



BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS ENGINEERING MANAGEMENT
NOIDA

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TYPE OF DOC.	Technical Specification			NAME	DKS	VK AG	
TITLE.				SIGN	-sd- [Signature]	-sd- [Signature] [Signature]	
Engineering Services: (a) Consultancy services for Approval of Plans/ Designs/ Drawings/ Specifications of Equipment, Civil Work, Structural Work, Foundation Work & Electrical System along with Quality Assurance Plans etc. (b) Engineering service for carrying out electrical power system study etc.				DATE	28.10.19	28.10.19 28.10.19	
				GROUP	TBEM		
				WO NO.	--		
CUSTOMER		Indian Oil Corporation Limited (IOCL)					
CONSULTANT		--					

PROJECT	LSTK (Lump sum Turn Key) job for ISBL (inside Battery Limit) work of 220KV Grid Power Import at IOCL, Panipat Refinery
TENDER NO./ NOA NO.	RPRC182491 dtd. 01.02.2019

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Remarks: 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 may furnish list of conflicts/ ambiguities/ deviations (Annexure-B), if any. Any conflicts/ ambiguities/ deviations mentioned elsewhere in technical offer shall not be reviewed

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Bharat Heavy Electricals Limited

Project. LSTK job for ISBL work of 220KV Grid Power Import at IOCL, Panipat Refinery
Technical Specification. Engineering Services for ISBL work of 220KV Grid Power Import at
IOCL, Panipat Refinery
Doc. No. TB-CS-316-001

Section 1: Scope, Project specific technical requirements & Bill of Quantities

This section covers following,

- 1.1 INTRODUCTION
- 1.2 PROJECT SCOPE UNDER LSTK CONTRCATOR
- 1.3 SCOPE UNDER BIDDER/ ENGINEERING SERVICE PROVIDER
- 1.4 GENERAL INFORMATION
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Section 1: Scope, Project specific technical requirements & Bill of Quantities

1.1 INTRODUCTION

Indian Oil Corporation Limited (IOCL), Panipat Refinery is in the process of developing infrastructure to import 70 MW power from grid at 220 KV. The ISBL (Inside Battery Limit) jobs starting from terminal point of 220KV transmission line up to Generation Board at Refinery premises includes provision of new 220KV full GIS Switchgear including Transformers and allied switchboards, protection and automation.

1.2 PROJECT SCOPE UNDER LSTK CONTRACTOR

The brief scope of ISBL work for this project include Design, Detailed Engineering, Drawing Preparation and Approvals, Electrical System Study Soil investigation, Procurement, Supply, Manufacture, Fabrication, Inspection & Expediting, Third Party Inspection, carrying out route Surveys, Statutory Clearances, Liaisoning with HVPNL, Transportation of all equipment/ Materials to the work site, Storage, Material Management, Project Management, Construction, Assembling, Installation, Testing, pre-commissioning, Commissioning and handing over of 220 KV infrastructure facilities inside battery limit area of Panipat Refinery on Single Point Responsibility (LSTK) Basis. ISBL jobs will mainly consist of, but not limited to, modification/ up-gradation of internal power distribution network in PRPC complex for absorbing grid power up to 70MW in the system including switch yard. ISBL category covers jobs starting from 220KV terminal point of transmission line in refinery up-to Generation Board at Refinery premises. This includes the following:

- a. Construction of 11 bays, 220KV GIS Switchyard with allied switchgear and protective equipment.
- b. Provision of 04 nos. of 220/33 KV 50 MVA grid transformers
- c. Substation building including all related civil and mechanical works
- d. Provision of Power evacuation system up to existing 33 KV switchboards at PR and PNC plants.
- e. Provision of 02 nos. of 33KV AIS extension panel at PR substation & 2 nos AIS panels at PNC end
- f. Fault current limiters for installation in parallel of URT.
- g. Provision of control, monitoring, metering & synchronization facility
- h. Implementation of contingency based fast power load shedding.

1.3 SCOPE UNDER BIDDER/ ENGINEERING SERVICE PROVIDER

The purpose of this specification is to assign/ deploy the engineering consultant for providing the services for approval for all the plans, design, drawings and specifications of all equipment, civil work, structural work, foundation work, GIS system and all other electrical system along with Quality Assurance Plans etc. in all respect.

In addition to this, the technical specification also covers the requirements to assign / deploy the engineering service provider for carrying out electrical power system study etc. complete in all respect.

Any service not specified below but is required to be necessary for successful completion of the complete ISBL with OSBL facility is considered to be part of scope of engineering services, however, engineering services to be provided shall cover the following on broad basis,

1. Consultancy services for approval for all the plans, design, drawings and specifications of all equipment, civil work, structural work, foundation work, GIS system and all other electrical

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system along with Quality Assurance Plans etc. complete in all respect.

2. Engineering services for carrying out electrical power system study etc. complete in all respect.

2. Coordination and liaisoning with customer for approval for all the plans, design, drawings and specifications of all equipment, civil work, structural work, foundation work, GIS system and all other electrical system complete along with Quality Assurance Plans etc. in all respect.

1.4 GENERAL INFORMATION

The specification comprises of following sections,

Section-1 : Scope, Project Specific Technical Requirements & Bill of Quantities.

Section-2 : Specification for Equipment/ Service.

Section-3 : Annexures
Annexure-A (Schedule of Technical Deviations)
Annexure-B (Compliance Certificate)

The following order of priority shall be followed. In case of conflict between requirements specified in various documents/ standard/ specification and statutory requirements, the most stringent one shall be followed. LSTK Contractor/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,

- 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 etc.

2. Section-1

3. Section-2

4. 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. LSTK Contractor/BHEL/ customer will resolve listed conflicts prior to award. In case of ambiguity, bidder shall inform LSTK Contractor/BHEL/ customer for their interpretation. In case bidder fails to convey the same prior to award, the Owner's decision on interpretation shall be considered final and binding 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 may furnish list of conflicts/ ambiguities/ deviations (Annexure-B), if any. Any conflicts/ ambiguities/ deviations mentioned elsewhere in technical offer shall not be reviewed.

The engineering service(s) is required for the following project:

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

Note:

The complete scope, please refer the commercial terms and conditions enclosed separately with the notice inviting tender/ enquiry.

1.5 SPECIFIC TECHNICAL REQUIREMENTS

The specific technical requirements shall be as per the following details,

1. The total project is being executed in Lump-sum Turnkey (LSTK) basis.
2. The specific technical requirements shall in line with customer technical specification/ comments provided by Customer time to time after award of work.
3. The Consultancy Firm/ Agency shall interact closely with LSTK Contractor/BHEL/ Customer for any input/ clarification/ comments and finalize details across the table.
4. The overall project shall be executed within completion period of 24 months.

1.6 ENGINEERING DRAWING/ DOCUMENT/ QUALITY ASSURANCE PLAN APPROVAL

The general modus operandi for the engineering service provider shall be as follows,

1. Finalize plot plan and basic drawings/ documents along with LSTK contractor based on equipment sizes, site restrictions, maintenance & shutdown considerations, operational, safety, construction access and statutory requirements like Oil Industry Safety Directorate (OISD) etc.
2. Specify the Master Drawing Lists of critical drawings/ documents/ quality assurance plans for the project including categorization of drawings as "Drawings/ documents/ quality assurance plans requiring Approval" and "Drawings/ documents/ quality assurance plans for Reference". Further Electronic mail transfer facility/ other state-of-the art communication facilities should be adopted for approval of drawings/ documents/ quality assurance plans for expediting the entire process.
3. **"Drawings/ documents/ quality assurance plans requiring Approval" shall be marked as Category-1 (Approval without any comments), Category-2 (Approval with comments), Category-3 (Not approved, resubmission required) and Category-R (For information, comments, if any is to be complied). Engineering certification shall be required from BHEL/ LSTK Contractor for ascertaining category of Drawings/ documents/ quality assurance plans in approval/ information category for payment purpose.**
4. Engineering consultant shall approve all critical drawings/ documents/ quality assurance plans submitted by LSTK contractor within 7 (Seven) working days from the date of submission and all other Drawings/ documents/ quality assurance plans within 10 (Ten) days. To expedite the process of approval across the table at designated design centers (within India) may also have to be taken up on a regular basis.
5. For Drawings/ documents/ quality assurance plans, the updated consolidated status indicating their submission, review & approval etc. should be made available by consultant to LSTK Contractor/ BHEL/ Customer through electronic mails. All Drawings/ documents/ quality assurance plans shall be properly signed & stamped with type of approval for identification.
6. Engineering consultant shall undertake management of archives including proper documentation, listing, indexing and updation of all documents/drawings under the project etc.
7. In addition to above, engineering service provider shall carry out electrical power system study etc. complete in all respect and same shall be reviewed and approved for onward

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submission to customer.

1.7 BILL OF QUANTITIES/ SCHEDULE OF ITEMS

The Schedule of Items/ Bill of Quantities shall be as per Annexure-BOQ. The bidder is required to quote competitive rates for all items without fail.

However, the details shown in Annexure-BOQ are tentative and non-exhaustive and may vary to any extent as per project specific requirements and comments from LSTK Contractor/ BHEL/Customer during detailed engineering stage.

In case, there is requirements of any other drawing/ data/ documents for completion of the scope, shall deemed to be included in bidder's scope without any addition claim. Conversely, if there is drawing/ data/ documents mentioned in the BOQ but same is not required and scope of work is completed, payments for the same shall be done considering the scope completion.

1.8 SCHEDULE OF PAYMENT

Schedule of payments shall be as per following details,

Sl. No.	Pre-requirements	Payments
I. For BOQ Item Sl. No. A.1, A.2, A.3, A.4, A.5, A.6 & A.7		
I.(i)	Engineering Certification for Approval/ Information Category for BOQ Item Sl. No. Mentioned above	90% of pro-rata rates of quoted rates for Sub-Item of Sl. No. mentioned above. Pro-rata rates shall be taken on the basis of total no. of drawings/ documents to be decided during detailed engineering/ BBU submitted by bidder for above items.
I.(ii)	Engineering Certification for Completion of activity in all respect for BOQ Item Sl. No. Mentioned above	Balance 10% quoted rates for Item Sl. No. mentioned above
II. For BOQ Item Sl. No. B		
II.1	Engineering Certification for Approval/ Information Category for BOQ Item Sl. No. Mentioned above	90% of pro-rata rates of quoted rates for Sub-Item of Sl. No. mentioned above. Pro-rata rates shall be taken on the basis of total no. of drawings/ documents to be decided during detailed engineering/ BBU submitted by bidder for above items.
II.2	Engineering Certification for Completion of activity in all respect for BOQ Item Sl. No. Mentioned above	Balance 10% quoted rates for Item Sl. No. mentioned above
III. For BOQ Item Sl. No. C		
III	On submission of claim after visit	100% of quoted rates

1.9 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:

kV: Kilovolt
Hz: Hertz

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IP:	Ingress Protection
PE:	Poly Ethylene
ANSI:	American National Standards Institute
ASTM:	American Society for Testing and Materials
BIS:	Bureau of Indian Standards
BS:	British Standard
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
OISD:	Oil Industry Safety Directorate
CCE:	Continuous and Comprehensive Evaluation
LPCB:	Loss Prevention Certification Board
CCOE:	Chief Controller of Explosives
OEM:	Original Equipment Manufacturer
BHEL:	Bharat Heavy Electricals Limited
OISD:	Oil Industry Safety Directorate
IOCL:	Indian Oil Corporation Limited
HVPNL:	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
AIS:	Air Insulated Sub-station
GIS:	Gas Insulated Sub-station
URT:	Unit Ratio Transformer
QAP:	Quality Assurance Plan
BOQ:	Bill of Quantities

1.10 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 Project.
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
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.

			ANNEXURE-BOQ
SCHEDULE OF ITEMS/ BILL OF QUANTITIES			
Sl. No.	Description	Unit	Qty
A	Consultancy Services for Approval of Plans/ Designs/ Drawings/ Specifications of Equipment, Civil Work, Structural Work, Foundation Work & Electrical System along with Quality Assurance Plans etc.		
1	Electrical	LS	1
1.1	Design calculation for selection of equipment rating & system design		
1.2	Key Single line diagram with rating of each equipment		
1.3	Protection Single line diagram with all details of relays and wiring		
1.4	Electrical Layout (Plan & Elevation/ Sections), Clearance layout/ diagram		
1.5	Equipment short circuit calculation		
1.6	Substation Structural layout/ Structure Loading Diagram		
1.7	Control room equipment layout		
1.8	Grounding design		
1.9	Grounding layout		
1.10	Lightning protection design		
1.11	Lightning protection layout		
1.12	Cable trench & tray layout (Plan & Elevation/ Sections) including cabling details		
1.13	DC System design & drawings		
1.14	AC System design & drawings		
1.15	Substation Erection drawing, list of hardware & Erection sag chart		
1.16	Metering bay Erection drawing, list of hardware		
1.17	Cable and Lines Erection drawing, list of hardware & Erection sag chart (220kV Line & 33kV Cable etc.)		
1.18	Design & drawing of Illumination system		
1.19	Design & drawing of Load shedding, Load management, ECS & SCADA system		
1.20	Design & drawing of Air Conditioning system		
1.21	Design & drawings of plant communication, fire alarm system, PA system etc.		
1.22	Design & drawings of Fire fighting facility/ system		
2	Civil & Structural	LS	1
2.1	Foundation layout drawing for Substation		
2.2	Design & drawing of Equipment foundation & foundation bolts		
2.3	Design & drawing of GIS Building cum Control Room building		
2.4	Design & drawing of Substation Equipment structure		
2.5	Design & drawing of Transformer foundation including oil collection pit etc.		
2.6	Design & drawing of transformer including oil collection pit etc.		
2.7	Design & drawing of Substation Roads, Drains, fence and gate etc.		
2.8	Layout drawing of Substation Roads, Drains, fence and gate etc.		
3	Manufacturer's Drawings, Data, Manuals	LS	1
3.1	Technical Particulars		
3.2	General arrangement drawing & Parts List		
3.3	Control Schematic drawing with Wiring diagram/ Terminal numbers		
3.4	Quality Assurance Plan & Inspection Test Procedure/ Schedule		
3.5	Installation, Commissioning, Operation & Maintenance Manual of equipment		
3.6	Spares list		
4	Manufacturer's Drawings, Data, Manuals for Control, Protection and Management System	LS	1
4.1	Technical Particulars & system write-up		
4.2	General arrangement drawing & Parts List		
4.3	Schematic drawing with Terminal numbers		
4.4	Protection settings		
4.5	Quality Assurance Plan & Inspection Test Procedure/ Schedule		
4.6	Installation, Commissioning & Operating Manuals of system		
4.7	Spares list		
5	Cable Schedule & Interconnection	LS	1
5.1	Control cable schedule & Interconnection		

SCHEDULE OF ITEMS/ BILL OF QUANTITIES			
Sl. No.	Description	Unit	Qty
5.2	Power cable schedule & Interconnection		
6	Electrical Power System Study & Relay Coordination Reports	LS	1
6.1	Load flow studies reports		
6.2	Short circuit and transient stability studies reports		
6.3	Grid Islanding setting derivation reports		
6.4	Load shedding adequacy check reports		
6.5	Protection co-ordination reports of new system		
6.6	EMTP studies reports(for switching / dynamic over-voltages, insulation coordination etc.)		
7	Miscellaneous	LS	1
7.1	Comprehensive & detailed Bill of Quanties for Project		
7.2	Project Engineering documentation schedule		
7.3	Any other relevant drawing/ data/ document necessary for satisfactory installation and commissioning and completion of project		
B	Engineering Service for carrying out electrical power system study etc.	LS	1
1	Load flow studies reports		
2	Short circuit and transient stability studies reports		
3	Grid Islanding setting derivation reports		
4	Load shedding adequacy check reports		
5	Protection co-ordination reports of new system		
6	EMTP studies reports(for switching / dynamic over-voltages, insulation coordination etc.)		
C	Visit to Project Site/ Customer's Office/ LSTK Contractor's Office/ Design Center/ HVPNL Office etc.	LS	1
1	Visit to Project Site/ Customer's Office/ LSTK Contractor's Office/ Design Center/ HVPNL office for expediting the process of consultancy services for approval of Plans/ Designs/ Drawings/ Specifications of Equipment, Civil Work, Structural Work, Foundation Work & Electrical System along with Quality Assurance Plans etc.	Mandays*	20
2	Visit to Project Site/ Customer's Office/ LSTK Contractor's Office/ Design Center/ HVPNL office for collection of data/ drawings / documents for carrying out the electrical power system study. In addition to this, all kinds of co-ordination and approval of 220kV switchyard from HVPNL.	Mandays*	10

Note:

1. *** Lumpsum allowance per day including boarding, lodging, local conveyance, etc., all inclusive. (BHEL shall pay to & fro 1st AC fare from Bidder's headquarters to Project Site/ Customer's Office/ LSTK Contractor's Office/ Design Center/ HVPNL Office for each visit separately).

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Details for Manufacturer Equipment/ System

Sl. No.	Description	Unit	Approx. Qty	
I.	Manufacturer Equipment/ System for BOQ Item Sl. No. A.3: The Manufacturer Equipment/ System along with quantities shall be as per following details but not limited to this and hence may vary during detailed engineering,			
1	Transformers			
	220/33kV, 50/65 MVA, ONAN/ONAF Transformers with NIFP based fire fighting system, online oil dehydration system, OLTC along with all accessories.	No	4	
2	Isolators			
2.1	220kV, 2000A, 3X1 Phase, HCB Isolator (Electrically operated mechanically ganged) with one earth switch (Electrically operated mechanically ganged) complete with operating mechanism boxes and accessories etc. excluding support insulators, structure and terminal connectors.	Set	2	
3	Surge Arresters			
3.1	198kV, 10kA, class-III, 1 Phase Surge Arrester (SA) complete with surge monitor and insulating base as per specification, complete with accessories	No	6	
4	Current Transformer			
4.1	220kV, 1 Phase Tariff Metering Current Transformer	No	6	
5	Voltage Transformer (CVT/EMVT)			
5.1	220kV, 8800pF, 1 Phase Capacitor Voltage Transformer (CVT), (220/ $\sqrt{3}$ kV)/(110/ $\sqrt{3}$ V)/(110/ $\sqrt{3}$ V)/(110/ $\sqrt{3}$ V)	No	6	
5.2	220kV, 1 Phase Tariff Metering Potential Transformer	No	6	
6	Wave Trap			
6.1	220kV, 1 Phase Wave Trap, 2000A, 0.5mH [#]	Set	2+2 [#]	
7	Bus Post Insulator			
7.1	220kV Post Insulator			
	- Insulators for Wave Trap	Lot	1	
	- Insulators for Bus Support	Lot	1	
7.2	220kV Post Insulator			
	- Insulators for Isolators	Lot	1	
8	220kV GIS			
8.1	220kV GIS, as per specification	Lot	1	
8.1.1	Line Bay	Set	1	
8.1.2	ICT Bay	Set	4	
8.1.3	Spare Bay	Set	4	
8.1.4	Bus Coupler Bay	Set	1	
8.1.5	Bus Voltage Measurement with Bus Earth Switch Bay	Set	2	
8.1.6	Bus Surge Arrester Bay (1Set=3x1 phase)	Set	2	
8.2	Local Control Cubical (LCC) for GIS Bays	Lot	1	
8.3	GIS Support Structure	Lot	1	
8.4	GIS Earthing Material	Lot	1	
8.5	GIS Cabling (GIS bays to LCC)	Lot	1	
8.6	Initial filling of SF6 gas (including usual losses during commissioning and putting into commercial operation of GIS)	Lot	1	
8.7	GIB Duct with structure	Lot	1	
8.8	SF6 to Air Termination (1 Phase)	No	6	
8.9	SF6 to Oil Termination (1 Phase)	No	12	
8.10	SF6 to Cable Termination (1 Phase)	No	12	
8.11	SF6 Gas Monitoring System	Lot	1	

8.12	Partial Discharge Monitoring System	Lot	1	
9	MV Switchgear			
9.1	33kV AIS Local Isolation Breaker (LIB) Panel	Set	4	
9.2	33kV Fault Current Limiter Panel	Set	4	
10	220kV Power Cables			
10.1	220kV, 3Cx300sqmm, XLPE Cable	Lot	1	
10.2	220kV, 3Cx400sqmm, XLPE Cable	Lot	1	
10.3	220kV, 1Cx630sqmm, XLPE Cable	Lot	1	
11	LT Power and Control Cables			
11.1	1.1kV grade Power & Control Cable	Lot	1	
12	MK-JB			
12.1	Bay Marshalling Kiosk	Lot	1	
13	220kV CT-JB)			
13.1	Current Transformer Junction Box	Lot	1	
14	220kV VT-JB)			
14.1	Voltage Transformer Junction Box	Lot	1	
15	Battery System			
15.1	220V Battery Bank System (Ni-Cd)	No	2	
15.2	48V Battery Bank System (Ni-Cd)	No	2	
15.3	48V Battery Bank System (Ni-Cd) for HVPNL Mundh S/Stn	No	2	
16	UPS System			
16.1	110V, 25kVA (min), Parallel redundant UPS with Ni-Cd Battery Set	Set	2	
17	Battery Charger			
17.1	220V Battery Charger (Float cum Boost)	No	2	
17.2	48V Battery Charger (Float cum Boost)	No	2	
17.3	48V Battery Charger (Float cum Boost) for HVPNL Mundh S/Stn	No	2	
18	LT Distribution Boards (AC & DC)			
18.1	415V AC Distribution Board	No	1	
18.2	415V Emergency Distribution Board	No	1	
18.3	415V Main Lighting Distribution Board	No	1	
18.4	415V Emergency Lighting Distribution Board	No	1	
18.5	220V DC Distribution Board	No	1	
18.6	48V DC Distribution Board	No	2	
19	Illumination System			
19.1	Indoor Illumination System	Lot	1	
19.2	Outdoor Illumination	Lot	1	
20	Clamps and connectors			
20.1	Clamp & Connectors	Lot	1	
21	String Insulators			
21.1	120KN Disc Insulators	Lot	1	
21.2	Stringing hardware	Lot	1	
22	Overhead Conductor Materials			
22.1	ACSR Moose Conductor	Lot	1	
23	Bus Bar Material			
23.1	4" IPS Aluminium Tube	Lot	1	
24	Shield Wire Material			
24.1	Shield Wire 7/9 SWG	Lot	1	
25	Earthing Material			
25.1	40mm MS Rod	Lot	1	
25.2	75x12mm GI Flat	Lot	1	
25.3	50x6mm GI Flat	Lot	1	
26	Rod/ Pipe Electrode			
26.1	Rod Electrode	Lot	1	
26.2	Pipe Electrode	Lot	1	
27	Cable Trench Material			
27.1	Cable Support	Lot	1	
27.2	Cable Trays	Lot	1	
28	GI/ HDPE Pipes			

28.1	GI/ HDPE Pipes including bends for cabling	Lot	1	
29	Sump Pump			
29.1	Centrifugal pump for sump pit	Lot	1	
II.	Manufacturer Equipment/ System for BOQ Item Sl. No. A.3: The Manufacturer Equipment/ System along with quantities shall be as per following details but not limited to this and hence may vary during detailed engineering,			
1	PLCC			
1.1	PLCC Equipment	Set	1	
2	Control & Relay Panels			
2.1	Control & Relay Protection Panel	Lot	1	
2.2	Bus Bar Protection Panel	Lot	1	
3	SCAP, Transducer Panel, Energy Metering & Grid Islanding Panels			
3.1	Synchronization Control & Annunciation Panel (SCAP)	Lot	1	
3.2	Central Transducer Panel	Lot	1	
3.3	Grid Islanding Panel	Lot	2	
4	SAS, LMS & ECS Modification			
4.1	Sub-Station Automation System (SAS)	Lot	1	
4.2	Load Management System (LMS)	Lot	1	
4.3	ECS Modification & Integration	Lot	1	
5	PA System/ Telephone System			
5.1	PA System	Lot	1	
5.2	Telephone System	Lot	1	
6	DGFA Panel			
6.1	DGFA Panel	Lot	1	
7	LAN System			
7.1	LAN System	Lot	1	

Bharat Heavy Electricals Limited

Project. LSTK job for ISBL work of 220KV Grid Power Import at IOCL, Panipat Refinery
Technical Specification. Engineering Services for ISBL work of 220KV Grid Power Import at
IOCL, Panipat Refinery
Doc. No. **TB-CS-316-001**

Section 2: Specification for Equipment/ Service

This section covers following,

- 1.1 ENGINEERING DESIGN BASIS-ELECTRICAL
- 1.2 ENGINEERING CONSULTANT
- 1.3 ELECTRICAL SYSTEM STUDY
- 1.4 ANNEXURE-S2/C1/2-TENTATIVE BOQ FOR LSTK CONTRCATOR
- 1.5 ANNEXURE-S2/C1/17-GENERAL ELECTRICAL LAYOUT (GELO)
- 1.6 ANNEXURE-S3/C1/3-220kV GIS SLD
- 1.7 ANNEXURE-S2/C1/5-INTERCONNECTION SLD OF PR
- 1.8 ANNEXURE-S2/C1/6-INTERCONNECTION SLD OF PNCP
- 1.9 ANNEXURE- ELECTRICAL SYSTEM STUDY- CORRIGENDUM

SECTION -1

CHAPTER-2

ENGINEERING DESIGN BASIS ELECTRICAL

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1.0 SCOPE

This design basis is indicative guidelines only. Total system design based on the applicable standards, HVPNL guidelines, CEA guidelines & system design basis shall be the responsibility of LSTK bidder. In case of any conflict between statutory requirements, this design basis and standard design philosophy, the most stringent requirement shall govern.

