D	PLC Status – 2	Unhealthy	Healthy	Hardwired	
AI	A	Running VFD R phase current			Serial	
AI	A	Running VFD Y phase current			Serial	
AI	A	Running VFD B phase current			Serial	
AI	W	Running VFD 3-Phase Real Power			Serial	
AI	R	Running VFD 3-Phase Reactive Power			Serial	
AI		Running VFD Speed			Serial	
AI	A	Excitation Current Channel-1 (For Sync Motor with excitation system)			Serial	
AI	A	Excitation Current Channel-2 (For Sync Motor with excitation system)			Serial	

NOTE:

- DI- Digital Input
- AI- Analog Input
- A- Ammeter
- W- WATTAGE
- R- REACTIVE POWER
- S- STATUS

6.8 Maximum lengths for various cables to be considered for Pump tag- 300-KA-CF-2401 for design of the VFD for motors, as mentioned in the Data sheet no. B957-000-16-50-DS-5003 shall be as listed below:

Cable length between 6.6kV Input/Output Breaker Panel and VFD	:	100m
Cable length between Output Breaker Panel & Motor	:	725m
Cable length between VFD & DCS	:	200m

7. SPARES

- 7.1 Commissioning spares for all electrical equipment are included in Vendor's scope of supply and shall be included in the base price. List of the same shall be furnished with the offer.
- 7.2 Mandatory Electrical spares refer elsewhere in the MR.
- 7.3 Vendor shall submit a list with unit prices of recommended spares for two years of normal operation for motors. Recommended list of maintenance spares for two years operation shall

include the following as a minimum for motors. Vendor shall ensure & quote for the same accordingly.

- a.) Bearing for DE/NDE-one set
- b.) Terminal box cover with screws
- c.) Fan
- d.) Terminal block

8. MAKES OF EQUIPMENT AND COMPONENTS

8.1 Refer Doc No. B957-300-16-50-VL-5030 enclosed in MR.

9. ATTACHMENTS

Sr. No.	Document Title	Document No.	Rev.
1.	Datasheet- HV Switchgear	B957-000-16-50-DS-0101	B
2.	HW Datasheet- VCB (Q2, Q4) Output breaker panel	B957-000-16-50-DS-0118	A
3.	HW Datasheet contactor feeder for trolley mounted motor	B957-000-16-50-DS-0205	A
4.	Scheme for dual Redundant VFDs for Induction Motor	B957-000-16-50-DS-0458	B
5.	Data Sheet – HV Motors – DOL	B957-000-16-50-DS-3101	D
6.	Data Sheet – HV Motors – VFD	B957-000-16-50-DS-3102	B
7.	Data Sheet – HV VFD	B957-000-16-50-DS-5003	B
8.	Data Sheet – MV Motors – DOL	B957-000-16-50-DS-6401	D
9.	Data Sheet – Load Data Format	B957-000-16-50-DS-9901	B
10.	Data Sheet – Format for type test reports	B957-000-16-50-DS-9903	A
11.	Data Sheet – Format for harmonic spectrum	B957-000-16-50-DS-9909	A
12.	Vendor List (Electrical)	B957-300-16-50-VL-5030	B
13.	Vendor Data Requirement	B957-300-16-50-VR-5030	B
14.	Specification for medium voltage switchboards	6-51-0001	8
15.	Specification for flameproof control stations	6-51-0006	6
16.	Specification for medium voltage Induction Motors	6-51-0031	7
17.	Specification for HV Variable Frequency drive system	6-51-0050	3
18.	Specification for hazardous area lighting fixtures and junction boxes.	6-51-0061	6
19.	Specification for Energy Efficient MV Induction Motors	6-51-0064	2
20.	ITP for HV switchboards	6-81-1001	4
21.	ITP for flameproof control stations	6-81-1006	5
22.	ITP for HV Induction Motors	6-81-1031	5
23.	ITP- HV Variable frequency drive system	6-81-1050	3
24.	ITP for hazardous area lighting fixtures and junction boxes.	6-81-1061	4
25.	ITP for Energy Efficient MV Induction Motors	6-81-1064	1

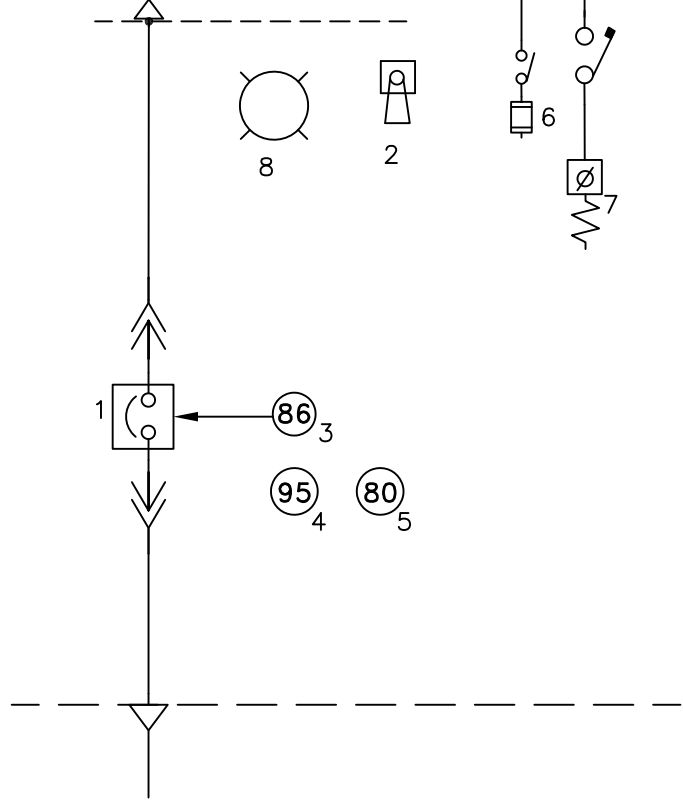
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PROJECT: MPCM & EPCM FOR BPREP CLIENT: M/S BPCL BINA	REV	DATE	PURPOSE	BY	CHKD	APPRV
	A	06.11.24	ISSUED WITH MR/TENDER	SK	RSR	RSR

D.C CONTROL BUS (110 V)

240V AC AUX. CKT BUS

FROM VFD



EQUIPMENT DATA			
ITEM NO	NEMA NO.	QTY.	DESCRIPTION
1	52	1	VACUUM CIRCUIT BREAKER
2	-	1	BREAKER CONTROL SWITCH CLOSE-NEUTRAL-TRIP (SPRING RETURN TO NEUTRAL)
3	86	1	TRIPPING RELAY (ELECTROMECHANICAL TYPE)
4	95	1	TRIP CKT SUPERVISION RELAY
5	80	1	CONTROL SUPPLY SUPERVISION RELAY
6	-	1	DP. SWITCH WITH FUSE FOR D.C. CONTROL SUPPLY
7	-	1	PANEL SPACE HEATER WITH SWITCH AND THERMOSTAT
8	-	AS REQD	CLUSTER LED TYPE INDICATING LAMPS
9	-	1	CUBICLE LAMP (CFL) WITH SWITCH AND FUSE

NOTES:

1. ANTIPUMPING RELAY USED, IF ANY, SHALL BE CONSIDERED AS PART OF BREAKER MECHANISM.
2. THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN JOB SPECIFICATION SHALL BE IN VENDOR'S SCOPE..
3. FOR THE OTHER REQUIREMENTS OF RELAYS AND METERS, REFER JOB SPECIFICATION.
4. FOR THE REQUIREMENTS OF ECS INTERFACE, REFER I/O LIST ENCLOSED SEPARATELY IN M.R/TENDER
5. VA BURDEN OF PT SHALL BE DECIDED BY THE VENDOR/CONTRACTOR.
6. THERE SHALL BE ONE COMMON CONTROL SWITCH FOR ALL CONTROL SUPPLY FEEDER. SEPARATE FUSES FOR FOLLOWING BRANCH CIRCUIT SHALL BE PROVIDED:
 - SPRING CHARGING CIRCUIT
 - CLOSING CIRCUIT
 - TRIPPING, CONTACT MULTIPLIER & DIGITAL INPUT CIRCUIT
 - INDICATION CIRCUIT

Annexure-1

FORMAT FOR SUBMISSION OF TYPE TEST REPORTS FOR SWITCHBOARDS														
TEST ON SWITCHBOARDS	SHORT CIRCUIT		INTERNAL ARC						HEAT RUN		POWER FREQUENCY AND IMPLUSE VOLTAGE WITHSTAND		DEGREE OF PROTECTION	
			CIRCUIT BREAKER COMPARTMENT		BUS BAR COMPARTMENT		CABLE COMPARTMENT							
Rating	OFFERED	TYPE TESTED	OFFERED	TYPE TESTED	OFFERED	TYPE TESTED	OFFERED	TYPE TESTED	OFFERED	TYPE TESTED	OFFERED	TYPE TESTED	OFFERED	TYPE TESTED
Model														
Fault Level														
Internal Arc Class														
Enclosure Dimension (LXBW)														
Main Bus Bar Centre Line Distance														
Vertical/Distributed Bus Bar Centre Line														
Bus Bar Material														
Insulator Type / Material														
Support Distance														
Enclosure / Partition Material														
Report No.														
Report Date														
Testing Agency														

Notes : -

Submit complete test report along with the format.

Annexure-2

FORMAT FOR SUBMISISON OF TYPE TEST REPORTS FOR BUS DUCTS								
TEST ON BUS DUCTS	SHORT CIRCUIT		HEAT RUN		POWER FREQUENCY AND IMPLUSE VOLTAGE WITHSTAND		DEGREE OF PROTECTION	
	OFFERED	TYPE TESTED	OFFERED	TYPE TESTED	OFFERED	TYPE TESTED	OFFERED	TYPE TESTED
Rating								
Fault Level								
Enclosure Dimension (LXBXW)								
Bus Bar Centre Line Distance Phase to Phase								
Insulator Type / Material								
Enclosure / Partition Material								
Report No.								
Report Date								
Testing Agency								

Notes : -

Submit complete test report along with the format.

FORMAT FOR SUBMISISON OF TYPE TEST REPORTS FOR BREAKER

TEST ON VCB	SHORT CIRCUIT		BREAKER DUTY CYCLE		HEAT RUN		POWER FREQUENCY AND IMPLUSE VOLTAGE WITHSTAND	
	OFFERED	TYPE TESTED	OFFERED	TYPE TESTED	OFFERED	TYPE TESTED	OFFERED	TYPE TESTED
Rating								
Model								
Type (Cassette / truck mounted)								
Interrupter Type								
Report No.								
Report Date								
Testing Agency								

Notes : -

Submit complete test report along with the format.

VENDOR LIST (ELECTRICAL) FOR COMPRESSOR- CENTRIFUGAL

(MR No. – B957-300-KA-MR-5030)

PROJECT : OVERALL PROJECT MANAGEMENT AS MPMC AND
PMC/EPCM SERVICES FOR ETHYLENE CRACKER
UNIT AND U&O FOR BPREF.

