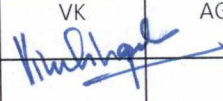


	BHARAT HEAVY ELECTRICALS LIMITED TRANSMISSION BUSINESS ENGINEERING MANAGEMENT NOIDA					
	DOCUMENT NO.	TB-411-316-004	REV 00	PREPARED	CHECKED	APPROVED
	TYPE OF DOC.	TECHNICAL SPECIFICATION	NAME	DKS	VK	AG
	TITLE 33kV AIS Local Isolation Breaker Panel with its Accessories <i>(Suitable for highly corrosive environment of process/ petrochemical industry)</i>		SIGN			
			DATE	10.04.2020	10.04.2020	10.04.2020
			GROUP	TBEM		
			WO NO.	I19TB00003 REV00		
	CUSTOMER	Indian Oil Corporation Limited (IOCL)				
	CONSULTANT	TATA Consulting Engineers Limited (TCE)				
	PROJECT	LSTK job for ISBL work of 220KV Grid Power Import at IOCL, Panipat Refinery				
LOA. NO.	RPRC182491/26286965 dtd. 24.01.2020					
WO. No.	26286965 dtd. 24.01.20120					
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	Remarks: It is to be noted that data and details of Guaranteed Technical Particulars (GTP) shall not be reviewed during Technical Evaluation/ Review, hence compliance of Guaranteed Technical Particulars (GTP) in line with Technical Specification shall be deemed to under complete compliance of bidder.					
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SECTION 1:

SCOPE, PROJECT SPECIFIC TECHNICAL REQUIREMENTS & BILL OF QUANTITIES

1. Scope

The electrical scope of work under this requisition shall include but not be limited to design, engineering, manufacturing, inspection including third party inspection and testing at manufacturer's works before supply, proper packing and delivery to project site, supervision of installation, testing at site & commissioning complete with all materials, support base structures at designated locations including hardware and anchoring bolts, accessories, commissioning spares & maintenance spares, consumables, special spanners, tools & tackles, any specific required supervision of ancillary services & mandatory spares etc. including training of BHEL/ Customer personnel, if required at site for the equipment (33kV AIS Local Isolation Breaker Panel with its Accessories) complete in all respects for efficient & trouble-free working mentioned under this specification.

The draw out type High Voltage standalone switchboard module for 33 KV system, incorporating Vacuum circuit breakers, CT, PT, relays etc complete in all respects. The purpose of standalone panel is to use as local isolation breaker (LIB) with demarcation of transformer differential and cable differential zone with due overlapping. The LIB shall have all required hardware for buildup of transformer differential protection up-to LIB and provision of Cable differential, Transformer REF, SEF protection accordingly and as per project requirement.

This section covers the specific technical requirements of the equipment (33kV AIS Local Isolation Breaker Panel with its Accessories). This constitutes minimum technical parameters for the above item as specified by the BHEL/ Customer. The offered equipment (33kV AIS Local Isolation Breaker Panel with its Accessories) shall also comply with the Section-3 (Project Details and General technical requirements for all equipment under the Project) and Section-2 (Equipment Specification Under Scope of Supplies) of this specification.

The specification comprises of following sections:

Section-1	:	Scope, Project Specific Technical Requirements & Bill of Quantities
Section-2	:	Equipment Specification under scope of Supplies
Section-3	:	Project Details & General Technical Requirements (For All Equipment under the Project)
Section-4	:	Annexures
		Annexure A- Compliance Certificate
		Annexure B- Schedule of Technical Deviations
		Annexure C- Guaranteed Technical Particulars
		Annexure D- Technical Checklist

The following order of priority shall be followed. In case of conflict between requirements specified in various documents, the more stringent one shall be followed. BHEL/Customer concurrence shall, however, be obtained before taking a final decision in such matters.

1. Statutory Regulations

In particular, the latest version of the following statutory regulations, as applicable, shall be followed for system,

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- o Indian Electricity Act
 - o CEA regulations
 - o The Factory Act
 - o The Petroleum Rules
 - o OISD standards
 - o Requirements of other statutory bodies as applicable, e.g. CEA, CCE, LPCB.
2. Section-1
 3. Section-2
 4. Section-3
 5. Codes & Standards

Bidder shall furnish list of conflicts/ ambiguities/ deviations, if any, along with their technical offer and also furnish the basis that is considered for submitting technical offer. BHEL/ Customer will resolve listed conflicts prior to award. In case of ambiguity, bidder shall inform BHEL/ Customer of their interpretation. In case bidder fails to convey the same prior to award, BHEL/ Customer decision on interpretation shall be considered final if need arises during the execution. No additional cost or extra time on account of conflicts/ ambiguities/ deviations shall be admissible.

In general, no deviation from the requirements specified in various clauses of this specification shall be allowed and hence, a certificate to this effect shall have to be furnished along with the offer (Annexure-A), however bidder shall furnish list of conflicts/ ambiguities/ deviations (Annexure-B), if any. Any conflicts/ ambiguities/ deviations mentioned elsewhere in technical offer shall not be reviewed.

33kV Fault Current Limiter Panel with its Accessories is required for the following project:

Name of the Customer	:	Indian Oil Corporation Limited (IOCL)
Name of Consultant	:	Tata Consulting Engineers Limited
Name of Main Contractor	:	Bharat Heavy Electricals Limited
Name of the Project	:	LSTK job for ISBL work of 220KV Grid Power Import at IOCL, Panipat Refinery

The scope of supplies shall be as per commercial terms and conditions enclosed separately with the notice inviting tender/ enquiry.

2. Codes & Standards

1. Equipment (33kV AIS Local Isolation Breaker Panel with its Accessories) shall comply with the latest edition of the following standards as applicable, unless otherwise specified,
 - IS 5: Colors for ready mixed paints and enamels
 - IS 694: PVC-insulated cables for working voltages up to and including 1100 V
 - IS 1248: Direct acting indicating analogue electrical measuring instruments and their accessories
 - IS 2071: High Voltage Test Technique
 - IS 2544: Porcelain post-insulators for systems with nominal voltage greater than 1000V
 - IS 2705: Current transformers
 - IS 3156: Voltage transformers
 - IS 3231: Electrical relays for power system protection

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|----------------|--|
| IS 3427: | AC Metal enclosed switchgear and control gear for rated voltages above 1kV up to and including 52 kV |
| IS 3618: | Phosphate treatment of iron and steel for protection against corrosion |
| IS 5082: | Material data for aluminum bus bars |
| IS 5578: | Guide for marking of insulated conductors |
| IS 6005: | Code of practice of phosphating of iron and steel |
| IS 9920: | Switches and switch isolators for voltages above 1000 V |
| IS 9921: | AC disconnectors (isolators) and earthing switches for voltage above 1000V |
| IS 10601: | Dimensions of terminals of high voltage switchgear and control gear |
| IS 11353: | Guide for uniform system of marking and identification of conductors & apparatus terminals |
| IS 12661: | HV motor starters |
| IS 12729: | General requirements for switchgear and control gear for voltages exceeding 1000V |
| IS 13118: | General requirements for circuit breakers for voltages above 1000 V |
| IS 13703: | Low voltage fuses for voltages not exceeding 1000V ac or 1500V dc. |
| IS 9431: | Indoor post insulators of organic material for systems with nominal voltages greater than 1000 V up to and including 300 kV. |
| IS 722: | A.C. Electric Meters. |
| IS 3618: | Phosphate treatment of iron and steel for protection against corrosion. |
| IS 9385: | High Voltage fuses |
| IS 9046: | AC Contactors of voltage above 1000V up to & including 11000 V. |
| IS 694: | PVC insulated cables for working voltages up to & including 1100 V. |
| IS 6875: | Control switches and push buttons. |
| IEC 298: | AC Metal enclosed switchgear and control gear for rated voltages above 1kV and up to and including 52kV. |
| IEC 529: | Degree of protection provided by enclosures. |
| IEC 470: | HV alternating current contactors. |
| IEC 694: | Common specification for high voltage switchgear and control gear |
| IEC 62271-100: | High-voltage alternating-current circuit-breakers |
| IEC 2271-200: | AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV |
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.
 3. The equipment shall also conform to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.
 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.

3. Specific Technical Requirements

The equipment (33kV AIS Local Isolation Breaker Panel with its Accessories) shall be indoor, draw out type High Voltage standalone switchboard module for 33 KV system, incorporating Vacuum circuit breakers, CT, PT, relays etc. complete in all respect. The purpose of standalone panel is to use as local isolation breaker (LIB) with demarcation of transformer differential and cable differential zone with due overlapping. The LIB shall have all required hardware for buildup of

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transformer differential protection up-to LIB and provision of Cable differential, Transformer REF, SEF protection accordingly and as per project requirement. Each LIB shall be suitable for cable termination for both incoming and outgoing side suitable as per project requirement.

The Specific technical requirements for the equipment (33kV AIS Local Isolation Breaker Panel with its Accessories) shall be as follows,

Sl. No.	Technical Parameters	Unit	Particulars
1	Equipment		33kV AIS Local Isolation Breaker Panel with its Accessories
2	Type		Metal enclosed
3	Installation		Indoor
A	Meteorological data		
1.1	Maximum ambient temperature	°C	50
1.2	Minimum ambient temperature	°C	-5
1.3	Average ambient temperature	°C	35
1.4	Design ambient temperature	°C	45
2	Average no. of thunder storm days	Days	45
3.1	Maximum Relative humidity	%	95
3.2	Maximum Relative humidity	%	26
4	Average Annual Rain Fall	mm	900
5	Maximum Wind Pressure	Kg/ sqm	195
6	Maximum Altitude above Mean Sea Level	m	1000
7	Isoceraunic Level	Days/ Year	45
8	Seismic Level (Horizontal Acceleration)	Zone	4
9	Average no. of rainy day per Year	Days/ Year	120
B	System Parameters		
1	Nominal/ normal system voltage	kV	33kV + 6%
2	Maximum/ highest operating voltage	kV	36
3	Frequency	Hz	50±3%
4	Number of phases/ poles		Three
5	System Neutral earthing*		Solidly grounded
6	One-minute power frequency withstand voltage		
	- For type tests	kVrms	70
	- For routine tests	kVrms	70
7	1.2/ 50 microsecond impulse withstand voltage	kVp	170
8	Maximum system fault level including initial motor contribution	kVrms	31.5 for 1second
9	Short time rating for bus bars, circuit breakers, current transformers and switchgear assembly	kVrms	31.5 for 1second

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10	Dynamic withstand rating	kA	78.75kA or better
11	Control supply voltage *		
	- Trip and closing coils 220 V DC	Vdc	220V + 10%, -15%
	- Spring charging motor 220 V DC	Vdc	220V + 10%, -15%
	- Space heaters 240 V AC single phase with neutral solidly earthed	Vac	240 V + 6%, 1- phase, 50 Hz, single phase with neutral solidly earthed
C	Bus Bars		
1	Continuous current rating at 500C ambient	Amin	1500
2	Temper rise allowed above ambient	°C	40°C for plain joints 55°C for silver plated joints
D	Switchgear cubicle constructional requirements		
1	Color finish exterior & interior		As mentioned, elsewhere
2	Cable entry		Power cables and control cables- bottom
3	Busduct entry		Top
4	Earthing		GI strip
E	Circuit Breakers		
1	The circuit breakers current rating shall be selected from the load current as per project requirement which is at an ambient of 500C	Amin	1500
2	Short circuit breaker current	KArms	31.5 for 1second
	- AC component		As per IS:13118 or IEC:62271
3	Short circuit making current	kAp	78.75kAp or better
4	Operating duty		B-3 Min-MB-3 Min-MB
5	Total break time		Not more than 4 cycles
6	Total make time		Not more than 5 cycles
7	Operating mechanism		Motor wound spring charged stored energy type as per IEC-62271
F	Relays		
1	One-minute frequency	kVrms	2.0
G	Meters		
1	Accuracy class		1.0
2	One-minute power frequency	kVrms	2.0
H	Current Transformers		
1	Class of insulation		Class b or better
2	Rated output of each core		Adequate for the relays

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			and devices connected, but not less than fifteen (15) VA. Minimum VA requirement shall be mandatory.
3	Accuracy class		
	- Protection core		Class PS for differential and core balance CTs; 5P20 for other protection CT's
	-Measurement core		1.0
4	Minimum primary earth fault current to be detected by core balance current transformer	A	3.0
I	Voltage Transformers		
1	Rated voltage factor		1.2 continuous for all VTs and 1.8 for 8hrs for underground system
2	Class of insulation		Class b or better
3	Other parameters		
J	HV Fuses		
1	Voltage class	kV	33
2	Rupturing capacity	kAp	80
3	Rated current		As applicable
K	Transducers		As per section-2

- The equipment offered by the Bidder shall be complete in all respects including technical specification and project requirements.
- The Switchboards shall be metal enclosed cubicle type, suitable for indoor installation, floor - mounting and free - standing. The design for the total enclosure shall be dust-tight, damp-proof, vermin proof and totally enclosed offering degree of protection not less than IP4X.
- The switchgear cubicles shall be rigid and robust in design & construction. Panel Sheet used for fabrication shall be cold rolled steel or suitable metallurgy material. Cubicles shall be made from rigid welded structural frames made of structural steel or suitable material sections or of pressed / formed sheet of not less than 2 mm thickness. The design shall have to be type tested for full short circuit rating, internal arc resistance and ingress protection.
- The Internal Arc withstand shall be in the category IAC AFLR as per IEC62271-200 for 31.5 KA for 0.3 Sec or better. The bidder to offer the design of the panel in line with the Internal Arc compliance requirements only.
- The hot spot temperature for bus bars including joints at design ambient temperature shall not exceed the limits defined in IEC-62271 for normal operating conditions.
- The site installation, testing and commissioning of the system shall be done under the supervision of OEM.
- The proposed system shall be installed in SS-63 as an indoor installation. All required structural work specific to system shall be in the scope of the bidder including design and

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supply of all materials.