2.0 ABBREVIATIONS, CODES & STANDARDS / PUBLICATIONS

2.1 ABBREVIATIONS

Code	Description
AC	Alternating Current
ACB	Air Circuit Breaker
ASB	Auxiliary Service Board
CBCT	Core Balance Current Transformer
CEA	Central Electricity Authority
CT	Current Transformer
DC	Direct Current
DCP	Data Concentrator Panel
DG	Diesel Generator
DGMS	Director General Mines Safety
DOL	Direct On Line
EHV	Extra High Voltage
ELCB	Earth Leakage Circuit Breaker
LSTK	Emergency Power Control Center
EPMCC	Emergency Power cum Motor Control Center
FRLS	Flame Retardant Low Smoke
GI	Galvanised Iron
GTG	Gas Turbine Generator
HMI	Human Machine Interface
HSR	High Availability Seamless Redundancy
HV	High Voltage
IEC	International Electro-Technical Commission
LDB	Lighting Distribution Board
LV	Low Voltage
MCC	Motor Control Centre
MCCB	Moulded Case Circuit Breaker
MOV	Motor Operated Valve
MV	Medium Voltage
NGR	Neutral Grounding Resistor
OLTC	On Load Tap Changer
PCC	Power Control Centre
PESO	Petroleum & Explosive Safety Organisation
PLC	Programmable Logic Control
PMCC	Power Cum Motor Control Centre
PRP	Parallel Redundancy Protocol
PT	Potential Transformer
PTB	Physikalisch-Technische Bundesanstalt
PVC	Polyvinyl Chloride
RCC	Reinforce Cement Concrete
RSTP	Rapid Spanning Tree Protocol
SFU	Switch Fuse Unit
SPN	Single Phase & Neutral
STG	Steam Turbine Generator
TP	Three Phase
TPN	Three Phase & Neutral
UPS	Uninterrupted Power Supply

2.2 CODES & STANDARDS / PUBLICATIONS

The main codes and standards, considered as minimum requirements, as applicable, are as follows. It is to be noted that apart from following IS/IEC standards, a specific standards are also mentioned in the respective chapters, same shall have to be considered during design basis.

S.No.	Description	Standards / Codes	Edition
1	Code of practice for the fire safety of buildings - Electrical Installations.	IS-1646	Latest
2	Code of practice for selection: installation and maintenance of automatic fire detection and alarm system.	IS-2189	Latest
3	Code of practice for the protection of buildings and allied structures against lightning.	IS-2309	Latest
4	Code of practice for fire safety of industrial buildings - Electrical generating and distributing stations.	IS-3034	Latest
5	Code of practice for Earthing.	IS-3043	Latest
6	Code of practice for Interior Illumination.	IS-3646	Latest
7	Application guide for Insulation Coordination.	IS-3716	Latest
8	Code of practice for installation and maintenance of electrical equipment in mines	IS-4051	Latest
9	Guide for safety procedures and practices in electrical work	IS-5216	Latest
10	Guide for selection of electrical equipment for hazardous areas.	IS-5571	Latest
11	Classification of hazardous areas (other than mines) having flammable gases and vapours for electrical installations.	IS-5572	Latest
12	Code of practice for Industrial Lighting.	IS-6665	Latest
13	Guide for Control of undesirable static electricity.	IS-7689	Latest
14	Guide for improvement of power factor - consumer's installations.	IS-7752	Latest
15	Application guide for on load tap changers.	IS-8478	Latest
16	Reference ambient temperature for electrical equipment	IS-9676	Latest
17	Code of practice for selection, installation and maintenance of transformer.	IS-10028	Latest
18	Code of practice for selection, installation and maintenance for switchgear and control gear.	IS-10118	Latest

19	Application guide for Power Transformer.	IS-10561	Latest
20	Voltage bands for electrical installations including preferred voltages and frequencies.	IS-12360	Latest
21	Guide for short circuit calculations in three phase AC systems.	IS-13234	Latest
22	Code of practice for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres.	IS-13408(Part-1)	Latest
23	Guide to the use of electrical apparatus for potentially explosive atmospheres in the presence of combustible dusts	IS- 15142	Latest
24	National Electrical Code (NEC) - BIS Publication.	SP-30	Latest
25	Recommended practices on static electricity	OISD-STD-110	Latest
26	Classification of Area for electrical installation at Hydrocarbon Processing and handling facilities	OISD STD-113	Latest
27	Inspection and safe practices during electrical installation	OISD-STD-147	Latest
28	Design aspects for safety in electrical systems	OISD STD-149	Latest
29	Fire Protection System for Electrical Installations	OISD STD 173	Latest
30	Lightning Protection	OISD STD-180	Latest
31	Electrical apparatus for explosive gas atmospheres - General requirements.	IS/IEC 60079-0	Latest
32	Equipment protection flameproof enclosures "d"	IS/IEC 60079-1	Latest
33	Electrical apparatus for explosive gas atmospheres - Intrinsic safety 'i'	IS 5780/IEC 60079-11	Latest
34	Electrical apparatus for explosive gas atmospheres Increased safety type "e"	IS-6381/IEC 60079-7	Latest
35	Electrical apparatus for explosive gas atmospheres - Oil immersion "o"	IS 7693/IEC 60079-6	Latest
36	Electrical Apparatus for explosive gas atmospheres - Powder filling 'q'	IS 7724/IEC 60079-5	Latest

37	Classification of flammable gases or vapours with air with air according to their maximum experimental safe gaps and minimum igniting currents	IS 9570/IEC 60079-12	Latest
38	Electrical apparatus for explosive gas atmosphere -Part-15 Construction, test and marking of type of protection "n" electrical apparatus	IS/IEC 60079-15	Latest
39	Energy Efficient induction motors- Three phase squirrel cage	IS 12615	Lateat
40	Outdoor distribution transformer of ratings up to and including 100kVA for use on systems with nominal system voltages up to and including 11kV	IS 1180	Latest

3.0 GENERAL / DESIGN CONSIDERATIONS

S.No.	Project Philosophy
1	LV - Low Voltage. The voltage which does not normally exceeds 250 V.
2	MV - Medium Voltage. The voltage which normally exceeds 250 V and does not exceeds 650 V.
3	HV - High Voltage. The voltage which normally exceeds 650 V but does not exceed 33 kV.
4	EHV - Extra High Voltage. The voltage which exceeds 33 kV under normal condition.

4.0 SPECIFIC DESIGN REQUIREMENTS

S.No.	Project Philosophy
1	Add on system shall be integrated with existing system for PA system, ECS system, telephone exchange , DGFA system , LAN connectivity.
2	Each DGFAP panel and each loop shall have 30% spare capacity.
3	Transformers and Switchboards shall have 20% spare capacity.
4	Incomers and buscoupler of MCC shall be provided with ACB and numerical relays with auto-changeover facility.
5	DC system shall have 25% spare capacity for future load growth and DCDB shall have 20% spare feeders.
6	UPS system shall have 20% spare capacity for future load growth and ACDB shall have 20% spare feeders.
7	Dummy panel shall be provided in switchboards where switchboard is located over the expansion joint in substation building.
8	Transformers rated 1 MVA and above shall be provided with air bag for conservators.
9	DCDB shall be provided with two incomers and one bus coupler.
10	Window type HT CT shall be provided in HV switchboards.
11	Road crossings a) Road crossings where large number of cables cross the roads, shall be provided using Cable culverts. At road crossings where few cables cross the roads, Electrical road crossings (ERC) using 150mm GI/RCC pipes may be provided. The ERC shall have minimum 20% spare pipes. The pipes shall be embedded in concrete. b) Minimum 2 nos. 150mm pipes shall be provided at any road crossing.
12	MV motors for hazardous area shall be IE2 as per IS 12615:2011. MV motors for

	safe area shall be IE3 as per IS 12615:2011.
13	Flooring of substation switchgear hall shall be painted with insulating paint. Additionally insulating mats may be provided if required as per standards and CEA guidelines.
14	All monitoring signals from relays to SCADA/SAS shall be on IEC 61850 , while Open protocol based communication to be used for SCADA system
15	Separate DC systems shall be provided for switchgear protection and critical lighting

5.0 OWNER / CLIENT SPECIFIC REQUIREMENTS

5.1 SITE CONDITIONS

S.No.	Description	Selected Option	Available Options
1	Equipment design temperature (IS-9676)	45 DEG C	
2	Relative humidity	60-75%	
3	Soil Resistivity	As per Report-Annex-soil investigation soil report	
4	Minimum temperature. for battery sizing	5 Deg C	
5	Altitude above mean sea level	Less than 1000m above MSL	
6	Maximum temp	50 deg C	
7	Minimum temp	-5 dec C	
8	Siesmic Zone	Zone-4	

5.2 POWER SOURCE DETAILS

S.No.	Description	Selected Option	Available Options
1	Power System		
2	Grid Supply	220kV	
2.1	Name of sub station	Mundh S/s (HVPNL)	
2.2	Number of feeders	2	
2.3	Length of feeder	35 KM (tentative)	
2.4	Type /size of conductor/ cable size	0.5 sq inch (Moose Conductor)	
2.5	Voltage	220KV	
2.6	Frequency	50Hz	
2.7	Maximum fault level	As per HVPNL data, to be arranged by vendor)	
2.7.1	3 Phase fault		
2.7.2	1 Phase fault		
2.7.3	X/R Ratio		
2.8	Minimum fault level	As per 220 KV system requirement.	
2.9	Design fault level		
2.10	Basic Insulation Level	As per 220 KV system requirement.	
2.11	System neutral Earthing	Solidly Grounded	

2.12	Minimum power factor	0.9 or better	
2.13	Parallel operation of incomers	Yes	
2.14	PLCC requirement	Yes	
3	CPP and its configuration	Provided in relevant sections.	
3.1	Type of Generator		
3.1.1	Number of Generator		
3.1.2	Rating of Generator/Voltage/P.f		
3.1.3	Requirement of Generator Circuit Breaker		
3.2	Parallel operation with grid	Yes	
3.3	Type of Neutral Earthing for Generators	Resistance Earthing	
3.4	Black Start DG Envisaged	NA	
4	Emergency generator	NA	
4.1	Generator Voltage	11 KV at generation level; 33 KV at distribution level	
4.2	Parallel operation with other sources	NA	
4.3	Auto Starting	NA	
4.4	Type of Emergency Generator	NA	
5	Solar Power System	Not Envisaged	
5.1	Solar PV System	NA	
5.2	Buildings on which solar power system to be mounted	NA	
5.3	Technology	NA	
5.4	Battery	NA	
5.5	Connectivity	NA	
5.6	Monitoring System	NA	
5.7	Location of Inverter	NA	

5.3 POWER SUPPLY DISTRIBUTION SYSTEM

5.3.1 VOLTAGE AND FREQUENCY VARIATION

S.No.	Description	Selected Option	Available Options
1	AC System		
	EHV		
1.1	Voltage	220 KV \pm 10%	
1.2	Frequency	50 Hz \pm 5%	

	Other than EHV		
1.3	Voltage		33kV/6.6kV/415V \pm 6%
1.4	Frequency		50 Hz \pm 3%
2	DC System		
2.1	Electrical Control system	protection and	220V \pm 10%
2.2	DC critical	Lighting system	220V \pm 10%

Note:

Refer section 5.6.10 of this document for design voltage/frequency variation for motors.

5.3.2 UTILISATION VOLTAGE

S.No.	Description	Selected Option	Available Options
1	Primary EHV distribution voltage	220kV	
2	Secondary HV distribution voltage	33kV	
3	Primary EHV distribution system neutral Earthing	Solidly Earthed	
4	Secondary HV distribution system Neutral Earthing	Solidly Earthed	
5	HV motor voltage for DOL	NA	
6	MV motor voltage	415 V AC (except VFD motor) (For motors rating 0.18<=kW<=160)	
7	AC Motors	240V AC (except MOVs) (For motors rating < 0.18kW)	
8	DC Motor	As per equipment supplier standard	
9	Motor operated valves	415V AC, TP	
10	Battery chargers incoming power supply	415V AC,TPN	
11	UPS System incoming power supply	415V AC,TPN	
12	AC Lighting/Power Panels	415V AC,TPN	
13	Auxiliary Boards incoming power supply	415V AC,TPN	
14	Welding Receptacles	415V AC,TPN	
15	Bulk loads like Process Heaters etc	415V AC,TPN	
16	Normal Lighting/Emergency Lighting	240V AC,SPN	
17	LAN UPS	240V AC, SPN	

5.3.3 UTILISATION VOLTAGE FOR CRITICAL SUPPLIES

S.No.	Description	Selected Option	Available Options
1	Switchgear protection control power supply	220V DC	
2	Critical lighting power supply	220V DC	

S.No.	Description	Selected Option	Available Options
3	Input power supply for Plant communication system	110V AC UPS	
4	Input power supply Fire alarm system power supply	220V AC SPN (Dedicated battery backup)	
5	Power supply for electrical annunciation panel	220V DC	a)220V DC b)110V DC

5.3.4 OPERATING PHILOSOPHY

S.No.	Description	Selected Option	Available Options
1	Auto/Manual transfer at primary distribution voltage bus with momentary paralleling	Yes	a)YES b)NO
2	Auto/Manual transfer at secondary distribution voltage bus with momentary paralleling	Yes	a)YES b)NO
3	Auto /Manual transfer at MV with momentary paralleling		
3.1	At PCC/EPC/EP MCC Level	Yes	a)YES b)NO
3.2	At MCC/ASB/LDB Level	Yes (MCC-1) No ASB LDB	a)YES b)NO
4	Continuous Parallel operation of Incomers		
4.1	Primary EHV voltage	Yes	a)YES b)NO
4.2	Secondary HV voltage	No	a)YES b)NO
4.3	PCC/PMCC	No	a)YES b)NO
5	Power Factor Correction	Not Required	
5.1	Power factor improvement capacitors- location	Not Applicable	a)6.6kV bus b)415V c)Both 6.6kV & 415V

			d)Any other
5.2	Minimum P.F. to be maintained at Transformer Primary	Not Applicable	
5.3	Monitoring at Transformer Primary	Not Applicable	a)YES b)NO
6	Load shedding	Load shedding work as per scope of tender	a)YES b)NO
6.1	Voltage level for Load Shedding	Load shedding work as per scope of tender	a)33kV b)11kv c)6.6kV d)0.415kV e)Any Other

5.4 CONTROL-PROTECTION - METERING

5.4.1 CONTROL PHILOSOPHY

S.No.	Description	Selected Option	Available Options
1	Location of Relays for Transformer	Control and Relay Panel	
2	Location of Relays for line protection and 220 KV GIS Switchgears	Control and Relay Panel	
3	Location of Protection relays for HV/LV switchgear	Control and Relay Panel	
3.1	Secondary Voltage HV switchgear	On switchgear	a)On switchgear b)Separate relay and control panel
3.2	Secondary voltage LV Switchgears	On switchgear	
4	EHV/HV Switchgear control		
4.1	EHV System Transformer	SCAP, SCADA and Local Panel in GIS bay	
4.2	EHV system Line Bays	SCAP and SCADA	
4.3	HV switchgear	SCAP, SCADA and Local Panel in GIS bay	a)On switchgear b)Separate relay and control panel
4.4	LV Switchgears	SCADA and local	a)On switchgear b)Separate relay and control panel c)ECS
5	Numerical Protection/Monitoring system for		
5.1	EHV system	Yes	a)YES b)NO

5.2	HV Switchboard	Yes	a)YES b)NO
5.3	PMCC/PCC	Yes	a)YES b)NO
5.4	MCC	Yes	a)YES b)NO
6	Control and logic through numerical relays	Yes	a)YES b)NO
7	Hardwired synchronization control panel-SCAP	Yes (at both PR and PNCP ends)	a)YES b)NO
7.1	Synchronizing trolley required	Yes (Minimum 3 Nos.)	a)YES b)NO
7.2	Type of Panel	Simplex	a)Mosaic b)Simplex
7.3	Extent of Coverage on SCAP	Entire 220 KV, 33 KV system.	
8	Type of annunciation panel	Both SCAP and HMI	a)HMI b)Part of SCAP

S.No.	Description	Selected Option	Available Options
9	Load shedding panel	Part of ECS	a)Part of ECS b)Separate PLC c)Hardwired

5.4.2 POWER ISOLATION FOR TRANSFORMERS LOCATED REMOTELY AWAY FROM HV SUBSTATION

S.No.	Description	Selected Option	Available Options
1	Push button in transformer bay for tripping remote breaker	Yes (Pushbutton shall trip local isolation breaker)	a)YES b)NO
2	Local power isolating device	Yes	a)YES b)NO
3	Type	Breaker in panel	
4	Protection relay required	Yes	

5.4.3 RELAY PROTECTION SYSTEM:

For relay protection details for 220 KV line and 220 KV GIS system and Transformer, please refer the relevant section

5.4.3.1 PROTECTION DEVICES FOR POWER DISTRIBUTION SYSTEM

Protection devices for power distribution system shall be as indicated below - (Figure inside bracket refers to note below)
(YES - Applicable)

5.4.3.2 POWER GENERATION AND EXTERNAL POWER SUPPLY:

S.No.	Relay Description	NEMA Code	HV Incomer	LV System
1	Distance protection	21	No	
2	Synchronous check	25	YES	YES
3	Under voltage with timer	27	YES	YES
4	Reverse power	32		
6	Loss of excitation	40	NO	NO
7	Negative sequence	46		Yes (in motors)
8	Over current	50	YES	YES
9	Earth fault relay	50N	YES	YES
10	Over current	51	YES	YES
11	Voltage restrained	51V	YES	

S.No.	Relay Description	NEMA Code	HV Incomer	LV system
12	Earth Fault back up	51G		
13	E/F	51N	YES	YES
14	Over voltage with timer	59	YES	YES
15	VT failure	60	YES	YES
16	Auxiliary relay for transformer	63TX	YES	YES
17	Transformer Restricted Earth Fault	64R	YES	YES
18	Stator back up earth fault	64G	NA	NA
19	Generator Rotor Earth fault	64R	NA	NA
20	Directional O/C	67	YES	No
21	Directional E/F	67N	YES	No
22	Under frequency/df/dt	81	YES	NA
23	Tripping relay	86	YES	YES
24	Gen differential	87G	NA	NA
25	Gen and Transformer differential	87GT	NA	NA
26	Transformer differential	87T	YES	NA
27	Feeder differential	87F	YES	NO
28	Bus bar differential and check	87B/ 87CH	YES	NO
29	Trip circuit supervision	95	YES	YES
30	Dead bus charging	98	YES	YES

	relay			
31	Over fluxing	99	YES	NA
32	Out of step	78	NA	NA

5.4.3.3 RELAY PROTECTION PHILOSOPHY

S.No.	Project Philosophy
1	In case of EHV- Refer relevant section related with GIS & transformer protection. HV switchboards with following additional relays shall be provided: a. One set of 87B (Bus differential) and 95 B (Bus wire supervision) for each bus section. b. 67 and 67N (Directional IDMTL over current and earth fault) relays for the incomers.
2	Instantaneous earth fault (50N) shall be provided only for transformer with delta primary.
3	Directional IDMTL earth fault (67N) shall be provided for transformer with star primary.
5	Transformer differential to be provided For transformers rated 5 MVA and above.
6	Motor differential protection to be provided For motors rated 1500 kW and above, excluding VFD fed motors.
7	Cable differential protection for all feeders connected to main distribution bus. A plant feeder implies outgoing feeders from one switchboard to another switchboard of same voltage level.
8	Trip circuit supervision relay 95 shall be provided as part of the numerical relay for HV/ MV feeders wherever numerical relays are provided.
9	For switchgears where continuous or momentary paralleling of Incomers is envisaged, check synchronising relay shall be provided.
10	51G and 64R relays for input transformer of VFD system shall be decided by VFD Manufacturer.
11	The bus tie feeders in HV switchboards shall be provided with 51, 50, 51N, 50 N 86 and 95 relays.
12	HV capacitor bank feeders shall be provided with 51, 51N, 59 (over voltage), 60 (Neutral displacement), 86 and 95 relays.
14	The following feeders shall be provided with timers for delayed tripping on bus under voltage while the under voltage relay shall be common for the bus a. HV and MV capacitor feeders b. HV and MV breaker controlled motor feeders c. Contactor controlled motor feeders with DC control supply. Numerical relays where ever provided for motor and capacitor feeders shall use in built under voltage relay and timer for delayed tripping on bus under voltage.
15	One no. DC supply supervision relay (80) shall be provided for each incoming DC supply to the switchboard.
16	One set of bus differential relays (87B) and bus wire supervision relay (95 B) for each bus section shall be provided for all HV switchboards.
17	In case of numerical relays, all relays shall be comprehensive units including all protection, metering and control.
18	Under voltage and over voltage function along with associated

	timer shall be part of the numerical relays.
19	Auto changeover logic between Incomers and bus coupler shall be built in the numerical relay.
20	Tripping relays (86) shall be conventional electromechanical relay (VAJH type)

S.No.	Project Philosophy
21	2 Nos. of 86 relays shall be considered for HV and MV breaker fed motors for ease of differentiating between process & electric trip. Process trip relay shall be self reset type whereas electrical trip shall be hand reset type.
22	Breaker control switch shall be hardwired type.
23	Stand by earth fault relay 51G shall be provided in the incomer of switchboard fed from transformers where transformer & switchboard both are located remotely from HV substation.
24	Restricted earth fault relay 64R shall be provided for transformer rating ≥ 2.5 MVA in the incomer of switchboard fed from transformers and secondary winding is star connected.
25	Relay 51V voltage controlled over current relay shall be provided on GIS and HV generation bus feeders
26	Relay 87 and 64R shall be separate numerical relay. Hence shall not be part of main comprehensive numerical relay. CT for 87 and 64R can be clubbed, as two core of single CT.
27	Numerical relays in all HV motor feeders shall be suitable for RTD/BTD inputs. High temperature alarm and trip from relay shall be wired to DCS

5.4.4 METERING

5.4.4.1 METERING DEVICES IN EHV, HV AND MV SWITCHBOARDS

The metering devices in EHV, HV and MV switchboards shall be as below (minimum) -
Type of metering: multi function meters & part of the Numerical relay

(Figure inside bracket refers to note below) (YES - Applicable)

S.No.	Feeder Type	A	V	Hz	PF	MW	MW H	HM	MVAR	MVA H	MVA
1	Grid Incomers	YES	YES	YES	YES	YES (2)	YES (8)	-	YES(2)	YES (2)	YES (1,2)
2	Grid Bus Tie	YES									
3	Grid Transformer	YES	YES			YES	YES				
4	Grid Bus P.T.		YES	YES							
5	HV Incomer	YES	YES	YES	YES	YES	YES	-	YES	YES	YES

S.No	Feeder Type	A	V	Hz	PF	MW	MWH	HM	MVA R	MVA H	MV A
6	HV Bus Tie	YES	-	-	-	-	-	-	-	-	-
7	HV Transformer	YES	-	-	-	YES	YES	-	-	-	-
8	HV Bus P.T.	-	YES	-	-	-	-	-	-	-	-
9	HV Plant Feeder	YES	-	-	YES	-	YES	-	-	-	-
10	HV Motor	YES	-	-	YES	YES	YES(kWh)	YES	-	-	-
11	HV Capacitor	YES	YES	-	-	-	-	-	YES	-	-
12	PCC/PMCC Incomer	YES	YES	-	YES	YES	YES(kWh)	-	-	-	-
13	PCC/PMCC Bus Tie	YES	-	-	-	-	-	-	-	-	-
14	PCC Bus P.T.	-	YES	YES	-	-	-	-	-	-	-
15	ACB Outgoing (Non motor)	YES	-	-	-	YES	YES(kWh)	-	-	-	-
16	MV Motor (>55kW)	YES	-	-	-	YES	YES	-	-	-	-
17	MCC/ASB Incomer	YES	YES	-	-	YES	-	-	-	-	-
18	MCCB/SFU O/G(250A)	YES	-	-	-	YES	YES(kWh)	-	-	-	-
19	LDB Incomer	YES	YES	-	-	YES	YES(kWh)	-	-	-	-

Notes:

1. MVA meter in EHV external power supply Incomers shall include maximum demand indication also and shall follow the HVPNL guidelines also..
2. Separate MW, MVAR, MVA and MVAH meters shall be provided for EHV external power supply Incomers only.
3. Seperate 3 nos. voltmeter and 3 nos. ammeter shall be provided for EHV external power supply incomers.
4. All metering shall be part of numerical relay in case of feeders having numerical relays.
5. Field ammeters shall be provided for all motors rated above 5.5kW.
6. Ammeter (size 48mm x 48mm) shall be provided in space heater circuit of breaker fed HV & MV motors.
7. Digital mutli-function meters shall be provided in incomers, bus-coupler and all outgoing feeders (except motor feeder) of PCC/PMCC. This shall be in addition to metering as part of numerical relays.