CLIENT : M/s BPCL – BINA REFINERY

CONSULTANT : ENGINEERS INDIA LIMITED

EIL JOB NO. : B957

B	12.08.2025	REVISED AND RE-ISSUED WITH MR	SKANU	SK	RSR
A	02.06.2025	ISSUED WITH MR	SKANU	SK	RSR
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

GENERAL NOTES- VENDOR LIST PREAMBLE

- 1.0 CONTRACTOR shall procure all the material / equipment forming permanent part of the unit / plant from OWNER / PMC approved vendors enclosed elsewhere in the bidding document. This shall include sub- ordered items / components also. The "Approved Vendors" shall be item specific.
- 2.0 CONTRACTOR to procure material from any of OWNER / PMC approved vendors. However, current validity, holiday status and range of approval as per EIL enlistment letter need to be verified by the CONTRACTOR with vendor before placement of order.
- CONTRACTOR shall also verify the work load, stability and solvency status of the vendor prior to placement of order.
 - Vendors on OWNER/PMC holiday list shall not be considered for ordering, which need to be verified by the CONTRACTOR prior to placement of order. CONTRACTOR shall comply with this requirement without any time or cost implication to Owner.
 - In case any vendor is registered with EIL as an approved vendor subsequent to the issue of this bidding document, the same may also be considered by the CONTRACTOR with prior intimation to OWNER/PMC and obtain their concurrence prior to placement of order.
 - Wherever job specification calls for requisite proven track record, the same shall be complied and necessary documents to be submitted for BPCL/EIL approval prior to ordering. Licensor approval is required wherever necessary.
 - Vendors on OWNER / PMC holiday list shall not be considered for ordering.

CONTRACTOR shall comply with this requirement without any time or cost implication to the OWNER. If a vendor is put on OWNER / PMC's holiday list subsequent to CONTRACTOR placing an order, it shall be CONTRACTOR's responsibility to ensure quality work and timely supply from the vendor.

- 3.0 Wherever the nos. of approved vendors are less than 3 (three) CONTRACTORS may consider additional vendors with prior approval of OWNER / PMC. "Approval status" documents / credentials to be furnished by the vendors in such cases the CONTRACTOR shall be solely responsible. OWNER / PMC's decision on approval shall be final and non-negotiable. Non-acceptance of a particular proposed vendor due to any reasons whatsoever shall not be a cause of schedule and cost implication. Delay in approval of additional vendor, if any, on account of non- submission of performance track record and other documents as per requirements is solely to contractor's account and no time and cost implication implication(s) shall be entertained on account of additional vendor approval
- 4.0 For items not covered in the vendor list (covered elsewhere in bidding document), the vendor shall be approved by OWNER/ PMC prior to placement of order by CONTRACTOR. CONTRACTOR shall list down the proposed suppliers/vendors for such items and submit the One Vendor details for OWNER/PMC's review / approval along with necessary documents/credentials. Non- acceptance of a particular proposed vendor due to any reasons whatsoever shall not be a cause of schedule and cost implication.

- 5.0 CONTRACTOR shall make an independent assessment of capability of all the vendors for timely deliveries of material / equipment. Any delays in deliveries by vendor(s) shall not be a cause of schedule and cost implication.
- 6.0 At any stage of the project, if it comes to the notice of OWNER / PMC that CONTRACTOR has procured material / equipment, intentionally or unintentionally whatsoever, from an unapproved vendor and/or items not falling in approved range of vendor(s), the same shall be rejected forthwith and CONTRACTOR shall be liable to replace such material / plant / machinery without any schedule and cost implication to the OWNER.
- 7.0 The vendor list provided by Process Licensor in any of the Licensor documents shall be considered. If Vendor for any item is not covered in this vendor list but appearing anywhere in the Licensor process package, Licensor vendor list will be followed.
Sub- Vendor list given in the job specifications attached with the tender shall be considered for respective items if not covered in this vendor list.
In case of any Mandatory /Proprietary items appearing in this vendor list as well as in the Licensor's process package, the vendors as recommended by the Process Licensor shall be followed.
- 8.0 It is understood that in few cases, name of the Vendor changes due to change in their Company or Corporate shareholding, OWNER may accept such Vendors under its new name with prior approval and submission of requisite supporting document.
Any such approval shall however, not absolve the CONTRACTOR from any of his obligations under the contract; neither shall any such approval signify nominations or instruction to use such a vendor. All approved vendors are deemed to have been freely chosen by the CONTRACTOR at his own risk.
- 9.0 The approved vendors list for fabricated equipment (Vessels, Column, Heat Exchangers, Ejectors etc.) is for fabrication alone. Where mechanical design of the equipment is included in CONTRACTOR'S scope, CONTRACTOR shall himself be responsible for designing and obtaining approval / review of Mechanical design calculations as per codes/specifications specified elsewhere in the Bid/Contractor document from OWNER / PMC.
- 10.0 Proposal of any new vendor based on its successful PTR is permissible only as special case. In case no quote is received from the bid specified approved vendors, substantial proof such as regret letters / E-mails from vendors etc. to be submitted for the same as documentary evidence. However, OWNER/PMC decision shall be final and binding on the contractor for which commercial implication (if any) shall not be entertained by the OWNER.

Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14AB		Description : AUXILIARY RELAYS		
Approved Suppliers				
1	3642	M/S JVS ELECTRONICS PVT LTD	INDIA	
2	3860	HITACHI ENERGY INDIA LIMITED	INDIA	
3	A392	GE T&D INDIA LIMITED	INDIA	



068055048054

Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14BA		Description : BIMETAL RELAYS		
Approved Suppliers				
1	L103	SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED	INDIA	
2	S003	SIEMENS LIMITED	INDIA	
3	S450A	SCHNEIDER ELECTRIC INDIA P LTD-HYDERABAD	INDIA	
4	3791	C & S ELECTRIC LTD	INDIA	
5	G147	GE INDIA INDUSTRIAL PVT LTD	INDIA	
6	B002	BCH ELECTRIC LTD	INDIA	
7	A200	ABB INDIA LTD (BANGALORE)	INDIA	



068055048054

Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14CA		Description : CABLE GLANDS (HAZARDOUS AREA)		
Approved Suppliers				
1	B024	BALIGA LIGHTING EQUIPMENTS (P) LIMITED	INDIA	
2	C205	COMET INDUSTRIES	INDIA	
3	3681	FCG POWER INDUSTRIES PVT LTD	INDIA	
4	4244	METALMECH ENGINEERING	INDIA	
5	27421	CMP PRODUCTS LIMITED	UNITED KINGDOM	
6	3704	METAL CRAFT INDUSTRIES	INDIA	
7	3890	AKSHAR BRASS INDUSTRIES	INDIA	
8	4187	SIGMA INDUSTRIES	INDIA	
9	S375	STANDARD METAL INDUSTRIES	INDIA	
10	S158	SUDHIR SWITCHGEARS PVT LTD	INDIA	
11	K173	KAYSONS TECHNO EQUIPMENTS PVT. LTD.	INDIA	
12	F036	FLAMEPROOF EQUIPMENTS PVT.LTD	INDIA	
13	F024	FLEXPRO ELECTRICALS PVT LTD	INDIA	
14	C195	COMET BRASS PRODUCTS	INDIA	

068055048054

Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14CD		Description : CONTACTORS		
Approved Suppliers				
1	L103	SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED	INDIA	
2	S450A	SCHNEIDER ELECTRIC INDIA P LTD-HYDERABAD	INDIA	
3	S003	SIEMENS LIMITED	INDIA	
4	A200	ABB INDIA LTD (BANGALORE)	INDIA	
5	B002	BCH ELECTRIC LTD	INDIA	
6	G147	GE INDIA INDUSTRIAL PVT LTD	INDIA	
7	3791	C & S ELECTRIC LTD	INDIA	



068055048054

Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14CF		Description : CONTROL SWITCHES / SELECTOR SWITCHES		
Approved Suppliers				
1	H142	HOTLINE SWITCHGEAR & CONTROLS	INDIA	
2	4012	TEKMEC SWITCHGEAR & CONTROLS	INDIA	
3	R159	RELIABLE ELECTRONIC COMPONENTS PVT LTD	INDIA	
4	S003	SIEMENS LIMITED	INDIA	
5	S373	SWITRON DEVICES	INDIA	
6	L103	SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED	INDIA	
7	K143	KAYCEE INDUSTRIES LTD.	INDIA	
8	4002	P.P. INDUSTRIES	INDIA	



068055048054

Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14FA		Description : FUSES		
Approved Suppliers				
1	C194	EATON POWER QUALITY PRIVATE LIMITED	INDIA	
2	S003	SIEMENS LIMITED	INDIA	
3	L103	SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED	INDIA	
4	I013	NOVATEUR ELECTRICAL & DIGITAL SYSTEMS P	INDIA	
5	G147	GE INDIA INDUSTRIAL PVT LTD	INDIA	



068055048054

Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14HA		Description : HEAVY DUTY SWITCHES		
Approved Suppliers				
1	L103	SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED	INDIA	
2	S003	SIEMENS LIMITED	INDIA	
3	3790	C & S ELECTRIC LTD	INDIA	