8. All kinds of structural works required for cabling associated with the system shall be in the scope of bidder including supply of materials.
9. Control & protection philosophy shall be as per section-2.
10. 33kV Local Isolation Circuit Breaker CT details as per attachment ANNEXURE- Details for 33kV LIB CT.
11. For each 33kV LIB, 2 Nos. Cable Differential Protection Relays (being supplied under a separate contract) shall be mounted on the respective LIB panels' LT compartments. Necessary space provisions shall be considered in the LIB panels. The actual dimension & arrangement of the Cable Differential Protection Relays to be incorporated in LIB panel GA drawing shall be furnished to successful bidder during detailed engineering.
12. CT positioning shall be on both sides of CB as per Key Protection Single Line Diagram attached.
13. The offered numerical relays and MFMs shall be compliant to/ shall have provisions for integration with IEC-61850 based SAS system (SAS being supplied under a separate contract).

4. Other General Requirements

The other general requirements for the equipment (33kV AIS Local Isolation Breaker Panel with its Accessories) with its Accessories shall be as follows,

1. Schedule
 - a. Bidder shall submit detailed bar chart indicating all the milestones from engineering till manufacturing/ testing, dispatch to site, supervision for installation, testing and commissioning.
 - b. Bidder to submit list of consumables with shelf life of less than one year. It shall be supplied before erection after clearance from BHEL/ Customer/ Consultant.
2. Office and Staff
 - a. Bidder shall also provide their standard recommendations for precautions to be taken during unloading and storage etc. for approval of BHEL/ Customer/ Consultant. Requirement of closed store, if any shall be taken care by bidder.
 - b. Office facilities & accommodation for bidder's staff along with conveyance, transportation of all special tools & plants, testing kits etc. shall be in bidder's scope.
3. Supervision for Site Installation, Testing & Commissioning
 - a. Bidder shall depute its qualified supervisor for installation, testing & commissioning of the equipment (33kV AIS Local Isolation Breaker Panel with its Accessories).
 - b. Bidder shall submit complete methodology for installation, testing & commissioning of the equipment (33kV AIS Local Isolation Breaker Panel with its Accessories) for further approval of BHEL/ Customer/ Consultant.
4. Bidder to note that the equipment (33kV AIS Local Isolation Breaker Panel with its Accessories) may be commissioned at different point of time, and hence bidder shall be required to deploy the resources multiple times at site in line with site requirement.
5. Bidder shall dispatch the consumables just before the start of the work at site and only after specific clearance from BHEL/ Customer.
6. Any special tools and tackles required to complete the cable installation, testing and commissioning etc. shall be included in the offer. However, general tools and tackles for installation of the equipment (33kV AIS Local Isolation Breaker Panel with its Accessories) shall be provided by BHEL.

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7. The bidder must fill up all the details required for offered item/s. Instead of indicating "refer drawing, or as per IS/IEC", the exact value/s must be filled in.

5. Bill of Quantities

Quantities for supply and services for the equipment (33kV AIS Local Isolation Breaker Panel with its Accessories) shall be as per Annexure- 33kV AIS Local Isolation Breaker Panel with its Accessories. However, any item/ service not appearing herein but required for completeness of the work is deemed to be included in bidder's scope.

6. Drawings / Documents required for Engineering Manufacturing Clearance

The drawings/ documents, as follows shall be used for providing engineering manufacturing clearance of the equipment (33kV AIS Local Isolation Breaker Panel with its Accessories) and furthermore, it shall be used for delay analysis, if any from bidder. The schedule for submission and resubmission shall be in line with details provided in section-3.

1	33kV LIB Panel- Single Line Diagram, GA Drawing & Schematics with Guaranteed Technical particulars
2	33kV LIB Panel- Type Test Reports
3	33kV LIB Panel- Quality Assurance Plan & Inspection Test Schedule

7. Type Testing

Bidder shall ensure that the equipment (33kV AIS Local Isolation Breaker Panel with its Accessories), being procured shall be of proven design and should have valid type test certificates as per specified in IS/ IEC standards (amended up to date) at any ISO/IEC accredited laboratories.

Type test certificates shall not be more than five (5) years old as on original scheduled date of technical bid opening. In those cases, where type test certificates are more than five (5) years old from original scheduled date of technical bid opening, bidder shall carry out the type tests at any ISO/ IEC accredited laboratories prior to dispatch of equipment with no commercial implication to BHEL/Customer.

In case any of Type tests have not been conducted on the offered design or there has been a change in the design after the type tests. The requisite tests shall be conducted by bidder on the offered design without any extra cost and delivery impact to BHEL/ Customer.

8. Quality Plan

The successful bidder shall submit Quality Assurance Plan in line with reference QAP attached in Section-2 for the equipment (33kV AIS Local Isolation Breaker Panel with its Accessories), etc. with in-process inspection methods, tests, records, etc. for BHEL/ Customer approval. Customer hold points will also be included in the plan, which shall be mutually agreed by the BHEL/ Customer. In case bidder has reference Quality Assurance Plan agreed with BHEL/ Customer, same shall be submitted for specific project to BHEL/ Customer approval. There shall be no commercial implication to BHEL/ Customer on account of Quality Plan approval.

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Superior quality control system shall be adopted to assure high product quality. Raw materials of the best commercial grade quality and high reliability shall be used in the manufacture of the equipment (33kV AIS Local Isolation Breaker Panel with its Accessories). All materials shall be procured, manufactured, inspected and tested by vendor/ sub-vendor as per approved quality plan. The supplier shall perform all tests necessary to ensure that the material and workmanship conform to the relevant standards and comply with the requirements of the specification. Charges for all tests for the equipment (33kV AIS Local Isolation Breaker Panel with its Accessories) shall be deemed to be included in bidder's scope.

9. Inspection & Testing

1. The equipment (33kV AIS Local Isolation Breaker Panel with its Accessories) shall be subject to inspection by BHEL/ Customer or authorized representative at bidder/manufacturers' works. Hence, Bidder shall furnish all necessary information concerning the supply to BHEL/ Customer.
2. The inspector shall have free access to the manufacturer's/ supplier's works for the purpose of inspecting the process of manufacture in all its stages and he will have the power to reject any material, which appears to him to be of unsuitable description or of unsatisfactory quality.
3. Bidder shall give at least 2 weeks' advance notice to BHEL/ Customer, regarding the date of testing to enable him or his representative to witness the tests. All the tests must be done as per the approved QAP.
1. Bidder shall ensure that the hazardous area equipment provided shall have the necessary test certificates and valid CCOE approval certificates.
2. Bidder shall also furnish factory acceptance test (FAT) for BHEL/ customer approval in line with specific requirements mentioned in Section-2.

10. Supervision of Field Testing & Commissioning

1. Supervision for Field testing and commissioning of the equipment (33kV AIS Local Isolation Breaker Panel with its Accessories) shall be done by OEM only.
2. Bidder shall carry out the supervision of installation, field testing and commissioning of the equipment (33kV AIS Local Isolation Breaker Panel with its Accessories). Further appropriate test and commissioning reports and as-built documentation as necessary shall be submitted.
3. Bidder shall also submit site acceptance testing (SAT) procedures and get them approved from BHEL/ Customer before carrying out the site testing at site.
4. Bidder shall coordinate with manufacturers of other equipment wherever required and shall freely and readily supply all technical information for this purpose as and when called for.

11. Makes of Equipment/ Components

1. The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.
2. Bidder while ordering shall ensure the availability of spare parts and maintenance support services for the equipment (33kV AIS Local Isolation Breaker Panel with its Accessories) at least for 10 years from the date of supply.
3. Bidder shall give a notice of at least one year to the BHEL/ Customer before phasing out the products/spares to enable the owner for placement of order for spares and services.

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4. The equipment offered by the Bidder shall be complete in all respects. Any material and component not specifically stated in this specification but which are necessary for trouble free operation of the equipment and accessories specified in this specification shall be deemed to be included unless specifically excluded. All such equipment/ accessories shall be supplied without any extra cost. In addition to this, all similar components shall be interchangeable and shall be of same type and rating for easy maintenance and low spare inventory.
 5. Specific reference in this specification and documents to any material by trade name, make or catalogue number shall be construed as establishing quality and performance requirements.

12. Packing and Dispatch

1. The equipment (33kV AIS Local Isolation Breaker Panel with its Accessories) 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. sea, rail and road in such a manner that it is protected against the climatic conditions and for any damage during transportation, transit and storage. 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 nos.' etc., shall be clearly marked on the package together with other details as per purchase order.
2. The equipment may be stored outdoors for long periods before installation. The packing should also be suitable for outdoor storage areas with heavy rains/ high ambient temperature unless otherwise agreed and hence, Packing shall be suitable for long storage (minimum 1 year).

13. Definitions Used

The following expressions hereunder and elsewhere in the technical specification used and their grammatical variations shall unless repugnant to the subject or context thereof, have the following meanings hereunder respectively assigned to them, namely:

1. Battery Limit: The demarcated area within which the Unit is to be located.
2. Bid/Bidding Documents: The totality of the documents comprising the Bidding Document for the notice inviting tender.
3. Contract: The totality of agreement between Customer/ Purchaser/ Owner/IOCL and the Contractor/ LSTK Contractor/ BHEL as derived from the contract documents.
4. Contractor/ LSTK contractor: The bidder selected by the Customer/ Purchaser/ Owner/IOCL for the performance of the work and supply of materials. In this case, it is BHEL.
5. Customer/ Purchaser/ Owner: Indian Oil Corporation Limited.
6. Consultant: Any person(s)/ Firm nominated/ assigned by the Contractor/ LSTK Contractor/ BHEL for providing the engineering consultant services. In this case, it is TCE.
7. Bidder/ vendor: The bidder selected for this intended work shall be known as vendor.

14. Abbreviations Used

The following terminology/ acronym hereunder and elsewhere in the technical specification used and their grammatical variations shall unless repugnant to the subject or context thereof, have the following full form hereunder respectively assigned to them, namely,

Bharat Heavy Electricals Limited

Project: LSTK job for ISBL work of 220KV Grid Power Import at IOCL, Panipat Refinery

Technical Specification: 33kV AIS Local Isolation Breaker Panel with its Accessories

Doc No. TB-411-316-004 Rev 00

CRCA:	Cold Rolled Cold Annealed
FRP:	Fiber Reinforced Polyster
LED:	Light Emitting Diode
MCC:	Motor Control Center
MCCB:	Moulded Case Circuit Breaker
NO:	Normally Open Contact
NC:	Normally Close Contact
CT:	Current Transformer
VT:	Voltage Transformer
PT:	Potential Transformer
VCB:	Vacuum Circuit Breaker
SWG:	Standard Wire Gauge
LIB:	Local Isolation breaker
URT:	Unit Ration Transformer
SLD:	Single Line Diagram
BIL:	Basic Insulation Level
SCAP:	Synchronization Control & Annunciation Panel
ECS:	Electrical Control System
SAS:	Substation Automation System
GIS:	Gas Insulated Switchgear
LCC:	Local Control Centre
DC:	Direct Current
HV:	High Voltage
EHV:	Extra High Voltage
kV:	Kilovolt
Hz:	Hertz
IP:	Ingress Protection
SAT:	Site Acceptance Testing
OEM:	Original Equipment Manufacturer
kV:	Kilovolt
Hz:	Hertz
IP:	Ingress Protection
PE:	Poly Ethylene
ANSI:	American National Standards Institute
ASTM:	American Society for Testing and Materials
IEC:	International Electro Technical Commission
IEEE:	Institute of Electrical & Electronics Engineers
IS:	Indian Standards
NEMA:	National Electrical Manufactures Association
CEA:	Central Electricity Authority
DIN:	Deutsches Institiut fur Normung
CCE:	Continuous and Comprehensive Evaluation
LPCB:	Loss Prevention Certification Board
CCOE:	Chief Controller of Explosives
OEM:	Original Equipment Manufacturer

Bharat Heavy Electricals Limited

Project: LSTK job for ISBL work of 220KV Grid Power Import at IOCL, Panipat Refinery

Technical Specification: 33kV AIS Local Isolation Breaker Panel with its Accessories

Doc No. TB-411-316-004 Rev 00

BHEL:	Bharat Heavy Electricals Limited
OISD:	Oil Industry Safety Directorate
IOCL:	Indian Oil Corporation Limited
HVPLN:	Haryana Vidyut Prasaran Nigam Limited
ISBL:	Inside Battery Limit
OSBL:	Outside Battery Limit
LSTK:	Lump sum Turnkey
PRPC:	Petroleum Refining and Petrochemical
PNC:	Panipat Naphtha Cracker Complex
PR:	Panipat Refinery Complex
GIS:	Gas Insulated Sub-station
QAP:	Quality Assurance Plan
BOQ:	Bill of Quantities
ASTM:	American Society for Testing and Materials
BIS:	Bureau of Indian Standards
BS:	British Standard
DGMS:	Director General of Mines and Safety
EPR:	Ethylene Propylene Rubber
FR:	Flame Retardant
HR PVC:	Heat Resistant Polyvinyl Chloride
ICEA:	Insulated Cable Engineers Association
IS:	Indian Standards
NEMA:	National Electrical Manufacturers Association
PEM:	Project Engineering Management
PVC:	Polyvinyl Chloride
UV:	Ultra Violet
XLPE:	Cross-linked Polyethylene