8. ABT (Availability based tariffs) meters and TOD meters comprising of both primary (main) and secondary (check) ,meters of 0.2S class as per HVPNL guidelines to be provide in both the incomers . Each meter should be supplied with a CMRI and communication hardwares. The provision should be their for remote connectivity as per requirement of HVPNL.

5.5 SUBSTATION DESIGN

5.5.1 SUBSTATION AUTOMATION SYSTEM

S.No.	Description	Selected Option	Available Options
1	Substation Automation System (SAS)	Required	
2	Communication protocol for relay network	IEC 61850	a)IEC 61850 b)open protocol
3	System architecture	IEC 61850 PRP	a)IEC 61850 RSTP b)IEC 61850 PRP c)IEC 61850 HSR d)Redundant architecture for other open protocols
4	Data concentrator for SAS	To be decided as per system configuration.	a)not required b)common for HV & MV c)seperate for HV & MV
5	Communication with other devices		
5.1	Communication with ECS	Yes	
5.1.1	Protocol for communication with ECS	IEC 61850 (1)	a)IEC 61850 b)Modbus
5.2	Communication with DCS	part of data concentrator	a)part of data concentrator b)part of ECS RTU
5.2.1	Protocol for communication with DCS	Modbus TCP/IP	
6	HMI for SAS	Operator Cum Engineering Workstation – 2 Nos. at PR and 2 Nos. at PNCP (CPP control room)	

S.No.	Description	Selected Option	Available Options
7	Laptop	separate for HV & MV for each substation	a)not required b)common for HV & MV for each substation c)seperate for HV & MV for each substation
8	Local storage of data	part of HMI	a)not required (part of

			ECS) b)part of HMI c)part of data concentrator
9	Relay parameterization	SAS HMI	a)SAS HMI b)ECS HMI

Note:

1. The integration with existing ECS required with suitable protocol convertor card which is to be provided by the vendor.

5.5.2 EHV SWITCHYARD

S.No.	Description	Selected Option	Available Options
1	Type	As per scope of GIS switchgears (Section 3, chapter-1)	
2	Type of bus		a)String bus b)Tubular bus
3	Structure for outdoor		a)Galvanised b)Painted c)Not applicable
4	Bus material		a)Aluminium b)Copper

5.5.3 SUBSTATION FEATURES

S.No.	Description	EHV	HV	MV	MCC/Elec. Room
1	Elevated with trays in cable cellar	YES	YES	YES	YES
2	Raised with internal trenches	NA	NA	NA	NA
3	All top cable entry with trays below ceiling	NO	NO	NO	NO
4	Pressurisation against ingress of dust	NO	NA	NA	NO
5	Air-conditioned room for operator	YES	NA	NA	NA
6	Roof slab for				
6.1	Power transformer	NA	NO	NA	
6.2	Distribution transformer	NA	NO	NO	
7	Air conditioning of switchgear hall	YES	NO	NO	YES
8	EOT crane in sub-station	YES	NO	NO	NO

5.5.4 SPECIFIC EQUIPMENT LOCATIONS

S.No.	Description	Selected Option	Available Options
1	Batteries in substation and control Rooms	Separate room	
2	Battery charger in substation	Air- Conditioned Switchgear Hall (Separate Room)	a)Air conditioned room b)Non air conditioned room
3	UPS System	Air conditioned Switchgear Hall (Separate Room)	
4	Lead-Acid and Nickel-Cadmium	Separate room	a)Separate room b)Common room
5	Annunciation panel	Part of HMI in Operator Room and SCAP	
6	Energy saver panel with Lighting transformers	YES	
7	GIS Hall	Air Conditioned	a)Air Conditioned b)Pressurised

1. For detailed layout of Switchgear Hall, please refer Section-3, Chapter-3.

5.6 EQUIPMENT DESIGN

5.6.1 EHV DESIGN

5.6.1.1 EHV OUTDOOR SWITCHYARD

S.No.	Description	Selected Option	Available Options
1	Bus bar system	Double Bud Configuration	a)Single b)Double
2	Circuit breaker type	GIS	
3	Isolator type	As per Section 3 Chapter-6.	

5.6.1.2 EHV SWITCHBOARD

S.No.	Description	Selected Option	Available Options
1	Execution	As per Section-3, Chapter-1.	
2	Type of Switchgear		
3	Busbar		
4	Circuit Breaker Type		

5.6.2 HV SWITCHBOARD

S.No.	Description	Selected Option	Available Options
1	Execution	Drawout	a)Drawout

			b)Fixed
2	Type of switchgear	Air Insulated	a)Air insulated b)Gas insulated
3	Bus bar	Single bus	a)Single bus b)Double bus
4	Circuit breaker type	VCB	a)SF6 b)VCB
5	Motor Control	Breaker	a)Breaker b)Vacuum contactor

5.6.3 CURRENT TRANSFORMER (CT)/POTENTIAL TRANSFORMER (PT)

S.No.	Description	Selected Option	Available Options
1	CT Secondary		
1.1	General Protection	1A	
1.2	Special protection(87,64R,51G etc)	1A	
1.3	Metering	1A for conventional and remote metering	
2	PT Secondary	110V AC	

5.6.4 TRANSFORMERS (POWER/DISTRIBUTION)

S.No.	Transformer	Voltage Ratio	Vector Group	Tap Changer	Cooling
1	Grid power transformer	220/34.5	Ynyn0	OLTC	ONAN/ONAF
2	Generator unit transformer	NA	NA	NA	NA
3	Intermediate power transformer	33/6.9kV	Dyn 1	OLTC	ONAN/ONAF

Note:

- 1) Provision of Oil Soak Pit & Oil Collection Pit for transformers shall be as follows: a) Oil quantity $\leq 2000\text{L}$: Not Required
b) $2000\text{L} < \text{Oil Quantity} \leq 9000\text{L}$: Soak Pit

c) Oil Quantity $> 9000\text{L}$: Soak Pit + Collection Pit

2)Fire fighting system for transformers above 10MVA or oil greater than 2000 Liters.

5.6.5 MV SWITCHBOARD

S.No.	Description	Selected Option	Available Options
1	PCC / PMCC		
1.1	Breaker panels	Drawout Single front	
1.2	Contactor feeders	Drawout Single Front (See Note-1)	a)Drawout Single Front b)Drawout Double front c)Fixed Single front
2	MCC	Drawout Single Front (See Note-1)	a)Drawout Single Front b)Drawout Double front c)Fixed Single front
3	ASB	Drawout Single Front (See	a)Drawout Single Front

		Note-1)	b)Drawout Double front c)Fixed Single front
4	LDB	Drawout Single Front (See Note-1)	a)Drawout Single Front b)Drawout Double front c)Fixed Single front
5	Motors		
5.1	PMCC	Above 55 kW Up to 160 kW	
5.2	MCC	Up to 55 kW	
6	Type of switchboard for small package (AC system, Pressurisation system, Bagging plant etc)	Compartmentalised Fixed type	a)Compartmentalised Fixed type b)Non Compartmentalised Fixed type

Note:-

1. MCCs, ASB, LDB may be considered Double Front where required due to space limitations in the building.

5.6.6 MEDIUM VOLTAGE OUTGOING FEEDER TYPE

S.No.	Description	Selected Option	Available Options
1	Switch fuse	YES (UPTO 63 Amps)	
2	Switch fuse with Contactor and CBCT for earth fault protection	NA	
3	MCCB with Contactor and CBCT for earth fault protection	Above 63A	

Note:-

1. MCCB shall be provided with shunt trip coil.

5.6.8 CONTROL SUPPLY VOLTAGE

S.No.	Description	Selected Option	Available Options
1	Breaker control	220V DC	a)220V DC b)110V DC
2	Breaker spring charging	220V DC	a)240V AC b)220V DC c)110V DC
3	Contactor feeder	240V AC	
4	Control supply for earth fault relay in contactor feeder(Note 1)	240V AC	a)24V DC b)220V DC c)110V DC d)240V AC
5	Control supply for contactor motor starter	Control Transformer in individual DOL starter.	a)Control Transformer b)Tapping P-N of Respective Feeder c)Control Transformer in individual DOL Starter

S.No.	Description	Selected Option	Available Options
6	Control transformer for each feeder	Yes	a)YES b)NO c)Not Applicable

5.6.10 MOTORS

S.No.	Motors	High voltage	415 volts
1	Enclosure		
1.1	Indoor	IP55	IP55
1.2	Outdoor	IP55	IP55
2	Insulation class	F (Temp. Rise limited to B)	B / F (Temp. Rise limited to B)
3	Anti-condensation heater	Yes	30 kW and Above
4	Additional canopy (outdoor motors)	Yes	Yes
5	Design voltage variation	±6%	±6%
6	Design frequency variation	±3%	±3%
7	Combined voltage / frequency variation (Design)	±10 % Any combination of above	±10 % Any combination of above

1. Motors for MOV actuator shall have F class of insulation with temperature rise limited to class-B.

5.6.11 UPS SYSTEM

S.No.	Description	Selected Option	Available Options
1	Redundancy	100%	a)50% b)100%
2	Type of redundancy	Parallel redundant	a)Parallel redundant b)Hot standby
3	Back-up time	120 minutes	a)30 minutes b)60 minutes c)120 minutes
4	Bypass transfer control	Auto	a)Auto b)Manual
5	Separate fault diagnostic unit (Note 1)	YES	a)YES b)NO
6	Battery type	Ni-Cd (2X50% configuration in all options)	a)Lead acid b)Ni-Cd c)VRLA(in 2x50% configuration)
7	Type of UPS	Transistorised (12 pulse configuration) or IGBT for 6 pulse configuration	a)IGBT b)Transistorised

S.No.	Description	Selected Option	Available Options
8	UPS Output Supply	Single Phase	a)Single Phase b)Triple Phase
9	UPS Output Voltage	110V AC	

1. Seperate Fault Diagnostic Unit (FDU) is not required in case UPS system is serial connected to HMI and fault diagnostic can be done from HMI.

5.6.12 COMMUNICATION SYSTEM

S.No.	Description	Selected Option	Available Options
1	Plant Communication System	Yes	a)YES b)NO
2	Telephone System	Yes	a)YES b)NO c)Separate
3	Telephone system and plant Communication system	Separate	a)Separate b)Integrated
4	Interface of Communication system		
4.1	With fire alarm system	Yes	a)YES b)NO
4.2	With telephone system	Yes	a)YES b)NO

5.6.13 FIRE DETECTION AND ALARM SYSTEM

S.No.	Description	Selected Option	Available Options
1	Type	Analogue addressable	a)Conventional b)Analogue addressable
2	Name of buildings to be provided with Detectors	Control room, sub-station, SRR, other buildings as required.	
3	Detection System	Break Glass, Multi sensor detection	
4	Type of manual call point	Without call back facility	a)With call back facility b)Without call back facility
5	Qty of Siren and location	During detail engineering	
6	Power supply for Siren	415V AC	a)415V AC b)110V AC UPS c)48V DC
7	Siren range	5 Km(Diametrically)	
8	Response indicator for rooms and concealed area for Addressable Fire alarm system	Yes	a)YES b)NO c)Not Applicable

5.6.14 DC SYSTEM

S.No.	Description	Selected Option	Available Options
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1. Battery type			
1.1	Switchgear Protection Control and critical lighting	Ni-Cd	a)Lead acid b)Ni-Cd c)VRLA
1.2	Instrumentation System	NA	a)Lead acid b)Ni-Cd c)VRLA
1.3	Diesel Engine Starting	NA	
1.4	DC Motors	Ni-Cd if required	a)Lead acid b)Ni-Cd c)VRLA
1.5	Fire alarm system	To be supplied from common DC with suitable converters.	
1.6	Telephone system	To be supplied from common DC	
1.7	End Cell Voltage		
1.7.1	Lead Acid Battery	1.85 VOLT	
1.7.2	VRLA Battery	1.75 VOLT	
1.7.3	Ni-Cd Battery	1.0 VOLT	
2	Battery backup time		
2.1	Switchgear Protection and Control	120 minutes	a)30 minutes b)60 minutes c)120 minutes
2.2	DC Critical lighting	120 minutes	a)30 minutes b)60 minutes c)120 minutes
2.3	Instrumentation	NA	a)30 minutes b)60 minutes c)120 minutes
2.4	Diesel Engine Starting	NA	
2.5	DC Motors	As per equipment manufacturer's recommendation	
3	Battery Configuration	2X50%	a)2X50% b)1X100%

5.6.15 VARIABLE FREQUENCY DRIVE

S.No.	Description	Selected Option	Available Options
1	By pass feature required	Yes(Note-1)	a)YES b)NO
2	VFD rated output voltage		
2.1	MV Inverter	i) Motor kW rating less than 315kW at 415V ii) More than 315kW & up to 700kW at voltage upto 690V	
2.2	HV Inverter	Motor rating more than 700kW	

Notes:

1. Bypass for VFD shall be provided as a standard practice unless not recommended from

Process or driven equipment operation point of view.

5.6.16 CABLE SIZES

The power and control cables shall have the following minimum cross sectional areas

S.No.	Description	Selected Option	Available Options
1	Medium voltage power cable	Refer Note 4	a)Above 16 sqmm (Aluminium) b)2.5 sqmm to 16 sqmm (Copper)
2	Control cables	2.5sqmm(Copper) (Note-5)	
3	Lighting	2.5 sqmm (Copper)	
4	Communication system	0.9 mm dia. (Copper)	
5	Telephone System	0.63 mm dia.(Copper)	
6	Fire alarm system	1.5 sqmm (Copper)	


Notes:

1. For lighting inside the building, minimum 1.5 sqmm copper conductor, PVC Insulated wire shall be used in conduit system (for circuit and point wiring), with proper colour coding.
2. Cable sizes are indicative only and these shall be finalised as per the recommendations of the equipment manufacturer.
3. Special cable type and size shall be decided on specific requirement.
4. All power cables 2.5 sqmm to 16 sqmm shall be with copper conductor and above 16 sqmm shall be aluminium conductor.
5. Control cable shall be twisted pair overall shielded type.
6. All cables shall be with FRLS outer sheath.
7. All Control cable shall be stranded core type.
8. All 33 KV cables shall be copper cables only, irrespective of size.

5.7 CABLING SYSTEM

5.7.1 CABLE DETAILS

S.No.	Design Criteria	EHV	HV	415 volts
1	Loads located beyond 1 km	NA	3-core cable	3 1/2-core cable
2	Loads located 200-1000 m	NA	3-core cable	3 1/2-core cable
3	Loads located upto 200 m	NA	3-core cable	3 1/2- core
4	Loads beyond 1000A rating and located near the transformer.	NA	Bus duct /1 core cable	Bus duct /1 core cable
5	Recommended limiting size of multi-core cable (sqmm)	NA	400	300
6	Short-circuit withstand time (seconds)	1.Incomer from transformer:1 2.Incomer from other	1.Incomer from transformer:1 2.Incomer from other switchboard:0.6	Not Applicable

	 ENGINEERS INDIA LIMITED <small>एन्जिनियर्स इंडिया लिमिटेड</small>	switchboard:0.6 3.Plant feeder:0.6 4.Transformer feeder:0.2	3.Plant feeder:0.6 4.Motor/Transformer feeder:0.2	
7	Insulation voltage grade	Earthed	Unearthed	Earthed
8	Type of cable insulation	NA	XLPE-FRLS	PVC-FRLS
9	Fire survival (Resistant) cable for Fire proof MOV	-	-	Yes
10	Power Cable for Motors/MOV	-	3 core	3 core
11	Cable Conductor	NA	Refer Cl. 5.6.16	Refer Cl. 5.6.16
12	Power & Earthing cable	Armored	Armored	Armored

Note: Cables to be considered for sourcing PMCC of GIS switchgears.

5.7.2 CABLE LAYING PHILOSOPHY

S.No.	Description	Selected Option	Available Options
1	Process area	Overhead cable tray	a)Overhead cable tray b)RCC trench
2	Offsite paved area	Above Ground cable tray on sleeper/RCC trench	a)Above Ground cable tray on sleeper b)Overhead rack c)RCC trench
3	Offsite unpaved area	Above Ground cable tray/RCC Trench	a)Above Ground cable tray b)RCC Trench
4	Type of cable trays	Galvanized prefabricated	a)Galvanized prefabricated. b)Sitefabricated and painted c)FRP type
5	Road Crossings for underground cables	Cable culvert/RCC Pipes	a)RCC Pipes b)Cable culvert
6	Road Crossings for Above ground cables	Overhead cable bridge	a)Overhead cable bridge b)Culvert

1. Plant communication, fire alarm and telephone cables shall be laid in instrumentation overhead cable duct / instrumentation trenches as far possible. In case these are not available. Cable shall be laid in electrical routes along berm of the roads.
2. Additional cable tray to be provided as per site conditions. Existing structural support adequacy to be checked and re-enforced if required by the vendor.

5.8 EARTHING SYSTEM

S.No.	Description	Selected Option	Available Options
1	Earth electrode	a) For EHV: Refer Section-3 Chapter-7 b) For balance system: Copper clad electro maintenance free earthing system to be provided. c) Electronic Earthing: Copper plate earthing.	
2	Main earth loop material	GI strip	
3	Substation earth loop	GI strip	
4	EHV switchyard earth grid	Refer Section-3 Chapter-7	

Note:-

1. For Electronic earthing, copper plates shall be used as Earth electrode type. Electronic earthing should not be inter-connected with power equipment earthing.
2. For electronic earthing, armored copper cable to be used for electronic earthing loops.

5.9 LIGHTING SYSTEM

5.9.1 SUPPLY SYSTEM

S.No.	Description	Selected Option	Available Options
1	Centralised with Lighting distribution board-LDB	YES	a)YES b)NO
2	LDB at each substation	NA	a)YES b)NO
3	Lighting transformer required	YES	a)YES b)NO
4	100% Standby transformer for normal lighting system	YES	a)YES b)NO
5	100% Standby transformer for emergency lighting system	YES	a)YES b)NO
6	Lighting transformer voltage ratio	415V/415V	a)415V/415V

5.9.2 CONTROL PHILOSOPHY

S.No.	Description	Selected Option	Available Options
1	Outdoor yard	Auto/Manual	a)Auto b)Manual c)Centralised

			d)Local
2	Street lighting	Auto/Manual/Local	a)Auto b)Manual c)Centralised d)Local
3	Sub-station Room	Manual and group operation	a)Auto b)Manual c)Centralised d)Local
4	Auto control	Synchronous timer (From ECS)	a)Synchronous timer b)Photocell c)ECS
6	Lamp type for outdoor general lighting	1. All lightings shall be LED type only.	
7	Lamp wattage for outdoor lighting (Normal)	To be designed as per lux level required of OISD.	
8	Lamp type for emergency AC lighting	LED	a)CFL b)LED
9	ELCB at Incomer of Lighting / Power Panels	Yes(ELCB shall be provided in Outgoing of LDB/ASB)	a)YES b)NO
10	Switch ON/OFF push button at substation entry	Yes	a)YES b)NO

Notes:-

1. Intelligent type synchronous timer shall be provided for control of outdoor lighting.
2. Normal Lighting in substation building shall be contactor controlled with switch at entrance, whereas emergency lighting shall be based on Timer with bypass switch on the switchboard feeder.
3. LED Lamps shall be provided for substation, control room/ SRR and for street lighting.
4. 20% of outdoor general lighting in process area and offsite hazardous area shall be provided with LED Lamps.

5.9.3 AC EMERGENCY LIGHTING

S.No.	Description	Selected Option	Available Options
1	Name of area	All areas	
2	Name of buildings	Substation, Control room/	
3	Power supply source	Separate lighting source to be taken from existing LT SWBDs (Separate Sub-station) through lighting transformers.	

5.9.4 DC CRITICAL LIGHTING FOR ESCAPE

S.No.	Description	Selected Option	Available Options
1	Name of Units	Switchyard	
2	Name of building	Substation and cellar room, Control Room, SRR.	
3	Power supply	110V DC	a)220V DC b)110V DC
4	DC lighting for remote buildings	Separate centralized DC system with independent charger and batteries.	

5.9.5 WIRING TYPE

S.No.	Description	Selected Option	Available Options
1	Outdoor switchyard	Armoured cable	

S.No.	Description	Selected Option	Available Options
2	Large service building	Black Enamelled Surface conduit	
3	Buildings with false ceiling	Black Enamelled Surface conduit above false ceiling/ PVC concealed conduit below false ceiling	a)Surface conduit above false ceiling b)Cables
4	Substation (Switchgear Room)	Slotted Channel Tray above false ceiling	a)METSEC channel b)Concealed conduit
5	Substation (Cable Cellar)	Surface Conduit	a)Surface Conduit b)Armoured cable
6	Other buildings in safe area	Black Enamelled surface conduit/ PVC concealed conduit	

5.9.6 SPECIFIC LIGHTING REQUIREMENTS

S.No.	Description	Selected Option	Available Options
1	Aviation lighting	Yes (LED type, flashing)	a)YES b)NO
2	Security lighting for peripheral road boundary wall	Required (LED type)	
3	Type of control gear for HPMV/HPSV lamps	NA	a)Separate b)Integral
4	Control gear box location	Accessible level	
5	Type of high mast flood	30 meters Telescopic	a)30 meters Telescopic

light	tubular	tubular b)Lattice structural mast
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5.11 ELECTRICAL EQUIPMENT FOR HAZARDOUS AREAS

The electrical equipment for hazardous areas shall be selected as per IS-5571 and petroleum rules & Gas group shall be selected based on the hazardous area classification. The minimum requirement is summarised below:

S.No.	Equipment	Zone-1	Zone-2
1	MV Motors	Ex-de	Ex-n (Note-2.9, 2.10 & 2.11)
2	HV Motors	Ex-de / Ex-p (Refer note-2.8)	Ex-n/Ex-de/Ex-p(Note-2.9, 2.10 & 2.11)
3	Push Button Station	Ex-de	Ex-de
4	Motor Starters	Ex-de	Ex-de
5	Plug & Socket	Ex-de	Ex-de
6	Welding Receptacle	Ex-de	Ex-de
7	Lighting fitting	Ex-de	Ex-nR
8	Control Gear Box	Ex-de	Ex-nR/Ex-de

S.No.	Equipment	Zone-1	Zone-2
9	Junction Boxes	Ex-de	Ex-n
10	Transformer Unit	Ex-de	Ex-de
11	Plug & Socket	Ex-de	Ex-de
12	Break Glass Unit (Fire Alarm System)	Ex-de	Ex-de
13	Lighting Panel/Power Panel	Ex-de	Ex-de
14	Transformers	Hermetically sealed with surface temperature not exceeding 200 DEG C	Hermetically sealed with surface temperature not exceeding 200 DEG C

For additional Hazardous Area requirements, refer notes below -

5.11.1 NOTES

S.No.	Notes
1	The electrical equipment for hazardous areas shall generally be suitable for gas group IIB and temp classification T3 as applicable to the selected type of explosion protection. In case of hydrogen or hydrocarbon mixtures having more than 30% hydrogen, the gas group to be considered shall be IIC.
2	As additional safety features, the following requirements for electrical equipment shall be followed.
2.1	All electric motors for agitators/mixers and metering pumps handling flammable material shall be flameproof type irrespective of the area being classified as zone 2 or zone 1.