068055048054

Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14IA		Description : INSTRUMENT TRANSFORMERS CT & PT (MV)		
Approved Suppliers				
1	4160	RECO TRANSFORMERS PRIVATE LIMITED	INDIA	
2	3901	NEWTEK ELECTRICALS	INDIA	
3	3789	PRAGATI ELECTRICALS PVT LTD	INDIA	
4	S372	SILKAANS ELECTRICALS MFG.CO.PVT.LTD	INDIA	
5	P237	PRECISE ELECTRICALS	INDIA	
6	P228	PRAGATI ELECTRICALS PVT LTD	INDIA	
7	N119	NARAYAN POWERTECH PVT LTD	INDIA	
8	K149	KALPA ELEKTRIKAL PVT LTD	INDIA	
9	G135	GILBERT & MAXWELL ELECTRICALS PVT LTD	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14MA		Description : MCB		
Approved Suppliers				
1	3888	POLYCAB INDIA LIMITED	INDIA	
2	L071	LEGRAND (INDIA) PVT. LTD (FORM. M-006)	INDIA	
3	A372	ABB INDIA LTD	INDIA	
4	S393	STANDARD ELECTRICALS LTD	INDIA	
5	S003	SIEMENS LIMITED	INDIA	
6	S450	SCHNEIDER ELECTRIC INDIA PVT LTD	INDIA	
7	3824	HAVELLS INDIA LIMITED	INDIA	
8	1168	INDIANA CURRENT CONTROL LTD	INDIA	
9	3726	NOVATEUR ELECTRICAL & DIGITAL SYSTEMS PVT. LTD.	INDIA	
10	3793	C & S ELECTRIC LTD	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14MB		Description : MCCB		
Approved Suppliers				
1	G147	GE INDIA INDUSTRIAL PVT LTD	INDIA	
2	S003	SIEMENS LIMITED	INDIA	
3	A200B	ABB INDIA LTD	INDIA	
4	S450A	SCHNEIDER ELECTRIC INDIA P LTD-HYDERABAD	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14MC		Description : METERS		
Approved Suppliers				
1	4233	ELMEASURE INDIA PRIVATE LIMITED	INDIA	
2	S141	SECURE METERS LIMITED	INDIA	
3	3901	NEWTEK ELECTRICALS	INDIA	
4	N130	NIPPEN ELECTRICAL INSTRUMENTS CO.	INDIA	
5	A028A	AUTOMATIC ELECTRIC LTD.	INDIA	
6	R042	RISHABH INSTRUMENTS LIMITED	INDIA	
7	M239	MECO INSTRUMENTS PVT LTD	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14PB		Description : PUSH BUTTON AND INDICATING LAMPS		
Approved Suppliers				
1	T166	TEKNIC ELECTRIC (I) PVT. LTD.	INDIA	
2	S003	SIEMENS LIMITED	INDIA	
3	S450A	SCHNEIDER ELECTRIC INDIA P LTD-HYDERABAD	INDIA	
4	B002	BCH ELECTRIC LTD	INDIA	
5	H142	HOTLINE SWITCHGEAR & CONTROLS	INDIA	
6	E173	ESSEN DEINKI	INDIA	
7	S365	SHRI TULSI SWITCHGEARS PVT LTD	INDIA	
8	P291	PRECIFINE PRODUCTS PVT. LTD.	INDIA	
9	4002	P.P. INDUSTRIES	INDIA	
10	4012	TEKMEC SWITCHGEAR & CONTROLS	INDIA	
11	3791	C & S ELECTRIC LTD	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14SA		Description : FUSE SWITCH COMBINATION		
Approved Suppliers				
1	3825	HAVELLS INDIA LIMITED	INDIA	
2	3790	C & S ELECTRIC LTD	INDIA	
3	G147	GE INDIA INDUSTRIAL PVT LTD	INDIA	
4	S003	SIEMENS LIMITED	INDIA	
5	L103	SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED	INDIA	
6	I013	NOVATEUR ELECTRICAL & DIGITAL SYSTEMS P	INDIA	
7	S393	STANDARD ELECTRICALS LTD	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14TA		Description : TIMERS		
Approved Suppliers				
1	E151	ELECTRONIC AUTOMATION PVT LTD	INDIA	
2	L103	SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED	INDIA	
3	B002	BCH ELECTRIC LTD	INDIA	
4	S003	SIEMENS LIMITED	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14BC		Description : BUS DUCTS (HV)		
Approved Suppliers				
1	U036	UNITED ELECTRIC CO (DELHI) PVT LTD	INDIA	
2	K191	STARDRIVE BUSDUCTS PRIVATE LIMITED	INDIA	
3	3792	C & S ELECTRIC LTD	INDIA	
4	3954	GODREJ & BOYCE MANUFACTURING COMPANY LIMITED	INDIA	
5	B184	BHARAT HEAVY ELECTRICALS LIMITED-JHANSI	INDIA	
6	N132	NARMADA SWITCHGEAR PVT. LTD	INDIA	
7	E107	ENPRO ENGINEERING	INDIA	
8	B222	GODREJ & BOYCE MANUFACTURING COMPANY LIMITED	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14CE		Description : CONTROL SWITCHES (BREAKER)		
Approved Suppliers				
1	S373	SWITRON DEVICES	INDIA	
2	R159	RELIABLE ELECTRONIC COMPONENTS PVT LTD	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14IB		Description : INSTRUMENT TRANSFORMERS CT & PT (HV)		
Approved Suppliers				
1	E144	ELECTRICAL CONTROLS & SYSTEMS	INDIA	
2	K149	KALPA ELEKTRIKAL PVT LTD	INDIA	
3	3857	SCHNEIDER ELECTRIC INFRASTRUCTURE LIMITED	INDIA	
4	3859	HITACHI ENERGY INDIA LIMITED	INDIA	
5	3730	GEMINI INSTRATECH LTD	INDIA	
6	K013	KAPPA ELECTRICALS	INDIA	
7	P228	PRAGATI ELECTRICALS PVT LTD	INDIA	
8	3862	STRATON ELECTRICALS PRIVATE LIMITED	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14LA		Description : LIGHTNING ARRESTORS		
Approved Suppliers				
1	C010	CG POWER AND INDUSTRIAL SOLUTIONS LIMITED	INDIA	
2	4229	ELEKTROLITES (POWER) PRIVATE LIMITED	INDIA	
3	W035	W.S. INSULATOR OF INDIA	INDIA	
4	O009	OBLUM ELECTRICAL INDUSTRIES (P) LTD	INDIA	
5	E091	ELPRO INTERNATIONAL LIMITED	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14PA		Description : PROTECTION RELAYS		
Approved Suppliers				
1	E143	EASUN REYROLLE LTD	INDIA	
2	S003B	SIEMENS LTD - GOA	INDIA	
3	A070	ABB INDIA LTD (BARODA)	INDIA	
4	A392	GE VERNOVA T&D INDIA LIMITED	INDIA	
5	S824	SCHWEITZER ENGINEERING LABORATORIES	UNITED STATES	
6	S450A	SCHNEIDER ELECTRIC INDIA P LTD-HYDERABAD	INDIA	



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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 14VA		Description : VACUUM INTERRUPTER		
Approved Suppliers				
1	A365	ABB GLOBAL INDUSTRIES & SERVICES LTD	INDIA	
2	4202	CG POWER AND INDUSTRIAL SOLUTIONS LIMITED	INDIA	
3	3856	SCHNEIDER ELECTRIC INFRASTRUCTURE LIMITED	INDIA	



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TYPICAL ECS & SCAP I/O LIST FOR ELECTRICAL CONTROL SYSTEM

PROJECT : MPMC AND PMC/EPCM SERVICES FOR ETHYLENE CRACKER UNIT AND UTILITIES & OFFSITES RELATED TO BINA PETCHEM & REFINERY EXPANSION PROJECT (BPREP)

OWNER : M/s BHARAT PETROLEUM CORPORATION LTD.

EPCM : ENGINEERS INDIA LTD.

JOB NO. : B957

A	11.11.2024	ISSUED WITH MR/TENDER	SK	RSR	RSR
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

EQUIPMENT DESCRIPTION	FEEDER TYPE	INFORMATION TYPE	NATURE OF INFORMATION	INFORMATION DESCRIPTION	SET CONDITION	RESET CONDITION	INTERFACE	REMARKS
220 & 66 kV DBB GIS	INCOMER	AI	MEASURING	R-Phase Current			HARDWIRED	FROM MEASURING CT CORES TO TRANSDUCERS IN ECS TRANSDUCER PANEL
220 & 66 kV DBB GIS	INCOMER	AI	MEASURING	Y-Phase Current			HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	AI	MEASURING	B-Phase Current			HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	AI	MEASURING	Three Phase Real Power (Bi-directional)			HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	AI	MEASURING	Three Phase Reactive Power (Bi-directional)			HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	AI	MEASURING	Power Factor			HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	CB in Service and	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	CB in Service and	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Bus Side Isolator 1	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Bus Side Isolator 1	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Bus Side Isolator 1 Earth Switch	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Bus Side Isolator 1 Earth Switch	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Bus Side Isolator 2	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Bus Side Isolator 2	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Line Side Isolator 1	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Line Side Isolator 1	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Line Side Isolator 1 Earth Switch	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Line Side Isolator 1 Earth Switch	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	High Speed Earth Switch	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	High Speed Earth Switch	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Feeder Differential	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Relay 86 - Lock Out Relay	Operated=1		HARDWIRED	

220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Gas Pressure Low	Operated=1		HARDWIRED	Separate for each compartment
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	No Voltage Signal from Cap. Voltage Detector	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Local Remote Selector Switch	Local		HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Local Remote Selector Switch	Remote		HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DO	COMMAND	CB Close Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DO	COMMAND	Trip form ECS (TC-1)	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DO	COMMAND	Trip from ECS (TC-2)	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DO	COMMAND	Close Inhibit (From ECS)	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DO	COMMAND	Bus Side Isolator 1 Open Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DO	COMMAND	Bus Side Isolator 1 Close Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DO	COMMAND	Bus Side Isolator 1 Earth Switch Open Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DO	COMMAND	Bus Side Isolator 1 Earth Switch Close Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DO	COMMAND	Bus Side Isolator 2 Open Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DO	COMMAND	Bus Side Isolator 2 Close Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DO	COMMAND	Line Side Isolator Open Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DO	COMMAND	Line Side Isolator Close Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Pole Discordance	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Relay 95 - Trip Circuit - 1 Supervision	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Relay 95 - Trip Circuit -	Operated=1		HARDWIRED	

				2 Supervision				
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Relay 80	Operated=1		RELAY LAN	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Tripped on Undervoltage	Activated=1		RELAY LAN	
220 & 66 kV DBB GIS	INCOMER	DI	STATUS	Numerical Relay	Unhealthy=1		RELAY LAN	For each type of Relay
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	AI	MEASURING	R-Phase Current			HARDWIRED	FROM MEASURING CT CORES TO TRANSDUCERS IN ECS TRANSDUCER PANEL
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	AI	MEASURING	Y-Phase Current			HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	AI	MEASURING	B-Phase Current			HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	AI	MEASURING	Three Phase Real Power (Bi- directional)			HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	AI	MEASURING	Three Phase Reactive Power (Bi- directional)			HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	AI	MEASURING	Power Factor			HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	CB in Service and	Closed	Open	HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	CB in Service and	Open	Closed	HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Cable Side Isolator 1	Closed	Open	HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Cable Side Isolator 1	Open	Closed	HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Cable Side Isolator 1 Earth Switch	Closed	Open	HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Cable Side Isolator 1 Earth Switch	Open	Closed	HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Outgoing Cable Earth Switch	Closed	Open	HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Outgoing Cable Earth Switch	Open	Closed	HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Line Side Isolator 1	Closed	Open	HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Line Side Isolator 1	Open	Closed	HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Line Side Isolator 1 Earth Switch	Closed	Open	HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Line Side Isolator 1 Earth Switch	Open	Closed	HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	High Speed Earth Switch	Closed	Open	HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	High Speed Earth Switch	Open	Closed	HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Feeder Differential for Cable	Operated=1		HARDWIRED	

66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Feeder Differential for Line	Operated=1		HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Relay 86 - Lock Out Relay	Operated=1		HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Gas Pressure Low	Operated=1		HARDWIRED	Separate for each compartment
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	No Voltage Signal from Cap. Voltage Detector	Operated=1		HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Local Remote Selector Switch	Local		HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Local Remote Selector Switch	Remote		HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DO	COMMAND	CB Close Command	Activated=1		HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DO	COMMAND	Trip form ECS (TC-1)	Activated=1		HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DO	COMMAND	Trip from ECS (TC-2)	Activated=1		HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DO	COMMAND	Close Inhibit (From ECS)	Activated=1		HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DO	COMMAND	Bus Side Isolator 1 Open Command	Activated=1		HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DO	COMMAND	Bus Side Isolator 1 Close Command	Activated=1		HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DO	COMMAND	Bus Side Isolator 1 Earth Switch Open Command	Activated=1		HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DO	COMMAND	Bus Side Isolator 1 Earth Switch Close Command	Activated=1		HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DO	COMMAND	Bus Side Isolator 2 Open Command	Activated=1		HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DO	COMMAND	Bus Side Isolator 2 Close Command	Activated=1		HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DO	COMMAND	Line Side Isolator Open Command	Activated=1		HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DO	COMMAND	Line Side Isolator Close Command	Activated=1		HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Pole Discordance	Operated=1		HARDWIRED	