15. List of Documents/ Drawings

Following drawing/ documents are attached for information purpose,

1. TB-411-510-001: 220/33kV Switchyard- Single Line Diagram
2. TB-411-510-002: 220/33kV Switchyard- Key Metering & Protection Single Line Diagram

33kV LIB1 CT1 DETAILS (203-LIB1 CT1/ 208-LIB1 CT1)

Core No.	Current Ratio	Output Burden (VA) at lowest Tap	Minimum KPV (Volts)	Max Ie (mA) at KPV/2	Maximum Rct (Ohms)	Accuracy Class	Purpose
1	1250/1 A	-	625	30	6.25	PS	Cable Differential Protection
2	1250/1 A	30	-	-	-	1.0, ISF $\leq$ 5	Metering
3	1250/1 A	15	-	-	-	5P20	O/C / E/F Protection

33kV LIB2 CT1 DETAILS (203-LIB2 CT1/ 208-LIB2 CT1)

Core No.	Current Ratio	Output Burden (VA) at lowest Tap	Minimum KPV (Volts)	Max Ie (mA) at KPV/2	Maximum Rct (Ohms)	Accuracy Class	Purpose
1	1250/1 A	-	625	30	6.25	PS	Cable Differential Protection
2	1250/1 A	30	-	-	-	1.0, ISF $\leq$ 5	Metering
3	1250/1 A	15	-	-	-	5P20	O/C / E/F Protection

33kV LIB1/2 CT2 DETAILS (203-LIB1 CT2/ 203-LIB2 CT2/ 208-LIB1 CT2/ 208-LIB2 CT2)

Core No.	Current Ratio	Output Burden (VA) at lowest Tap	Minimum KPV (Volts)	Max Ie (mA) at KPV/2	Maximum Rct (Ohms)	Accuracy Class	Purpose
1	1250/1 A	-	625	30	6.25	PS	Cable/ Transformer Differential Protection
2	1250/1 A	-	625	30	6.25	PS	Cable/ Transformer Differential Protection

33kV LIB VT DETAILS (203-LIB1/ 203-LIB2/ 208-LIB1/ 208-LIB2)

Winding No.	Ratio	Accuracy Class	Rated Burden (VA)	Purpose
1	$(33 \text{ kV}/\sqrt{3}) / (110 \text{ V}/\sqrt{3})$	1.0	50	Metering
2	$(33 \text{ kV}/\sqrt{3}) / (110 \text{ V}/\sqrt{3})$	3P	50	Protection

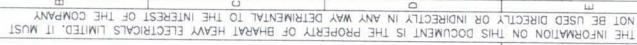
Project: 220/33 kV GIS Substation at IOCL Panipat Refinery
 Customer: IOCL
 Consultant: TCE

ANNEXURE- Details for 33kV LIB CT

33kV LIB CT DETAILS (203-LIB1/ 203-LIB2/ 208-LIB1/ 208-LIB2)								
Core No.	Current Ratio	Output Burden (VA) at lowest Tap	Minimum KPV (Volts)	Max I _e (mA) at KPV/2	Maximum R _{ct} (Ohms)	Accuracy Class	Purpose	
1	1250/1 A	-	625	30	6.25	PS	Cable Differential Protection	
2	1250/1 A	15	-	-	-	1.0, ISF ≤ 5	Metering	
3	1250/1 A	15	-	-	-	5P20	O/C / E/F Protection	
4	1250/1 A	-	625	30	6.25	PS	Cable/ Transformer Differential Protection	
5	1250/1 A	-	625	30	6.25	PS	Cable/ Transformer Differential Protection	

Sl. No.	Item Description	Long Description	Unit	Qty.	Remarks
A.1 Supply Item- Main Items					
1	33kV AIS Local Isolation Breaker (LIB) Panel incorporating VCBs, CT, PTs suitable for cable differential, transformer differential, REF protection relays	Three phase, metal enclosed, indoor type AIS Local Isolation Breaker (LIB) of rating 33 kV, 1500 Amp continuous current, suitable for fault level to 31.5 kA rms for 1 second panel with its accessories shall be complete in all respects and comprising of following but not limited to, a. Vacuum circuit breakers, CT, PT, relays etc. complete in all respects for all three phases. b. Local Isolation Breaker (LIB) shall have demarcation of transformer differential and cable differential zone with due overlapping. c. Local Isolation Breaker (LIB) shall have all required hardware for build up of transformer differential protection up-to LIB and provision of Cable differential, Transformer REF, SEF protection accordingly and as per project requirement. d. One set of 3 phase unit shall be installed in a proper metal enclosure suitable for installation in indoor sub-station. The metal enclosure shall be of IP4X class or more. The housing shall ensure all safety aspects for installation in the indoor sub-station and shall comply all IS/IEC specifications relevant for metal enclosure installation. e. LIB shall be suitable for cable termination for both incoming and outgoing side suitable as per project requirement f. Structural material required for installation of system. g. Provision of earthing connectivity etc. h. Any other item/(s) required to complete the supply in all respects but not limited to above shall be in bidder's scope.	Set	4	Technical specification shall be in line with Section-2/ Section-3, Chapter-11 and technical corrigendum-1 &2.
A.2 Supply Item- Mandatory Spare					
1	Closing coil	Closing coil shall be complete in all respects. (1 Set=2 No of each rating & type)	Set	1	Technical specification shall be in line with Section-2/ Section-3, Chapter-11 and technical corrigendum-1 &2.
2	Shunt trip coil	Shunt trip coil shall be complete in all respects. (1 Set=2 No of each rating & type)	Set	1	Technical specification shall be in line with Section-2/ Section-3, Chapter-11 and technical corrigendum-1 &2.
3	Control fuses / MCB	Control fuses / MCB shall be complete in all respects. (1 Set=10 No of each rating & type)	Set	1	Technical specification shall be in line with Section-2/ Section-3, Chapter-11 and technical corrigendum-1 &2.
4	Indicating lamps covers	Indicating lamps covers shall be complete in all respects. (1 Set=5 No of each colour)	Set	1	Technical specification shall be in line with Section-2/ Section-3, Chapter-11 and technical corrigendum-1 &2.
5	Indicating lamps	Indicating lamps shall be complete in all respects. (1 Set=20% or 3 No (min.), whichever is more)	Set	1	Technical specification shall be in line with Section-2/ Section-3, Chapter-11 and technical corrigendum-1 &2.
6	Vacuum Bottle	Vacuum Bottle shall be complete in all respects. (1 Set=1 No of each type)	Set	1	Technical specification shall be in line with Section-2/ Section-3, Chapter-11 and technical corrigendum-1 &2.
7	Racking handle	Racking handle shall be complete in all respects. (1 Set=4 No of each type of breaker)	Set	1	Technical specification shall be in line with Section-2/ Section-3, Chapter-11 and technical corrigendum-1 &2.
8	CT and PT	CT and PT shall be complete in all respects. (1 Set=3 No of each type and rating)	Set	1	Technical specification shall be in line with Section-2/ Section-3, Chapter-11 and technical corrigendum-1 &2.
9	Bus support insulator	Bus support insulator shall be complete in all respects. (1 Set=6 No of each type)	Set	1	Technical specification shall be in line with Section-2/ Section-3, Chapter-11 and technical corrigendum-1 &2.

10	Spring charging motor (1Set=1No of each type)	Spring charging motor shall be complete in all respects. (1 Set=1 No of each type)	Set	1	Technical specification shall be in line with Section-2/ Section-3, Chapter-11 and technical corrigendum-1 &2.
11	Auxiliary Contactors	Auxiliary Contactors shall be complete in all respects. (1Set=20% of each type and make OR 1 No (min) of each type and make, whichever is more)	Set	1	Technical specification shall be in line with Section-2/ Section-3, Chapter-11 and technical corrigendum-1 &2.
B	Main Services Items				
1	Supervision for Installation, Testing & Commissioning of 33kV AIS Local Isolation Breaker (LIB) Panel with its accessories	Supervision for installation, testing & commissioning of 33kV AIS Local Isolation Breaker (LIB) Panel with its accessories shall be complete in all respects. Any other supervisory service(s) required to complete the work in all respects shall be in bidder's scope.	Set	4	Technical specification shall be in line with Section-2/ Section-3, Chapter-11 and technical corrigendum-1 &2.



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A. 220kV OUTDOOR EQUIPMENT

BSL NO.	DESCRIPTION	SYMBOL	LEGEND	BAY NO/LOCATION	UNIT	QTY
1.	18KV, 10KA, CLASS-III, 1 PHASE SURGE ARRESTER (SA)		SA	201, 211.	NO	06
2.	220KV, 8000KF, 1 PHASE CAPACITOR VOLTAGE TRANSFORMER (CVT). (220V/1KV/110V/4KV/110V/4KV/110V/4KV)		CVT	201, 211.	NO	06
3.	220KV, 1 PHASE WAVE TRAP, 2000KA, 0.5mH #		WT	201, 211.	NO	04
4.	220KV, 1 PHASE TARIFF METERING PT		PT1	202, 211.	NO	06
5.	220KV, 1 PHASE TARIFF METERING CT		CT1	202, 211.	NO	06
6.	220KV, 220KV, 1V3 PHASE 4WS ISOLATOR (ELECTRICALLY OPERATED MECHANICALLY LATCHED) WITH ONE SWITCH (ELECTRICALLY OPERATED MECHANICALLY LATCHED)		ISX	202, 211.	SET	02

MY CUSTOMER TO CONFIRM.

B. 220kV INDOOR GIS

SL.NO.	DESCRIPTION	SYMBOL	LEGEND	BAY NO/LOCATION	UNIT	QTY
1.	220kV, 2000A, 1X3 PHASE CIRCUIT BREAKER		52	201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211.	SET	11
2.	220kV, 2000A, 1X3 PHASE DISCONNECTING SWITCH WITHOUT EARTH SWITCH		88A	201, 202, 203, 204, 205, 207, 208, 209, 210, 211.	SET	40
3.	220kV, 2000A, 1X3 PHASE DISCONNECTING SWITCH WITH SINGLE EARTH SWITCH		88A, 88AE 88B, 88BE 88L, 88LE	BUS-1, BUS-2 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211.	SET	24
4.	220kV, 2000A, 1X3 PHASE HIGH SPEED / FAST EARTHING SWITCH		88HE2	BUS-1, BUS-2 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211.	SET	12
5.	198kV, 10kA, CLASS-III, 1 PHASE SURGE ARRESTER		SA	202, 203, 204, 205, 207, 208, 209, 210.	NO	24
6.	220kV, 1 PHASE CURRENT TRANSFORMER		CT	201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211.	NO	33
7.	220kV, 1 PHASE VOLTAGE TRANSFORMER		VT	BUS-1, BUS-2	NO	06
8.	220kV, 1 PHASE SFB TO AIR BUSHING		SAB	201, 211.	NO	06
9.	220kV, 1 PHASE SFB TO OIL BUSHING		SOB	202, 203, 207, 208.	NO	12
10.	220kV, 1 PHASE SFB TO CABLE MODULE		SCM	204, 205, 209, 210.	NO	12

A 22.5V OUTDOOR EQUIPMENT INCLUDING 220/33KV POWER TRANSFORMER

SL.NO.	DESCRIPTION	SYMBOL	LEGEND	BAY NO./LOCATION	UNIT	QTY
1.	220/44.3KV, 50/60MVA, ONAN/ONAF YNyn0, 3 PHASE TRANSFORMER		TR	202, 203, 207, 208.	NO	04
2.	3.3KV AIS LUB PANEL		LUB1, LUB2	203, 208.	SET	04
3.	3.3KV FAULT CURRENT LIMITER PANEL		FCL	202-207.	SET	02
4.	33KV/1 SCOTSDOWN C/L XLPE ARMORED SCREENED CABLE INCLUDING END TERMINATION AND STRAIGHT THROUGH JOINTS		---	202, 203, 208, 209.	LOT	01
5.	33KV/1 C/CA300MM C/L XLPE ARMORED SCREENED CABLE INCLUDING END TERMINATION AND STRAIGHT THROUGH JOINTS		---	203, 208.	LOT	01
6.	33KV/1 C/CA300MM C/L XLPE ARMORED SCREENED CABLE INCLUDING END TERMINATION AND STRAIGHT THROUGH JOINTS		---	203, 208.	LOT	01

SYSTEM PARAMETERS -

SL. NO.	DATA	220kV SYSTEM	33kV SYSTEM
01	NOMINAL VOLTAGE (kV)	220kV±10%	33kV±6%
02	FREQUENCY (Hz)	50±5%	50±3%
03	SYSTEM EARTHING	SOLIDLY EARTHED	SOLIDLY EARTHED
04	SHORT-TIME CURRENT RATING (kA/Sec)	50kA/3sec	25kA/1sec
05	RATED PEAK WITHSTAND CURRENT (kA)	125	150
06	BASIC INSULATION LEVEL (kVp)	1050	1050
07	RATED CURRENT AT 50°C (A)	2000	2500
08	RATED POWER FREQUENCY WITHSTAND VOLTAGE DRY/NET (kVrms)	460	70
09	LIGHTNING IMPULSE WITHSTAND VOLTAGE (kVp)	1050	170
10	CREEPAGE DISTANCE (mm/AV)	25	25
11	MINIMUM AMBIENT TEMPERATURE (°C)	-2.5°C	-2.5°C
12	MAXIMUM AMBIENT TEMPERATURE (°C)	+50.0°C	+50.0°C
13	EQUIPMENT DESIGN TEMPERATURE (°C)	+45.0°C	+45.0°C
14	AUXILIARY SUPPLY VOLTAGE (Vdc)	415V/3 PHASE/ 240V/1 PHASE	415V/3 PHASE/ 240V/1 PHASE
15	PROTECTION & CONTROL SUPPLY (Vdc)	220±5%	220±10%