2.2	All electric motors for vertical sump pumps handling flammable material shall be flameproof type. (Ex-de)
2.3	Irrespective of the area classification (whether zone 1 or zone 2), all lighting fixtures within the storage areas shall be flameproof type. (Ex-de)
2.4	Irrespective of the area classification (whether zone 1 or zone 2), all motors and lighting fittings within the pump house/pump station/compressed house associated with offsite tank farm and within the loading/unloading gantries shall be of flameproof type. (Ex-de)
2.5	All emergency/critical lighting fixtures and associated junction boxes in hazardous areas (whether zone-1 and zone-2) shall be flameproof type. (Ex-de)
2.6	Even though fired heaters in process units are not considered for area classification, all electrical equipments associated with fired heaters in process units shall as a minimum be suitable for installation in Zone-2 area.
2.7	Building such as Compressor sheds inside the process area shall be designed to allow adequate ventilation to allow area classification as Zone-2. Lighting equipment, EOT crane etc. in the shed shall be flameproof type. All other electrical equipment shall be suitable for Zone-1 or Zone-2 area depending on extent of hazard.
2.8	All motors for hazardous area Zone-1 shall preferably be Ex-de type. Pressurised motors may be provided in exceptional cases, when Ex-de motors are not available.
2.9	Ex-n motors shall be used unless any other type is specified by process licensor, except for following cases: (i) HV motors in Zone-2 area for centrifugal compressors shall be Ex-de type. (ii) Ex-de motors shall be used in zone-2 areas having frequent start-stop requirements such as EOT cranes, elevators, MOV actuators, etc.
2.10	For zone-2 areas, motors with rating above 100kW having average starting frequency of more than 1 per week, Ex-de or Ex-p motors shall be used.
2.11	Ex-p motors shall be used for higher rated motors where Ex-n motors are not available.
2.12	Cooling Tower fan motors and light fittings shall be flameproof type Ex de

S.No.	Notes
3	Statutory Approval 1. Statutory Authority for Electrical Installation: State Electrical Inspectorate/CEA 2. Statutory authority for hazardous area: PESO

5.12 ECS/SCADA

The existing ECS system to be augmented for inclusion of new signals related with the load shedding, required hardware addition will be in vendor's scope through OEM of the ECS system. Separate new SCADA system to be provided for new system.

S.No.	Description	Selected Option	Available Options
1	Extent of coverage		
1.1	No of substations	All	
1.2	Monitoring		
1.2.1	EHV/HV	Yes	a)YES

	switchboard		b)NO
1.2.2	415V switchboard (I/C, B/C & outgoing breaker feeders)	Yes	a)YES b)NO
1.2.3	Emergency DG set	No	a)YES b)NO
1.3	Control		
1.3.1	EHV/HV switchboard	Yes	a)YES b)NO
1.3.2	415V switchboard (I/C, B/C & outgoing breaker feeders)	No	a)YES b)NO
1.3.3	Emergency DG set	No	a)YES b)NO
2	Base ECS functionalities		
2.1	Breaker control in CPP & Switchyard	ON/OFF for all other breakers	
2.2	Breaker control in other substations	ON/OFF control for all feeders	
2.3	Area lighting	ON/OFF control	
2.4	Electrical plant data acquisition and display		a)YES b)NO
2.5	Routine log report generation and energy balance report		a)YES b)NO
2.6	Detection and reporting of alarms	Yes, to be considered in the new SCADA system	a)YES b)NO
2.7	Sequence of event recording		a)YES b)NO
3	Advanced ECS functionalities		
3.1	Load shedding including maximum demand limit control	YES (to be part of existing ECS)	a)YES b)NO
3.1.1	Load management system	Separate load management for grid and generator including all its engineering and cabling works	
3.2	Synchronization	Manual Synchronizing facility: from SCAP Auto Synchronizing facility: From SCADA.	a)YES b)NO
3.3	Capacitor feeder control for power factor improvement	From SCADA	a)YES b)NO
3.4	Active & Reactive power control	Yes- To be part of new load management system. Yes-To be part new load management system	a)YES b)NO
3.5	Frequency & load control of all generators except DG		a)YES b)NO
3.6	Excitation control of synchronous motors	NA	a)YES b)NO
3.7	Grid transformer OLTC	Yes-To be part of load	a)YES

	control	management system	b)NO
4	Communication with other systems	As per project requirement.	

Note: ECS for new facilities to be hooked up with existing ECS system.

6.0 SPARE PARTS

6.1 MANDATORY SPARES

Mandatory spares shall be procured along with the main equipment. Such spares for each equipment shall be as per the below table. These spares include only those spares, which are critical for equipment.

S.No.	Part Description	Description
1	Common items for complete project	
1.1	All Protection Relays	1 No. of each type & make
1.2	Control fuses / MCB	10 Nos. of each rating & type
1.3	Exciter Diodes and fuses	NA
1.4	Control and Selector switches	1 No. of each type and make
1.5	Aux. contactors	20% of each type and make OR 1 No.(min) of each type and make, whichever is more
2	220 KV Gas Insulated Switchboard (GIS)	
2.1	Portable gas filling equipment/SF6 gas cart	1 set
2.2	Handle for dis-connector switch drive	4 Nos.
2.3	Handle for earthing switch drive	4 Nos.
2.4	Pre selection key for three position switch	1 No.
2.5	Power cable termination kit	2 sets for each type of cable.
2.6	Tripping coil	4 No.
2.7	Closing coil	4 No.
2.8	Capacitive type voltage detectors	1 Set
2.9	Control fuses / MCB	10 Nos. of each rating & type
2.10	Density monitoring device	2 Nos of each type
2.11	Pressure Gauge	2 Nos of each type
2.12	Indicating lamps covers	5 nos. of each colour
2.13	Indicating lamps	20% or 3 nos. (min.), whichever is more
2.14	Spring charging motor assembly with gear system	2 nos of each type
2.15	PT of GIS system	2 nos of each type and rating
2.16	CT of GIS system	2 nos of each type and rating
2.17	Isolator power and auxiliary contact	1set
2.18	Isolator operating motor/ SOV assembly	1 set
3	Power Transformer	Refer point 14 below
4	33kV, 11kV & 6.6kV Air Insulated Switchboard (AIS)	one set of spare for each switchboard (Refer Note-7)
4.1	Closing coil	2 No. of each rating & type
4.2	Shunt trip coil	2 No. of each rating & type
4.3	Control fuses / MCB	10 Nos. of each rating & type

4.4	Indicating lamps covers	5 Nos. of each colour
4.5	Indicating lamps	20% or 3 Nos. (min.), whichever is more
4.6	Vacuum Bottle	1 No. of each type
4.7	Racking handle	4 Nos of each type of breaker
4.8	CT and PT	1 set (3 Nos.) of each type and rating of CTs and PTs
4.9	Bus support insulator	6 Nos. of each type
4.10	Spring charging motor	1 no. of each type
4.11	Auxilliary Contactors	20% of each type and make OR 1 No.(min) of each type and make, whichever is more
5	415V PCC/PMCC/LSTK or MV Switchboard	
5.1	Closing coil	1 No. of each rating & type
5.2	Shunt trip coil	1 No. of each rating & type
5.3	Control fuses / MCB	10 Nos. each rating & type
5.4	Indicating lamps covers	5 Nos. of each colour
5.5	Indicating lamps	20% or 3 Nos. (min.), whichever is more
5.6	CT and PT	1 set (3 Nos.) of each type and rating of CTs and PTs
5.7	Bus support insulator	6 Nos. of each type
5.8	Spring charging motor	1 no. of each type
5.9	Auxilliary Contactors	20% of each type and make OR 1 No.(min) of each type and make, whichever is more
5.10	Thermal relay/ Digital motor protection relays	1 no. of each type
5.11	Power contactors.	1 no. of each type
5.12	MCCB/MCB	1 no. of each type
		each type, whichever is more
6	Substation Automation System (SAS) / HMI / Data Concentrator	one set of spare for each SAS / HMI / Data Concentrator
6.1	All cards such as input & output cards, power supply cards, processor cards etc.	1 No. of each type
6.2	Ethernet switches	1 No. of each type
6.3	Control fuses / MCB	10 Nos. of each rating & type
7	Relays for Switchboard / Relay control Panel	one set of spare for each Switchboard (Refer Note-8)/ Relay control Panel
7.1	Protection Relays	1 No. of each type
7.2	Auxiliary Relays	1 No. of each type
8	UPS System	one set of spare for each UPS system
8.1	Power Thyristors / Transistors / IGBT / IGCT	1 No. of each rating & type
8.2	Control cards	1 No. of each type
8.3	Power supply cards	1 No. of each rating and type
8.4	Power fuses	20% for each rating OR 1 no. (min.)of each rating, whichever is more
8.5	Control fuses / MCB	10 Nos. of each rating & type

8.6	Indicating lamps	10% OR 3 nos. (min.), whichever is more
8.7	Indicating lamps covers	2 Nos. of each colour
8.8	Blocker Diode	2 Nos. of each rating & type
9	DC System	one set of spare for each DC System
9.1	Power Thyristors / Transistors / IGBT / IGCT	1 No. of each rating & type
9.2	Control cards	1 No. of each type
9.3	Power supply cards	1 No. of each rating and type
9.4	Power fuses	20% for each rating OR 1 no. (min.) of each rating, whichever is more
9.5	Control fuses / MCB	10 Nos. of each rating & type
9.6	Indicating lamps	10% OR 3 nos. (min.), whichever is more
9.7	Indicating lamps covers	2 Nos. of each colour
9.8	Blocker Diode	2 Nos. of each rating & type
10	MV induction motors 37 kW & above	one set of spare for each rating & type
10.1	Bearing (DE & NDE)	1 set
10.2	Terminal studs/bushing assembly	1 set each
11	Fire alarm system	
11.1	All cards	1 No. of each type
11.2	Power fuses	20% for each rating OR 1 no. (min.) of each rating, whichever is more
11.3	Control fuses / MCB	10 Nos. of each rating & type
11.4	Terminal blocks	20 Nos
11.5	Fire Detectors	1% of total installed capacity of each type OR 1 no.(min.) of each type, whichever is more
11.6	Glass for Break Glass Boxes/ Manual call point	% of each type OR 1 No. (min.) 5 of each type, whichever is more
12	Paging system / Plant Communication System	
12.1	All cards	1 No of each type
12.2	Power fuses	20% for each rating OR 1 no. (min.) of each rating, whichever is more
12.3	Control fuses / MCB	10 Nos. each rating & type
13	Electrical Control System (ECS) for extension part and Load management package	
13.1	Interposing relays (As applicable)	5 Nos. of each type
13.2	Power supply & control cards	1 No. of each type
13.3	Transducers	20% of estimated quantity of each type and make OR 1 no (min) of each type and make, whichever is more
13.4	Function generator cum counter	1 No.
13.5	4-20mA signal injection set	1 No.
13.6	Isolation transformer	1 No.

14	Power transformer	
14.1	Bushing (HV & LV)	One number bushing of all types
14.2	Gasket - all types	One set
14.3	MOG	One number of each type
14.4	WTI & OTI	One number of each type
14.5	Buchholz Relay	One number of each type
14.6	Silica gel breather Assembly	One number of each type
15.	NIFPS	
15.1	Cylinder filled with Nitrogen of required capacity (Per Transformer)	1 No.
15.2	Detectors per transformer	3 Nos.
15.3	Regulator assembly per sub-station	1 No.
16.0	Outdoor switchyard components	
16.1	CVT	2 no CVT of each type and rating
16.2	Lightning arrestor	2 nos of LA of each type and rating
16.3	Isolator	
16.3.1	Male and female contact	1 set of each type and rating
16.3.2	Limit switch	1 no of each type and rating and make
16.3.3	MOTOR WITH GEAR ASSEMBLY & BEVEL GEAR ASSEMBLY COMPLETE.	1 set
16.3.4	AUXILIARY SWITCH CONTACTS ASSEMBLY	1 set
16.3.5	EARTHING ROD & BLADE CONTACT SIDE	1 set
16.3.5	HINGE PINS, TERMINAL CONNECTOR, TERMINAL PAD	1 set
16.4	Insulator & other common items	
16.4.1	POST INSULATOR SUPPORT- 220 KV	2 nos
16.4.2	Insulator string assembly	1 nos of each type and rating
16.4.3	ACSR Moose conductor	100 meters
16.4.4	Clamps, connectors	1 set
17.0	SCAP, LMS, Communication system , metering	
17.1	All type of Electronic cards / processor/ IO assembly	1 no of each type
17.2	Transducers	2 no of each type, make & rating
17.3	Network switch	1 no of each type
17.4	Discrepancy switch in SCAP	2 no of each type
17.5	Selector switches/ TNC switches	1 no of each type & rating
17.6	Special tariff meters (ABT, TOD)	1 no of each type
17.7	CMRI/ MRI system	1 no of each type

NOTES:

1. The word 'TYPE' means the Make, Model no., Type, Range, Size/ Length, Rating, Material as applicable.
2. Wherever % age is identified, Contractor shall supply next rounded figure.
3. The terminology used under 'Part Description' is the commonly used name of the part and may vary from manufacturer to manufacturer.
4. Mandatory spares as indicated above do not cover commissioning spares.
5. Mandatory spares as indicated above do not cover two year O&M spares.
6. Mandatory spares shall be applicable for electrical items of motors / sub-packages as per mandatory spares philosophy specified elsewhere in the bid document.
7. For Isolation breaker panel (GIS or AIS) one set of "Tripping Coil (1 No.), Closing coil (1 No.) and Control fuse/MCB (10 Nos. of each rating and type)" shall be considered as mandatory spares for each Isolation breaker panel (GIS or AIS).
8. For Isolation breaker panel (GIS or AIS) one set of "Auxiliary relays (1 no. of each type)" shall be considered as mandatory spares for Relays for Isolation breaker panel

(GIS or AIS).

6.2 COMMISSIONING SPARES

Commissioning Spare Parts shall be procured along with the main equipment as per equipment manufacturer's recommendations. The list of such recommended spares shall be obtained along with the offer.

6.3 RECOMMENDED SPARE FOR NORMAL OPERATION & MAINTAINENCE

Quotation for two-years spares for normal operation and maintenance (over and above mandatory spares) along with unit price shall be obtained with the proposal for Client to order the same separately.

6.4 SPECIAL TOOLS AND TACKLES

Required Special Tools and Tackles shall be procured along with the main equipment as per equipment manufacturer's recommendations. The list of such recommended special tools/tackles shall be obtained along with the offer.

7.0 VENDOR DATA REQUIREMENT

Vendor Data Requirement as indicated in the respective equipment Material Requisitions shall be followed.

ADDITIONAL DESIGN GUIDELINES

power distribution boards shall be provided with ELCB / CBCT with ELR for all its feeders.

- 1.3 LSTK contractor shall provide adequate area lighting at site of construction, fabrication yards, office, etc. by means of high flood light masts, flood lighting poles, etc. which are to be supplied and maintained by the LSTK contractor.

2.0 SYSTEM DESIGN PHILOSOPHY

- 2.1 The design of electrical installation shall ensure provision of a safe and reliable supply of electricity at all times. Safe conditions shall be ensured under all operating conditions including those associated with start up and shut down of plant as well as those arising out of failure of electrical equipment. The isolation of part of system of electrical equipment due to either maintenance or shut down shall not compromise safety. Power distribution system shall constitute substation location, as far as possible near load centres.
- 2.2 System shall be designed considering following aspects in general: -
- To facilitate inspection, cleaning and maintenance with the care to safety in operation and personnel protection.
 - To minimise turnaround times.
 - To provide safety, reliability and flexibility of service.
 - Adequate provision for future extension and modification.
 - Maximum interchangeability of equipment.
 - Desired level of operator interface to achieve co-ordinated efficient and fail-safe operation, data logging and maintenance of the equipment.
 - To decide redundancy, stand by, spares and overload capacities to achieve desired reliability and flexibility requirement.
 - To get cost effective and techno commercially proven technology, Economic considerations shall cover capital and running costs and an assessment of the reliability and consequent availability of the system.
- 2.3 All the electrical consumers within the battery limit shall be correctly identified and listed to have complete details of rating, efficiency, power factor, operating duty cycle (continuous, intermittent, standby), category of supply required (emergency, normal, critical) etc.
- 2.4 Required redundancy (based on specific process / operating needs) shall be built in substation which feeds power supply to process units / important facilities so that in case of tripping of one feeder, the unit may not be adversely affected and continuity in operation at full capacity is achieved.
- 2.5 While sizing the system necessary consideration shall be given to restrict the system voltage drop within permissible limits during starting of large rated motor or group of motors. At the same time, the short circuit current shall be kept within limits keeping in view of the market availability of switchgears. For this purpose current limiting reactors / unit ratio transformers if required may be used. Reduced voltage starting (soft starter feature) for motors may be considered as per system requirements.
- 2.6 **LOAD GROUPING**
- Electrical consumers shall be classified as 'normal / non-essential, emergency / essential or vital / critical loads as per the concepts defined below:

- 2.6.1 'Emergency' or 'essential' loads shall be identified on the criteria that, when failing in operation or when failing if called upon, will affect the continuity of operation, the quality or the quantity of product. For such loads, reliable source shall be ensured. Such feeders shall be grouped on a separate bus-section in the respective MCCs / PCCs.
- 2.6.2 Some of the loads which can be identified as emergency / essential load but not essentially limited to following:
- Electrical loads required for continuous operation of process plants / utility etc.
 - Electrical loads required for safe shut down of facilities
 - Emergency lighting
 - All communication facilities
 - Fire Alarm System / Fire fighting equipment
 - Level gauge / vessel lamp illumination
 - AC & DC UPS / Battery charging equipment
 - Control room AC equipment
 - Essential ventilation system for offices / manned areas of other buildings.
- 2.6.3 'Critical' or 'vital' loads shall be identified on the criteria that, when failing in operation or when called upon, can cause an unsafe condition of the installation, jeopardize life or cause a major damage to the installation. For critical loads if any, UPS shall be provided to facilitate uninterrupted supply. The loads on UPS are AVR / PLC / DCS / Auxiliary supply for drives etc. Critical drives if any shall be provided with DC motors.
- 2.6.4 Some of the load which can be identified as critical / vital load but not essentially limited to following:
- Loads providing control and protection to plant equipment
 - Loads serving critical equipment for safety of plant, equipment and / or personnel
- 2.6.5 Non-essential service is a service, which is neither 'essential' nor 'vital'. Hence the non-essential load does not require any special measure such as standby feeder or standby source to safeguard the continuity of service.
- 2.7 SYSTEM VOLTAGES
- Following factors shall be taken into account while selecting the voltage levels: -
- Short circuit level
 - Availability of the switchgear with suitable current rating and short circuit rating.
 - Existing available voltage levels in the refinery.
 - Utilisation voltages of various equipment
 - Provision of future extension.
 - Size and location of loads
 - Choice of voltage may also be affected by local regulations, standards as well as the voltage of existing installations
 - Overall economy for optimum voltage selection.
- 2.8 All the components of electrical system shall be designed to take into account following: -
- After Diversity Maximum demand (ADMD) after diversity under most severe operating and ambient conditions with an additional 10 % contingency.
 - Intermittent service loads, if any.

- Minimum 20 % spare for future addition.

2.9 PLANT UTILITY LEVELS

Motors rated above 160 KW	:	6.6 kV TP, 50Hz
Motors rated up including to and 160KW	:	415V AC, TP, 50Hz
UPS system	:	415 V AC, TP, 50Hz (I/C)
AC lighting / Auxiliary boards	:	415 V AC, TPN, 50Hz
Normal lighting	:	240 V AC, SPN, 50 Hz
Telephone system	:	240 V AC, SPN, 50 Hz
Critical lighting	:	220V DC
Control supply		240V AC for MCC to be derived from individual control transformer in MCC.
		220V DC for HT Switchgears and PCC / PMCC
		110V, AC for DCS / PLC control supply to be derived from UPS.
		Control supply from UPS/central DC system for excitation panel, AVR, Fire Alarm system and Paging system.

2.10 VOLTAGE DROPS

The maximum voltage drops in various sections of the electrical system shall be within the limits stated in the following table:

Sr. No.	System Element	Maximum Permissible Voltage Drop
1	Bus duct between transformer secondary and switchgear (HT / LT)	0.5 %
2	Cables between PCC and MCC or auxiliary switchboard	
	Location of switchboard: Near PCC	0.5 %
	Remote	Max. 2.5 %
3	Cables between HT Switchgear and HT motor	3% normal / 15% starting
4	Maximum Voltage drop up to LT motor terminal	
	during running condition	5%
	during starting condition	20 %
5	Cables between auxiliary switchboard and lighting panel	Max. 1.5 %
6	Circuit between lighting panels and lighting points	4%
7	DC supply circuits / UPS circuits	5 %

The voltage available at the motor terminals during start - up must be sufficient to ensure positive starting or re acceleration of the motor (even with the motor fully loaded, if required) without causing any damage to the motor.

For HT motors, the voltage available at the motor terminals must not be less than 85 % of the rated value during start-up or re acceleration. For LT motors, the voltage available at the motor terminals must not be less than 80 % of the rated value during start-up or re-acceleration.

2.11 DESIGN CRITERIA FOR CABLES / BUS DUCT

Sr. no.	Design Criteria	220kV/33 kV / 6.6 kV	415 V
2.11.1	Loads beyond 1000 A rating	Bus duct	Bus duct
2.11.2	Loads located beyond 1 km	Cable	N/A
2.11.3	Loads located up to 1000 m	Cable	Cable
2.11.4	Recommended limiting size of multi core cable (mm)	400– 3 core 1000 – 1 core	400– 3 core
2.11.5	Short circuit withstand time (seconds)	1 Sec for Bus duct 3 Sec for GIS Busduct For Cables: 0.2 sec. – Inst., 0.6 sec. – Incomer, 1 sec. – Plant feeder	1 Sec.
2.11.6	Insulation voltage grade	33 kV Earthed 6.6 kV Unearthed	Earthed
2.11.7	Type of cable insulation	XLPE	PVC FRLS

2.12 SHORT CIRCUIT CAPACITIES

All the switchgears shall be designed for following fault level withstand capacity.

220 kV switchgear – 19000 MVA for 3 sec.

33 kV switchgear- 1850 MVA for 1 sec.

6.6 kV switchgear - 500 MVA for 1 sec.

415 V switchgear - 35 MVA for 1 sec.

Sizing of high voltage cables shall be based on short circuit withstand capacity in addition to the current capacity.

2.13 INSULATION SYSTEM

Following factors shall be considered while designing the Insulation of Electrical system

- System voltage
- System grounding
- Switching over voltages
- Lightning surges
- For HT motors (VCB controlled) surge arresters shall be provided.

2.14 For resistance grounded systems, the resistance value shall be chosen to limit the earth fault current to a value recommended by generator / motor manufacturer for insulation protection and sufficient for selective and reliable operation of earth fault protection system. The value of limited earth fault current shall generally not exceed 50 % of transformer full load current.

2.15 AUTO CHANGE OVER SCHEMES (Please also refer Section-3 chapter-14 for detailed guidelines.

2.15.1 Switchgears (HT, LT) to be supplied by contractor shall have 2 incomers and 1 no. Bus coupler. Normal operation shall be with 2 incomers 'ON' and the bus coupler 'OFF'. Upon failure of any of

the incomer due to loss of power supply, bus coupler shall be closed through automatic bus transfer, thereby restoring power supply to the affected section. Once the power supply is resumed / fault is cleared on affected incomer, closing of the incomer and tripping of unwanted breaker (any of the incomer or bus coupler) shall be done manually, with momentary paralleling of two incomers through synchro check relay.