66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Relay 95 - Trip Circuit - 1 Supervision	Operated=1		HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Relay 95 - Trip Circuit - 2 Supervision	Operated=1		HARDWIRED	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Relay 80	Operated=1		RELAY LAN	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Tripped on Undervoltage	Activated=1		RELAY LAN	
66 & 33 Kv DBB GIS	ISOLATING BREAKER PANEL	DI	STATUS	Numerical Relay	Unhealthy=1		RELAY LAN	For each type of Relay
220 & 66 kV DBB GIS	LINE PT	AI	MEASURING	R-Y Line Voltage			HARDWIRED	FROM PT TO TRANSDUCERS IN ECS TRANSDUCER PANEL
220 & 66 kV DBB GIS	LINE PT	AI	MEASURING	Y-B Line Voltage			HARDWIRED	
220 & 66 kV DBB GIS	LINE PT	AI	MEASURING	R-B Line Voltage			HARDWIRED	
220 & 66 kV DBB GIS	LINE PT	AI	MEASURING	Line Frequency			HARDWIRED	
220 & 66 kV DBB GIS	LINE PT	DI	STATUS	Line PT Primary Side Disconnecter	OPEN		HARDWIRED	
220 & 66 kV DBB GIS	LINE PT	DI	STATUS	Line PT Primary Side Disconnecter	CLOSED		HARDWIRED	
220 & 66 kV DBB GIS	LINE PT	DI	STATUS	Line PT Primary Side Disconnecter	EARTHED		HARDWIRED	
220 & 66 kV DBB GIS	LINE PT	DI	STATUS	Line PT Secondary MCB	Tripped=1		HARDWIRED	
220 & 66 kV DBB GIS	LINE PT	DI	STATUS	Line	Dead = 1		HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	AI	MEASURING	R-Phase Current			HARDWIRED	FROM MEASURING CT / PT CORES TO TRANSDUCERS IN ECS TRANSDUCER PANEL
220 & 66 kV DBB GIS	PLANT FDR	AI	MEASURING	Y-Phase Current			HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	AI	MEASURING	B-Phase Current			HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	AI	MEASURING	Three Phase Real Power (Bi- directional)			HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	AI	MEASURING	Three Phase Reactive Power (Bi- directional)			HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	AI	MEASURING	Power Factor			HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	CB in Service and	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	CB in Service and	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	Bus Side Isolator 1	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	Bus Side Isolator 1	Open	Closed	HARDWIRED	

220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	Bus Side Isolator 1 Earth Switch	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	Bus Side Isolator 1 Earth Switch	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	Bus Side Isolator 2	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	Bus Side Isolator 2	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	Line Side Isolator 1	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	Line Side Isolator 1	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	Line Side Isolator 1 Earth Switch	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	Line Side Isolator 1 Earth Switch	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	High Speed Earth Switch	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	High Speed Earth Switch	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	Feeder Differential	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	Relay 86 - Lock Out Relay	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	Gas Pressure Low	Operated=1		HARDWIRED	Separate for each compartment
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	No Voltage Signal from Cap. Voltage Detector	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	Local Remote Selector Switch	Local		HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	Local Remote Selector Switch	Remote		HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DO	COMMAND	CB Close Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DO	COMMAND	Trip from ECS (TC-1)	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DO	COMMAND	Trip from ECS (TC-2)	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DO	COMMAND	Close Inhibit (From ECS)	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DO	COMMAND	Bus Side Isolator 1 Open Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DO	COMMAND	Bus Side Isolator 1 Close Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DO	COMMAND	Bus Side Isolator 1 Earth Switch	Activated=1		HARDWIRED	

				Open Command				
220 & 66 kV DBB GIS	PLANT FDR	DO	COMMAND	Bus Side Isolator 1 Earth Switch Close Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DO	COMMAND	Bus Side Isolator 2 Open Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DO	COMMAND	Bus Side Isolator 2 Close Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DO	COMMAND	Line Side Isolator Open Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DO	COMMAND	Line Side Isolator Close Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	Pole Discordance	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	Relay 95 - Trip Circuit - 1 Supervision	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	Relay 95 - Trip Circuit - 2 Supervision	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	Relay 80	Operated=1		RELAY LAN	
220 & 66 kV DBB GIS	PLANT FDR	DI	STATUS	Numerical Relay	Unhealthy=1		RELAY LAN	For each type of Relay
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	AI	MEASURING	R-Phase Current (Bi-directional)			HARDWIRED	FROM MEASURING CT / PT CORES TO TRANSUDCERS IN ECS TRANSUDCER PANEL
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	AI	MEASURING	Y-Phase Current (Bi-directional)			HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	AI	MEASURING	B-Phase Current (Bi-directional)			HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	AI	MEASURING	Three Phase Real Power (Bi-directional)			HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	AI	MEASURING	Three Phase Reactive Power (Bi-directional)			HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	AI	MEASURING	Power Factor			HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	CB in Service and	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	CB in Service and	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Bus Side Isolator 1	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Bus Side Isolator 1	Open	Closed	HARDWIRED	

220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Bus Side Isolator 1 Earth Switch	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Bus Side Isolator 1 Earth Switch	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Bus Side Isolator 2	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Bus Side Isolator 2	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Line Side Isolator 1	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Line Side Isolator 1	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Line Side Isolator 1 Earth Switch	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Line Side Isolator 1 Earth Switch	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	High Speed Earth Switch	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	High Speed Earth Switch	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Restricted Earth Fault	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Transformer Differential	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Relay 86 - Lock Out Relay	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Gas Pressure Low	Operated=1		HARDWIRED	Separate for each compartment
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	No Voltage Signal from Cap. Voltage Detector	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Local Remote Selector Switch	Local		HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Local Remote Selector Switch	Remote		HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DO	COMMAND	CB Close Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DO	COMMAND	Trip from ECS (TC-1)	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DO	COMMAND	Trip from ECS (TC-2)	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DO	COMMAND	Close Inhibit (From ECS)	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DO	COMMAND	Bus Side Isolator 1 Open Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DO	COMMAND	Bus Side Isolator 1 Close Command	Activated=1		HARDWIRED	

220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DO	COMMAND	Bus Side Isolator 1 Earth Switch Open Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DO	COMMAND	Bus Side Isolator 1 Earth Switch Close Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DO	COMMAND	Bus Side Isolator 2 Open Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DO	COMMAND	Bus Side Isolator 2 Close Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DO	COMMAND	Line Side Isolator Open Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DO	COMMAND	Line Side Isolator Close Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Pole Discordance	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Relay 95 - Trip Circuit - 1 Supervision	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Relay 95 - Trip Circuit - 2 Supervision	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Relay 80	Operated=1		RELAY LAN	
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Numerical Relay	Unhealthy=1		RELAY LAN	For each type of Relay
220 & 66 kV DBB GIS	TRANSFORMER / TIE FDR	DI	STATUS	Transformer Trouble	Operated=1		RELAY LAN	
220 & 66 kV DBB GIS	GRID TRANSFORMER	AI	MEASURING	Oil Temperature			HARDWIRED	4-20mA THROUGH TRAFO MBOX
220 & 66 kV DBB GIS	GRID TRANSFORMER	AI	MEASURING	Winding Temperature			HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC L/R Selector Switch	Local	Not Local	HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC L/R Selector Switch	Remote	Not Remote	HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	ECS/ RTCC Selector Switch	ECS	Not ECS	HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	ECS/ RTCC Selector Switch	RTCC	Not RTCC	HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC I/A Selector Switch	Independent	Not Indepen.	HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC I/A Selector Switch	Auto	Not Auto	HARDWIRED	-

220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC Run Mode	Master	Not Master	HARDWIRED	-
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC Run Mode	Follower	Not Follower	HARDWIRED	-
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	Tap Changer In Progress	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	Tap Changer Stuck	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DO	COMMAND	Tap Raise Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DO	COMMAND	Tap Lower Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC Tap at Position 1	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC Tap at Position 2	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC Tap at Position 3	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC Tap at Position 4	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC Tap at Position 5	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC Tap at Position 6	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC Tap at Position 7	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC Tap at Position 8	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC Tap at Position 9	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC Tap at Position 10	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC Tap at Position 11	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC Tap at Position 12	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC Tap at Position 13	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC Tap at Position 14	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC Tap at Position 15	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC Tap at Position 16	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	OLTC Tap at Position 17	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	TCIV Closed	Activated=1		HARDWIRED	From NIFPS
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	Fire Detector Tripped	Activated=1		HARDWIRED	From NIFPS
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	Oil Drain Valve Open	Activated=1		HARDWIRED	From NIFPS
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	Extinction in Progress	Activated=1		HARDWIRED	From NIFPS
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	Cylinder Pressure Low	Activated=1		HARDWIRED	From NIFPS

220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	System Out of Service	Activated=1		HARDWIRED	From NIFPS
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	NIFPS not in Auto	Activated=1		HARDWIRED	From NIFPS
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	DC Supply to NIFPS Fail	Activated=1		HARDWIRED	From NIFPS
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	Fire Detector Tripped	Activated=1		HARDWIRED	From HWWS
220 & 66 kV DBB GIS	GRID TRANSFORMER	DI	STATUS	Online Moisture Removal System	Healthy		HARDWIRED	From system panel
220 & 66 kV DBB GIS	BUSPT	AI	MEASURING	R-Y Line Voltage			HARDWIRED	FROM PT TO TRANSDUCERS IN ECS TRANSDUCER PANEL
220 & 66 kV DBB GIS	BUSPT	AI	MEASURING	Y-B Line Voltage			HARDWIRED	
220 & 66 kV DBB GIS	BUSPT	AI	MEASURING	R-B Line Voltage			HARDWIRED	
220 & 66 kV DBB GIS	BUSPT	AI	MEASURING	Bus Frequency			HARDWIRED	
220 & 66 kV DBB GIS	BUSPT	DI	MEASURING	Bus PT Primary Side Disconnecter	OPEN		HARDWIRED	
220 & 66 kV DBB GIS	BUSPT	DI	MEASURING	Bus PT Primary Side Disconnecter	CLOSED		HARDWIRED	
220 & 66 kV DBB GIS	BUSPT	DI	MEASURING	Bus PT Primary Side Disconnecter	EARTHED		HARDWIRED	
220 & 66 kV DBB GIS	BUSPT	DI	STATUS	Bus PT Secondary MCB	Tripped=1		HARDWIRED	
220 & 66 kV DBB GIS	BUSPT	DI	STATUS	STAGE 1 UFLS Operated	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUSPT	DI	STATUS	STAGE 2 UFLS Operated	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUSPT	DI	STATUS	STAGE 3 UFLS Operated	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUSPT	DI	STATUS	STAGE 4 UFLS Operated	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUSPT	DI	STATUS	Check Supervision for Bus Differential	Operated=1		RELAY LAN	
220 & 66 kV DBB GIS	BUSPT	DI	STATUS	Differential Protection for Bus	Operated=1		RELAY LAN	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	AI	MEASURING	R-Phase Current (Bi-directional)			HARDWIRED	THROUGH MEASURING CT CORES TO TRANSDUCERS IN ECS TRANSDUCER PANEL
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	AI	MEASURING	Y-Phase Current (Bi-directional)			HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	AI	MEASURING	B-Phase Current (Bi-directional)			HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	AI	MEASURING	Three Phase Real Power (Bi-directional)			HARDWIRED	