REFERENCE DRAWING (S) / DOCUMENT(S) -

SL. NO.	DRAWING/ DOCUMENT NO.	DRAWING TITLE
1.	ANNEXURE -7P	220KV GIS- SLD
2.	ANNEXURE -5-2/C-1/5	INTERCONNECTION SLD FOR PR
3.	ANNEXURE -5-2/C-1/6	INTERCONNECTION SLD FOR PNCIP POWER EVACUATION FACILITY

CT/VT PARAMETERS -

220kW GIS CT DETAILS

[illegible]

220W OUTDOOR CT DETAIL

0000-0000-0000-0000

Core No.	Current Ratio	Output Ratios (V/A) Minimum, Max	Minimum KVP (V/A)	Max. I _{max} at KVP	Minimum R _{in} (Ohms)	Accuracy Class	Inputs
1	2000-1000-500:1 A.	20				0.2, R/F ± 5	7 rad/7.6 cm/sec
2	2000-1000-500:1 A.	20				0.2, R/F ± 2	7 rad/7.6 cm/sec

CONCLUSIONS AND FUTURE RESEARCH

Winding No.	Ratio	Accuracy Class	Rated Burden (VA)	Purpose
1	(250 V)/(110 V)	3P	50	Protection
2	(250 V)/(110 V)	3P	50	Protection
3	(250 V)/(110 V)	3P	50	Protection
4	(250 V)/(110 V)	6.2	50	Measuring

220KV, 4400pF (+10%, -5%) 0

Winding No.	Rate	Amount due
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Winding	Rate	Accuracy	Rated Current	Purpose
Test	CH3	(A)		Rated Current
1	(250 V/5 A) (1125/3 A)	0.2	50	Rated Current
2	(250 V/5 A) (1125/3 A)	0.2	50	Rated Current

NOTES: —

- 1/2 SOURCE: FOR CSE TITULATIONS AND ANY CHANGE IN LINE WITH THE REQUIREMENTS OF SERVICE
 COMMUNITY AND STANDARD DESIGN OF YEAR
 COMMON VAPOR METERING ROOM (VMO) SHALL BE PROVIDED FOR BOTH INCOMER BAYS.
 1/3 CSE IN VMO ROOM CHANGE AS PER OUR RECOMMENDATIONS.
 1/4 FOR INDIVIDUAL EQUIPMENT OF CSE A VMO SHALL BE IN LINE WITH SPECIFICATION. DIVISION F
 TRANSFORMER DETAILS SHALL BE UPDATED AS PER MANUFACTURER'S DOCUMENTS.
 1/5 C/VT PARAMETERS SHALL BE DETAILED IN SEPARATE SINGLE LINE (SASL) (NO. TB-3-411-611-002-200/250/300/350/400/450/500/550/600/650/700/750/800/850/900/950/1000/1050/1100/1150/1200/1250/1300/1350/1400/1450/1500/1550/1600/1650/1700/1750/1800/1850/1900/1950/2000/2050/2100/2150/2200/2250/2300/2350/2400/2450/2500/2550/2600/2650/2700/2750/2800/2850/2900/2950/3000/3050/3100/3150/3200/3250/3300/3350/3400/3450/3500/3550/3600/3650/3700/3750/3800/3850/3900/3950/4000/4050/4100/4150/4200/4250/4300/4350/4400/4450/4500/4550/4600/4650/4700/4750/4800/4850/4900/4950/5000/5050/5100/5150/5200/5250/5300/5350/5400/5450/5500/5550/5600/5650/5700/5750/5800/5850/5900/5950/6000/6050/6100/6150/6200/6250/6300/6350/6400/6450/6500/6550/6600/6650/6700/6750/6800/6850/6900/6950/7000/7050/7100/7150/7200/7250/7300/7350/7400/7450/7500/7550/7600/7650/7700/7750/7800/7850/7900/7950/8000/8050/8100/8150/8200/8250/8300/8350/8400/8450/8500/8550/8600/8650/8700/8750/8800/8850/8900/8950/9000/9050/9100/9150/9200/9250/9300/9350/9400/9450/9500/9550/9600/9650/9700/9750/9800/9850/9900/9950/10000/10050/10100/10150/10200/10250/10300/10350/10400/10450/10500/10550/10600/10650/10700/10750/10800/10850/10900/10950/11000/11050/11100/11150/11200/11250/11300/11350/11400/11450/11500/11550/11600/11650/11700/11750/11800/11850/11900/11950/12000/12050/12100/12150/12200/12250/12300/12350/12400/12450/12500/12550/12600/12650/12700/12750/12800/12850/12900/12950/13000/13050/13100/13150/13200/13250/13300/13350/13400/13450/13500/13550/13600/13650/13700/13750/13800/13850/13900/13950/14000/14050/14100/14150/14200/14250/14300/14350/14400/14450/14500/14550/14600/14650/14700/14750/14800/14850/14900/14950/15000/15050/15100/15150/15200/15250/15300/15350/15400/15450/15500/15550/15600/15650/15700/15750/15800/15850/15900/15950/16000/16050/16100/16150/16200/16250/16300/16350/16400/16450/16500/16550/16600/16650/16700/16750/16800/16850/16900/16950/17000/17050/17100/17150/17200/17250/17300/17350/17400/17450/17500/17550/17600/17650/17700/17750/17800/17850/17900/17950/18000/18050/18100/18150/18200/18250/18300/18350/18400/18450/18500/18550/18600/18650/18700/18750/18800/18850/18900/18950/19000/19050/19100/19150/19200/19250/19300/19350/19400/19450/19500/19550/19600/19650/19700/19750/19800/19850/19900/19950/20000/20050/20100/20150/20200/20250/20300/20350/20400/20450/20500/20550/20600/20650/20700/20750/20800/20850/20900/20950/21000/21050/21100/21150/21200/21250/21300/21350/21400/21450/21500/21550/21600/21650/21700/21750/21800/21850/21900/21950/22000/22050/22100/22150/22200/22250/22300/22350/22400/22450/22500/22550/22600/22650/22700/22750/22800/22850/22900/22950/23000/23050/23100/23150/23200/23250/23300/23350/23400/23450/23500/23550/23600/23650/23700/23750/23800/23850/23900/23950/24000/24050/24100/24150/24200/24250/24300/24350/24400/24450/24500/24550/24600/24650/24700/24750/24800/24850/24900/24950/25000/25050/25100/25150/25200/25250/25300/25350/25400/25450/25500/25550/25600/25650/25700/25750/25800/25850/25900/25950/26000/26050/26100/26150/26200/26250/26300/26350/26400/26450/26500/26550/26600/26650/26700/26750/26800/26850/26900/26950/27000/27050/27100/27150/27200/27250/27300/27350/27400/27450/27500/27550/27600/27650/27700/27750/27800/27850/27900/27950/28000/28050/28100/28150/28200/28250/28300/28350/28400/28450/28500/28550/28600/28650/28700/28750/28800/28850/28900/28950/29000/29050/29100/29150/29200/29250/29300/29350/29400/29450/29500/29550/29600/29650/29700/29750/29800/29850/29900/29950/30000/30050/30100/30150/30200/30250/30300/30350/30400/30450/30500/30550/30600/30650/30700/30750/30800/30850/30900/30950/31000/31050/31100/31150/31200/31250/31300/31350/31400/31450/31500/31550/31600/31650/31700/31750/31800/31850/31900/31950/32000/32050/32100/32150/32200/32250/32300/32350/32400/32450/32500/32550/32600/32650/32700/32750/32800/32850/32900/32950/33000/33050/33100/33150/33200/33250/33300/33350/33400/33450/33500/33550/33600/33650/33700/33750/33800/33850/33900/33950/34000/34050/34100/34150/34200/34250/34300/34350/34400/34450/3450

PROJECT: LSTK JOB FOR ISBL WORK OF 220KV GRID POWER IMPORT AT
PANIPAT REFINERY
IOA NO BBBC/182/81/0628066 DTD 24.01.2020

AMERICAN OIL CORPORATION LIMITED

[illegible]

TATA CONSULTING ENGINEERS LIMITED

[illegible]

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SIZE—A1

Comments Resolution Sheet for

DRAWING / DOCUMENT TITLE: 220/33kV Switchyard- Single Line Diagram

DOCUMENT NUMBER: TB-411-510-001

REVISION NO: 00

Sl. No.	Comment (s)/ Observation(s)	Resolution(s)
A	CONSULTANT	
1	No comments	
B	CONSULTANT	
1	Surge arrestor shall also be provided in the incomer/line bays also in line with the observation point: (f) of mail ref. no.: PR/P&U/DGM(MN-EL)/26286965/2020/3 ; Dt.28.1.20.	It is to be noted that the requirements of surge arrestor, if required in line with sytem studies, shall taken care.
2	The no. of FCL is shown as 1 Set instead of the requirement of 2 Set in document no.: TB-1-411-510-001 9 Sheet 02 of 02. Please correct and submit.	Noted and complied.
3	The no. of runs of cable shown in the SLD is still incomplete. Please correct as detailed below, a. Cabling from existing URT to New Fault limiting devices both incoming and outgoing side- 3 Runs per phase per URT X 1 Core X 630 sqmm i.e. total of 18 runs per URT and 36 runs for two URT system b. From SS-9 LIB to SS-9 Generation Board (PNCP): 3 Runs per phase per feeder X 1 Core X400 sqmm i.e. total 9 Runs per feeder and 18 runs for 2 feeders	Noted and complied.

NOTE:

CONTRACTOR IS OBLIGED TO FURNISH THIS SHEET (DULY FILLED UP WITH RESOLUTION TO ALL CUSTOMER/CONSULTANT COMMENTS ALONG WITH REVISED DRAWINGS

NOTES (FOR IOCL PANTPAT END)

	CURRENT TRANSFORMER
	BUSLING CURRENT TRANSFORMER
	CAPACITOR VOLTAGE TRANSFORMER
	EMT
	LIGHTNING ARRESTER
	CIRCUIT BREAKER
	DISCONNECTER
	EARTHING SWITCH
	SFE-TO-AIR BUSHING
	SFE-TO-OIL BUSHING
	SFE-TO-CABLE MODULE
	WAVE TRAP
	GIS BUS DUCT
	OPTICAL FIBRE
	O/D DISCONNECTER (HCB TYPE)
	GIS CT / AS SWITCH BOARD CT

1. ALL PROTECTION FEATURES SHOWN IN THIS DRAWING SHALL BE PROVIDED IN THE OFFERED SYSTEM.
2. **NOTES (FOR REMOTE END - HYVNL MUNDH S/S)**
3. FOR THE 220 KV SYSTEM, IF RATING OF CWT SHALL BE 8800KVA AND MH RATING OF WAVE TRAPS SHALL BE 1250A, 1.0MH, 50MVA/15% DOG/ HYVNL TO CONFIRM THE SAME.
4. DIFFERENTIAL, COM DISTANCE PROTECTION RELAY AT MUNDH S/S END SHALL MATCH WITH THAT SUPPLIED FOR DCL PAMPANI END.
5. REMOTE END PLCG ITEMS (WAVE TRAPS, DIGITAL PLC TERMINALS, COUPLING DEVICE, ASSOCIATED DC SYSTEM) AT MUNDH S/S ARE IN THE SCOPE OF BIHEL.
6. REMOTE END DIFFERENTIAL COM DISTANCE PROTECTION RELAY SHALL BE SUPPLIED LOOSE BY BIHEL AND WILL BE INTEGRATED AT DESTINATION AT MUNDH S/S.
7. REMOTE END REQUIRE SUPPLY OF 220KV/11KV TRANSFORMER TO INSTAL. PLCG ITEMS AND DIFFERENTIAL COM DISTANCE PROTECTION RELAY AT MUNDH S/S.
8. MOUNTED IN RESPECTIVE PROTECTION RELAY AT REMOTE END (MUNDH S/S) WILL BE NOT IN PRESENT SCOPE. HOWEVER, INSTALLATION, TESTING & COMMISSIONING AND INTEGRATION TO EXISTING SCADA IS IN BIHEL SCOPE.
9. DIFFERENTIAL COM DISTANCE PROTECTION RELAY AT BOTH ENDS WILL BE CONNECTED THROUGH DIRECT LINE CONNECTION (SCHEMATIC ATTACHED).
10. REMOTE END PORT BOX (JOINT BOX, FUSE) (MULTIPLEXER SW/PH/40) ARE NOT IN BIHEL/ DCL SCOPE.
11. DETAILED DETAILS OF REMOTE END STATION TO BE INFORMED BY HYVNL (S/D, C/T, VT, EXISTING, SAS, SCHEMES).

COMPUTER FILE NAME

REF. DRG. NO.