- 2.15.2 The bus coupler change over scheme shall have two separate relays for monitoring the bus healthy and unhealthy condition. Preferably healthy bus relay shall be set at 80 % setting and unhealthy bus relay shall be set at 40 % or less. Fuse failure/MCB interlock shall be provided in all voltage based schemes
- 2.15.3 For switchboards having auto-transfer facility, tripping of incomers on under voltage shall be inhibited if the voltage dip is transient and is experienced on both the incomers simultaneously.
- 2.15.4 MCC shall be provided with 2 incomers and one no. bus coupler. Working & standby load shall be distributed on different bus sections. MCC with incomer rating ≤ 630 A shall have only manual bus transfer facility with necessary Castle key interlock. MCC with breaker for Incomers and bus coupler shall have auto transfer scheme as above.
- 2.15.5 86 relay contacts of both the incomers shall be provided in the bus coupler closing circuit to block the operation in both the Auto / Manual mode.
- 2.15.6 In order to ensure healthiness of bus coupler auto changeover scheme, a Bus coupler 'Auto Circuit Supervision' similar to trip circuit supervision scheme shall be provided for all bus couplers.
- 2.15.7 Downstream Bus coupler changeover scheme shall not be blocked on operation of pilot wire / cable differential protection.
- 2.15.8 In case of failure of any of the working load (due to mechanical or electrical fault), standby load from other bus section shall be started remotely (if process demands) with start command from DCS/PLC.
- 2.16 PROTECTION AND METERING SCHEMES
- 2.16.1 Selection and co ordination of Protection and metering system shall be such as to ensure:
 - Selective and sensitive and reliable protection of equipment against damage due to internal or external faults or atmosphere discharge.
 - Isolation of fault in the shortest possible time.
 - Simplicity of the scheme with maximum protection at minimum cost.
 - Uninterrupted operation of healthy system.
 - Personnel & plant safety.
- 2.16.2 All HT systems (220 kV/33kV/6.6kV in particular, shall be provided with differential protection. The CT arrangement / locations provided for differential protection shall be such that overlapping zones are formed for differential protections provided for HT feeders, incomers, bus couplers, tie feeders etc so that the protection zone gets extended up to the last breaker / zone for which differential protection is provided. Restricted earth fault protection shall be provided for transformer windings with grounded neutrals.
- 2.16.3 Protective relays shall be of latest version, numerical / communicable type with non-volatile memory, comprehensive unit providing protection, metering, control and communication with MMI on IEC-61850 compatible to communicate with MMI and ECS. Necessary hardware at ECS end for communication to be provided by the LSTK contractor. 100% redundancy shall be provided for communication. Relays shall support features like remote relay parameterization, disturbance recorder etc. It shall be possible to set / operate the relay from the front facia. Lock out relay shall be conventional type with hand reset facility (VAJH only).
- 2.16.4 Special protection for any feeder such as differential, restricted earth fault, directional distance power relays etc. shall also be through numerical relay having serial port for monitoring.
- 2.16.5 In general, fast acting relays (with time delays if required) shall be used and all fault tripping shall be done through high speed tripping relays

- 2.16.6 Bare minimum Protection devices for power distribution system shall be as indicated below, however LSTK shall provide any other necessary protection relays required for complete protection of system:

- 2.16.7. The following feeders shall be provided with timers for delayed tripping on bus under voltage while the under voltage relay shall be common for the bus.
- 2.16.8 HT breaker controlled motor feeders or contactor feeders with DC control supply. U/V tripping of motors in 6.6 kV system shall be based on critical / non-critical selection (0.5 / 5 sec).
- 2.16.9 One no. DC supply supervision relay (80) shall be provided for each incoming DC supply to the switchboard with audio / visual annunciation.
- 2.16.10 One set of bus differential relays (87B) and bus wire supervision relay (95 B) for each bus section shall be provided for HT switchboards. Bus differential protection IN / OUT selector switch shall be provided on panel with indication. Bus differential protection shall have overlapping zones.
- 2.16.11 Two sets of 86 relays shall be considered for each HT motor feeder. One for electrical tripping and other for process tripping 86 relay for process trip shall be of self reset type

tripping and other for process tripping. 86 relay for process trip shall be of self reset type with flag or reset facility from DCS / PLC.

- 2.16.12. All cable differential protection shall be OFC based.,
- 2.16.13 PT fuse failure relays in HT / LT panels and Busbar differential supervision relay (VTX-31) to be installed
- 2.16.14 Value of stabilising resistor for Differential relay (Numerical Relay) to be selected suitably based on fault level
- 2.16.15 The breaker contacts for critical logic (upstream / downstream tripping, changeover etc.) shall be provided directly from breaker auxiliary contacts and not from auxiliary contactors.
- 2.16.16 Memory / History of the Numerical relay shall not get erased due to loss of auxiliary supply of the relay. Preferably similar make of relays to be installed in one particular substation.
- 2.16.17 Transformer auxiliary protection: Buchholz, OT, WT, MOG, OLTC alarm / trips to be provided.

2.17 DC POWER SUPPLY

Unless otherwise specified, independent DC power supply systems shall be provided for following

Electrical switchgear control

Critical drives

Critical lighting

2.18 EMERGENCY POWER SUPPLY

The emergency power supply system shall be designed to feed the following types of loads as required:

- Electrical loads essential for safe shut down
- Emergency lighting
- Fire alarm / communication system
- DC supply system
- UPS system
- Loads critical for process, plant and personnel safety.

3.0 AREA CLASSIFICATION

3.1 Following factors shall be considered for proper selection of electrical equipment for use in hazardous areas:

- Area classification (Zone 0 / Zone1 / Zone2)
- Gas classification (Gr. II A / IIB / IIC) – Characteristic of the gas / vapour involved
- Temperature classification (T1 to T6)
- Environmental conditions – selected electrical equipment shall be protected against corrosive and solvent agencies, water ingress, dusty, chemically polluted atmosphere as determined by the environmental conditions.

3.2 All electrical equipment installed in classified areas shall be selected as per IS 5571, OISD-113 and other relevant standards. For Zone 2 areas as a minimum Ex (e) type of equipment shall be used. However, Ex (e) type of equipment shall not be used for Zone – 1 area.

3.3 Pressurised type of motors Ex(p) may be considered in case flameproof motors in required kW rating and gas gr. are not available. All pressurised motors shall be complete with flameproof pressurisation panel, control valves, flow meter, pressure switch etc. DC power supply shall be considered for the pressurisation panel of the pressurised motors. Pressurisation system shall have parallel filter and draining arrangement prior to purging. Necessary interlock shall be provided such that on failure of pressurisation system, electrical equipment will be switched off with audiovisual alarm.

3.4 Selection of equipment for hazardous areas shall be as follows: -

Area Classified	Type of protection	Symbol
Zone 0	- No electrical equipment to be installed.	
Zone 1	- Flameproof enclosure	'd'
	- Intrinsic safety category	'i'
	- Pressurised	'p'
	- Other electrical apparatus specifically designed for Zone 1	's'
Zone 2	- Increased safety	'e'

3.5 Increased safety / non sparking apparatus located outdoor shall be provided with minimum IPW55 protection as per IS 4691.

3.6 All electrical equipment for hazardous areas shall be certified by testing authorities like CMRI, PTB, BASEEFA, UL / FM for the service and the area of installation and shall be approved by CCE. All indigenous flameproof equipment Ex (d) shall be under BIS license.

- 3.7 As additional safety features, the following requirements for electrical equipment shall be followed.
- 3.7.1 All electric motors for agitators, mixers, LPG Pumps and metering pumps handling flammable material shall be flameproof type irrespective of the area being classified as Zone-2 or Zone-1.
- 3.7.2 All electric motors for vertical oil sump pumps shall be flameproof type Ex-d.
- 3.7.3 Irrespective of the area classification (whether Zone-1 or Zone-2) all motors and lighting fixtures within the storage areas, pump house associated with storage areas and within the loading / unloading gantries shall be flameproof type.
- 3.7.4 All electric motors for agitators, mixers, LPG Pumps and metering pumps handling flammable material shall be flameproof type irrespective of the area being classified as Zone-2 or Zone-1.
- 3.7.5 All electric motors for vertical oil sump pumps shall be flameproof type Ex-d.
- 3.7.6 Irrespective of the area classification (whether Zone-1 or Zone-2) all motors and lighting fixtures within the storage areas, pump house associated with storage areas and within the loading / unloading gantries shall be flameproof type.
- 3.7.7 Even though fired heaters in process units are not considered for area classification, all electrical equipment associated with fired heaters in process units shall, as a minimum be suitable for installation in Zone-2 area.
- 3.7.8 Motors for hazardous area application, when fed from VSD shall have enclosure protection flameproof Ex'd ' irrespective of area classification.
- 3.7.9 All electrical equipment installed inside a compressor shed where hydrogen is being processed / handled shall be flameproof type suitable for gas group-IIC irrespective of gas group (IIA/IIB/IIC) and area being classified as Zone-1 or Zone-2.
- 3.7.10 All electrical equipment installed for an analyser room shall be flameproof type suitable for gas group-IIA, IIB, IIC irrespective of the area being classified as Zone-1 or Zone-2.
- 3.7.11 All electrical equipment at the process cooling tower deck shall be Ex-e type as per OISD norms.
- 3.7.12 All equipment inside the process units shall be suitable for Zone-2 Ex (e) temperature class T3 irrespective of area being safe.
- 3.7.13 Process units having different types of gas groups like IIA / IIB/ IIC or different area classification like Zone-1 or Zone-2 or safe shall have electrical equipment to meet all gas groups / area classification to facilitate installation and minimum spare inventory and uniformity.

4.0 EQUIPMENT DESIGN PHILOSOPHY

4.1 TRANSFORMERS

- 4.1.1 The transformers except lighting transformers shall be ONAN / ONAF, 3 phase, oil immersed, double wound type suitable for outdoor installation. Lighting transformers shall be dry type.
- 4.1.2 Transformer sizing shall be such as to take care of minimum 8 hour maximum demand, starting of highest rated induction motor with other load in running condition and minimum 30 % spare capacity for future requirement.
- 4.1.3 The ONAN rating of ONAN/ONAF type power transformers shall be equal to or higher than maximum demand. ONAF rating shall be equal to or higher than 125% of ONAN rating.

- 4.2 HT SWITCHGEAR (33 kV & 6.6 kV)
- 4.2.1 All switchgears and associated equipment shall be rated for the rating of transformer /motor being fed from it under any circuit configuration.
- 4.2.2 Rating of Bus-coupler shall be suitable for following conditions:
- 4.2.3
- Maximum running load on either side of bus section.
 - Bus coupler rating equal to largest incoming circuit breaker rating.
 - Should not be less than bus bar current rating.
- 4.2.4 Minimum 25 % spare feeders or one no. of each rating and type on each side of the bus section whichever is more shall be provided.
- 4.2.5 In case of HT vacuum circuit breaker, adequate provision shall be made for motor switching to limit the over voltage to 2.2 per unit of rated peak line to earth voltage. Required surge arrestors may be provided for this purpose.
- 4.2.6 The rating of Circuit breakers /contactors used in Motor feeder shall be at least 125% of the maximum continuous motor rating.
- 4.2.7 Electrical running loads shall be uniformly distributed on each bus and it shall be ensured that running and standby loads are fed from two different bus sections.
- 4.2.8 HT switchgears shall be supplied with necessary earthing trolleys / earthing rods / breaker lifting trolleys.
- 4.2.10 For tie feeders, receiving end circuit breaker shall have ON / OFF control and indicating lamps for sending end circuit breaker with selective closing of sending end breaker.
- 4.3 LT SWITCHGEAR (PCC / MCC / ASB / LDB / PDB)
- 4.3.1 Switchgears shall have rating atleast equal to maximum demand under any circuit configuration and provision for 30 % future requirement
- 4.3.2 Minimum 25 % spare feeders or one no. of each rating and type on each side of the bus section whichever is more shall be provided.
- 4.3.3 Separate feeders shall be provided in the switchboard for each load / motor.

- 4.3.4 Service breaking capacities (Ics) for all breakers and MCCBs shall be equal to or higher than the maximum fault level at the point of installation.
- 4.3.5 For feeders rated above 630A, ACBs shall be provided and that below and including 630A, fuse switch units shall be provided.
- 4.3.6 All the switchgear components shall be designed to withstand maximum expected fault level for a minimum time of 1 second.
- 4.3.7 All motor feeders shall be provided with IEC type 2 co-ordination.
- Motors rated above 55 kW & upto 160 kW shall be controlled through ACB & motor protection relay and shall be fed from PCC.
- All motors feeders rated above 22 kW & upto 55 kW shall be controlled through switch fuse unit, contactor, overload relay with CBCT, ELR/ digital motor protection relay for earth fault protection & shall be fed from MCC.
- All motors feeders rated upto & including 22 kW shall be controlled through switch fuse unit, contactor & overload relay. All loads upto 22 KW rating shall be provided with ELCBs.
- All motor feeders rated above 5.5 kW shall be provided with CT for remote metering.
- 4.3.8 The maximum rating of incomers / buscouplers of motor control centres / auxiliary switchboards / power distribution boards / lighting distribution boards shall be preferably limited to 1200A. The incoming / tie feeders shall be ACB only.
- 4.3.9 Motor Control Centres with breaker incomer and breaker buscoupler shall be provided with synchro check relay for momentary paralleling during auto transfer.
- 4.3.10 Electrical running loads shall be uniformly distributed on each bus and it shall be ensured that running and standby loads are fed from two different bus sections.
- 4.3.11 All the TPN switch fuse feeders shall be provided with ammeter. All emergency / critical drives, irrespective of their ratings shall be provided with ammeters.
- 5.0 MAN MACHINE INTERFACE (MMI)
- 5.1 MMI shall include CPU, Keyboard, Monitor, Mouse, Printer etc. Two number Man Machine Interfaces shall be provided at each location at PR and PNCP control room, one number industrial workstation for engineering workstation and one number PC for operator's workstation. System configuration shall be latest proven model and upgradable. The minimum configuration for this project shall be Intel Xeon 6 core processor (W3690, W3670) or better with 32 inch LED display and laser jet colour printer. The RAM shall be minimum 16 GB with hard disk 512 GB (minimum) . Power supply for Substation MMI shall be obtained from emergency / critical source available in the substation / nearby substation / control room.
- 5.2 MMI shall allow minimum of the following functions. Any other facility as per project scope to be included in the design.

- Feeder status monitoring
- Data Logging
- Relay parameterisation
- Event recording
- Annunciation
- View of historical data and trends
- Preparation of maintenance schedule.

5.3 Data link connectivity to be provided without data concentrator between relays and ECS to be provided with the use ring switches and Ethernet switches for complete system (33 kV & 6.6 kV) and LT system. Required hardware for IEC-61850 to serial link communication at ECS end to be provided by the contractor.

5.4 User-friendly windows based software shall be provided for interactive display of substation data in multi-window feature. Software shall have the capability to display substation single line diagrams, display for electrical system parameters, reports, alarm annunciation, daily and monthly data logging, continuously polling, relay programming, relay monitoring, data logging, relay supervision, tripping features, fault disturbance record of each relay, graphic representation and trending of data etc. The display shall have electrical system overview and detailed information about its sub system. All softwares shall be written for operating on a common operating system platform plant wide and shall be able to communicate with existing ECS. A change of operating platform for MMI, CPU during detail engineering shall not have any commercial implications. Audio / Visual Alarm annunciation shall be provided along with hooter.

5.5 MMI system shall have two distinctive passwords one for viewing of data metering etc. and second for authorisation for change in relay setting etc.

5.6 All numerical relays shall communicate on IEC-61850 platform.

5.7 All hardware and software shall be suitable for substation operation and integration with ECS-RTU and to achieve minimum but not limited to the requirement as defined elsewhere.

5.8 Each relay / MMI system shall be time synchronized with GPS clock system.

6.0 MOTORS

6.1 In general, three phase squirrel cage induction motors designed for direct on line starting shall be used. Motors shall be totally enclosed fan cooled suitable for outdoor application.

6.2 The type of enclosure for motors (i.e. indoor /outdoor, industrial / increased safety/ flameproof) shall be adequate for the application and area in which it is to be used.

- 6.3 The mechanical parameters such as duty, mounting type, shaft extension, direction of rotation, starting torque requirements etc. shall be adequate for the application. Sleeve or anti friction type bearings shall be used. Vertical motors shall have thrust bearings suitable for the load imposed by the driven machinery. Motors with sleeve bearings may require proximity probes to measure shaft vibration adjacent and relative to the bearings. Generally, all motors, except for application such as crane, hoist, turbine / engine starting, shall be designed for continuous duty with rated load.
- 6.4 All HT motors shall be provided with 6 nos. duplicate RTDs temperature detectors for winding temperature detection and 2 nos. for bearing temperature detection. Dual dial type temperature indicator without contacts for bearing also shall be provided for all HT motors. All LT motor including & above 75 KW shall be provided with PTC thermistors.
- 6.5 The terminal box of HT motor shall be designed to withstand the specified short circuit current for 0.25 second without damage. A separate neutral terminal box shall be provided for making star connection and it shall be adequately sized to accommodate the current transformers for differential protection.
- 6.6 For critical synchronous motors, excitation panels shall have reliable power supply either from dedicated three phases or single phase UPS or any other reliable source as feasible.
- 6.7 All the motors shall have class ' F ' insulation with temperature rise limited to class ' B '.
- 6.8 Motors shall be capable for 20 % overspeed without danger of mechanical failure.
- 6.9 Type of motors that require variable speed drive system shall be suitable for variable speed range with temperature rise within limit and also shall be suitable for area classification. For hazardous area application motors with variable speed drive system shall be Ex ' d ' type. The total system i.e. motor including VSD shall be type tested as a unit. All motors operating on VSDs shall have embedded temperature detectors / thermistors for winding with thermistor relay which will trip the motor in case the temperature of winding exceeds the permissible limits. Flameproof motors operating on variable speed drive system shall have CMRI or equivalent authority certifying the suitability of drive motor with VSDs. For temperature detectors / thermistors 2/3 logic shall be provided for tripping.
- 6.10 HT motors with VSD application shall have insulated bearing.
- 6.11 Limiting Conditions for Motor start up (e.g. starting current limitation or method of starting): -
- 6.12 - Starting current of HT motors rated upto 2.5 MW shall be limited to 550 % (inclusive of +ve tolerance). Generally, motors rated between 2.5 MW & 7.5 MW shall be started through Soft starter and motor rated above 7.5 MW unless otherwise required by process, shall be started through variable speed drive system having soft start feature
- Starting current of motors rated upto 75 kW shall be limited to 600% (inclusive of +ve tolerance) of normal current.
- Starting current of motor rated more than 75 kW and upto 160 kW shall be limited to 550% (inclusive of +ve tolerance) of normal current.
- 6.13 Any assisted type of starting method (e.g. soft starter, Auto transformer etc.) for HT / LT motors may be considered for regulation / voltage drop within limits, ensuring proper acceleration of the driven equipment.
- 6.14 Re-acceleration for identified critical motors shall be provided to cover brief interruption up to 5 seconds in normal power supply. Insulation for these motors shall be designed for 140 % of rated insulation level to take care of any over voltages that might result during changeover.
- 6.15 Outdoor motors shall be provided with canopy.

- 6.16 Motors of rating above 30 kW shall be provided with space heater. Ammeter shall be provided on the panel for the space heater circuit.
- 6.17 Motors shall be rated for starting at 80 % voltage at motor terminals.
- 6.18 Winding temperature and bearing temperature alarm and trip shall be provided for all HT motors. Minimum 10% additional RTD points shall be provided.
- 6.19 One no. motor from each lot for motors more than 1.5 MW rating, shall be subjected to type test.

7.0 HT CAPACITOR BANK

- 7.1 HT Capacitor bank shall be connected on 6.6 kV bus to improve the power factor of the system.
- 7.2 HT Capacitor shall comprise appropriate nos. of basic single phase units (minimum 4 nos. basic units in parallel per phase) which shall be connected in star formation.
- 7.3 Capacitor banks shall be with necessary discharge resistors to reduce the terminal voltage of each unit to a value equal to or less than 50 V in 5 minutes.
- 7.4 Necessary rack assembly for housing Capacitor units with necessary post insulators, Discharge resistors, series reactors, etc. shall be provided for outdoor assembly. For indoor assembly, necessary panel to accommodate the basic capacitor units, interconnecting busbars, insulators, discharge resistors, series reactors, switching units, metering, protection units etc. The panel shall have minimum IP 55 protection and shall be constructed with sheet steel of minimum thickness 2.0 mm.
- 7.5 Necessary series reactor shall be provided to limit inrush current and suppress harmonics.
- 7.6 Capacitor dielectric medium shall be MPP or mixed dielectric. Impregnant in the capacitors shall be non – toxic.
- 7.7 Necessary protections include IDMTL over current with high set element for protection against short circuit, Instantaneous earth fault, under voltage, Over voltage, Built in fuse for each element, neutral unbalance voltage, current.
- 7.8 The capacitor bank feeders shall generally be tripped on bus under voltage / over voltage conditions. Necessary interlock / timer shall be provided for blocking re switching operation to take care of capacitor residual voltage.
- 7.9 The continuous current rating of fuses and switching devices for capacitors shall be 30 % higher than the normal full load current

8.0 BUS-DUCT

- 8.1 HT and LT bus ducts shall be phase segregated.
- 8.2 Bus bars shall be of electrolytic grade copper for 220 KV and 33 KV system and for 6.6 KV system electrolytic grade aluminium/copper to be provided.
- 8.3 It shall be suitably supported at regular intervals and both bus-bars and supports shall be adequately sized and clamped to withstand rated short circuit current without permanent deformation.
- 8.4 The bus insulators shall be non-hygroscopic, non-inflammable material. Earth bus shall run along the full length of bus duct without any break.
- 8.5 Outdoor bus-duct shall be weatherproof to IP-55 and shall be provided with canopy, silica gel breather.

- 8.6 Busduct shall be supplied with busbar flexible links for connection at both the ends and expansion joints for every 3m of busduct and busduct support materials.
- 8.7 Openings with cover at suitable locations shall be provided on busduct for accessing the busbars for maintenance.
- 9.0 NEUTRAL GROUNDING RESISTOR (NGR)
- 9.1 Neutral grounding resistor shall be housed in a sheet metal enclosure and shall be naturally ventilated.
- 9.2 The value of the NGR shall be such as to limit the earth fault current and also to ensure the protective relay operation.
- 9.3 NGR shall be able to carry at least 10 % of its rated current continuously, unless otherwise specified, and full rated current (100%) for a minimum duration of 10 seconds.
- 10.0 BATTERIES
- 10.1 While sizing the batteries, temperature correction, ageing factor and maintenance factor shall be considered.
- 10.2 Batteries shall be complete with batteries and battery racks.
- 10.3 Float type of level indicators shall be provided for each cell in the battery bank.
- 10.4 Batteries shall be adequate to meet the requirements as per duty cycle, type of load and min. 20 % spare capacity for future requirement.
- 10.5 Isolator shall be provided for battery bank isolation near battery.
- 10.6 All batteries shall be Ni-Cd type and of suitable construction to suit the application.
For all other requirement refer Section -3 Chapter-10.
- 11.0 BATTERY CHARGER
- 11.1 The charger shall have dual parallel redundant modules of float cum boost charging unit. Necessary mode selector switch shall be provided for the two chargers & battery connection. The output of FCBC shall be connected to two DC bus sections with coupler switch and finally connected to each section of a dual DCDB.
- 11.2 Provision shall be made to monitor DC leakage current in the system with a milliamp meter at DCDB / control room or in ECS.
- 11.3 The rating of the charger shall be adequate to trickle / boost charging of batteries and to feed the DC load requirement with minimum 25 % spare capacity.
- 11.4 25% spare outgoing feeders for future use shall be provided in each DCDB for each rating and type of feeder.
- 11.5 One summary fault contact shall be provided for remote alarm.
- 11.6 Battery chargers shall be provided with tap cell connection to take care of interruption of float charger when other charger is being used to boost charge the battery bank.
- 11.7 For all other requirement refer Section -3 Chapter-10

- 12.0 UNINTERRUPTED POWER SUPPLY (UPS).
- 12.1 The UPS shall have duty and ratings of feeders adequate for the application and shall be suitable for indoor use. UPS system shall be sized to take care of the crest factor of the load current.
- 12.2 Each UPS unit shall have dual parallel redundant modules. Each module shall consists of rectifier transformer, rectifier-cum charger, inverter, filter circuit, static switches, bypass transformer, facility for manual transfer between inverter supply and bypass line, facility for bypassing inverter, static switch for maintenance and ACDB, set of batteries adequate to supply required rated output for two hours.
- 12.3 Under normal operating conditions, the rectifier cum charger shall feed the inverter and charge the battery set. In case of mains failure, the battery shall supply the necessary power to the inverter. Inverter in turn shall feed the load through the static switch. If the inverter malfunction or get overloaded, the load shall be instantaneously transferred to the bypass line through the static switch. Normally, the inverter shall be operated in synchronised mode with the bypass line and manual transfer forward/ reverse shall be effected without any break. The overload capacity & current limiting shall be adequate for the application. Harmonic filters if required shall be considered at input side.
- 12.4 Fused disconnect switch shall be provided for each outgoing feeder of the UPS and the fuse shall be of fast clearing type. The fuse rating shall be selected to achieve co-ordination to protect the UPS during short circuit. The rating of the largest branch circuit shall not exceed 25% of the system rating.
- 12.5 The UPS rating shall be adequately sized considering 25% spare capacity for future load.
- 12.6 25% spare outgoing feeders for future use shall be provided in each ACDB for each rating and type of feeder.
- 12.7 Three separate source supply shall be provided to UPS Incomers.
- 12.8 Two separate AC distribution boards (Dual ACDB), fed from parallel redundant UPS shall be used for instrumentation power distribution system for the improved reliability of instrumentation system. Redundant outgoing feeders shall be provided in ACDB.
- 12.9 The distribution shall be designed such that the failure of a single sub circuit does not cause an unacceptable loss of control or loss of data display to the plant operator.
- 12.10 For all other requirement refer Section-3 Chapter-10.
- 13.0 LIGHTING, POWER & DC DISTRIBUTION BOARDS
- 13.1 No. of LPs, PPs & DCDB shall be provided for complete lighting & power distribution adequate for the plant.
- 13.2 Lighting distribution boards fed through 415/ 415 V lighting transformers with off circuit taps +/-10 % in steps of 2.5 % shall be planned for feeding the lighting system of the package units.
- 13.3 Each lighting transformers shall be sized to feed the entire plant normal lighting load with 30 % as a minimum spare capacity.
- 13.4 Lighting distribution board shall have two incomers and one bus-coupler. One Incomer shall be fed from PCC and other from EPCC where available otherwise from the other bus section of PCC.