220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	AI	MEASURING	Three Phase Reactive Power (Bi- directional)			HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	AI	MEASURING	Power Factor			HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	CB in Service and	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	CB in Service and	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	Isolator 1	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	Isolator 1	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	Isolator 1 Earth Switch	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	Isolator 1 Earth Switch	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	Isolator 2	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	Isolator 2	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	Isolator 2 Earth Switch	Closed	Open	HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	Isolator 2 Earth Switch	Open	Closed	HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	Bus Bar Differential	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	Relay 95B	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	Relay 86 - Lock Out Relay	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	Gas Pressure Low	Operated=1		HARDWIRED	Separate for each compartment
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	No Voltage Signal from Cap. Voltage Detector - 1	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	No Voltage Signal from Cap. Voltage Detector - 2	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	Local Remote Selector Switch	Local		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	Local Remote Selector Switch	Remote		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DO	COMMAND	CB Close Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DO	COMMAND	Trip form ECS (TC-1)	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DO	COMMAND	Trip from ECS (TC-2)	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DO	COMMAND	Close Inhibit (From ECS)	Activated=1		HARDWIRED	

220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DO	COMMAND	Isolator 1 Open Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DO	COMMAND	Isolator 1 Close Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DO	COMMAND	Isolator 1 Earth Switch Open Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DO	COMMAND	Isolator 1 Earth Switch Close Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DO	COMMAND	Isolator 2 Open Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DO	COMMAND	Isolator 2 Close Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DO	COMMAND	Isolator 2 Earth Switch Open Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DO	COMMAND	Isolator 2 Earth Switch Close Command	Activated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	Pole Discordance	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	Relay 95 - Trip Circuit - 1 Supervision	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	Relay 95 - Trip Circuit - 2 Supervision	Operated=1		HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	Relay 80	Operated=1		RELAY LAN	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	Numerical Relay	Unhealthy=1		RELAY LAN	For each type of Relay
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	AI	MEASURING	MW Value from relay	Activated=1		RELAY LAN	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	AC Control Supply 1	Failed	Healthy	HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	AC Control Supply 2	Failed	Healthy	HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	DC Control Supply 1	Failed	Healthy	HARDWIRED	
220 & 66 kV DBB GIS	BUS COUPLER / SECTIONALISER	DI	STATUS	DC Control Supply 2	Failed	Healthy	HARDWIRED	
6.6 KV AIS	ISOLATING BKR PNL	AI	W	3-Phase Real Power			RELAY LAN	
6.6 KV AIS	ISOLATING BKR PNL	AI	R	3-Phase Reactive Power			RELAY LAN	
6.6 KV AIS	ISOLATING BKR PNL	AI		Power Factor			RELAY LAN	
6.6 KV AIS	ISOLATING BKR PNL	DI	D	Line PT Secondary MCB	Tripped=1		HARDWIRED	
6.6 KV AIS	ISOLATING BKR PNL	DI	S	CB in service &	Closed	Not closed	HARDWIRED	

6.6 KV AIS	ISOLATING BKR PNL	DI	S	CB in service &	Open	Not open	HARDWIRED	
6.6 KV AIS	ISOLATING BKR PNL	DI	D	Relay 86	Operated	Reset	HARDWIRED	
6.6 KV AIS	ISOLATING BKR PNL	DI	D	Relay 95	Operated	Reset	HARDWIRED	
6.6 KV AIS	ISOLATING BKR PNL	DI	D	Trip on under voltage	Activated	Reset	RELAY LAN	
6.6 KV AIS	ISOLATING BKR PNL	DI	D	Numerical Relay	Unhealthy	Healthy	RELAY LAN	
6.6 KV AIS	ISOLATING BKR PNL	DO	C	Trip from ECS	Activated	Reset	HARDWIRED	
6.6 KV AIS	ISOLATING BKR PNL	DO	COMMAND	Close Inhibit (From ECS)	Activated=1		HARDWIRED	
6.6 KV AIS	ISOLATING BKR PNL	DI	D	Feeder Differential	Operated=1		RELAY LAN	
6.6 KV AIS	ISOLATING BKR PNL	DI	D	Transformer Trouble	Operated=1		RELAY LAN	63TX, 51G, 64R
6.6 KV AIS	ISOLATING BKR PNL	DI	D	Trafo Trouble Alarm (Buch., OTI, WTI)	Operated=1		RELAY LAN	
6.6 KV AIS	ISOLATING BKR PNL	DI	D	Trafo Trouble Trip (Buch., OTI, WTI)	Operated=1		RELAY LAN	
6.6 KV AIS	ISOLATING BKR PNL	DI	STATUS	AC Control Supply	Failed	Healthy	HARDWIRED	
6.6 KV AIS	ISOLATING BKR PNL	DI	STATUS	DC Control Supply	Failed	Healthy	HARDWIRED	
415V SWBD	Incomer (from trafo)	AI	A	R phase current			RELAY LAN	
415V SWBD	Incomer (from trafo)	AI	A	Y phase current			RELAY LAN	
415V SWBD	Incomer (from trafo)	AI	A	B phase current			RELAY LAN	
415V SWBD	Incomer (from trafo)	AI	W	3-phase real power			RELAY LAN	
415V SWBD	Incomer (from trafo)	AI	R	3-phase reactive power			RELAY LAN	
415V SWBD	Incomer (from trafo)	AI		Power factor			RELAY LAN	
415V SWBD	Incomer (from trafo)	DI	S	CB in service & Closed	Closed	Not closed	Hardwired	
415V SWBD	Incomer (from trafo)	DI	S	CB in service & Open	Open	Not open	Hardwired	
415V SWBD	Incomer (from trafo)	DO	C	Trip from ECS	Activated	Reset	Hardwired	
415V SWBD	Incomer (from trafo)	DO	C	Close Inhibit (From ECS)	Operated	Reset	Hardwired	
415V SWBD	Incomer (from trafo)	DI	D	Relay 95	Operated	Reset	HARDWIRED	
415V SWBD	Incomer (from trafo)	DI	D	Trip on under- voltage	Activated	Reset	RELAY LAN	
415V SWBD	Incomer (from trafo)	DI	D	Numerical Relays	Unhealthy	Healthy	RELAY LAN	
415V SWBD	Incomer (from trafo)	DI	S	Transformer trouble	Activated	Reset	RELAY LAN	
415V SWBD	Incomer (from trafo)	DI	D	Relay 86	Operated	Reset	Hardwired	
415V SWBD	Incomer (from trafo)	DI	D	Over Temperature monitoring	Operated	Reset	Hardwired	

				system				
415V SWBD	Line PT I/O signals	AI	V	R-Y line voltage			RELAY LAN	
415V SWBD	Line PT I/O signals	AI	V	Y-B line voltage			RELAY LAN	
415V SWBD	Line PT I/O signals	AI	V	B-R line voltage			RELAY LAN	
415V SWBD	Line PT I/O signals	DI	D	Line VT MCB	Open	Closed	Hardwired	
415V SWBD	Incomer (other SWBD)	AI	A	R phase current			RELAY LAN	
415V SWBD	Incomer (other SWBD)	AI	A	Y phase current			RELAY LAN	
415V SWBD	Incomer (other SWBD)	AI	A	B phase current			RELAY LAN	
415V SWBD	Incomer (other SWBD)	AI	W	3-phase real power			RELAY LAN	
415V SWBD	Incomer (other SWBD)	AI	R	3-phase reactive power			RELAY LAN	
415V SWBD	Incomer (other SWBD)	AI		Power factor			RELAY LAN	
415V SWBD	Incomer (other SWBD)	DI	S	CB in service & Closed	Closed	Not closed	Hardwired	
415V SWBD	Incomer (other SWBD)	DI	S	CB in service & Open	Open	Not open	Hardwired	
415V SWBD	Incomer (other SWBD)	DO	C	Trip from ECS	Activated	Reset	Hardwired	
415V SWBD	Incomer (other SWBD)	DO	C	Close Inhibit (From ECS)	Operated	Reset	Hardwired	
415V SWBD	Incomer (other SWBD)	DI	D	Relay 95	Operated	Reset	Hardwired	
415V SWBD	Incomer (other SWBD)	DI	D	Trip on under-voltage	Activated	Reset	RELAY LAN	
415V SWBD	Incomer (other SWBD)	DI	D	Numerical Relay	Unhealthy	Healthy	RELAY LAN	
415V SWBD	Incomer (other SWBD)	DI	D	Relay 86	Operated	Reset	Hardwired	
415V SWBD	Incomer (other SWBD)	DI	D	Over Temperature monitoring system	Operated	Reset	Hardwired	
415V SWBD	Bus coupler	AI	A	R phase current			RELAY LAN	
415V SWBD	Bus coupler	AI	A	Y phase current			RELAY LAN	
415V SWBD	Bus coupler	AI	A	B phase current			RELAY LAN	
415V SWBD	Bus coupler	AI	W	3-phase Real power			RELAY LAN	
415V SWBD	Bus coupler	AI	R	3-phase Reactive power			RELAY LAN	
415V SWBD	Bus coupler	AI		Power factor			RELAY LAN	
415V SWBD	Bus coupler	DI	S	CB in service & Closed	Closed	Not closed	Hardwired	
415V SWBD	Bus coupler	DI	S	CB in service & Open	Open	Not open	Hardwired	
415V SWBD	Bus coupler	DO	C	Trip from ECS	Activated	Reset	Hardwired	
415V SWBD	Bus coupler	DO	C	Close Inhibit (From ECS)	Operated	Reset	Hardwired	
415V SWBD	Bus coupler	DI	D	Relay 95	Operated	Reset	Hardwired	