SIGN, AND DATE

INVENTORY NO

 BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION BUSINESS GROUP		UNTL. DIMS.	SCALE	WEIGHT (KGS)	N.A.	DRN.	RD	NAME	SIGN.	DATE
		DEPTH CODE 4 1 1	$\frac{3}{4}$ "=1"	N.T.S.						
TITLE 220/132KV SWITCHYARD - KEY METERING & PROTECTION SINGLE LINE DIAGRAM						DRAWING/ DOCUMENT NO. TB-3-411-510-002		NO 02		NO OF SHEET 08
						SHIT. NO 01				

CUSTOMER: LSTK JOB FOR ISBL WORK OF 220kV GRID POWER IMPORT AT
PANIPAT REFINERY
IOA NO RPRCI82491/26286965 DTD 24.01.2020

INDIAN OIL CORPORATION LIMITED

CONSULTANT:

TATA CONSULTING ENGINEERS LIMITED

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BHARAT HEAVY ELECTRICALS LTD.
TRANSMISSION BUSINESS GROUP

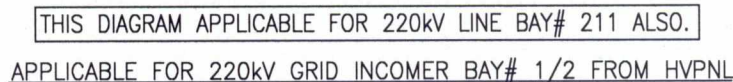
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ITEM	GR.		N.T.S
CODE	Q/M/Y		
411			

TITLE 220/33KV SWITCHYARD- KEY METERING

PROTECTION SINGLE LINE DIAGRAM

		220/33KV SWITCH-AR - KEY METERING & PROTECTION SINGLE LINE DIAGRAM	
220/33KV SWITCH-AR - KEY METERING & PROTECTION SINGLE LINE DIAGRAM		220/33KV SWITCH-AR - KEY METERING & PROTECTION SINGLE LINE DIAGRAM	
DEPT. TBM CODE DATE	UNTO. OFR.  SCALE N.T.S.	WEIGHT (KG) REF. TO ASST. DIRG.	ITEM NO. INDOCR
TITLE	N.A.	N.A.	N.A.
DRAWING / DOCUMENT NO.	TB-3-411-510-002	02	REV
SFT. NO. 02	NO. OF SFT. 08		



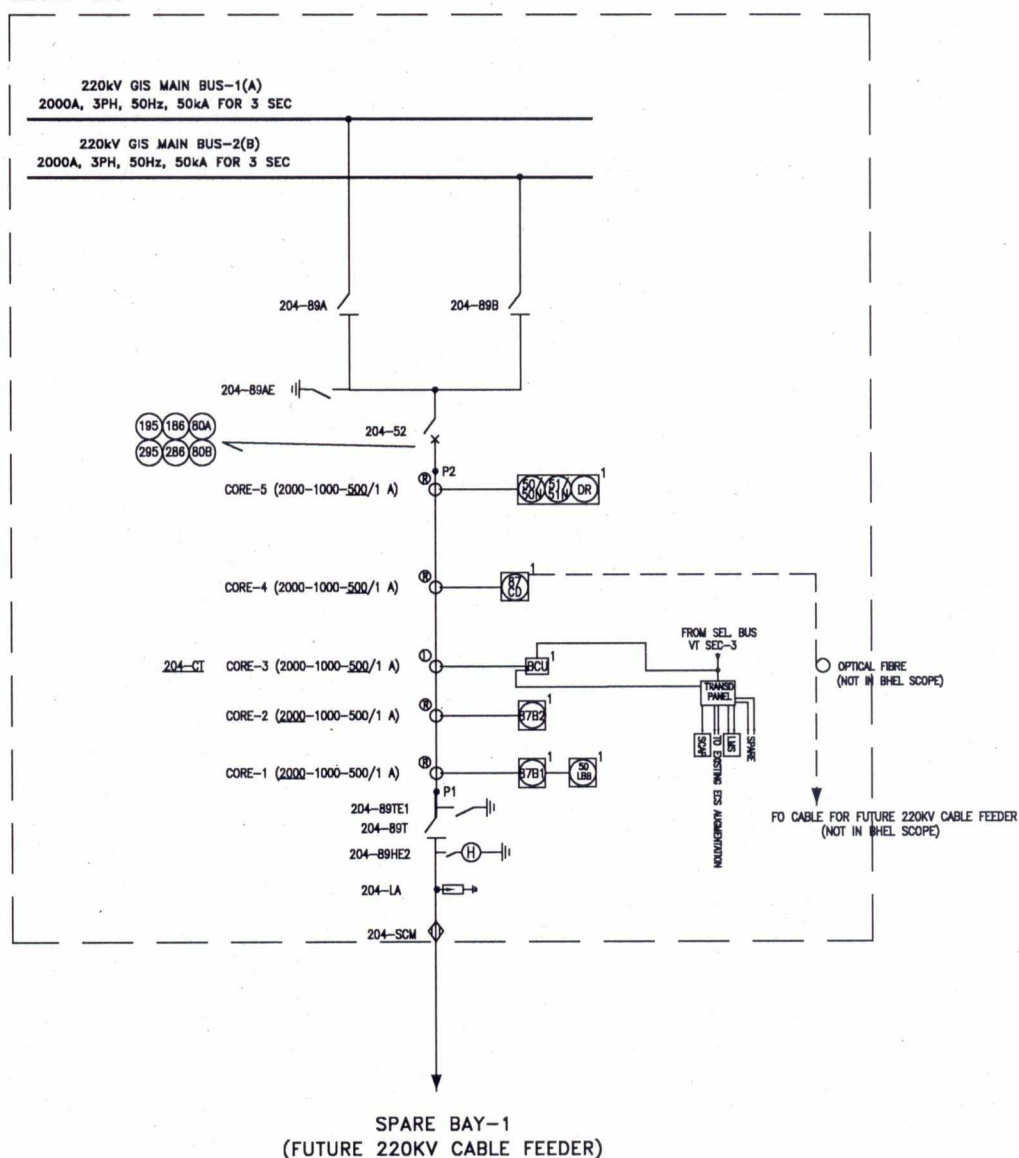
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DATE		DIN		RD		12.03.2020	
CITY		APP.		RD		12.03.2020	
TITLE		CADD		APPRO. BY		12.03.2020	
DEPT.	UNTL. OR.	SCALE	WEIGHT (KG)	REF. TO ASSY. DRG.	ITEM NO.	NO. OF	REV.
ITEM	DRG.	N.T.S.	N.A.	N.A.	NO. OF	NO. OF	
CAGE	W/M						
220/230V SWITCHARD - KEY METERING & PROTECTION SINGLE LINE DIAGRAM							
DRAWING / DOCUMENT NO.				REV.			
TB-3-411-510-002				02			
SHEET NO.		NO. OF SHEET		04		08	

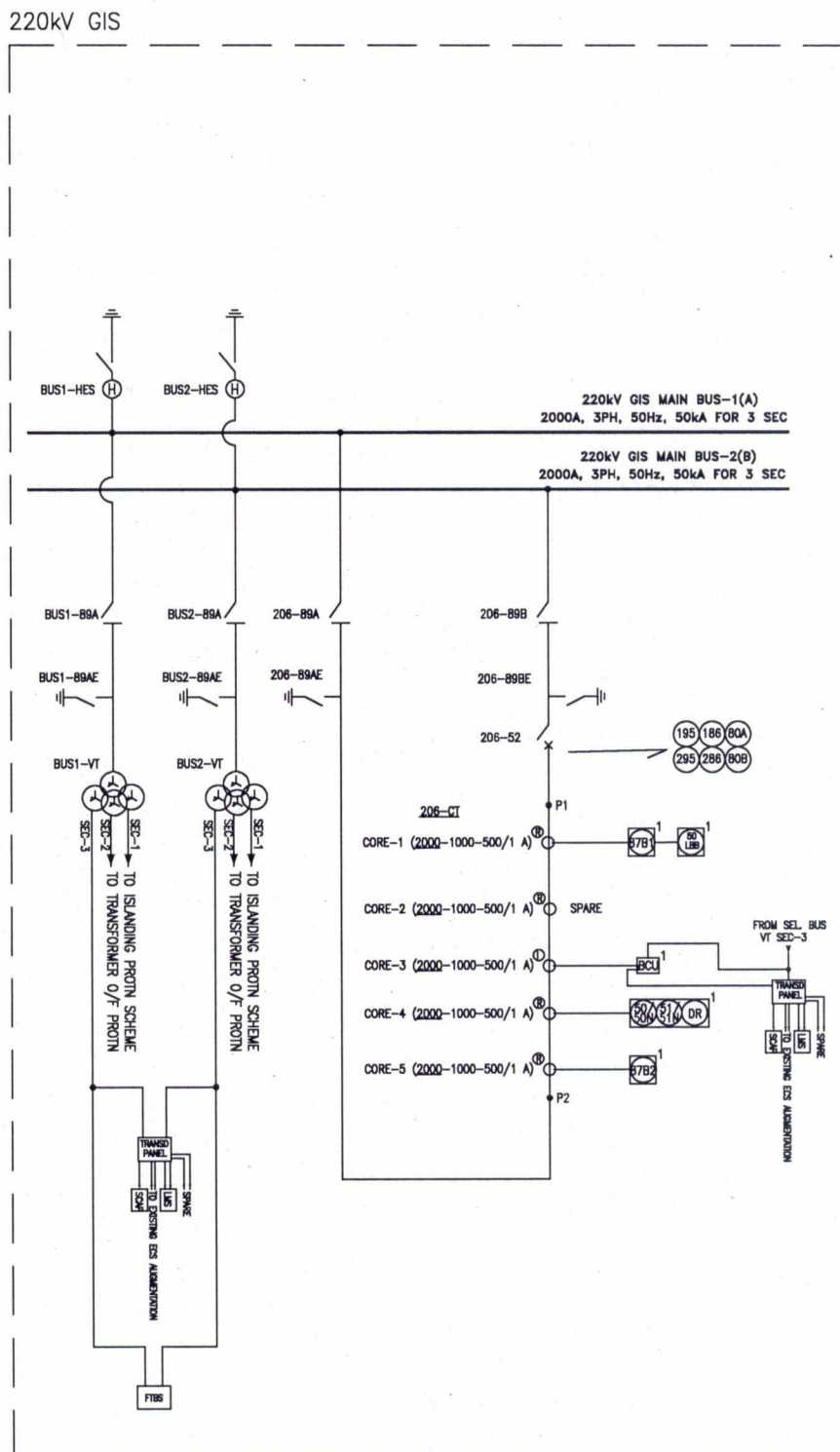


SIZE-A3

CUSTOMER: ISTK JOB FOR ISHL WORK OF 220KV GRID POWER IMPORT AT PAINPAT REFINERY		LOA NO. RPOC182491/26286965 DTD.24.01.2020		OWNER:	
INDIAN OIL CORPORATION LIMITED					
CONSULTANT: TATA CONSULTING ENGINEERS LIMITED					
TATA					
					
DEPT. : CODE : TITLE :		UNITED DMS : 		SCALE : N.T.S N.A.	
220/33KV SWITCHYARD - KEY METERING & PROTECTION SINGLE LINE DIAGRAM		BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION BUSINESS GROUP		WEIGHT (KGS) N.A.	
DRN. RD CHD. RO APRD. VK		NAME : SIGN. : DATE :		12.03.2020 12.03.2020 12.03.2020	
DRWING / DOCUMENT NO. TB-3-411-510-002		REF. TO ASST. DRG. N.A.		TOTAL NO. OF ITEMS N.A.	
SHT. NO 05		NO. OF SHT.		08	



APPLICABLE FOR 220KV SPARE BAY# 1/2/3/4 (BAY-204, 205, 209 & 210)

[illegible]

APPLICABLE FOR 220kV BUS COUPLER (BAY-206) & BUS VT-1/2

ALL DIMENSIONS ARE IN mm

FIRST ANGLE PROJECTION

INVENTORY NO
SIGN, AND DATE
REF. DRG. NO.
COMPUTER FILE NAME
NOT BE USED DIRECTLY OR INDIRECTLY IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY
THE INFORMATION ON THIS DOCUMENT IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LIMITED. IT MUST

220 kV CURRENT TRANSFORMER (GIS CT)

CORE NO.	CURRENT RATIO	OUTPUT BURDEN AT LOWEST TAP	MIN KPV	MAX Ie AT KPV	MAX RCT	ACCURACY CLASS	PURPOSE
1	2000-1000-500/1A	-	2000-1000-500V	30-60-120mA	10-5-2.5 Ohms	PS	PROTECTION
2	2000-1000-500/1A	-	2000-1000-500V	30-60-120mA	10-5-2.5 Ohms	PS	PROTECTION
3	2000-1000-500/1A	30VA	-	-	-	0.2%MF5	METERING
4	2000-1000-500/1A	-	2000-1000-500V	30-60-120mA	10-5-2.5 Ohms	PS	PROTECTION
5	2000-1000-500/1A	-	2000-1000-500V	30-60-120mA	10-5-2.5 Ohms	PS	PROTECTION

220 kV CURRENT TRANSFORMER - TARIFF METERING (OUTDOOR CT)

CORE NO.	CURRENT RATIO	OUTPUT BURDEN AT LOWEST TAP	MIN KPV	MAX Ie AT KPV	MAX RCT	ACCURACY CLASS	PURPOSE
1	250/1A	10VA	-	-	-	0.2%MF5	TARIFF METERING
2	250/1A	10VA	-	-	-	0.2%MF5	TARIFF METERING

BUSHING CURRENT TRANSFORMER (HV SIDE)

CORE NO.	CURRENT RATIO	OUTPUT BURDEN AT LOWEST TAP	MIN KPV	MAX Ie AT KPV/2	MAX RCT	ACCURACY CLASS	PURPOSE
1	250/1A	-	(200kV + 100) V	30 mA	1.25 Ohms	PS	REF PROTECTION