- 13.5 Normally both the incomers shall be 'ON' with buscoupler in open condition. In case of any problem to any of the incomer, tripping of the affected incomer followed by closing of buscoupler shall be done manually. Undervoltage relay contacts of both the bus sections wired in parallel shall be used to switch on the DC lighting circuits. Where second incomer is from emergency PCC, Normal running condition normal incomer and bus coupler shall be in closed condition. During the fault on normal incomer, Bus coupler shall open and emergency incomer shall be switched 'ON'.
- 13.6 No. of LPs shall be considered based on location / area served and total loading.
- 13.7 Plant lighting circuits shall be fed from dedicated lighting distribution boards installed in a safe area. For LPs, incomer shall be provided with switch fuse unit / MCB and outgoing shall be with MCBs for control and protection of lighting circuits. ELCB shall be provided in each LDB outgoing circuits to lighting panels.
- 13.8 Plant lighting circuits shall be single phase (P & N) rated 240 V AC. Each circuit shall be rated to 16A but not loaded more than 8 A. A minimum of 25% of MCBs of each board shall be left as spares. Normally about 8-10 fittings shall be wired in each circuit.
- 13.9 Plant lighting distribution board shall include 25% spare outgoing circuits
- 13.10 Adjacent lighting fittings shall not be fed from the same circuit.
- 13.11 Plant lighting circuits (excluding level gauge lighting) for open to sky areas shall be designed for auto/manual switching through timer. In addition, it shall be possible to switch ON/ OFF entire lighting from ECS and local switchboard.
- 13.12 Lighting control scheme shall also be designed to trip the entire lighting system in case of air raid warning. Tripping signal for the lighting system shall be wired from the nearest existing substation.
- 13.13 Auxiliary relays as required for remote switching ON / OFF of lighting system shall be included in lighting distribution board.
- 13.14 For all other requirement refer Section-3 Chapter-8.
- 14.0 LOCAL CONTROL STATIONS (LCS)
- 14.1 The local control stations shall be of aluminium alloy (LM6) construction.
- 14.2 The type and number of switchgear components such as push buttons, selector switches, ammeters, lamps etc. shall be based on the functional requirements of the control scheme and the type of equipment.
- 14.3 Control stations shall be provided for each motor in the field.
- 14.4 Enclosure of the control station shall be suitable for site conditions such as weather proof, dust proof, flame proof, corrosion resistant etc. All outdoor control stations shall be with canopy.
- 14.5 Stop push button shall be of stay put type, however it can be of momentary type in case of drives such as lube oil pump etc which are critical.
- 14.6 Two numbers of stop push buttons shall be provided for the motors, which are installed at elevated platforms, such as cooling tower fan etc. One of the push buttons shall be installed at ground level and the other near the motor.
- 14.7 Local control station shall be provided with ammeter for motors rated above 5.5 kW. Local control station for aux. Lube oil pumps, heater etc. shall be provided with ammeter irrespective of motor rating. LCS for all emergency / critical drives shall be provided with ammeters.
- 14.8 Weatherproof, break glass type emergency push button station shall be provided near transformers to trip the transformer feeder in case of emergency. Emergency trip push button shall also be provided for motors above 1000 kW rating.

- 15.0 CABLES (HT / LT)
- 15.1 Cables shall be sized considering the following factors.
- Maximum continuous load current
 - Voltage drop
 - System voltage
 - Laying conditions
 - (Derating due to ambient air temperature, ground temperature, grouping and proximity of cables with each other, thermal resistivity of soil etc. shall be taken into account)
 - Short circuit withstand criteria for HT cables
- 15.1 All power, control, data, signal cables shall be FRLS PVC outer sheath.
- 15.2 All LT power cables shall be with stranded aluminium / copper conductor with PVC insulation, PVC sheathed armoured and construction as per IS 1554. Power cables with conductor size upto and including 16 sq. mm shall be with copper conductor, conductor size above 16 sq.mm. shall be aluminium conductor.
- 15.3 All control cables shall be with 2.5 sq. mm, stranded copper conductor with PVC insulation, PVC sheath, armour and construction as per IS 1554. Control cables shall be twisted pair or shielded wherever electro-magnetic / electrostatic interference is anticipated.
- 15.4 All control cables shall have 20 % spare cores. All cores shall be identified with numerical core numbers printed on core instead of colours.
- 15.5 All HT power cables shall be made of stranded aluminium or copper conductor with dry cured XLPE insulation, PVC sheathed armoured, conductor screen, insulation screen and construction as per IS 7098.
- 15.6 All cables shall be armoured and shall have extruded inner and outer sheath
- 15.7 Cables connected in parallel shall be of the same type, cross section and terminations.

- 15.8 All power and control cables shall be in continuous lengths (except for very long feeders) without any joints. The cables used for lighting and wires in conduits shall have appropriate junction boxes with adequately sized terminals. Cable joints in hazardous areas shall not be permitted.
- 15.9 In case of difficulty in connecting the cables to instrument or relay terminals, minimum cross section may be reduced to 1.5 sq.mm Cu. For lighting inside the building, minimum 1.5 sq mm Cu conductor, PVC insulated wire shall be used in conduit system (for circuit and point wiring), with proper colour coding.
- 15.10 All LT power cables shall be 3 core / 3 1/2 core / 4 core with stranded aluminium / copper conductor with PVC insulation and construction as per IS 1554. For all LPs / PPs incoming power supply cable shall be 4 core of required cross section.
- 15.11 6.6 kV and 11 kV cables shall be unearthed grade.
- 15.12 Size of Aluminium conductor cable shall be limited to 3.5C x 300 sq. mm, in LT, 3C x 400 sq. mm in HT and 1c x 1000 sq. mm in LT/HT.
- 15.13 For all other requirement refer Section-3 Chapter-6

16.0 CABLE TRAYS

- 16.1 Cable trays shall be run in either cable trenches / on overhead cable rack or along the pipe rack to suit the site conditions.

- 16.2 Separate cable trays shall be selected for:-

- HT cables
- LT power cable
- LT control cable
- Instrumentation cables/communication cable
- Cable trays shall be sized considering single layer of cables.

- 16.3 The trays shall not show deflection / bend / deformation after laying of cables.

- 16.4 All cable trays and accessories shall be prefabricated, G.I. ladder type. For tray system design, in addition to self-load and wind forces, following guidelines for design shall be considered.

- | | | | |
|---|--------------------------|---|----------|
| - | Support span | = | 2000 mm |
| - | Cable load for | | |
| - | • 150 mm wide cable tray | : | 30 kg/m |
| - | • 300 mm wide cable tray | : | 60 kg/m |
| - | • 600 mm wide cable tray | : | 90 kg/m |
| - | • 750 mm wide cable tray | : | 120 kg/m |

- 16.5 In addition to this, 70 kg concentrated load at centre span shall be considered. All structural steel design shall be as per Indian Standards and shall be suitable / designed to withstand fire for a minimum period of 30 minutes.

- 16.6 Bends, tees, reducers, crosses, droppers etc. shall have the required bending radii as recommended by the manufacturer with 10% allowance for various cable sizes with a minimum of 300 mm.

- 17.0 LIGHTING EQUIPMENT
- 17.1 Lighting fittings shall be of energy efficient LED type. For detailed specification refer Section-3 Chapter-8.
- 17.2 Aviation warning lights shall be installed in accordance with the recommendation by the International Airport Authority of India. The lamp fittings shall consist of a double lamp unit with automatic switchover to the stand-by lamp upon failure of the operating one. LED type, heavy duty, weatherproof aviation-warning light shall be used for chimneys.
- 17.3 Motorised tubular, telescopic High mast fittings shall be provided for illumination of tank farm / general area.
- 17.4 Fittings to be installed in the hazardous area shall be suitable for the zone and CMRI certified with CCE approval.
- 17.5 All fittings to be installed outdoors shall have ingress protection of IP 55 minimum and shall be weatherproof and have a guard.

18.0 JUNCTION BOXES

18.1 The Junction boxes/Telephone Tag boxes shall be MS with epoxy paint for safe areas or die cast aluminium alloy construction with IP 55 degree of protection suitable for installation in classified areas, hazardous areas. It shall be suitable for terminating or looping armoured signal/power cables. JB's shall be provided with earthing stud. It shall be suitable for wall/column/structure/ceiling mounting.

18.2 Junction boxes installed in classified hazardous area shall be explosion proof or increased safety type depending on area classification.

19.0 CONVENIENCE / WELDING RECEPTACLES

19.1 Enclosure of the convenient receptacle shall be suitable for site conditions such as weather proof, dust proof, flame proof, corrosion resistant etc. Necessary interlocks and earthing facilities shall be provided as per safety requirements. These receptacles shall be provided at selected locations in the plant.

19.2 Welding receptacles shall be provided at suitable locations to make sure the receptacle is accessible from any point of the process area with a trailing cable of 30 meters length. The welding receptacle shall be rated for 63A, 415V, 3 phase and shall have a scraping earth.

19.3 63A, 415V, 3 phase receptacle (with scraping earth) shall be provided at suitable location. to power for portable equipment. Suitable local isolation provision to be kept in the welding receptacle. Minimum 4 Nos. to be provided in outdoor switchyard area and 1 No. inside switchgear.

19.4 15A, 240V, single phase, three pin sockets shall be provided at suitable locations to make sure that the receptacle is accessible from any of the equipment, near static/rotary equipment with a trailing cable of 15 meters length. However for hazardous areas 240/24V transformer shall be provided with socket to supply 24V to the portable equipment.

19.5 Outdoor receptacles shall be provided with canopies.

20.0 PUBLIC ADDRESS (PA) SYSTEM

PA system shall meet the requirements of plant operations. It shall consist of:

- 20.1 Microprocessor based central exchange, master station with external loudspeaker, microphone etc. & Desk type call stations along with external loudspeaker for installation in buildings, wall mounted call stations suitable for area classification with horn type loudspeaker.
- 20.2 Stand alone systems shall be provided for switchyard and substations etc. which shall be suitable for interfacing with Fire alarm system, EPABX system, Radio Paging system etc. System shall also be designed such that it can be integrated to centralized control.
- 20.3 Paging speakers provided in areas having ambient noise levels shall produce a paging sound level at least 10 db above the anticipated ambient noise level. Where it is not possible to achieve the sound level of above 10 dB above the ambient, rotating beacons shall be installed such a way that that the operator is alerted in the area. The typical area where the provision of rotating beacons are envisaged as compressor house, generator house etc. Acoustic hoods shall be provided for call stations located in high noise areas.
- 20.4 The design of the system shall be such as to provide two channel communication i.e. Page & Party in each zone. Page & Party system shall comprise of one channel for paging & one channel for party talk.
- 20.5 In the Party mode, conversation shall not be heard over the loud speaker but it shall be carried out on the handsets. This mode shall be used for actual conversation, exchange of information etc.

- 20.6 It shall be possible to make a paging call by lifting the handset, off the hook switch & pressing the "press to page" switch. The paging message shall get transmitted over all the loud speakers when the paging person speaks in the microphone of the handset. While paging, it shall automatically mute the loud speaker near the paging handset to eliminate the acoustic feedback.
- 20.7 It shall be possible to communicate between two field stations without the interference of the MCS / operator. Also it shall be possible to have direct communication with the MCS.
- 20.8 A facility to monitor the health of the system including field stations / speaker shall be provided in the system.
- 20.9 The equipment shall be sturdy, impact resistant, dust & damp proof generally conforming to minimum IP 55 degree of protection. For classified hazardous areas flameproof equipment shall be provided duly certified by recognised certifying authority for the area of installation. The equipment for outdoor shall be weatherproof type conforming to IP 55 degree of protection & shall be provided with canopy. All equipment & accessories shall be given tropical protection against fungus, insects & corrosion. Equipment shall be made tamper proof by use of non standard screws, which can be opened only by means of special keys supplied by the manufacturer. Solid state components shall be used throughout & assembled in plug-in type modules.
- 21.0 TELEPHONE SYSTEM
- 21.1 The substations, cabinet rooms, control rooms, switchyard shall be provided with sophisticated microprocessor based intercom telephone system to facilitate intercommunication.
- 21.2 Extension lines for telephone shall have to be integrated with existing EPABX system. The required addition of hardware in existing exchange will be in the scope to LSTK contractor. Required details to be arranged accordingly.
- 21.3 Telephones installed in classified hazardous area shall be flameproof type suitable for the area classification, gas group & temperature class. For outdoor installation, weather proof construction to be included.
- 22.0 FIRE ALARM SYSTEM
- 22.1 Fire Alarm system shall be microprocessor based, intelligent, analogue addressable type.
- 22.2 System shall be stand alone for entire plant area consisting of individual process units, utility areas, substation, control rooms etc. System shall be designed to provide necessary audio visual signals at the main control panel with mimic panel and repeater control panel. The system shall be hooked up with main fire control panel located at fire station control room.
- 22.3 However system shall be suitable for integration with centralized fire alarm system CCTV, PA, EPABX, Gas Detection system, Fire suppression system and HTAC system. All required integration including supply of material shall be in the scope of LSTK contractor.
- 22.4 System shall be comprising of individual break glass type manual call points, smoke/heat detectors, main panel, repeater panel, hooter, siren, and other hardware. The power supply to be taken from centralized DC/UPS power supply system.
- 22.5 FRLS armoured cables shall be used for the system.

- 22.6 Detectors and Manual call points shall be connected in separate loop.
- 22.7 For all other requirement refer Section-3 Chapter-8.

23.0 SYSTEM LAYOUTS

23.1 SUB-STATIONS

- 23.2 Layout of substation shall comply with OISD regulations, IE rules, TAC regulations and any other applicable statutory rules and regulations.
- 23.3 The Substation shall be a separate building with RCC roofing and brick walls.
- 23.4 Substation shall have minimum three entries, one entry for equipment , one normal entry and the Third one for emergency exit. For long sub-station additional entries to be considered as per standards.
- 23.4 Substation shall be sized to take care of present and future needs and to maintain adequate clearances between equipment for ease of maintenance. Space for two adjacent panels for future extension on each side of switchboard shall be maintained.
- 23.5 Ground floor of S/S shall be cable cellar and the first floor shall have all switchgear panels. The cellar level of the S/S floor shall be suitably raised from adjacent grade level to avoid water ingress. The roof shall be given adequate water proofing treatment to ensure that rain water does not seep into the S/S.
- 23.6 S/S shall be Air Conditioned. It is to be ensured that the inlet air of the Air Conditioning system shall be free from moisture and hazardous mixtures. Gas detectors shall be provided at the suction point of Air Conditioning system out door unit.
- 23.10 Normally transformers shall be installed outdoor. Electronic equipment like UPS / VSDs / excitation panel of synchronous motor/generator shall be installed in a separate Air-conditioned room. Battery banks shall be located in a separate freely ventilated room in the S/S building along with the necessary flameproof exhaust system and water connection. Floor of battery room and the walls upto height of 1 m. shall be properly acid/ alkaline resistant / painted with / alkali resistive paint. Light fittings in this room shall be Flameproof type..
- 23.11 Adequate access and lifting / loading / unloading facility shall be provided to bring in or take out switchgear panels. EOT cranes to be provided inside GIS switchgear. The layout of HT & LT switchgear, UPS battery chargers, LPs. PDBs, etc. shall be complying with the requirements of I.E.Rules and TAC recommendations and shall be developed to have neat, systematic and uncluttered cabling in the cable alley.
- 23.12 Following minimum clearances around various equipment shall be maintained:-

Front clearance for HT switchboard	:	2000 mm
Front clearance for all other switchboard / panels	:	1500 mm

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- Between front to front of different switchboards/panels : 2000 mm
- Rear clearance for panels having only access from front only : less than 200 mm or more than 750 mm
- Rear clearance for panels requiring back access : 1000 mm
- Side clearance from wall : 1000 mm
- Battery rack to wall clearance for : 100 mm
- Single row, single/double tier, double row, single tier : 750 mm
- Double row, double tier : 750 mm
- Battery rack to rack : 1000 mm
- Front clearance for wall mounted equipment : 2000 mm
- Head room clearance below busducts or any other overhead equipment : 2000 mm
- Clear space between switchboard top and bottom of beam : 1000 mm
- Front clearance for wall mounted equipment : 2000 mm
- Front clearance for operation station / annunciation / control panel. : 2000 mm

23.13

Switchgear room shall be provided with following minimum (but not limited to) equipment:

- Suitably rated insulation floor paints in front and back side of panels for their entire panel length
- Electrically tested rubber gloves kept in dust free teakwood box with chalk powder.
- Framed / Laminated shock treatment instruction card of min. 1 M x 0.8 M one for every 60 SqM, in English and local language. Name and address together with telephone no. of nearest doctor should be entered in it.
- Illuminated sign boards for HT/ LT boards
- First aid box easily accessible containing full compliments of ointments and medicines for treatment of electrical burns.
- Adequate no. and size of CO2 fire extinguisher and dry chemical powder suitable for dealing with fire.
- Round bottom fire buckets filled with clean dry sand.
- Neon lit Framed single line diagram board of min. 2M x 1M
- Two Nos. earthing rod
- Two Nos. Breaker lifting trolley each of HT and LT
- Earthing truck for each rating
- On line DC leakage tester (2 Nos.)
- HT line tester for 220 KV (Minimum 2 Nos.)
- HT line tester for 33 KV (Minimum 2 Nos.)
- Battery impedance tester
- 3 phase secondary injection kit
- Primary injection kit
- VLF test kit
- Transformer oil BDV test kit.
- Battery load tester.
- Digital insulator tester
- Transformer test kit
- Complete set of D and Ring spanners
- Adjustable motorised wrenches

- Cutting and nose pliers
 - Insulated screw driver
- 23.14 Operator's room shall be provided with furniture like chair, table and almirah for keeping tools.
- 23.15 Shelf / storage facility for hydrometer, voltmeter, hand gloves shall be provided in battery room.
- 23.16 Transformer yard / bay shall be provided with fencing and gate and shall have fire isolation walls (fire rating commensurate with the extent of fire which could be encountered). In general 230 mm thick RCC wall or 355 mm brick wall shall be considered to provide adequate fire protection. Wall shall be carried upto a height of at least 600 mm above the top of the equipment (e.g. transformer conservator) level. Fire wall shall extend at least 600 mm beyond the width of transformer and cooling radiators. Minimum 1000 mm clearances shall be provided all around the transformer.
- 23.17 Oil immersed transformers with oil capacity exceeding 2000 litres shall be provided with a soak pit of sufficient capacity to take the whole of the oil of the equipment. Where oil capacity of transformers exceeds 9000 litres, provision shall be made to drain away the oil to OWS system located away through suitable drain pipes of minimum 150 mm in diameter. Fixed fire extinguishing shall be provided for all oil – filled transformers having oil content more than 2000 litres. Nitrogen injection fire protection system shall be provided for fire -fighting of transformer rated more than 5 MVA.
- 23.18 All substation / MCC rooms shall be located outside the hazardous area.
- 24.0 CABLE LAYOUTS / ROUTING.
- 24.1 Cabling system for various areas shall be generally as under. However, as far as possible existing cabling system shall be followed in remotes areas.
- For switchyard/Process units RCC lined trenches filled with sand
 - For offsites & utilities areas. RCC trenches for paved and unpaved areas respectively. The trenches shall be provided with trays.
 - Lighting, fire alarm, communication cables shall be laid directly buried in road berms. The communication and fire alarm cables shall be laid in road berm opposite to the berm where street lighting cables are laid.
- 24.2 Cable trenches shall be sized depending upon the no. and voltage grade of cables used for different applications. Trenches in hazardous areas shall be filled up with sand. In unpaved areas cables may be directly buried in ground. At road crossing, cables shall be laid through culverts / hume pipes / pre-cast RCC duct banks etc. Concrete lined trenches shall have suitable drainage arrangement to avoid water collection or these trenches shall be connected to nearest storm water drain. Concrete lined cable trenches shall be sealed against ingress of liquid and gases.
- 24.3 The top of cable trenches before entering the substation, shall be maximum 1m above the ground level and also all cutouts shall be properly sealed by a sealing compound. Pipes laid for mechanical protection shall be sealed at both the ends.
- 24.4 All entry and exit openings for cables crossing in substation , control room etc. shall be provided with fire barrier and it shall have minimum three hours rating.
- 24.5 Fire proofing/painting for all power cables on 3 meter length of cable at motor end and load end in the field and panel end in the substation shall be provided. Fire barriers shall also be provided below the opening of all HT and HT switchboard in all substations.

- 24.6 The offered painting and fire barriers shall be tested at site and comply to the requirement defined in the BS:476 (part – 20) Method of determination of fire resistance of element of construction and IS:12458 Fire resistance test of fire barriers and UL:1479 Fire test of through penetration fire barriers. Fire protection for cables shall be provided as per IS 12459 : code of practice for fire protection of cables.
- 24.7 For directly buried under ground cables, route markers shall be provided at every 30m interval all along the cable routes, at cable joints and where direction of cable trench changes. Cable joint pits shall be sand filled .
- 24.8 Whenever cables will be required to run above ground, these shall be run in a single layer form in covered G.I. cable trays. Separate cable trays shall be provided for HT power, LT power, control and communication cables. Necessary tees and bends shall be provided to have neat and easily accessible routing.
- 24.9 Above ground cables shall be well supported on cable trays and shall be suitably protected against mechanical damage. Routing shall be decided to avoid interference with hot surfaces or places subject to undue fire risk. Cable trays shall be covered whenever they are running below pipes.
- 24.10 Cable trays, racks and trenches shall be sized to allow for 30% future cables. Cable installations shall provide minimum cable bending radii as recommended by cable manufacturer. Separate trays shall be provided for HT/LT power, control & plant communication cables. Separate cables shall be provided for AC and DC signal / control circuits.
- 24.11 Wherever piperack / pipe sleepers are not available for laying of above ground cable trays, cable tray support shall be sized to ensure lowest tray level to be min. 2.7m above grade and road crossing 7 mtrs above grade level.
- 24.12 Cables running between cable tray and the equipment shall run through rigid GI conduits. Necessary supports shall be provided for the same. Cables shall be protected by conduit upto a length of at least 300 mm above the floor level.
- 24.13 Plant cables shall run in either of the two directions formed by main axis, avoiding as much as possible crossings with instrument cable trenches and pipelines and preferably away from restricted areas.
- 24.14 Underground cable routes shall be designed to avoid close pipe crossings and adjacent runs with underground pipelines. A distance of at least 30 cm between cable and pipe shall be maintained. Cables shall preferably cross underneath buried pipelines
- 24.15 Parallel / Duplicate feeder cables shall be laid separately as far as possible
- 25.0 EARTHING LAYOUTS
- 25.1 Entire earthing system shall be designed as per IS.3043 code of practice for earthing. Further the requirements of I.E Rules, OISD standards for earthing shall be strictly adhered to.
- 25.2 The main earthing loop (MEL) shall be G.I. strip of adequate size (50 x 8 mm min.) This MEL shall also be connected to existing MEL at different locations wherever possible.
- 25.3 Earthing leads connecting equipment enclosures, supports etc. to MEL shall be of G.I. strip / wire /unarmoured aluminium cables of adequate size.
- 25.4 Earthing lead connections from MEL shall be taken by providing earth plates of adequate size to serve a particular group of devices.
- 25.5 Number of earth electrodes shall be decided based on the requirements of IE. Rules and to stabilise the potential gradient of the MEL & earth to a safe limit.