415V SWBD	Bus coupler	DI	D	Auto-changeover	Blocked	Not blocked	RELAY LAN	
415V SWBD	Bus coupler	DI	D	Numerical Relay	Unhealthy	Healthy	RELAY LAN	
415V SWBD	Bus coupler	DI	D	Trip from under voltage	Activated	Reset	RELAY LAN	
415V SWBD	Bus coupler	DI	S	Switchboard (A-I-M selector switch)	In auto mode	Not in auto mode	Hardwired	
415V SWBD	Bus coupler	DI	S	Switchboard (A-I-M selector switch)	In independent mode	Not in indep mode	Hardwired	
415V SWBD	Bus coupler	DI	S	Switchboard (A-I-M selector switch)	In manual mode	Not in manual mode	Hardwired	
415V SWBD	Bus coupler	DI	D	DC control supply #1	Failed	Healthy	Hardwired	
415V SWBD	Bus coupler	DI	D	DC control supply #2	Failed	Healthy	Hardwired	
415V SWBD	Bus coupler	DI	D	AC space heater supply #1	Failed	Healthy	Hardwired	
415V SWBD	Bus coupler	DI	D	AC space heater supply #2	Failed	Healthy	Hardwired	
415V SWBD	Bus coupler	DI	D	Relay 86	Operated	Reset	Hardwired	
415V SWBD	Bus PT	AI	V	R-Y bus voltage			RELAY LAN	
415V SWBD	Bus PT	AI	V	Y-B bus voltage			RELAY LAN	
415V SWBD	Bus PT	AI	V	B-R bus voltage			RELAY LAN	
415V SWBD	Bus PT	DI	D	Bus PT MCB	Open	Closed	Hardwired	
415V SWBD	Bus PT	DI	D	UF & df/dt Signal	Open	Closed	Hardwired	4 Stages
415V SWBD	Outgoing ACB feeder	AI	A	R phase current			RELAY LAN	
415V SWBD	Outgoing ACB feeder	AI	A	Y phase current			RELAY LAN	
415V SWBD	Outgoing ACB feeder	AI	A	B phase current			RELAY LAN	
415V SWBD	Outgoing ACB feeder	AI	W	Real power			RELAY LAN	
415V SWBD	Outgoing ACB feeder	AI	R	Reactive Power			RELAY LAN	
415V SWBD	Outgoing ACB feeder	AI		Power factor			RELAY LAN	
415V SWBD	Outgoing ACB feeder	DI	S	CB in service & Closed	Closed	Not closed	Hardwired	
415V SWBD	Outgoing ACB feeder	DI	S	CB in service & Open	Open	Not open	Hardwired	
415V SWBD	Outgoing ACB feeder	DI	C	Trip from ECS	Activated	Reset	Hardwired	
415V SWBD	Outgoing ACB feeder	DO	C	Close Inhibit (From ECS)	Operated	Reset	Hardwired	
415V SWBD	Outgoing ACB feeder	DI	D	Relay 95	Operated	Reset	Hardwired	
415V SWBD	Outgoing ACB feeder	DI	D	Numerical Relay	Unhealthy	Healthy	RELAY LAN	
415V	Outgoing ACB	DI	D	Trip from	Activated	Reset	RELAY LAN	

SWBD	feeder			under voltage				
415V SWBD	Outgoing ACB feeder	DI	D	Relay 86	Operated	Reset	Hardwired	
415V SWBD	Outgoing ACB motor	AI	A	R phase current			RELAY LAN	
415V SWBD	Outgoing ACB motor	AI	A	Y phase current			RELAY LAN	
415V SWBD	Outgoing ACB motor	AI	A	B phase current			RELAY LAN	
415V SWBD	Outgoing ACB motor	AI	W	Real power			RELAY LAN	
415V SWBD	Outgoing ACB motor	AI	R	Reactive Power			RELAY LAN	
415V SWBD	Outgoing ACB motor	AI		Power factor			RELAY LAN	
415V SWBD	Outgoing ACB motor	DI	S	Ready To Close			RELAY LAN	
415V SWBD	Outgoing ACB motor	DI	S	49T/50/50LR			RELAY LAN	
415V SWBD	Outgoing ACB motor	DI	S	Earth Fault			RELAY LAN	
415V SWBD	Outgoing ACB motor	DI	S	Unbalance			RELAY LAN	
415V SWBD	Outgoing ACB motor	DI	S	Under voltage Trip			RELAY LAN	
415V SWBD	Outgoing ACB motor	DI	S	Re- Acceleration			RELAY LAN	
415V SWBD	Outgoing ACB motor	DI	S	Reverse Blocking activated			RELAY LAN	
415V SWBD	Outgoing ACB motor	DI	S	Process Trip	Operated	Reset	RELAY LAN	
415V SWBD	Outgoing ACB motor	DI	S	CB in service & Closed	Closed	Not closed	Hardwired	
415V SWBD	Outgoing ACB motor	DI	S	CB in service & Open	Open	Not open	Hardwired	
415V SWBD	Outgoing ACB motor	DI	S	Motor Trip from Process	Operated=1		Hardwired	
415V SWBD	Outgoing ACB motor	DO	C	Trip from ECS	Activated	Reset	Hardwired	
415V SWBD	Outgoing ACB motor	DO	C	Close Inhibit (From ECS)	Operated	Reset	Hardwired	
415V SWBD	Outgoing ACB motor	DI	D	Relay 86	Operated	Reset	Hardwired	
UPS System	UPS System	DI	D	UPS Charger - 1/1	Failure	Normal	Hardwired	
UPS System	UPS System	DI	D	UPS Inverter - 1/1	Failure	Normal	Hardwired	
UPS System	UPS System	DI	S	UPS load on Invertor - 1/1	Operated	Reset	Hardwired	
UPS System	UPS System	DI	D	UPS Fan Failure - 1/1	Fault	Normal	Hardwired	
UPS System	UPS System	DI	D	UPS Fault - 1/1	Fault	Normal	Hardwired	
UPS System	UPS System	AI	A	UPS Current - 1/1			Hardwired	4-20mA through transducers in UPS
UPS System	UPS System	AI	V	UPS Voltage - 1/1			Hardwired	
UPS System	UPS System	DI	D	UPS Charger - 1/2	Failure	Normal	Hardwired	
UPS System	UPS System	DI	D	UPS Inverter - 1/2	Failure	Normal	Hardwired	
UPS System	UPS System	DI	S	UPS load on Invertor - 1/2	Operated	Reset	Hardwired	
UPS	UPS System	DI	D	UPS Fan	Fault	Normal	Hardwired	

System				Failure - 1/2				
UPS System	UPS System	DI	D	UPS Fault – 1/2	Fault	Normal	Hardwired	
UPS System	UPS System	AI	A	UPS Current – 1/2			Hardwired	4-20mA through transducers in UPS
UPS System	UPS System	AI	V	UPS Voltage – 1/2			Hardwired	
UPS System	UPS System	DI	S	UPS load on bypass supply – 1	Operated	Reset	Hardwired	
UPS System	UPS System	DI	D	UPS Battery – 1	Discharged	Normal	Hardwired	
UPS System	UPS System	DI	D	UPS Battery – 1	Isolated	Normal	Hardwired	
UPS System	UPS System	DI	D	UPS Battery Bank Monitoring System Alarm – 1	Operated	Reset	Hardwired	
UPS System	UPS System	DI	D	UPS Charger – 2/1	Failure	Normal	Hardwired	
UPS System	UPS System	DI	D	UPS Inverter – 2/1	Failure	Normal	Hardwired	
UPS System	UPS System	DI	S	UPS load on Inverter – 2/1	Operated	Reset	Hardwired	
UPS System	UPS System	DI	D	UPS Fan Failure - 2/1	Fault	Normal	Hardwired	
UPS System	UPS System	DI	D	UPS Fault – 2/1	Fault	Normal	Hardwired	
UPS System	UPS System	AI	A	UPS Current – 2/1			Hardwired	4-20mA through transducers in UPS
UPS System	UPS System	AI	V	UPS Voltage – 2/1			Hardwired	
UPS System	UPS System	DI	D	UPS Charger – 2/2	Failure	Normal	Hardwired	
UPS System	UPS System	DI	D	UPS Inverter – 2/2	Failure	Normal	Hardwired	
UPS System	UPS System	DI	S	UPS load on Inverter – 2/2	Operated	Reset	Hardwired	
UPS System	UPS System	DI	D	UPS Fan Failure – 2/2	Fault	Normal	Hardwired	
UPS System	UPS System	DI	D	UPS Fault – 2/2	Fault	Normal	Hardwired	
UPS System	UPS System	AI	A	UPS Current – 2/2			Hardwired	4-20mA through transducers in UPS
UPS System	UPS System	AI	V	UPS Voltage – 2/2			Hardwired	
UPS System	UPS System	DI	S	UPS load on bypass supply – 2	Operated	Reset	Hardwired	
UPS System	UPS System	DI	D	UPS Battery – 2	Discharged	Normal	Hardwired	
UPS System	UPS System	DI	D	UPS Battery – 2	Isolated	Normal	Hardwired	
UPS System	UPS System	DI	D	UPS Battery Bank Monitoring System Alarm – 2	Operated	Reset	Hardwired	
DC System	DC System	DI	D	DC supply Charger – 1	Failure	Normal	Hardwired	
DC System	DC System	DI	D	Battery discharged – 1	Discharged	Charged	Hardwired	
DC System	DC System	DI	D	Battery set Isolated – 1	Isolated	Connected	Hardwired	

DC System	DC System	DI	D	Charger Boost Charging – 1	Boost charging	Float Charging	Hardwired	
DC System	DC System	DI	D	DC Battery Bank Monitoring System Alarm – 1	Operated	Reset	Hardwired	
DC System	DC System	DI	D	DC Earth Fault relay DCDB Bus – 1	Failure	Normal	Hardwired	
DC System	DC System	DI	D	DC supply Charger – 2	Failure	Normal	Hardwired	
DC System	DC System	DI	D	Battery discharged – 2	Discharged	Charged	Hardwired	
DC System	DC System	DI	D	Battery set Isolated – 2	Isolated	Connected	Hardwired	
DC System	DC System	DI	D	Charger Boost Charging – 2	Boost charging	Float Charging	Hardwired	
DC System	DC System	DI	D	DC Battery Bank Monitoring System Alarm – 2	Operated	Reset	Hardwired	
DC System	DC System	DI	D	DC Earth Fault relay DCDB Bus – 2	Failure	Normal	Hardwired	
Distribution Transformer	Distribution Transformer	AI	MEASURING	Oil Temperature			HARDWIRED	4-20mA THROUGH TRAFO MBOX
Distribution Transformer	Distribution Transformer	AI	MEASURING	Winding Temperature			HARDWIRED	
MISC.	SOLAR PV	DI	D	Building Solar PV System Common Alarm	Operated	Reset	Hardwired	
MISC.	SOLAR PV	AI	A	R phase current			Serial	
MISC.	SOLAR PV	AI	A	Y phase current			Serial	
MISC.	SOLAR PV	AI	A	B phase current			Serial	
MISC.	SOLAR PV	AI	W	3-Phase Real Power			Serial	
MISC.	SOLAR PV	AI	R	3-Phase Reactive Power			Serial	
MISC.	MISCELLANEOUS	DO	COMMAND	Lighting feeder ' ON'	Activated	Reset	HARDWIRED	
MISC.	MISCELLANEOUS	DO	COMMAND	Lighting feeder ' OFF'	Activated	Reset	HARDWIRED	
MISC.	MISCELLANEOUS	DO	COMMAND	Load Shedding	Operated	Reset	HARDWIRED	
MISC.	MISCELLANEOUS	DI	STATUS	SAS Ethernet Switch Power Supply Fail	Failure	Normal	HARDWIRED	
MISC.	HVAC	DI	D	Building VAM System Common Alarm	Operated	Reset	Hardwired	

MISC.	HVAC	AI	T	Switchgear Hall / Battery Charger Room / UPS Room / VFD Room Temperature individually		Hardwired	4-20mA through transducers/ transmitter
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ECS I/O list for 6.6kV HV Switchgear in substations