BUSHING CURRENT TRANSFORMER (HV NEUTRAL SIDE)

CORE NO.	CURRENT RATIO	OUTPUT BURDEN AT LOWEST TAP	MIN KPV	MAX Ie AT KPV/2	MAX RCT	ACCURACY CLASS	PURPOSE
1	250/1A	-	(200kV + 100) V	30 mA	1.25 Ohms	PS	REF PROTECTION
2	250/1A	20VA	-	-	-	SP20	SEEF PROTECTION

BUSHING CURRENT TRANSFORMER (LV SIDE)

CORE NO.	CURRENT RATIO	OUTPUT BURDEN AT LOWEST TAP	MIN KPV	MAX Ie AT KPV/2	MAX RCT	ACCURACY CLASS	PURPOSE
1	1500/1A	-	(150kV + 300) V	30 mA	7.5 Ohms	PS	REF PROTECTION

220kV BUS VT (GIS EMVT)

WINDING NO.	VOLTAGE RATIO	RATED BURDEN	ACCURACY CLASS	PURPOSE
1	$\frac{220}{\sqrt{3}} / \frac{0.110}{\sqrt{3}}$ kV	50 VA	3P	PROTECTION
2	$\frac{220}{\sqrt{3}} / \frac{0.110}{\sqrt{3}}$ kV	50 VA	3P	PROTECTION
3	$\frac{220}{\sqrt{3}} / \frac{0.110}{\sqrt{3}}$ kV	150 VA	0.2	METERING

220kV CVT (8800 pF, +10%, -5%) - OUTDOOR CVT

WINDING NO.	VOLTAGE RATIO	RATED BURDEN	ACCURACY CLASS	PURPOSE
1	$\frac{220}{\sqrt{3}} / \frac{0.110}{\sqrt{3}}$ kV	50 VA	3P	PROTECTION
2	$\frac{220}{\sqrt{3}} / \frac{0.110}{\sqrt{3}}$ kV	50 VA	3P	PROTECTION
3	$\frac{220}{\sqrt{3}} / \frac{0.110}{\sqrt{3}}$ kV	50 VA	0.2	METERING

220kV VT - TARIFF METERING (OUTDOOR EMVT)

WINDING NO.	VOLTAGE RATIO	RATED BURDEN	ACCURACY CLASS	PURPOSE
1	$\frac{220}{\sqrt{3}} / \frac{0.110}{\sqrt{3}}$ kV	20 VA	0.2	TARIFF METERING
2	$\frac{220}{\sqrt{3}} / \frac{0.110}{\sqrt{3}}$ kV	20 VA	0.2	TARIFF METERING

BUSHING CURRENT TRANSFORMER (LV NEUTRAL SIDE)

CORE NO.	CURRENT RATIO	OUTPUT BURDEN AT LOWEST TAP	MIN KPV	MAX Ie AT KPV/2	MAX RCT	ACCURACY CLASS	PURPOSE
1	1500/1A	-	(150kV + 300) V	30 mA	7.5 Ohms	PS	REF PROTECTION
2	1500/1A	20VA	-	-	-	SP20	SEEF PROTECTION

33 kV LIB CURRENT TRANSFORMER (LIB-CT1)

CORE NO.	CURRENT RATIO	OUTPUT BURDEN AT LOWEST TAP	MIN KPV	MAX Ie AT KPV/2	MAX RCT	ACCURACY CLASS	PURPOSE
1	1250/1A	-	625V	30mA	6.25 Ohms	PS	PROTECTION
2	1250/1A	30VA	-	-	-	1.0MF5	METERING
3	1250/1A	18VA	-	-	-	SP20	PROTECTION

33 kV LIB CURRENT TRANSFORMER (LIB-CT2)

CORE NO.	CURRENT RATIO	OUTPUT BURDEN AT LOWEST TAP	MIN KPV	MAX Ie AT KPV/2	MAX RCT	ACCURACY CLASS	PURPOSE
1	1250/1A	-	625V	30mA	6.25 Ohms	PS	PROTECTION
2	1250/1A	-	625V	30mA	6.25 Ohms	PS	PROTECTION

~~CLASS-PS FOR LIB & 1000/1A CLASS-SP20-10VA FOR 1250~~

CUSTOMER: LSTK JOB FOR ISBL WORK OF 220kV GRID POWER IMPORT AT PAKIPAT REFINERY
LOA NO. RPRC182491/26286965 DTD.24.01.2020

OWNER:
INDIAN OIL CORPORATION LIMITED

CONSULTANT:
TATA CONSULTING ENGINEERS LIMITED



DEPT. CHD

ITEM RD

CODE VK

SCALE 1/4"

UNIT NO. N/A

DWG. NO. N/A

DATE 12.03.2020

REV. DATE

01 29/04/2020

CHD/APPD VK

REVISED AS PER TCE & IOCL COMMENTS

DT 19/03/2020

TITLE

220/33KV SWITCHYARD - KEY METERING & PROTECTION SINGLE LINE DIAGRAM

DRAWING/DOCUMENT NO.

TB-3-411-510-002

REV.

02

SHEET NO.

08

NO. OF SHEET.

08

SIZE-A3

Bharat Heavy Electricals Limited

Project: LSTK job for ISBL work of 220KV Grid Power Import at IOCL, Panipat Refinery

Technical Specification: 33kV AIS Local Isolation Breaker Panel with its Accessories

Doc No. TB-411-316-004 Rev 00

SECTION 2:

EQUIPMENT SPECIFICATION UNDER SCOPE OF SUPPLIES

1. Technical Specification for 33kV AIS Switchboard (LIB)
2. 33kV AIS Switchboard (LIB)- Technical Corrigendum 1
3. 33kV AIS Switchboard (LIB)- Technical Corrigendum 2

**TECHNICAL SPECIFICATION
FOR
33 KV AIS
SWITCHBOARD
(Standalone module complete in all
respect as per technical
specification, design basis & project
requirement)**

Abbreviations:

BIS	:	Bureau of Indian Standard
CT	:	Current Transformer
CRCA	:	Cold Rolled Cold Annealed
FRP	:	Fiber Reinforced Polyester
HV	:	High Voltage
LED	:	Light Emitting Diode
MCC	:	Motor Control Center
MCCB	:	Moulded Case Circuit Breaker
NO	:	Normally Open Contact
NC	:	Normally Close Contact
PT	:	Potential Transformer
PVC	:	Poly Vinyl Chloride
SWG	:	Standard Wire Gauge
VCB	:	Vacuum Circuit Breaker
VT	:	Voltage Transformer
XLPE	:	Cross linked Poly Ethylene

1. SCOPE

This specification covers the design, manufacture, testing, packing supply, storage at site, installation, site testing under supervision of OEM and commissioning of indoor, draw out type High Voltage standalone switchboard module for 33 KV system, incorporating Vacuum circuit breakers, CT, PT, relays etc complete in all respect. The purpose of standalone panel is to use as local isolation breaker (LIB) with demarcation of transformer differential and cable differential zone with due overlapping. The LIB shall have all required hardware for build up of transformer differential protection up-to LIB and provision of Cable differential, Transformer REF, SEF protection accordingly and as per project requirement.

The design and selection of equipments of switchgears and its components shall be in line with the design basis and design guidelines as mentioned in Section-1 chapter-2.

Each LIB shall be suitable for cable termination for both incoming and outgoing side suitable as per project requirement.

2. CODES AND STANDARDS

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

IS: 5	:	Colours for ready mixed paints and enamels
IS: 694	:	PVC-insulated cables for working voltages up to and including 1100 V
IS: 1248	:	Direct acting indicating analogue electrical measuring instruments and their accessories
IS: 2071	:	High Voltage Test Technique
IS: 2544	:	Porcelain post-insulators for systems with nominal voltage greater than 1000V
IS: 2705	:	Current transformers
IS: 3156	:	Voltage transformers
IS: 3231	:	Electrical relays for power system protection
IS: 3427	:	AC Metal enclosed switchgear and control gear for rated voltages above 1kV up to and including 52 kV
IS: 3618	:	Phosphate treatment of iron and steel for protection against corrosion
IS: 5082	:	Material data for aluminium bus bars
IS: 5578	:	Guide for marking of insulated conductors
IS: 6005	:	Code of practice of phosphating of iron and steel
IS: 9920	:	Switches and switch isolators for voltages above 1000 V
IS: 9921	:	AC disconnectors (isolators) and earthing

- switches for voltage above 1000V
- IS: 10601 : Dimensions of terminals of high voltage switchgear and control gear
- IS: 11353 : Guide for uniform system of marking and identification of conductors & apparatus terminals
- IS: 12661 : HV motor starters
- IS: 12729 : General requirements for switchgear and control gear for voltages exceeding 1000V
- IS: 13118 : General requirements for circuit breakers for voltages above 1000 V
- IS: 13703 : Low voltage fuses for voltages not exceeding 1000V ac or 1500V dc.

IEC 298 AC Metal enclosed switchgear and controlgear for rated voltages above 1kV and up to and including 52 kV.

IEC 529 Degree of protection provided by enclosures.

IEC 470 HV alternating current contactors.

IEC 694 Common specification for high voltage switchgear and controlgear

IS 9431 Indoor post insulators of organic material for systems with nominal voltages greater than 1000 V up to and including 300 kV.

IS 722 - A.C. Electric Meters.

IS 3618 Phosphate treatment of iron and steel for protection against corrosion.

IS 9385 High Voltage fuses

IS9046 - AC Contactors of voltage above 1000V up to & including 11000 V.

IS 694 - PVC insulated cables for working voltages up to & including 1100 V.

IS: 6875 - Control switches and push buttons.

IEC- 62271- 100: High-voltage alternating-current circuit-breakers

IEC- 62271- 200: AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV

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 Indian Electricity rules and other statutory regulations currently in force in the country.

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

2.5 In case of any contradiction between various referred standards/ specifications/ data sheet and statutory regulations the following order of priority shall govern:

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

All conflicts between the requirements of this specification & other relevant documents shall be referred to principal for resolution.

3. **SITE CONDITIONS:** Meteorological data to be used as mentioned in the relevant chapter of the section-1 and section-2.

4. **GENERAL REQUIREMENTS**

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

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

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

4.4 The equipment offered by the Bidder shall be complete in all respects. Any material and component not specifically stated in this specification but which are necessary for trouble free operation of the equipment and accessories specified in this specification shall be deemed to be included unless specifically excluded. All such equipment/ accessories shall be supplied without any extra cost. Also all similar components shall be interchangeable and shall be of same type and rating for easy maintenance and low spare inventory.

4.5 Specific reference in this specification and documents to any material by trade name, make or catalogue number shall be construed as establishing quality and performance requirements.

4.6 Site testing and commissioning activities shall be done under the supervision of OEM.

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4.7 The Internal Arc withstand shall be in the category IAC AFLR as per IEC62271-200 for 32.5 KA for 0.3 Sec. The bidder to offer the design of the panel in line with the Internal Arc compliance requirements only.

4.8 Enclosure and protection

4.8.1 The Switchgear boards shall have a single front, single tier, fully compartmentalized, metal clad construction complying with clause no. 3.102.1 of IEC-60298, comprising of a standalone floor mounted panels. Each circuit shall have a separate vertical panel with distinct compartments for circuit breaker truck/ trolley, cable termination, PT chambers, main busbars and auxiliary control devices.

4.8.2 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 item. The enclosure shall have complete protection against approach to live parts or contact with internal moving parts (IPH 6) as per IS: 3427.

4.8.3 The Switchboards shall be metal enclosed cubicle type, suitable for indoor installation, floor - mounting and free - standing. The design shall be totally enclosed, dust-tight, damp-proof and vermin proof offering degree of protection not less than IP4X.

4.8.4 Each panel shall be suitable for 33 KV cable terminations for both incoming and outgoing points as per project requirements.

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

4.8.6 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. The cable compartment shall have non hygroscopic phase separator.

4.8.7 The switchgear cubicles shall be rigid and robust in design & construction. Sheet steel used for fabrication shall be cold rolled. Cubicles shall be made from rigid welded structural frames made of structural steel sections or of pressed / formed sheet steel of not less than 3 mm thickness. The frames shall be enclosed by sheet steel of at least 2 mm thickness, smoothly finished, levelled and free from flaws. Stiffeners shall be provided wherever necessary.

- 4.8.8 All doors with frequent operation and usages shall be removable and supported by concealed type hinges. The hinges shall be strong and braced to ensure freedom from sagging, bending and general distortion of panel or hinged part.
- 4.8.9 The switchgear construction shall be such that the operating personnel are not endangered by breaker operation and internal explosions, and the front of the panels shall be provided in each high voltage compartment of a panel, so that in case of a fault in a compartment, the gases produced are safely vented out, thereby minimizing the possibility of its spreading to other compartments and panels. The pressure relief device shall not however reduce the degree of protection of panels under normal working conditions. The pressure relief device shall be the panel of the type tested design of the panel construction as per IEC-298-1981.
- 4.8.10 All identical equipment and corresponding parts shall be fully interchangeable.
- 4.8.11 Safety barriers/ shutters shall be provided to permit personnel to work safely within an empty compartment with the bus bars energised.
- 4.8.12 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.

The circuit breaker shall be lockable in "service" and "test" positions. Automatic non-metallic 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.

- 4.8.13 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".