- 25.6 DCS, PLC and other electronic instruments shall be provided with clean earth as recommended by the manufacturer for safe and nuisance-free operation. This shall be kept galvanically isolated from the system and safety earthing.
- 25.7 Value of resistance of an earthing system to the general mass of earth shall be as follows
- For electrical system and equipment a value that ensures operation of the protective device in the electrical circuit but not in excess of 1 Ω .
 - For lighting protection value of resistance of 5 Ω shall be desirable but in no case it shall be more than 10 Ω .
 - Overall grid resistance shall be less than 1 Ω .
- 25.8 Earthing shall be provided for following (but not limited to) as a minimum:-
- Metallic non current carrying parts of all electrical apparatus such as switchgears, motors, lighting / power panels, control panels, cable trays, terminal boxes, control stations, lighting fixtures, receptacles junction boxes etc.
 - Transformers / Generator neutrals.
 - Steel structures / pipe racks etc.
 - Cable armour
 - Cable shields and armour
 - Any other equipment required to be earthed / bonded
 - Fence / gate for transformer and switchyard
 - Lighting poles & masts
 - Electronic equipments / DCS / PLC etc
- All utility / process pipelines shall be earthed on entering or leaving the hazardous area, except where conflicting with the requirements of cathodic protection. In addition, steel pipe racks shall be earthed at every 25 meters. Earth continuity shall be ensured across all the flanges in process units & other hazardous areas. Equipment located remote from main earth network, may be earthed by means of individual earth conductors and earth electrodes.
- 25.9 Independent earthing loop for each S/S shall be connected with MEL
- 25.10 Earth pit engraved markers shall be provided for each earth pit.
- 25.11 Underground earthing strips to be provided with 50 % corrosion allowance.
- 25.12 For L.V. equipment earth loop impedance shall be such as to effect circuit disconnection in a time less than 1 second under solid earth fault conditions taking in to account the manufacturer's nominal time / current characteristics of protective device.

26.0 LIGHTNING PROTECTION

- 26.1 All structures, columns, towers, vessels stacks and premises shall be checked for risk assessment as per IS 2309. Where lightning protection is found to be necessary, the recommendations of the standard shall be strictly followed. Self-conducting structures may not be provided with aerial rod and down conductors. They shall however be connected to the earthing system at minimum two points at the base. An independent earthing network shall be provided for lightning protection and this shall be bonded with the main earthing network only at the point of buried earth electrode.
- 26.2 Air terminations, ring, Faraday cage and down conductors shall be of G.I. strips/wires of adequate size and shape.
- 26.3 A dedicated system of an adequate number of electrodes shall be provided. These electrodes shall be pipe electrodes.
- 26.4 Where structure of equipment are not electrically continuous or made of poorly conducting material, down conductors and air termination shall be provided. Additions bonding shall be applied to structures as necessary in order that resistance from the highest point to earth does not exceed 10Ω .

27.0 LIGHTING LAYOUTS

- 27.1 The lighting layouts shall be designed to meet the illumination levels recommended in IS 3046.
- 27.2 Minimum illuminations levels as specified below shall be achieved while designing the lighting system.

Area	Lux (minimum)
Roads and tank farm	10
Pump house, sheds, transformer bays	100
Main operating platforms & access stairs	60
Ordinary platforms	20

Process areas, pipe racks, heat exchangers, heater, cooling tower, separators, pump bays etc.	60
Switchgear room, charger room, UPS room	200
Cable cellar	70
Battery room	150
Control room, laboratory	400
Ware house	100
Compressor area	200
Office	300
Corridors / lifts	70

27.3 Lighting design shall conform to relevant International Codes & Standards, IES Hand Book and shall take into consideration the requirements from point of view of safety and ease in operation and maintenance. A maintenance factor of 0.8 shall be assumed for lighting illumination level calculation for normal areas. However, for dusty areas, maintenance factor as per relevant codes and standards shall be considered.

27.4 Generally plant lighting shall be classified as under:

Normal lighting

Emergency lighting

Critical lighting

27.5 Normal & emergency lighting system shall be on 415 / 240 V system, where critical lighting shall be on DC.

27.6 Sufficient lighting shall be provided so as to enable plant operators to move safely within the accessible areas of plant and to perform routine operations.

27.7 Lighting requirements provided during the failure of power supply for normal lighting shall be broadly,

- To facilitate carrying out of specified operations, for safe shutdown of the plant.
- To gain access and permit ready identification of fire fighting facilities.
- Escape route for safe evacuation of operating personnel.

Recommended areas for critical lighting :

-Control rooms

-Main substations

-Switchyard

-Emergency escape route.

-Operator cabin, plant area, pump house

-Any other specific areas requiring critical lighting.

Recommended areas for AC emergency lighting :

- Control rooms
- Main substations
- Switchyard
- Emergency escape route.
- Operator cabin, plant area, pump house
- Any other specific areas requiring critical lighting.
- Some portions of roads interconnecting substation
- Any other specific areas requiring emergency lighting.

- 27.8 Generally 25 % of normal lighting load shall be considered for AC emergency load.
- 27.9 Wiring for lighting and convenience outlets in outdoor areas shall be carried out with copper conductor, PVC insulated, armoured cables run along the column/platforms and structures on GI perforated trays of required width. The armoured cable shall enter lighting fixture / JB through double compression gland for safe area and through flameproof glands for Ex(d) and Ex(e) equipment. Where required, suitable mechanical protection shall be provided for lighting fixtures (e.g. wire guard) The lighting installations shall be designed to obviate stroboscopic effect.
- 27.10 Lamp fittings in structures shall be so located that maintenance and lamp changing can be effected without use of ladder or scaffolding.
- 27.11 The lighting fittings shall be situated in such a way that reflection on instruments / VDU etc. in control rooms and sub-stations is avoided.
- 27.12 All lighting fittings shall be wired using armoured PVC cable of suitable no. of cores and size. Necessary type and no. of junction boxes shall be provided for branch connections. DC critical lighting shall employ LED lamps only.
- 27.13 Adequate no. of ceiling fan points shall be provided in offices, rooms allocated for operating and maintenance personnel etc. 2 pole isolation devices shall be used for controlling fixtures in hazardous areas to isolate phase as well neutral.
- 27.14 For buildings with false ceiling, concealed conduit wiring below the false ceiling and surface conduit wiring above false ceiling shall be considered.
- 27.15 Adequate no. of pull boxes shall be used. No joints shall be allowed inside these pull boxes.
- 27.16 Battery room shall have fitting mounted on wall in order to facilitate easy replacement of fused lamps. Switches controlling the fittings and exhaust fan shall be installed outside the battery room.
- 27.17 Substation / cable gallery lighting shall be centrally controlled from push button near main entrance

10.0**MAKE OF COMPONENTS**

Sr. No	Component	Make
1)	Current transformer	Precision / Pragati / Kappa / Prayog
2)	Potential transformers	Precision / Pragati/ Kappa / Prayog
3)	Push buttons	Siemens / Teknic / L&T.

4)	Meters	:	A & V Meters - AE Make. KWH/ KVARH Meter - GEC / Simco . PF Meter – GEC/Simco.
5)	Terminals : a) Power	:	Elmex .
	b) Control	:	Elmex make .
6)	Relays	:	ABB /Siemens /Alstom / L & T (P&B).
7)	Auxiliary Contactors	:	Siemens / L&T
8)	Selector switch	:	Kaycee
9)	Timer	:	Siemens / L&T
10)	Interposing relays	:	ABB/Allen Bradiey /OEN
11)	Transducers	:	ABB/Southern Transducers / Rochester (USA)
12)	WTI	:	Perfect Controls / Precimeasure
13)	OTI	:	Perfect Controls / Precimeasure
14)	Tap Changer Assembly	:	BHEL/CGL
15)	Cable Jointing Kit	:	Raychem Heat Shrinkable

ANNEXURE – I: LIST OF REFERENCE STANDARD SPECIFICATIONS

13.0 DRAWING, DATA, MANUALS

- 13.1 The drawings (if any) accompanying the bidding document are of indicative nature and issued for bidding purpose only. Purpose of these drawings is to enable the bidder to make an offer in line with the requirements of the OWNER.
- 13.2 All the plans, design, drawings and specifications of all equipments, civil work, structural work, foundation work, GIS system and all other electrical system shall be **approved by any of the listed constancy firms** as mentioned in clause 13.7 prior to submission to Owner for final approval. All the associated cost and coordination activities till final approval shall be in contractor's scope. In any way, approval of drawings/ specification does not dilute the overall responsibility of contractor for proper completion of project as per applicable standards and guidelines. Contractor documents/ drawings shall be properly supported with relevant standard/ guidelines along with back up calculation for review of drawings approval agency and owner.
- 13.3 Before starting manufacture of any equipment, the Contractor shall have to take approval of relevant drawings and data from Engineer-In-Charge, in proper records post approval from consultancy firm.
- 13.4 The observation and comments from owner shall be included in drawings and schemes. Accordingly drawings to be modified and re-submitted for final approval from owner.

13.5 The detail list of data and drawings including its criticality shall be finalized in consultation of Engineer in-charge. The subsequent data and drawing submission and its approval schedule shall included in the project progress schedule and duly approved by Engineer in-charge. It's a sole responsibility of contractor to comply the overall project completion schedule as per tender documents and accordingly project progress schedule to be drafted, monitored and complied by contractor.

13.6 Any manufacture done prior to the approval of drawings/data shall be rectified in accordance with the approved drawings/data by the Contractor at his own cost and the equipment shall be supplied within the stipulated period.

13.7 The list of engineering consultancy firms for approval of all plans, design, drawings and specifications of all equipments, civil work, structural work, foundation work, GIS system and all electrical system is given below: It is to be noted that the design preparing agency and drawing approving agency cannot be same.

1. Engineers India Limited
2. Project & Development India: Limited
3. TOYO Engineering India Pvt. Limited
4. JACOBS Engineering Group
5. MECON Limited
6. Foster Wheeler India Pvt. Limited.
7. National Thermal Power Corporation Limited
8. Sterlin & Wilson Pvt. Limited.
9. Bechtel India Pvt. Limited.
10. Tata Consulting Engineers Limited.
11. Tractebel Engineering Pvt. Ltd.
12. Any Government Institutions/ Government approved agency.

13.8 Drawings, Data and Manuals shall be submitted in triplicate and in quantities and procedures as specified in General Conditions on Contract and/or elsewhere in this specification for approval and subsequent distribution.

13.9 The tentative document list to be submitted progressively and will generally be as detailed below with due approval of consultancy firm:

13.9.1 Design calculations in support of selection of equipment rating and system design.

13.9.2 Layout of substation with sections, clearance diagram

13.9.3 Protection SLD with all details of relays and wiring included

13.9.4 Technical particulars of each equipment and accessories

13.9.5 Grounding & lightning protection drawings and details including detailed calculations.

13.9.6 Cabling, cable trench and tray layout with section & details

13.9.7 Dimensional general arrangement drawing along with cross-sections

- 13.9.8 Foundation plan and loading data
- 13.9.9 Design calculation and detail drawing for civil work related to this specification.
- 13.9.10 Design calculation, GA drawing for Sub-station structure including equipment supporting structure and subsequently detailed drawings.
- 13.9.11 Mounting details of equipment and structure
- 13.9.12 Fire fighting and arrangement, if any.
- 13.9.13 Control schematic and wiring diagram.
- 13.9.14 Civil & structural analysis, design calculations and working drawings including bar bending schedule and fabrication.
- 13.9.15 Quality Assurance Plan

In addition to above, the following tentative list of documents are required to be submitted for owner's approval.

- 13.9.16 Complete Bill of Materials
- 13.9.17 Single line diagram giving rating of each equipment.
- 13.9.18 Detailed layout plan/CLO.
- 13.9.19 System Study and Relay Co-ordination Reports
- 13.9.20 Cable schedule and interconnection
- 13.9.21 Schedule for project management
- 13.9.22 Erection and maintenance manual of OEM
- 13.9.23 Operation and maintenance manual
- 13.9.24 Instruction manuals on substation equipment and its accessories. The manual shall clearly indicate method of installation, checkups and tests to be carried out before commissioning of the equipment.
- 13.9.25 Any other relevant drawing or data necessary for satisfactory installation and commissioning shall be finalized during preparation of project progress schedule with approval of Engineer in-charge
- 13.10 The Owner may review the documents, as required. The contractor shall note that the approval of drawings & documents by the Owner does not relieve him of his contractual obligation.
- 13.11 The bidder may note that the drawings, data and manuals listed herein are minimum requirement only. The bidder shall ensure that all other necessary write-up, curves, etc require to fully describe the equipment are to be submitted with the bid.
- 13.12 Final drawing/As built drawings shall be furnished after the equipment is commissioned incorporating all changes along with reproducible for Purchaser's records.
- 13.13 Manual for erection, testing, commissioning and maintenance of all equipment under contractor's scope of supply.
- 13.14 Schematic diagrams shall be supplied to specify the control requirements for each feeder.

- 13.15 **GENERAL ELECTRICAL LAYOUT(GELO):** GELO of the system shall be immediately submitted to HVPNL and Owner for approval. All kinds of co-ordination and approval of GELO of 220 KV switchyard from HVPNL is in the LSTK contractor's scope. The contractor shall ensure the bill of materials shall be prepared in line with HVPNL guidelines during bid process to avoid any major deviations although all additions/amendments if any post GELO approval from HVPNL will be in the scope of LSTK contractor with out any additional financial implication on owner. Philosophy of operation / Protection system shall be submitted for IOCL's approval after placement of P.O. and approval for the same shall be obtained across the table before commencement of manufacture. The contractual delivery period shall be reckoned from date of Purchase Order / LOI. Contractor shall submit the required number of prints of drawings and documents as specified in Annexure.
- 13.16 All drawings shall be prepared by using AutoCAD and documents shall be generated using Electronic version. The paper copy of the drawings & document shall be submitted for approval & reference. All final drawings and documents shall be submitted in CD in AutoCAD 2000 and MS office format as applicable for Owner's future reference. Also AutoCAD version of Main GA drawings is to be submitted for Owner's layout finalization.
- 13.17 Final documents shall be in International Quality hardbound volumes. The material shall not be accepted without the test certificates and other final documents. Supply of required documents is in Contractor's and failure to comply it even partially shall cause the purchase order to be considered unfulfilled.

14.0 QUALITY ASSURANCE

- 14.1 Contractor shall follow procedures for quality assurance and control as recommended by OEM, HVPNL guidelines, CEA regulations and in accordance with the technical specifications of IOCL.
- 14.2 The procedures shall be in such a form as to clearly delineate the manufacturing sequence and major inspection points and to reference Bidder's test and inspection procedures.
- 14.3 The TPI contractor of IOCL will follow the approved QAP. TPI is applicable as detailed in relevant technical specification.
- 14.4 Manufacturing and quality control procedures shall be available for audit to the IOCL and/or its representative at the place of manufacture.
- 14.5 IOCL and/or its representative reserves the right to inspect the equipment at the point of manufacture and witness factory and other such tests as may be necessary to ensure conformance to the specification.
- 14.6 Contractor shall offer the major equipment for stage-wise inspection, without which further manufacturing of the equipment is not allowed. This shall be in the scope of the contractor without any additional financial implications on IOCL.
- 14.7 IOCL and/or its representative may inspect the Contractor's facilities prior to award of contract.
- 14.8 IOCL and/or its representative may witness any/all of the tests described.
- 14.9 IOCL and/or its representative may conduct surveillance of the Contractor's facilities for compliance to his standard procedures of quality assurance & quality control while work on the specified equipment is in progress.

15.0 SCHEDULE OF DELIVERABLES

(Minimum- All required information to be prepared and submitted for execution of complete project) -

S. No.	DESCRIPTION OF DELIVERABLES AS PER SCC-T OF SUBJECT TENDER	
<u>A</u>	<u>Electrical</u>	
	Key Single line diagram	
	Electrical Layout Plan & Elevation, Clearance diagram	
	Equipment short circuit calculation	
	Substation Structural layout	
	Control room equipment layout	
	Grounding design	
	Grounding layout	
	Cable trench layout including that of control, earth & Fibre optic cables	
	DC System design & drawings	
	AC System design & drawings	
	Substation Erection drawing, list of hardware Erection sag chart	
	Metering bay Erection drawing, list of hardware	
	Cable and Lines Erection drawing, list of hardware Erection sag chart	
	Design & drawing of Illumination system	
	Design & drawing of Load shedding , Load management , ECS & SCADA system	
	Design & drawing of Air Conditioning system	
	Design & drawings of plant communication, fire alarm system, PA system	
	Design & drawings of Fire fighting facility	
<u>B</u>	<u>Civil and Structural</u>	
	Design & drawing of Substation	
	Design & drawing of Substation Equipment structure	
	Design & drawing of transformer	
	Design & drawing of Substation Roads, Drains, fence, gate	
<u>C</u>	<u>MANUFACTURER'S DRAWINGS, DATA, MANUALS</u>	
	Technical Particulars	

S. No.	DESCRIPTION OF DELIVERABLES AS PER SCC-T OF SUBJECT TENDER	
	GA & Parts List	
	Schematic drawing with Terminal numbers	
	QAP, Test Schedule	
	Installation, Commissioning & Operating Manuals of all equipment involved	
	Spares list	
<u>D</u>	<u>Manufacturer's Drawings, Data, Manuals for Control, Protection and Management System</u>	
	Technical Particulars & system write-up	
	Protection settings	
	QAP, Test Schedule	
	Spares list	
	Installation, Commissioning & Operating Manuals	
E	Cable Schedule & Interconnection	
F	Project progress schedule	
G	Project Completion & handing over in all respect	24months

Note: All the terms and conditions of latest version of IOCL LSTK GCC are applicable in conjunction with the points indicated above. (All the clauses of Section-1, Chapter-2- SCC)

Electrical System Study

10.1.1.29

Electrical System Study: The detailed electrical system study of new 220 KV GIS system including existing generation system of PR and PNCP shall be carried out by vendor for following objectives as per CEA and HVPNL guidelines and requirements

- i) Load flow studies
- ii) Short circuit and transient stability studies
- iii) Grid Islanding setting derivation
- iv) Load shedding adequacy check
- v) Protection co-ordination of new system.
- vi) EMTP studies (for switching / dynamic over-voltages, insulation coordination, etc)

Required data of existing IOCL system will be provided by owner while for HVPNL, the data shall be collected by the vendor. Lump load concept may be used for existing load of PR and PNCP. The system study report shall be submitted to owner for approval.

Any major change or addition in system design/hardware based on the system study report shall be vendor's scope.

The list of firms/agencies for the purpose of carrying out the electrical system study is as following:

- Engineers India Limited
- Project & Development India :Limited
- TOYO Engineering India Pvt. Limited
- JACOBS Engineering Group
- MECON Limited
- Foster Wheeler India Pvt. Limited.
- National Thermal Power Corporation Limited
- Sterlin & Wilson Pvt. Limited.
- Bechtel India Pvt. Limited.
- Tata Consulting Engineers Limited.
- Tractebel Engineering Pvt. Ltd.
- Power Grid Corporation of India Limited
- ABB Ltd
- Siemens Ltd
- GE
- Toshiba
- L&T

Or any other reputed agency with approval of EIC

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- | | |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10.1.1.30 | The lightning protection (DLSP) of the new outdoor switchyard shall be designed as per Rezvik method and as applicable standards. The calculation detailed to be submitted to owner after vetting by recommended agencies (As listed in Section-1/ Chapter-1). |
| 10.1.1.31 | Design, Engineering and supply of any other equipment/material required to complete the specified scope and successful commissioning of project |
| 10.1.1.32 | All statutory clearances required for project |
| 10.1.1.33 | Derivation of all protection setting suitable for HVPNL, equipment OEMs, IOCL and system requirement and as per applicable standards. Vendor to submit detail calculation sheet with standard references for approval to IOCL. |
| 10.1.1.34 | Complete relay coordination of new 220 KV system along with 33 KV power evacuation system in coordination with IOCL and HVPNL requirement. |
| 10.1.1.35 | Existing current transformers in proposed incomers at PNCP generation bus is under-rated. The replacement of CT will be required suitable for evacuation of 65 MVA. The CT shall have multi-core for purpose of bus-differential, cable differential, metering and protections as per system requirements. The differential CT should match with the other CTs of the bus. The design, selection, supply and site installation of required CTs for both the incomers is in the scope of the LSTK contractor. |
| 10.1.1.36 | The supply of the testing instruments for purchaser's use for operation and maintenance requirements shall also be in the scope LSTK contractors. The list of required instruments is provided in Section-3 Chapter-5. The make of the component shall be as approved by the IOCL. |

10.1.2 CIVIL AND STRUCTURAL WORK FOR 220 KV IOCL PANIPAT SUBSTATION

The work shall be included but not limited to the following INCLUDING SUPPLY OF ALL CONSTRUCTION MATERIAL:

**ANNEXURE-S2/C1/2-TENTATIVE BOQ FOR
LSTK CONTRCATOR**

Annexure S-2/C-1/2

Tentative BOM for Major equipment/ system - Bidder/ vendor to design, and supply the required BOM as per complete project requirement. The below quantities are tentative and it is responsibility of bidder/ vendor for complete design, supply and erection of all required materials for completion of project. Bidder shall make a site visit for understanding and quantification of BOM before submitting the bid. The detailed BOM shall be part of technical document to be submitted by bidder during bidding.