Type	Pt type	Description	Set condition	Reset condition	Interface	Remarks
INCOMER FROM TRANSFORMER						
DI	S	Ready to close			RELAY LAN	
DI	S	Synch. OK			RELAY LAN	
DI	D	Over Current			RELAY LAN	
DI	D	Earth Fault			RELAY LAN	
DI	D	51G Operated			RELAY LAN	
DI	D	Under Voltage			RELAY LAN	
DI	D	Reverse BLOCKING activated			RELAY LAN	
DI	D	64R Operated			RELAY LAN	
AI	A	R phase current			RELAY LAN	
AI	A	Y phase current			RELAY LAN	
AI	A	B phase current			RELAY LAN	
AI	W	3-Phase Real Power			RELAY LAN	
AI	R	3-Phase Reactive Power			RELAY LAN	
AI		Power Factor			RELAY LAN	
AI		Frequency			RELAY LAN	
DI	S	CB in service &	Closed	Not closed	HARDWIRED	
DI	S	CB in service &	Open	Not open	HARDWIRED	
DI	D	Relay 86	Operated	Reset	HARDWIRED	
DI	D	Relay 95	Operated	Reset	HARDWIRED	
DI	D	Trip on under voltage	Activated	Reset	RELAY LAN	
DI	D	Numerical Relays	Unhealthy	Healthy	RELAY LAN	
DO	C	Trip from ECS	Activated	Reset	HARDWIRED	
DO	C	Close Inhibit (From ECS)	Operated	Reset	HARDWIRED	
DI	D	Trafo Trouble Alarm (Buch., OTI,WTI)			RELAY LAN	
DI	D	Trafo Trouble Trip (Buch., OTI,WTI)			RELAY LAN	
AI	T	Oil Temperature			HARDWIRED	4-20mA through transducers in Trafo MB
AI	T	Winding Temperature			HARDWIRED	
DI	D	Transformer Differential	Operated=1		RELAY LAN	87T
DI	D	Over Temperature monitoring system	Operated	Reset	HARDWIRED	
INCOMER FROM ANOTHER SWITCHBOARD						

Type	Pt type	Description	Set condition	Reset condition	Interface	Remarks
AI	A	R phase current			RELAY LAN	
AI	A	Y phase current			RELAY LAN	
AI	A	B phase current			RELAY LAN	
AI	W	3-Phase Real Power			RELAY LAN	
AI	R	3-Phase Reactive Power			RELAY LAN	
AI		Power Factor			RELAY LAN	
AI		Frequency			RELAY LAN	
DI	S	CB in service &	Closed	Not closed	HARDWIRED	
DI	S	CB in service &	Open	Not open	HARDWIRED	
DI	D	Relay 86	Operated	Reset	HARDWIRED	
DI	D	Relay 95	Operated	Reset	HARDWIRED	
DI	D	Trip on undervoltage	Activated	Reset	RELAY LAN	
DI	D	Numerical Relays	Unhealthy	Healthy	RELAY LAN	
DO	C	Trip from ECS	Activated	Reset	HARDWIRED	
DO	C	Close Inhibit (From ECS)	Operated	Reset	HARDWIRED	
DI	D	Feeder Differential	Operated=1		RELAY LAN	87F
DI	D	Over Temperature monitoring system	Operated	Reset	HARDWIRED	
LINE PT						
AI	V	R-Y Line Voltage			RELAY LAN	
AI	V	Y-B Line Voltage			RELAY LAN	
AI	V	R-B Line Voltage			RELAY LAN	
DI	D	Line PT Secondary MCB	Tripped=1		HARDWIRED	
BUS COUPLER						
AI	A	R phase current			RELAY LAN	
AI	A	Y phase current			RELAY LAN	
AI	A	B phase current			RELAY LAN	
AI	W	3-Phase Real Power (Bi-directional)			RELAY LAN	
AI	R	3-Phase Reactive Power			RELAY LAN	
AI		Power Factor			RELAY LAN	
DI	S	CB in service &	Closed	Not closed	HARDWIRED	
DI	S	CB in service &	Open	Not open	HARDWIRED	
DI	D	Relay 86	Operated	Reset	HARDWIRED	
DI	D	Relay 95	Operated	Reset	HARDWIRED	
DI	D	Trip on undervoltage	Activated	Reset	RELAY LAN	
DI	D	Numerical Relays	Unhealthy	Healthy	RELAY LAN	
DO	C	Trip from ECS	Activated	Reset	HARDWIRED	
DO	C	Close Inhibit (From ECS)	Operated	Reset	HARDWIRED	
DI	D	Auto-changeover	Blocked	Not blocked	HARDWIRED	
DI	S	Switchboard (A-I-M selector switch)	Auto		HARDWIRED	

Type	Pt type	Description	Set condition	Reset condition	Interface	Remarks
DI	S	Switchboard (A-I-M selector switch)	Independent		HARDWIRED	
DI	S	Switchboard (A-I-M selector switch)	Manual		HARDWIRED	
DI	D	AC control supply #1	Failed	Healthy	HARDWIRED	
DI	D	AC control supply #2	Failed	Healthy	HARDWIRED	
DI	D	DC control supply #1	Failed	Healthy	HARDWIRED	
DI	D	DC control supply #2	Failed	Healthy	HARDWIRED	
DI	S	Ready to close			RELAY LAN	
DI	S	Synch. OK			RELAY LAN	
DI	D	Over Current / Earth Fault			RELAY LAN	
DI	D	Auto-changeover	Blocked	Not blocked	RELAY LAN	
DI	S	I/C-1 Under Voltage			RELAY LAN	
DI	S	I/C-2 Under Voltage			RELAY LAN	
DI	D	Reverse BLOCKING activated			RELAY LAN	
OUTGOING TRANSFORMER FEEDER						
AI	A	R phase current			RELAY LAN	
AI	A	Y phase current			RELAY LAN	
AI	A	B phase current			RELAY LAN	
AI	W	3-Phase Real Power			RELAY LAN	
AI	R	3-Phase Reactive Power			RELAY LAN	
AI		Power Factor			RELAY LAN	
AI		Frequency			RELAY LAN	
DI	S	CB in service &	Closed	Not closed	HARDWIRED	
DI	S	CB in service &	Open	Not open	HARDWIRED	
DI	D	Relay 86	Operated	Reset	HARDWIRED	
DI	D	Relay 95	Operated	Reset	HARDWIRED	
DI	D	Trip on undervoltage	Activated	Reset	RELAY LAN	
DI	D	Numerical Relay	Unhealthy	Healthy	RELAY LAN	
DO	C	Trip from ECS	Activated	Reset	HARDWIRED	
DO	C	Close Inhibit (From ECS)	Operated	Reset	HARDWIRED	
DI	D	Transformer Trouble	Operated=1		RELAY LAN	63TX, 51G, 64R
DO	C	Outgoing trafo fdr re-closing	Activated	Reset	HARDWIRED	
DI	S	Ready to close			RELAY LAN	
DI	D	Over Current			RELAY LAN	
DI	D	Earth Fault			RELAY LAN	
DI	D	Trafo Trouble Alarm (Buch., OTI,WTI)			RELAY LAN	
DI	D	Trafo Trouble Trip (Buch., OTI,WTI)			RELAY LAN	
DI	D	64R from Downstream			RELAY LAN	

Type	Pt type	Description	Set condition	Reset condition	Interface	Remarks
DI	D	Reverse BLOCKING activated			RELAY LAN	
DI	D	51G from Downstream			RELAY LAN	
OUTGOING PLANT FEEDER						
AI	A	R phase current			RELAY LAN	
AI	A	Y phase current			RELAY LAN	
AI	A	B phase current			RELAY LAN	
AI	W	3-Phase Real Power			RELAY LAN	
AI	R	3-Phase Reactive Power			RELAY LAN	
AI		Power Factor			RELAY LAN	
DI	S	CB in service &	Closed	Not closed	HARDWIRED	
DI	S	CB in service &	Open	Not open	HARDWIRED	
DI	D	Relay 86	Operated	Reset	HARDWIRED	
DI	D	Relay 95	Operated	Reset	HARDWIRED	
DI	D	Trip on under voltage	Activated	Reset	RELAY LAN	
DI	D	Numerical Relays	Unhealthy	Healthy	RELAY LAN	
DO	C	Trip from ECS	Activated	Reset	HARDWIRED	
DI	D	Feeder Differential	Operated=1		RELAY LAN	
DI	S	Ready to close			RELAY LAN	
DI	D	Over Current			RELAY LAN	
DI	D	Earth Fault			RELAY LAN	
DI	D	Reverse BLOCKING activated			RELAY LAN	
DI	D	Line Differential Operated			RELAY LAN	
OUTGOING CAPACITOR FEEDER						
AI	A	R phase current			RELAY LAN	
AI	A	Y phase current			RELAY LAN	
AI	A	B phase current			RELAY LAN	
AI	R	3-Phase Reactive Power			RELAY LAN	
AI	R	3-Phase Reactive Power			RELAY LAN	
AI		Power Factor			RELAY LAN	
DI	S	CB in service &	Closed	Not closed	HARDWIRED	
DI	S	CB in service &	Open	Not open	HARDWIRED	
DI	D	Relay 86	Operated	Reset	HARDWIRED	
DI	D	Relay 95	Operated	Reset	HARDWIRED	
DI	D	Trip on under voltage	Activated	Reset	RELAY LAN	
DI	D	Numerical Relay	Unhealthy	Healthy	RELAY LAN	
DI	S	Local / ECS Selector Switch in	LOCAL	Not_Local	HARDWIRED	
DI	S	Local / ECS Selector Switch in	ECS	Not_ECS	HARDWIRED	
DI	S	Ready to close			RELAY LAN	
DI	D	Over Current			RELAY LAN	

Type	Pt type	Description	Set condition	Reset condition	Interface	Remarks
DI	D	Earth Fault			RELAY LAN	
DI	D	Over Voltage			RELAY LAN	
DI	D	Under Voltage			RELAY LAN	
DI	D	Reverse BLOCKING activated			RELAY LAN	
OUTGOING MOTOR FEEDER						
DI	D	Motor Differential Operated			RELAY LAN	Applicable for motors $\geq 1500\text{kW}$
AI	A	R phase current			RELAY LAN	
AI	A	Y phase current			RELAY LAN	
AI	A	B phase current			RELAY LAN	
AI	W	3-Phase Real Power			RELAY LAN	
AI	R	3-Phase Reactive Power			RELAY LAN	
AI		Power Factor			RELAY LAN	
DI	S	CB in service &	Closed	Not closed	HARDWIRED	
DI	S	CB in service &	Open	Not open	HARDWIRED	
DI	D	Relay 86	Operated	Reset	HARDWIRED	
DI	D	Relay 95	Operated	Reset	HARDWIRED	
DI	D	Trip on under voltage	Activated	Reset	RELAY LAN	
DI	D	Numerical Relays	Unhealthy	Healthy	RELAY LAN	
DO	C	Trip from ECS	Activated	Reset	HARDWIRED	
DO	C	Close Inhibit (From ECS)	Operated	Reset	HARDWIRED	
DI	D	Motor Trip from Process	Operated=1		HARDWIRED	
DI	S	Ready to close			RELAY LAN	
DI	D	49T/50/50LR			RELAY LAN	
DI	D	Earth Fault			RELAY LAN	
DI	D	Unbalance Trip			RELAY LAN	
DI	D	Under Voltage Trip			RELAY LAN	
DI	S	Re-Acceleration			RELAY LAN	
DI	D	Reverse BLOCKING activated			RELAY LAN	
DI	D	Process Trip			RELAY LAN	
BUS PT						
AI	V	R-Y Line Voltage			RELAY LAN	
AI	V	Y-B Line Voltage			RELAY LAN	
AI	V	R-B Line Voltage			RELAY LAN	
DI	D	Bus PT Secondary MCB	Tripped=1		HARDWIRED	
DI	S	Dead Bus (<40%)			RELAY LAN	
DI	D	Under Voltage (<80%)			RELAY LAN	
DI	D	BPT not in Service / PT MCB Unhealthy			RELAY LAN	