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- 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.
 - LOTO is to be provided in the breaker in racked out condition.
- 4.8.14 All hardware shall be corrosion-resistant. All joints and connections of the panel members shall be made by zinc-passivated, or cadmium-plated, high-quality steel bolts, nuts and washers, secured against loosening.
- 4.8.15 Suitable removable type eyebolts shall be provided for the lifting of the panel/shipping section. These bolts, when removed shall not leave any opening in the panels.
- 4.8.16 All panels shall have IR thermographic imager window/ IR site glass for temperature monitoring.
- 4.8.17 All rear panel doors shall be provided with handles for ease of maintenance.

4.9 Accessibility

- 4.9.1 All relays, metering, and control components shall be mounted on the panel front only.
- 4.9.2 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-energizing the switchboard. All mounted equipment shall have identification tags of self-sticking PVC tapes at the rear also. In addition, identifications numbers shall be painted on the panel to give a permanent identification mark. Mounting of relays for a particular breaker feeder panel shall be limited to that particular feeder only.
- 4.9.3 All terminals shall be shrouded with plastic covers to prevent accidental contact.

4.10 Bus bar

- 4.10.1 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 and shall not be rated lower than the current rating of the incoming, sectionalizer and bus coupler breakers.
- 4.10.2 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.

- 4.10.3 Bus bars shall be housed in a separate chamber and shall be accessible for inspection. Wire guards or mesh shall be provided inside the enclosure to allow visual inspection of bus bars, to avoid accidental contact when the cover is removed.
- 4.10.4 Both bus bars and the supports shall be adequately sized and braced to withstand the specified short-circuit current for 1 second unless otherwise specified in data sheet. Dynamic stresses shall be calculated on the basis of the specified peak short-circuit current. All bus supports shall be of non-carbonising material, resistant to acids and alkalies.
- 4.10.5 Bus bars shall be insulated by using heat-shrinkable PVC sleeves. The sleeves 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 main bus bar and an aluminium foil wrapped closely around the insulation over a length of at least 5.00mm.
- 4.10.6 All bus bar joints and all tap-off connections from the main horizontal bus bars shall be provided with removable FRP shrouds.
- 4.10.7 Bus bars shall be prominently marked with Red, Yellow and Blue colour rings for easy phase identification at regular interval and at every power tap off point.
- 4.10.8 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. Care should be taken for thermal expansion of bus bar during full load/ short circuit condition.
- 4.10.9 The hot spot temperature for busbars including joints at design ambient temperature shall not exceed 85°C for normal operating conditions.
- 4.10.10 Only zinc passivated or cadmium plated high tensile strength steel bolts, nuts and washers shall be used for all bus bar joints and supports.
- 4.10.11 All busbar joints and bus tap joints shall be silver or tin plated. Joints shall be bolted type and shall be insulated. Spring washers shall be provided to ensure good contact at the joints.
- 4.10.12 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.
- 4.10.13 All insulating materials used shall be non-hygroscopic and shall be treated for preventing fungus growth. Surface of insulators shall be highly glazed and treated with silicone compounds to minimize accumulation of dust, condensation and tracking.

4.10.14 Bimetallic connectors shall be provided for connection between dissimilar metals.

4.10.15 The clearance between live bus bar and earth shall be as per relevant IS standard.

4.11 HV power connection

4.11.1 The incoming power connection shall be through XLPE cables and outgoing power connection shall be through XLPE cables, as indicated in the data sheet. Ample space for connection for these cables shall be provided at the rear of the switchboards. In order to avoid accidental contact in the cable compartment while carrying out inspection by opening the rear cover, a removable expanded metal barrier shall be provided in the cable compartment. Unless otherwise specified, the power cable shall enter the switchboard from the bottom. Non-magnetic cable gland plates shall be provided for feeders wherever single core cables are used.

4.11.2 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 as applicable in the standards.

4.11.3 In case the standard panel depth cannot accommodate the specified no. of cables, a rear extension panel of full height shall be provided. An earth strip shall also be brought to this extension panel.

4.11.4 Unless otherwise specified, all power cables shall enter the switchgear from the bottom.

4.12 Auxiliary wiring and terminals

4.12.1 Inside the cubicles, the wiring for control, signalling, protection and instrument circuits shall be done with BIS approved, PVC insulated, flame retardant type, copper conductor wire. The insulation grade shall be 660 V. The wiring shall preferably be enclosed in plastic channels or neatly bunched together. Wiring between HV breakers or cable compartments to relay and metering compartments shall be routed through flexible conduits. The conduits shall be clamped properly. No adhesives shall be used.

4.12.2 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 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. CT wires shall be color coded and shall have ring type lugs. Terminal blocks shall be suitable for ring type lugs.

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

4.12.4 PVC insulated copper conductor of cross section 1.5 mm² may normally be used provided the control fuse rating is 10 amps or less. For 16 amps control fuse circuit 2.5 mm² copper conductors shall be used. Each wire shall be terminated at a separate terminal. CT Circuit wiring shall be done with 2.5 mm² copper conductors. Shorting links/ suitable shorting arrangement for shorting CT secondary shall be provided.

4.12.5 Unless otherwise specified, all control cables shall enter the switchgear from the-bottom.

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

4.12.7 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.

4.12.8 The bus differential CT wiring shall be colour coded i.e. Red/Yellow/ Blue.

4.13 Control and indication

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

- a. One DC feeder shall be provided for each bus section. The bus coupler panel may be fed from any of the two supplies. There will be manual changeover switch to interconnect both the control supplies.
- b. One separate, single-phase power supply shall be provided for each bus section for feeding space heaters, compartment light etc. Supply voltage shall be 240 V AC, unless otherwise specified.
- c. Dedicated DC control supply is to be provided for all numeric relays.
- d. A Provision to receive DC and AC control supply shall preferably be provided in bus-coupler panel/ bus PT panel.

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

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Breaker 'CLOSE'	:	Red lamp
Breaker 'OPEN'	:	Green lamp
Breaker auto-trip	:	Amber lamp
Trip circuit healthy	:	White lamp
Spring charging	:	Blue lamp
Rear indicating lamps (optional)	:	R-Y-B

4.13.3 A common DC control supply fail indication shall be provided for each bus section with a blue coloured lamp. One alarm contact for remote indication is to be provided.

4.13.4 All lamps will be LED type indicating lamp.

4.13.5 Indication and alarm provision to be available for differential protection circuit control supply healthiness & failure.

4.14 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 minimum 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. 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.

4.15 Space heaters

The panels shall be provided with space heaters to prevent moisture condensation, and maintain cubicle temperature 5°C above the ambient. The space heaters shall be located at the bottom of the panel, and shall be controlled through a MCB and a thermostat with an adjustable setting. The thermostat shall preferably be located in the metering or relay chamber.

4.16 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.

4.17 Nameplates

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

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- 4.17.2 The nameplates for feeder compartments shall be in two parts. One part shall have necessary details pertaining to the compartments number of vertical panel of the switchboards. The other parts shall be removable and shall contain all details regarding the feeder number for drives/equipment controlled by the particular module as per approved single line diagram.
- 4.17.3 Blank nameplates shall be provided for all spare and vacant modules.
- 4.17.4 Nameplate or polyester adhesive stickers shall be provided for each equipment mounted inside the switchboard. Special warning plates shall be provided on removable covers or doors giving access to cable terminals and bus bars.
- 4.17.5 Special warning labels shall be provided inside the switchboards also, wherever considered necessary. Identification tags shall be provided inside the panels matching with those shown on the circuit diagram.
- 4.17.6 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.
- 4.17.7 Non removable labels are to be provided below the fuse base for control fuse rating in control panel compartment. The labels shall be of metallic strip permanently fixed below the fuse base.

4.18 Painting

- 4.18.1 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 coat of yellow zinc chromate primer. The under surface shall be made free from all imperfections before undertaking the finishing coat.
- 4.18.2 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.
- 4.18.3 Colour shade of final paint shall be as 631 of IS: 5 unless specified otherwise.
- 4.18.4 The finished panels shall be dried in staving 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.
- 4.18.5 All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust formation. If these parts are moving elements then they shall be greased

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5. SWITCHBOARD COMPONENTS

5.1 Circuit Breakers

- 5.1.1 Vacuum 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. No. of trolleys to be provided shall be as per data sheet. The breaker shall have phase separators (non-hygroscopic)
- 5.1.2 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.
- 5.1.3 Each breaker shall normally be provided with auxiliary contacts of 6NO+6NC directly operated from breaker operating mechanism. These contacts shall be in addition to those used in circuit breaker internal wiring. These contacts shall be rated for 10 amps at 240V AC and 2 amp (inductive breaking) at 220V dc. If more breaker auxiliary contacts are required, latching relay shall be used to multiply the contacts
- 5.1.4 The breakers shall have a motor-operated, spring-charged mechanism. It shall also be possible to charge the springs manually. The closing spring shall get re-charged (for subsequent closing) soon after a closing shot and prior to breaker tripping. In case the limit switch fails to cut out the spring-charging motor with the springs fully charged, the motor shall be automatically de-coupled. The control circuit shall be suitable for local as well as remote control. Breakers shall be trip-free and shall have an anti-pumping device. The breaker operating duty shall be 0-3 min-C0-3 min- CO, unless otherwise agreed.
- 5.1.5 The circuit breaker/s shall be of horizontal draw out construction, with horizontal isolation. The circuit breaker including its operating mechanism shall be mounted on a wheeled carriage moving on guides, designed to align correctly and allow easy movement on the circuit breaker.
- 5.1.6 Operating Mechanism
- Electric power operating mechanism shall be motor wound spring charged stored energy type. However, manual-operating mechanism may be of the spring charging stored energy type or the spring assisted type. For circuit breakers with electrical power operating mechanism, provision shall also be made for manual spring charging. Closing time of circuit breakers with manual operating mechanism shall be independent of the speed of the operating handle.
 - All stored energy operating mechanism shall be equipped with following features.

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- 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 universal motor operable on AC or DC control supplies.
 - ii) Provided with emergency manual charging facility. The motor shall be automatically, decoupled (mechanically) once the manual-charging handle is inserted.
 - iii) Closing operation of circuit breaker shall automatically initiate charging of the spring for the next closing operation without waiting for tripping of circuit breaker.
 - iv) Closing operation shall be completed once the closing impulse is given and the first device in the control scheme has responded even though the control switch/ Push Button is released provided no counter trip impulse is present.
- 5.1.7 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
- 5.1.8 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.
- 5.1.9 The breakers shall be provided with anti pumping & trip free provision. Each breaker shall be also provided with an operation counter.
- 5.1.10 Breaker operation shall fully on the spring energy without support of Spring charging motor.
- 5.1.11 Line PT shall be mounted in a separate drawout carriage or separate panel if adequate space is available in both SS-10 and SS-71.
- 5.1.12 The complete breaker assembly should have inter-changeability with breakers of identical ratings.

5.1.13 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.

5.1.14 No. and type of earthing trucks shall be as per data sheet.

5.2 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.

5.2.1 Current transformer (CT)

- i. Current transformers shall conform to IS: 2705. The short-time 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. One leg of the CTs shall be earthed. Separate CTs shall be provided for Differential and Restricted Earth fault protection shall be PS class CTs with suitable knee point voltages.
- ii. The bidder shall submit the design calculation on CT ratio, VA burden, Knee point voltage, accuracy class of the offered CTs during detailed engineering for approval on selection of CTs before initiation of manufacturing process.
- iii. Interposing CTs are not allowed for any kind of application including all types of differential protection.
- iv. All CTs shall be star connected.
- v. Proper access to each set of CTs shall be provided for repair/maintenance.
- vi. Prominent marking shall be done for differential CTs.
- vii. Bus differential & cable differential CTs shall be window type CT. The partial discharge shall be less than 20 Pico columbs.
- viii. The current transformer shall preferably be capable of being left open circuited on the secondary side with primary carrying rated full

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load current, without overheating or damage. Short time current rating & rated withstand time shall be same as corresponding circuit breaker.

- ix. Current transformer core laminations shall be of high grade silicon steel.
- x. The CT position should be selected in such a way proper overlapping zones are developed and no portion is left unprotected by differential protection.
- xi. In individual feeders, the protection CT and Bus differential CT shall be overlapped.
- xii. Distinct identification stickers shall be provided on all differential CTs for proper identifications.
- xiii. All type of CTs shall be of High voltage insulation grade, suitable as per switchgear design and no LT CTs is accepted.
- xiv. Separate core shall be provided for metering and protection purpose.
- xv. All the CT shall be provided with terminals and shorting links. One of the terminals of the CT shall be earthed. The polarity of the CT shall be clearly marked.
- xvi. The class of insulation for CTs shall be 'F'.

5.2.2 Voltage transformer (VT)

- i. The voltage transformers shall conform to IS: 3156. The voltage transformers shall be of draw out-type, and shall be provided with 4 pole miniature circuit breakers with auxiliary contacts on the secondary side. Primary side of the PT shall be protected by suitable HV HRC fuses.
- ii. The draw out mechanism shall disconnect the V.T. from the bus bars. The primary connection shall be disconnected before the VT become accessible. Neutral point of the star connected VTs both on the primary and secondary sides shall be earthed.
- iii. The VTs shall have an over-voltage factor of 1.8 for 8 hrs in line with requirements of ungrounded system, and an accuracy class of 1.0 from 10% to 120% of normal voltage.
- iv. The primary rated voltage shall be equal to the rated voltage V of the system, or $V/\sqrt{3}$, if the VT is connected between phase and neutral.
- v. The PT shall have independent core for protection and metering. The protection class shall be 3P or better.

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- xvii. The bidder shall submit the design calculation on PT ratio, VA burden, accuracy class of the offered PTs, construction details during detailed engineering for approval on selection of PTs before initiation of manufacturing process.
- vi. If not otherwise specified, the secondary voltage shall be 110 V, or 110/ 3 V. The burden and class of accuracy shall be as specified in data sheets.
- vii. Potential transformers shall be cast epoxy resin type. The potential transformers shall be of shell type single phase construction.
- viii. The potential transformers shall be capable of operating continuously at 110% of the rated voltage, without any damage. When star – star connection is required in non- effectively or ungrounded system, the potential transformers shall be suitable for continuous operation with a persistent phase to ground fault. Suitable damping resistors in secondary circuit may be considered as per system requirements to avoid ferro-resonance.
- ix. Maximum temperature rise of the transformer at rated burden and with rated primary voltage and frequency shall not exceed 40°C above an ambient of 50°C.
- x. The class of insulation for VTs shall be 'F'.

5.3 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, VTs, etc, shall be included in the scope of the switchboard supplier. The accuracy class for all instruments shall be 1.0 as per IS: 1248.

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

Electrical indicating instruments shall be with 90° deflection scale and provided with zero adjustment screw outside the cover.

5.3.1 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-

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linear compressed scale above rated current to indicate motor starting current.

5.3.2 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 VT secondary voltage of 110 V.

5.3.3 Frequency meters

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

5.3.4 Power factor meters

Power factor meters shall operate on a VT secondary voltage of 110 V. The CT secondary current shall be as shown 11 on the relevant drawings. The standard range shall be 0.5 lead-1.0-0.5 lag.

5.3.5 Multi-function meters:

The bidder has to provide multifunction meters on all the breakers with following specifications:

1. The MFM should be programmable type for CT and PT ratios , with 2 galvanically isolated digital output and 2 no's of analogue (4-20 mA) or(0-5V) suitable for Ethernet connectivity
2. The MFM should be programmable for
 - i. 3-phase 3 wire & 3-phase 4 wire
 - ii. 2 Analogue outputs separately configurable for different quantities
 - iii. 2 digital outputs
3. The transducer should at least measure the following quantities
 - i. Active power, (phase-wise , and total)
 - ii. Reactive power, (phase-wise , and total)
 - iii. Phase to Phase voltage
 - iv. Frequency
 - v. Current
 - vi. Power factor
 - vii. kWh

The 2 analogue output should be configurable independently for any quantity.

The MFM's soft communicable and necessary software should be part of supply

General Specifications for MFM's:

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1. Accuracy Class- 1 as per IEC 60688
2. Main frequency 45-55Hz
3. Measuring Voltage Un- 3ph x 50-300 V (Ph-N)
3ph x 50-500 V (Ph-Ph)
4. Measuring range- 0 to 120 % of Un
5. Maximum over voltage -2.5 Un for 1 sec
6. Nominal Measuring Secondary Current, In 1-5 amps
7. Measuring range upto 7.5 amps
8. Maximum overload current 25 In for 1 sec
9. Auxiliary supply, 80-260 VAC/VDC
10. Should have port for local programming
11. It should have Din rail mounting provision
12. Cut out size 96X96 mm

5.4 Surge Arrestor -NA

The surge arrestors shall be provided for all motor feeders and shall be metal oxide gap less type generally in accordance with IEC 60099-1 and suitable for indoor duty. These shall be mounted within the switchgear cubicle between line and earth, preferably in the cable compartment and shall be outside of the bus differential zone. Surge arrestor selected shall be suitable for non-effectively earthed system and rating shall be in such a way that the value of steep fronted switching over voltage generated at the switchgear terminals shall be limited to the requirements of switchgear. Bidder shall furnish temporary over voltage capability curve along with the bid.

- 5.4.1 The location of the surge arrestors shall be such that in the event of its failure bus differential protection shall not be operated i.e. the individual feeder protection shall clear the fault.

- 5.4.2 Please refer section-3 Chapter-14 for detailed specification on surge arrestors.

5.5 Relays

- 5.5.1 Type of relay will be latest state of art numerical relays.
- 5.5.2 All numeric protective relays shall be suitable for flush mounting, and fitted with dust-tight covers. Auxiliary relays are acceptable in fixed execution.
- 5.5.3 All tripping relays shall be separate from numerical relays and shall be of lockout type with hand-reset contacts, and shall be suitable to operate on the specified voltage. These relays shall have self coil cut off contacts, and shall be provided with hand-reset operation indicators. Tripping relays will be acceptable in non-draw out cases. Trip relay shall be VAJH type relays.
- 5.5.4 For numeric relays, refer to specification attached in Annex-11 to Annex-15.

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- 5.5.5 Complete manual- auto changeover and under-voltage schemes shall be built in numerical in soft logics. The logic applicable for the system shall be duly approved by IOCL during detailed engineering stage.

5.6 Auxiliary equipment

5.6.1 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. Multiplying relays used for logic shall be latch type/ VAJC type relays.

5.6.2 Control switches

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

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

5.6.3 Timers

All timers required specific to switchboard schemes shall be build up in the numerical relays and no additional timer to be provided.

5.6.4 Control Wiring

- All wiring for control, protection, alarm and indicating circuits on all equipment shall be carried out with at least 650V grade, PVC insulated, stranded, and tinned copper, 1.5 sq. mm. Conductors. For CT and PT wiring, minimum wiring size shall be 2.5 sqmm.
- All wiring shall be run on the sides of the panels and shall be neatly bunched and cleated without affecting access to equipment mounted in the panel. The control wiring shall be carried in PVC ducts with detachable snap-on cover and shall have enough length
- Where wiring enters or passes through compartments containing HV apparatus then they shall be in earthed metallic conduits or ducts.
- All wiring shall be taken to terminal blocks without joints or tees in their run.
- All wiring shall be colour coded as follows:

- Red, Yellow & Blue determined by the phase

Instrument Transformer AC circuit

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	with which the wire is associated
AC Phase Wire	- White
AC Neutral	- Black
DC Circuits	- Grey
Earth connections	- Green

- Engraved core identification ferrules or printed tube ferrules, marked to correspond with the wiring diagram shall be fitted to each wire.
- Ferrules shall fit tightly on the wires and shall be of interlocking type, without falling off when wire is removed. Ferrules shall be of white colour with black lettering. Each wire shall be identified by letter to denote its function followed by a number to denote its identity at both ends. All the wiring of trip circuit shall have a distinct ferruling system.
- All wiring for external connections shall be brought out to individual terminals on a readily accessible terminal block.
- All unused auxiliary contacts of the circuit breaker and relays shall be wired up to terminal block.

5.6.5 FITTINGS AND ACCESSORIES

- 5.6.5.1 Start' & 'Stop' push buttons shall be coloured green and red respectively. Reset push buttons shall be yellow in colour and test push buttons shall be blue in colour. All other push buttons shall be black in colour. All push buttons shall be of double break parallel contact design type.
- 5.6.5.2 Emergency stop push buttons shall be lockable in the operated position, i.e. push to operate and key to release type. Push buttons for emergency stop shall be recessed / shrouded type to avoid accidental operation.
- 5.6.5.3 Control & Selector Switches shall be of rotary type, having enclosed contacts accessible only after removal of cover.
- 5.6.5.4 All control & selector switches for circuit breakers and instruments shall be mounted on the front of the panel. Control switches for space heater/s and control supplies shall be mounted inside the panel.
- 5.6.5.5 Circuit Breaker control switches shall be provided with pistol grip handles. Selector switches shall be provided with round, knurled handles. All handles shall be black in colour. Properly designated name plates clearly marked to show the operating positions shall be provided on all switches.

- 5.6.5.6 Circuit breaker control switches shall be with pistol grip handle and shall have three position Trip – Neutral – Close with spring return to Neutral position. Switch operating mechanism shall prevent the switch from being operated twice successively in the same direction. Circuit breaker control switch shall have one NAC – contact along with other contacts as required.
- 5.6.5.7 All other instruments and selector switches shall have stay put contacts.
- 5.6.5.8 Contacts of all control & selector switches shall be rated for 10 Amps at 240V AC or 2 amps at 110V dc (Inductive break). Switch for space heater supply and control voltage supply shall normally be two pole rated for 25A A.C.
- 5.6.5.9 Control Terminal Blocks: Box – clamp type, 650V grade line-up terminals of minimum 2.5 sq.mm. size shall be provided. Connection to terminals shall not be from the back.
- 5.6.5.10 Not more than one wire on each side shall be connected on any terminal where duplication of terminals block/s is necessary, suitable solid bonding links shall be incorporated.
- 5.6.5.11 Terminal blocks at different voltage shall be segregated into groups and distinctly labelled.
- 5.6.5.12 Current transformer secondary leads shall be brought to terminal blocks having facility for short circuiting and grounding the secondary.
- 5.6.5.13 Terminals shall be numbered for identification and grouped according to function. Engraved back-on-white PVC labels shall be provided on the terminal blocks describing the function of the circuit.
- 5.6.5.14 Separate terminal stems shall be provided for internal and external wiring.
- 5.6.5.15 Control terminal blocks shall be so located that control cables are fully segregated from power cables. Suitable insulated or earthed metal race ways shall be provided for control wiring. Separate undrilled removable gland plate shall be provided for the control cables at the bottom of each panel.
- 5.6.5.16 Minimum 20% spare terminals shall be provided for future use.
- 5.6.5.17 Nameplates & Labels: One nameplate giving designation of the HV switchboard shall be affixed prominently on top of the switchboard. Details of designation will be specified.
- 5.6.5.18 Labels giving following details shall be affixed on each feeder panel:

i) Feeder No.

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ii) Equipment reference No. & description

iii) Rating (HP / KW / KVA / Amp.)

- 5.6.5.19 All components whether mounted inside or on the door shall be permanently & clearly labelled with reference number and/or letter or their function. Rating of fuse shall be part of fuse designation. Paper labels, stickers or labels fixed with adhesives are not acceptable. All labels shall be properly fixed by screws with provision to prevent distortion due to expansion.
- 5.6.5.20 All labels shall be non-corroding, preferably laminated plastic or rear engraved perspex with white letters on black background.
- 5.6.5.21 Labels for feeder panel designation fixed on front side shall be fitted with chrome-plated, self-tapping, countersunk-head screws. These labels shall be of identical size to permit Interchangeability.
- 5.6.5.22 Space-Heaters: Adequately rated anti-condensation space heaters shall be provided in each cubicle.
- 5.6.5.23 Space heater/s shall be strip type, rated for operation at 240V, single phase 50 Hz AC supply unless otherwise specified.
- 5.6.5.24 Each space-heater shall be complete with a rotary type ON/OFF switch, HRC fuse in the phase, neutral link in neutral and a control thermostat with temperature range of 25 – 75⁰C.
- 5.6.5.25 The space heaters shall be rated for maintaining the panel inside temperature 10°C above outside ambient temperature.
- 5.6.5.26 Cubicle Lighting: Each cubicle shall be provided with interior lighting by means of 20W fluorescent tube light fixture. An ON / OFF switch shall be provided. The lighting fixture shall be suitable for operation from a 240V, single phase, 50 Hz, A.C. supply unless otherwise specified.
- 5.6.5.27 Auxiliary Supply: Auxiliary supply for control, indication, space heater, etc. shall be made available at one point on the switchboard. Vendor shall provide suitable distribution of auxiliary supply in the switchboard.
- 5.6.5.28 Fuses: All fuses in control, indication & metering circuit shall be HRC link type fuse fitting.
- 5.6.5.29 Mounting of fuse fitting shall ensure adequate dissipation of heat generated and shall facilitate inspection & easy replacement of fuse.
- 5.6.5.30 Cable Termination: The switchboard panel shall be complete with suitable cable and sealing boxes for termination of various types & no. of cables as specified elsewhere. Cable and sealing box shall

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preferably be mounted inside the panel. Where XLPE cables are indicated cabling space & clearances shall be adequate for heat shrinkable termination.

5.6.5.31 Two earthing terminals shall be provided in each panel in cable box/cabling chamber, for earthing or armour / screen.

5.6.5.32 Where more than one core is terminated on each phase, links suitably designed and properly supported shall be provided to avoid unnecessary bending of cable cores, without decreasing the length of insulated cable tail. Electrical clearances which would normally be obtained when using one core per phase shall be maintained.

5.6.5.33 Compression type cable glands shall be provided for other power & control cables with PVC / XLPE insulated cables.

5.6.5.34 Where core-balance type current transformers are provided on switchgear feeder circuit cable/s for earth fault protection sufficient space, clearance and supporting / mounting arrangement shall be provided for the current transformer.

5.6.5.35 When specifically called for, a throat connection may be provided for connection to the bus trunking for incoming supply.

5.6.5.36 Infra-red window to be provided for IR thermography.

5.6.5.37 Indicating Lamps

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

- Indicating Lamps

Indicating Lamp shall be LED type with Lamp covers shall be provided with interchangeable coloured lenses of perspex or equivalent unbreakable material. The lenses shall not discolour in course of time due to heat of the lamp

Following colours shall be used for the function indicated, unless otherwise specified: -

Red - Circuit breaker 'ON'

Green - Circuit breaker 'OFF'

White - Continuous trip circuit supervision

Amber Auto trip

Blue - Spring charged

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White - Service Position

R,Y,B -

Potential indication only in PT panel

5.7 Test Facilities

- i) Switching devices shall have the facility to be test-operated when isolated.
- ii) Withdrawable switching devices shall be supplied with a test link to allow testing in the withdrawn position.
- iii) Facilities shall be provided for primary injection testing.
- iv) Additional test equipment which may be required (e.g. test block).