Type	Pt type	Description	Set condition	Reset condition	Interface	Remarks
DI	D	UF & df/dt Signal	Operated	Reset	Hardwired (4 Nos)	
OUTGOING VFD TRANSFORMER FEEDER						
AI	A	R phase current			RELAY LAN	
AI	A	Y phase current			RELAY LAN	
AI	A	B phase current			RELAY LAN	
AI	W	3-Phase Real Power			RELAY LAN	
AI	R	3-Phase Reactive Power			RELAY LAN	
AI		Power Factor			RELAY LAN	
DI	S	CB in service &	Closed	Not closed	HARDWIRED	
DI	S	CB in service &	Open	Not open	HARDWIRED	
DI	D	Relay 86	Operated	Reset	HARDWIRED	
DI	D	Relay 95	Operated	Reset	HARDWIRED	
DI	D	Trip on under voltage	Activated	Reset	RELAY LAN	
DI	D	Numerical Relay	Unhealthy	Healthy	RELAY LAN	
DO	C	Trip from ECS	Activated	Reset	HARDWIRED	
DO	C	Close Inhibit (From ECS)	Operated	Reset	HARDWIRED	
DI	D	Transformer Trouble	Operated=1		RELAY LAN	63TX, 51G, 64R
DI	S	Ready to close			RELAY LAN	
DI	D	Over Current			RELAY LAN	
DI	D	Earth Fault			RELAY LAN	
DI	D	Trafo Trouble Alarm (Buch., OTI, WTI)			RELAY LAN	
DI	D	Trafo Trouble Trip (Buch., OTI, WTI)			RELAY LAN	
DI	D	Trip from VFD			RELAY LAN	
DI	D	Reverse BLOCKING activated			RELAY LAN	
VFD TIE FEEDER						
DI	S	CB in service &	Closed	Not closed	HARDWIRED	
DI	S	CB in service &	Open	Not open	HARDWIRED	
DI	D	Trip Circuit Supervision	Unhealthy	Healthy	HARDWIRED	

ECS I/O list for 415V PCC/EPCC/MCC in substations

Typ	Pt type	Description	Set condition	Reset condition	Interface	
Central Lighting Control (For each LDB/ELDB)						
DO	C	Lighting feeder ' ON'	Activated	Reset	Hardwired	
DO	C	Lighting feeder ' OFF'	Activated	Reset	Hardwired	
VFD System (Non Redundant)						
Di	S	VFD Running			Hardwired	
DI	S	VFD Trip			Hardwired	

Typ	Pt type	Description	Set condition	Reset condition	Interface	
AI	A	VFD R phase current			Serial	
AI	A	VFD Y phase current			Serial	
AI	A	VFD B phase current			Serial	
AI	W	VFD 3-Phase Real Power			Serial	
AI	R	VFD 3-Phase Reactive Power			Serial	
AI		VFD Speed			Serial	
AI	A	Excitation Current Channel-1 (For Sync Motor with excitation system)			Serial	
AI	A	Excitation Current Channel-2 (For Sync Motor with excitation system)			Serial	
VFD System (Redundant)						
DI	S	VFD Running - 1			Hardwired	
DI	S	VFD Trip - 1			Hardwired	
DI	S	VFD Ready to start - 1			Hardwired	
DI	S	VFD Running – 2			Hardwired	
DI	S	VFD Trip – 2			Hardwired	
DI	S	VFD Ready to start – 2			Hardwired	
DI	D	PLC Status – 1	Unhealthy	Healthy	Hardwired	
DI	D	PLC Status – 2	Unhealthy	Healthy	Hardwired	
AI	A	Running VFD R phase current			Serial	
AI	A	Running VFD Y phase current			Serial	
AI	A	Running VFD B phase current			Serial	
AI	W	Running VFD 3-Phase Real Power			Serial	
AI	R	Running VFD 3-Phase Reactive Power			Serial	
AI		Running VFD Speed			Serial	
AI	A	Excitation Current Channel-1 (For Sync Motor with excitation system)			Serial	
AI	A	Excitation Current Channel-2 (For Sync Motor with excitation system)			Serial	
Building HVAC System						
DI	D	Building VAM System Common Alarm	Operated	Reset	Hardwired	
AI	T	Switchgear Hall/Battery Charger Room/UPS			Hardwired 4-20mA	

Typ	Pt type	Description	Set condition	Reset condition	Interface	
		Room/VFD Room Temperature			through transducers/transmitter	
Common Signals						
DO	C	Load Shedding	Operated	Reset	Hardwired	
DO	S	Load Shedding operated	Operated	Reset	Serial Interface signal for DCS	

Notes

- 1.0 Acquisition of input/output (I/O) signals as hardwired or software:
 - a) All numerical relays shall be connected to ECS-RTU. ECS shall acquire relay and metering status I/O signals of the relays. These I/O signals have been indicated as "relay and metering LAN" in the typical I/O list above.
 - b) All other I/Os shall be acquired hardwired and have been indicated as "hardwired" in the typical I/O list above. All hardwired signals shall be wired and terminated in respective panels.
 - c) In case any of these data cannot be acquired over the relay LAN, these signals have to be provided as hardwired. For requirement of numerical relays, refer Electrical part of contract document.
- 2.0 This I/O list is indicative only. Any other I/O required for meeting the contract requirements shall be identified and provided by CONTRACTOR.
- 3.0 Transformer oil temperature and transformer winding temperature shall be acquired hardwired from 66kV power transformers only. These I/Os shall be acquired as a 4-20 mA signal from the transformer.

Guidelines for ECS I/O Interface Design

Analogue Input Signals

Signal transducers for hard-wired analogue inputs shall have accuracy class 0.1 for the range 0-120%. All transducers shall be externally-powered types. External power supply shall be 230V AC UPS.

For all measurements for I, V, MW, MVAR, Hz, obtained on the relay and metering LAN, maximum possible accuracy shall be ensured

Digital Input Signals

Alarm (D)

Alarm is a signal which requires operator to be alerted such as VT circuit MCB (closed, open), relays 86 & 95 (operated, reset), auto-changeover (blocked, not blocked), DC control supply (healthy, failed), line voltage (unhealthy, healthy), bus voltage (unhealthy, healthy), motor trip from process, under-voltage trip. This shall be hardwired / on relay LAN as specified.

For hardwired signal, potential free contacts of rating 1 A, 110V DC or 240 V AC, make to alarm (NO) preferred. CONTRACTOR shall specifically indicate if NC contact is being provided in place of NO contact.

Generally a hardwired alarm point is put under "sequence of event" monitoring

Status (S)

For hardwired signal, potential free contacts of rating 1 A, 110V DC or

240 V AC, make to alarm (NO) required

Digital Output Signals

Command (C)

Hardwired through potential free changeover type contact of interposing relay, contact rating 5 A, 240 V AC and/or 4 A, 110V DC. Coil rating shall be 24 V DC

ANNEXURE-I TO MR TOPSHEET (B957-300-KA-MR-5030)

Note-1: Bidders shall provide mandatory spares as listed in Mandatory spare parts list (Doc. No. B957-300-80-42-SL-5030) forming part of inquiry document.

Note-2: Bidders are required to submit a list of commissioning spares (as recommended by them) along with the offer, which shall be supplied along with the compressor package. Any spares consumed over and above the spares supplied along with the compressor package, shall be furnished by the Compressor Bidders at the time of commissioning without any time/cost implication to the purchaser. Any un-used spare(s) shall be retained at purchaser's end without any cost implication. The prices of the same shall be included in base price of compressor package.

Note-3: Bidders are required to submit a list of special tools and tackles (as recommended by them) along with the offer which shall be supplied along with the compressor package. If no special tools/tackles are required for normal operation and maintenance of compressor package, the same shall be categorically indicated in the bid. The prices of the same shall be included in base price of compressor package.

Note-4: Bidders shall provide quotation of two years normal operation and maintenance spares for each compressor package. The same shall at-least contain the spares as specified in Document no. B957-300-80-42-OM-5030 forming part of Inquiry.

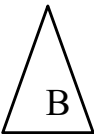
Note-5: The Bidder shall provide his services for supervision during erection, commissioning & field trial testing of each compressor package. Electrical & Instrumentation sub-Bidder's engineers shall also be present along with Bidder's erection, commissioning & testing engineers, as required. For each compressor package, the supervisory cost of **300 man-days** shall be considered for the purpose of commercial comparison. The bidder shall indicate the cost of providing the above services on per diem basis. Per-diem rates, as quoted by the bidder, shall be the basis of payment, however the actual payment for supervision services shall be based on actual man-days consumed at site.

Note-6: The successful bidder shall share the best maintenance practices with the Purchaser and shall conduct on-site training to the Purchaser team to familiarize on operation & maintenance aspects of the complete compressor package(s) considering a total of **15 days at site**. Bidder shall indicate in his proposal the cost for providing the above services on per-diem basis for site. Payment shall be done on the basis of actual days consumed. Also refer Electrical and Instrumentation specifications for customer training purposes.

Note-7: Bidder shall provide the lumpsum quotation of Comprehensive Post warranty Annual Maintenance contract for VFDs (as applicable for the package) in price breakup as below:

S. No.	Item description	Quoted price
1.	Comprehensive Post warranty Annual Maintenance Contract (PWAMC) for Main VFD(as applicable) for a period of 5 years after completion of guarantee period	
a.	PWAMC for VFD-1 for 1st year	
b.	PWAMC for VFD-1 for 2 nd year	
c.	PWAMC for VFD-1 for 3 rd year	
d.	PWAMC for VFD-1 for 4 th year	
e.	PWAMC for VFD-1 for 5 th year	

PWAMC is applicable for VCB also.



ANNEXURE-I TO MR TOPSHEET (B957-300-KA-MR-5030)

Quotation shall be provided on as applicable basis. Bidder to indicate "Not applicable" against configuration which are not applicable to proposed option.

Note-8: Bidder shall provide the quotation of carry out the 3-D modelling of complete compressor package as per Piping specifications forming part of Inquiry.

Note-9: The bidder shall participate during HAZOP study of the compressor package. The bidder shall indicate the cost of providing the above services on per diem basis considering **Two days / compressor package**. Per-diem rates, as quoted by the bidder, shall be the basis of payment, however the actual payment for HAZOP participation shall be based on actual man-days participated by bidder. Any suggestions/modifications raised during the HAZOP review shall be implemented by Bidder without any time/cost implication to the purchaser. Also refer to Job specifications.