SL no	Detail of item	Quantity
1.0	Supply, Installation & commissioning of 220 KV , 2000 Amps (Bus rating), 50 KA/3 Sec, 11 nos. Bays of Full GIS indoor Switchyard including GIS ducts, CT, PT, Isolators, earthing switches, disconnectors, C&R panel, SCADA, complete earthing work etc as per detail scope of work . LA & CVT (6 nos.) to be provided separately in AIS system. On line PD analyzer along with all hardware and monitoring system is also to be provided for 220 KV system. For detail specification please refer Section-3/Chapter-1.	1 lot
2.0	Supply of metering panel with HVPNL complied ABT meters, TOD meters in main meter and check meter configurations in both lines with all accessories in line with Annex-S-3/C-1/1.	1 Lot
3.0	Supply, Installation & commissioning of 50/ 65 MVA ONAN/ONAF 220/34.5KV Transformer with 18% impedance at 50 MVA base including fire fighting facility, C&R panels, complete earthing , RTCC with digital redundant AVR system, etc	4
4.0	220kV Gas Insulated Busduct (GIB) with support structure, wall frame assembly, bellow, SF6 to Air bushing and any other items as required for successful interconnection between AIS and GIS system.	1 lot
5.0	220kV, 2000A, 50kA/3 sec, SF6 to Air Bushing along with corona ring (as required) and support structure	1 lot
6.0	220 kV, 10kA, station class-3 type gapless lightning arrester with corona ring, analog type leakage detector, leakage counter and other accessories including its lattice type galvanized support structure.	1 Lot
7.0	(220/ $\sqrt{3}$)kV / (110/ $\sqrt{3}$) / (110/ $\sqrt{3}$) / (110/ $\sqrt{3}$)V,CL. 3P, 3P and 0.2, 4400/8800 μ F type Capacitive voltage transformer (CVT) including its galvanized support structure for Protection and Metering purpose with accessories required. The specification is tentative. Bidder to design and supply accordingly as per project requirements (Refer Section-3/Chapter-4.)	1 Lot.
8.0	220kV, 1250A, 50 KA/1 sec, 1 mH bus post mounted type Wave Trap (Tentative) with accessories required including its lattice type support galvanized structure. Wave trap design as per HVPNL specification and	1 lot

SL no	Detail of item	Quantity
	shall match with sending end system. The complete PLCC system shall be design supply by bidder.	
9.0	220 KV, 2000 Amp, Isolator with earthing switches with accessories required including its lattice type support galvanised structure in line with the technical specification attached	1 Lot
10.0	Gantry (Tower and Beam) for 220kV double circuit line termination from refinery battery wall to new GIS switchyard including all required strings, ACSR moose conductor, support insulator, clamps, connectors etc. The connectivity from point of supply to ISBL shall be in the scope of vendor including design, supply and commissioning .	1 lot
11.0	GIS cum control building, existing control room extension, outdoor switchyard area and peripheral road lighting system comprising fixtures, poles/mast, lighting panels, switches, junction boxes , receptacles, wiring, cabling, conduits, etc. for normal and emergency lighting. Dry type lighting transformer for lighting system to be located in control building along with main lighting distribution board.	1 lot
12.0	Complete Earthing system with the min 40 mm dia MS rod (tentative) for main earth mat design. Earth riser, treated & non treated earth pit, connection of equipment with main earth grid in outdoor switchyard area, GIS and control building. The detail earthing design is in the scope of LSTK vendor.	1 lot
13.0	3Cx400 sqmm 33KV(E) CU , XLPE, armored, screened cable as per project requirement. (Minimum Requirement). Detailed design and quantification to be ensured. by the LSTK bidder.	1 Lot
14.0	1Cx400 sqmm 33KV(E) CU , XLPE, armored, screened cable as per project requirement. (Minimum Requirement)	1 Lot
15.0	Complete cable trays, HDPE piping, GI piping and carrier system in GIS building, control building and outdoor switchyard area , power evacuation system infrastructure as per tender specification.	1 lot
16.0	1 set of 220 V DC system complete with dual FCBC charger of rating 80 A each (Min.), Ni-Cd battery set, Dual incomer DCDB including all its accessories (min 10 hours back up time to be consider for designing)	1 lot
17.0	1 set of 110V, 25 kVA (minimum), parallel redundant UPS with Ni-Cd battery set . The input supply shall be 415V, 3 phase and output shall be 110V, 1 Phase supply.	1 lot
18.0	Auxiliary and safety equipment like caution boards, shock hazard chart, sand buckets, portable fire extinguishers, first aid boxes, rubber mats/ insulating paints, HV gloves and portable earthing equipment, Live line detectors, Testing instruments etc.	1 lot
19.0	OFC Cable with HDPE pipe including its laying and all auxiliaries including jointing and end termination kits	1 Lot
20.0	33 KV AIS Panel with VCB, CT, PT , relays complete in all respect for Local isolation purpose including extension material	1 lot

SL no	Detail of item	Quantity
21.0	33 KV adopter panels, cable termination box, additional CT/PTs in the existing generation bus feeders as per project requirement.	1 Lot
22.0	33 KV , 3 phase cables straight through joints	1 Lot
23.0	33 KV , 3 phase cables end termination	1 Lot
24.0	Structural work for ISBL power evacuation system.	1 Lot
25.0	Earthing work for ISBL power evacuation system	1 Lot
26.0	Laying of cable in trenches with all auxiliaries supply and installation	1 Lot
27.0	Laying of cable in trays/ structures with all auxiliaries supply and installation	1 Lot
28.0	Civil / Building work for indoor GIS swgr, extension of existing control room in PR, C&R panels and all accessories of GIS system.	As per project requirement
29.0	Foundation work all power transformer, structures, LA, CVT, Fire fighting facility, Cable trench/ trays , lighting system etc	As per project requirement
30.0	Major Auxiliaries – 415 V PMCC, LDB, Lighting transformer, VAM based AC system for complete switchgear room with auxiliaries, fire fighting facility, plant communication systems & other in complete as per detailed scope of work	1 lot
31.0	Control and relay panel with complete protection relays	1 lot
32.0	New Remote SCAP at PR (Synchronizing, control and annunciation panel) for all GIS Feeders and 33 KV incomer feeders including supply of control cable , laying & its commissioning. Extension of existing SCAP panel in PNCP for accommodating the new 33 KV generation bus incomers and LIB feeders.	1 lot
33.0	SCADA system for new 220 KV system, associated 33 KV system including HMI in remote control room in PR and PNCP.	1 lot
34.0	Modification of existing ECS system of PR and PNCP for monitoring of proposed system and integration of load shedding scheme. Scope included supply of all materials, installation, laying and termination complete in all respect.	1 Lot
35.0	Transducer panel along with transducers for ECS/SCADA/Load management package complete with all auxiliaries in line with technical specification	1 Lot
36.0	Load management package including supply of its cables, laying and commissioning.	1 Lot
37.0	General - 220kV and 33kV Control & Protection System and Substation Automation System with Numerical Relays and related auxiliary tripping/ lockout relays for all bays, busbars, transformers and incoming lines.	1 lot

SL no	Detail of item	Quantity
38.0	Grid islanding facilities including islanding relays and associated system.	1 lot
39.0	Electrical system of new system as per scope.	As per project requirement.
40.0	Metering panel with Import and export reactive and active Energy measurement for 220kV Incomer feeder comprising of ABT meters & TOD meters as per HVPNL specification (main and check meters)	lot
41.0	33 KV power cables Protection relays for all feeders including its auxiliary and lock out relays.	
42.0	Substation Automation system for complete 220 KV system with provision to communication with RLDC/remote end substation.	
43.0	All required monitor, gateway, Ethernet switch, fiber optic cable, hardware, modem, metering station, engineering station and operating work station, software and any other hardware required for successful commissioning.	
44.0	LV XLPE Power and control cables Including Cables for extending supply from existing substation to new Switchboard with cable gland , lugs , conduits & other required accessories as per complete project requirement including 220 KV switchgear, 33 KV power evacuation system, SCAP system, substation automation system etc	1 lot
45.0	415 AC metal enclosed, fully compartmentalized distribution board of required capacity, outlets as per project requirement.	1 lot
46.0	Field Power panels, lighting distribution panels, Emergency lighting distribution panels, Welding receptacles including lighting transformers as per project requirements.	As per project Requirements
47.0	Commissioning spares	1 lot
48.0	Mandatory spares	As per project requirements

SWITCH YARD

SHED FOR VAM

SWITCH YARD

SUBSTATION-28

ROAD 7.5 M WIDE

WT-3

DC SHED

EXISTING DRAIN
29000

EXISTING DRAIN ——— 75000

5M WIDE ROAD

BOUNDARY WALL

LEGEND:-

_____	EXISTING LINE
_____	PROPOSED LINE
○—○	TENDING LINE



REFERENCE: GILMAN, M.G. = 1001/196/2000. 10.1016/j.jpl.2000.05.001

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YARD

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ANN URE-S2/C1/17-GENERAL
ELECTRICAL LAYOUT (GELO)

PLANT BLDG.

SHED FOR VAM

SWITCH YARD

SUBSTATION-28

ROAD 7.5 M WIDE

WT-3

DC SHED

EXISTING DRAIN
29000

EXISTING DRAIN ——— 75000

5M WIDE ROAD

BOUNDARY WALL



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~~POLY(DMS)-A-2000/98/700 - GFAVING 22607304~~

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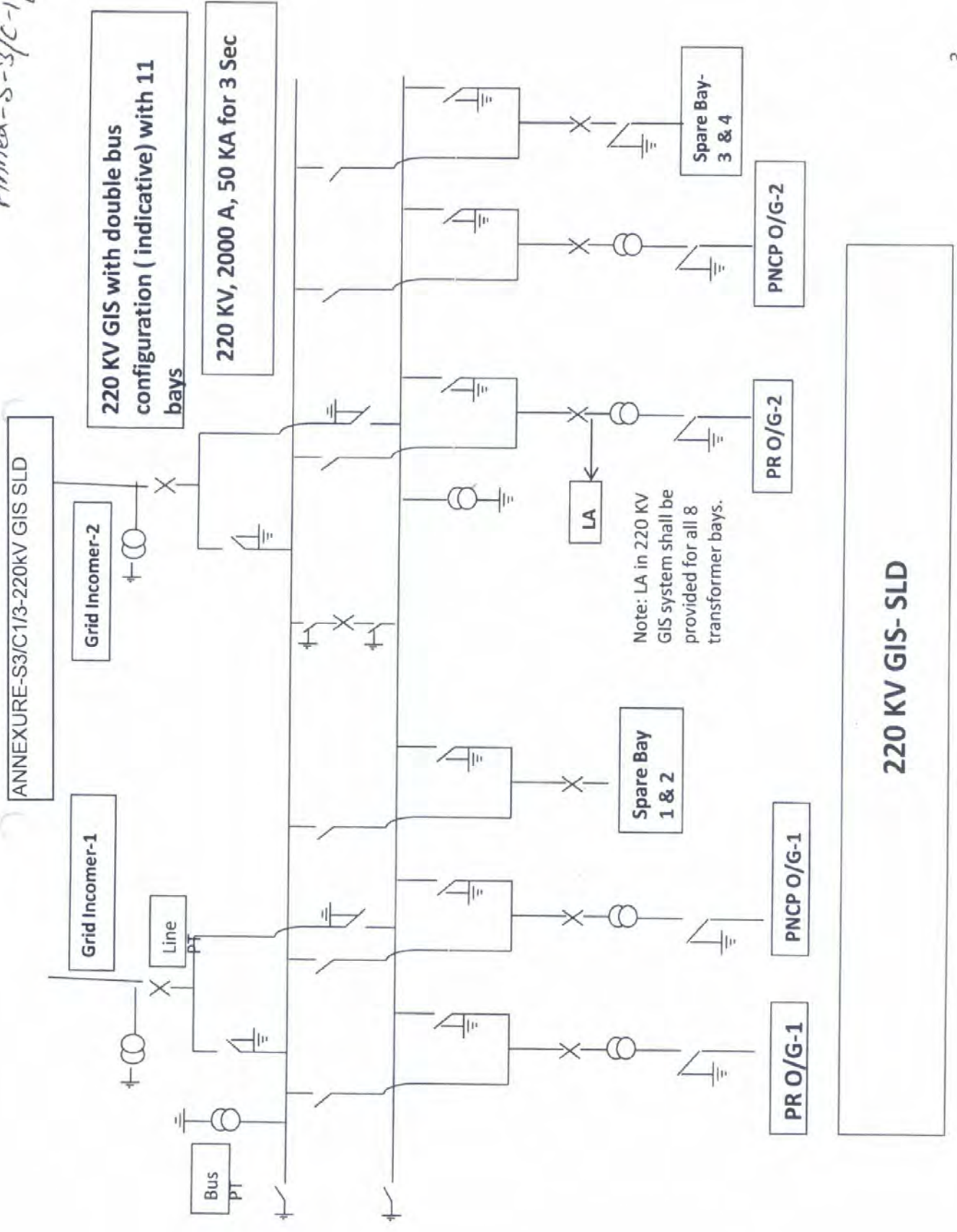
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Annex-S-3/c-1/3

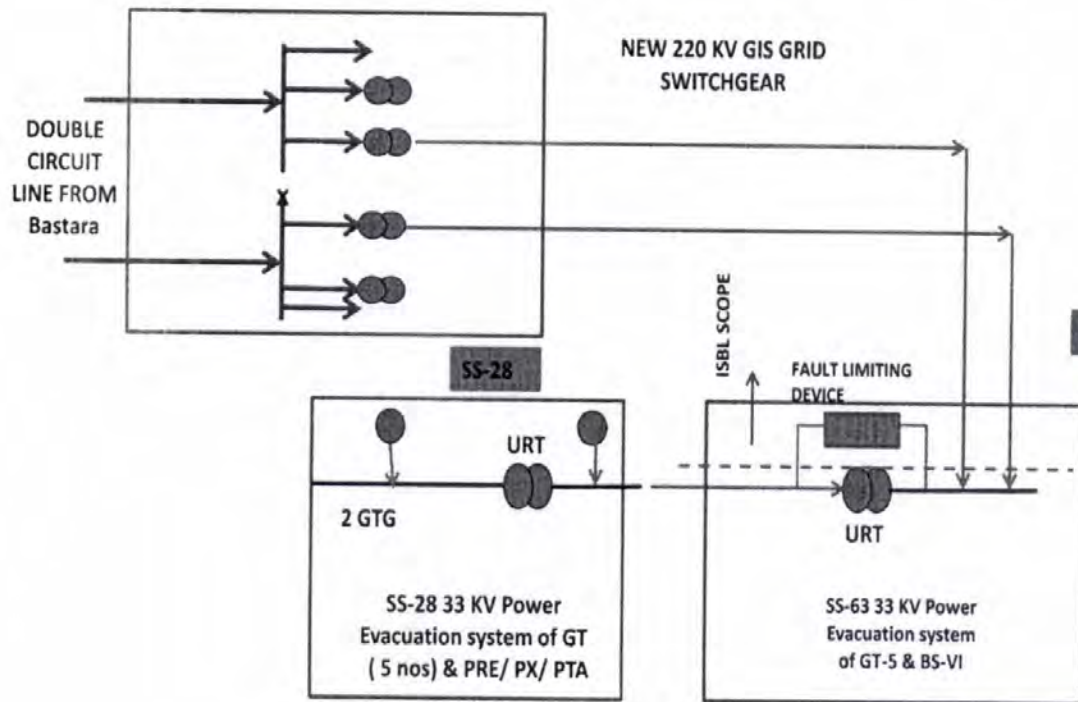


ANNEXURE-S2/C1/5-
INTERCONNECTION SLD OF PR

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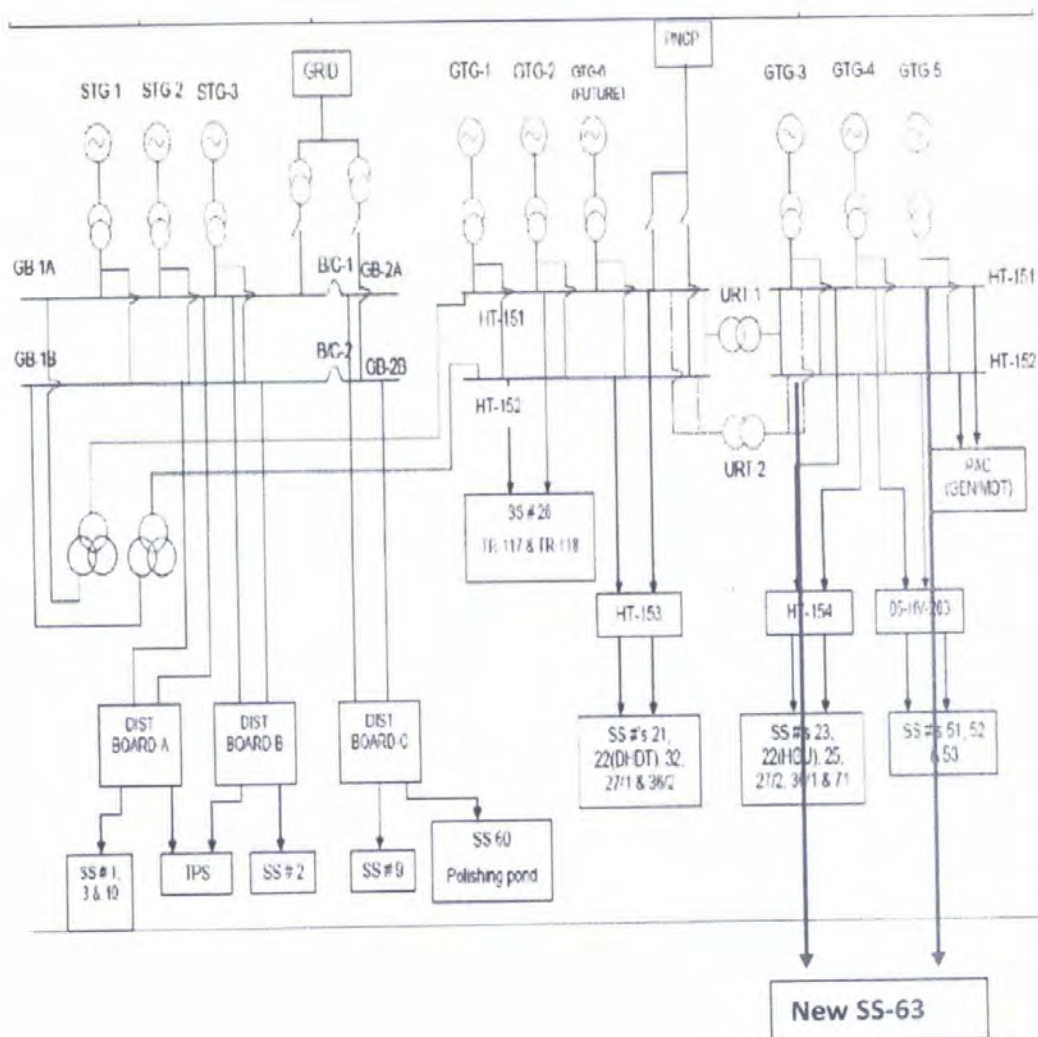
INTERCONNECTION SLD OF PR

Annex- S-2/C-1/5



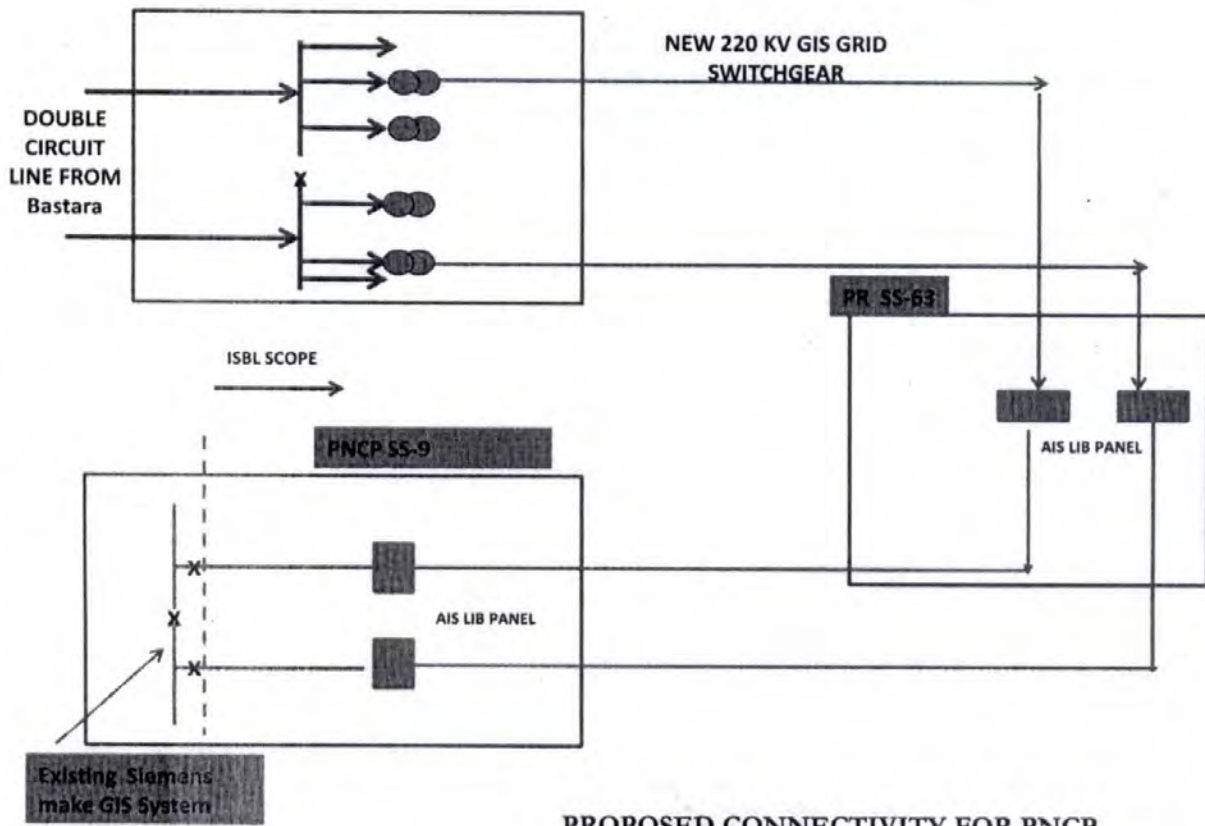
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INTERCONNECTION SLD FOR PNCP POWER EVACUATION FACILITY

Annex- S-2/C-1/6



PROPOSED CONNECTIVITY FOR PNCP

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7.	<p>Section-C Section-2 SCC Technical Part-A 10.1.1.29</p> <p>Electrical System Study: The detailed electrical system study of new 220 KV GIS system including existing generation system of PR and PNCP shall be carried out by vendor for following objectives as per CEA and HVPNL guidelines and requirements</p> <ul style="list-style-type: none"> i) Load flow studies ii) Short circuit and transient stability studies iii) Grid Islanding setting derivation iv) Load shedding adequacy check v) Protection co-ordination of new system. vi) EMTP studies (for switching / dynamic over-voltages, insulation coordination, etc) <p>Required data of existing IOCL system will be provided by owner while for HVPNL, the data shall be collected by the vendor. Lump load concept may be used for existing load of PR and PNCP. The system study report shall be submitted to owner for approval.</p> <p>Any major change or addition in system design/hardware based on the system study report shall be vendor's scope.</p>	<p>Electrical System Study: The detailed electrical system study of new 220 KV GIS system including existing generation system of PR and PNCP shall be carried out by vendor for following objectives as per CEA and HVPNL guidelines and requirements</p> <ul style="list-style-type: none"> i) Load flow studies ii) Short circuit and transient stability studies iii) Grid Islanding setting derivation iv) Load shedding adequacy check v) Protection co-ordination of new system. vi) Electromagnetic transient studies (for switching / dynamic over-voltages, insulation coordination, etc) <p>Required data of existing IOCL system will be provided by owner while for HVPNL, the data shall be collected by the vendor. Lump load concept may be used for existing load of PR and PNCP. The system study report shall be submitted to owner for approval.</p> <p>For equipment ratings, wherever minimum requirements are specified, sizing may change as per detailed design calculations and same shall be in the scope of LSTK contractor without any extra financial implication. For equipments where nominal rating are mentioned, same shall be final.</p>
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	<p>The list of firms/agencies for the purpose of carrying out the electrical system study is as following:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Engineers India Limited <input type="checkbox"/> Project & Development India : Limited <input type="checkbox"/> TOYO Engineering India Pvt. Limited <input type="checkbox"/> JACOBS Engineering Group <input type="checkbox"/> MECON Limited <input type="checkbox"/> Foster Wheeler India Pvt. Limited. <input type="checkbox"/> National Thermal Power Corporation Limited <input type="checkbox"/> Sterlin & Wilson Pvt. Limited. <input type="checkbox"/> Bechtel India Pvt. Limited. <input type="checkbox"/> Tata Consulting Engineers Limited. <input type="checkbox"/> Tractebel Engineering Pvt. Ltd. <input type="checkbox"/> Power Grid Corporation of India Limited <input type="checkbox"/> ABB Ltd <input type="checkbox"/> Siemens Ltd <input type="checkbox"/> GE <input type="checkbox"/> Toshiba <input type="checkbox"/> L&T <p>Or any other reputed agency with approval of EIC</p>	<p>The list of firms/agencies for the purpose of carrying out the electrical system study is as following:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Engineers India Limited <input type="checkbox"/> Project & Development India : Limited <input type="checkbox"/> TOYO Engineering India Pvt. Limited <input type="checkbox"/> JACOBS Engineering Group <input type="checkbox"/> MECON Limited <input type="checkbox"/> Foster Wheeler India Pvt. Limited. <input type="checkbox"/> National Thermal Power Corporation Limited <input type="checkbox"/> Sterlin & Wilson Pvt. Limited. <input type="checkbox"/> Bechtel India Pvt. Limited. <input type="checkbox"/> Tata Consulting Engineers Limited. <input type="checkbox"/> Tractebel Engineering Pvt. Ltd. <input type="checkbox"/> Power Grid Corporation of India Limited <input type="checkbox"/> ABB Ltd <input type="checkbox"/> Siemens Ltd <input type="checkbox"/> GE <input type="checkbox"/> Toshiba <input type="checkbox"/> L&T <p>Or any other reputed agency with approval of EIC</p>
8	<p>Technical Specification for 220kV GIS/ Section-3 Chapter-1 \ Clause 7. b</p>	<p>The GIS system shall be suitable for future extension on either end or single end by the addition of extra feeders, bus couplers, bus-bars, circuit breakers, dis-connectors, and other switch gear components. The arrangement of gas sections or compartments shall be such as to facilitate future extension without any drilling, cutting or welding on the existing equipment. To add equipment, it shall not be necessary to move or dislocate the existing switchgear bays</p>

Bharat Heavy Electricals Limited

Project. LSTK job for ISBL work of 220KV Grid Power Import at IOCL, Panipat Refinery
Technical Specification. Engineering Services for ISBL work of 220KV Grid Power Import at
IOCL, Panipat Refinery
Doc. No. TB-CS-316-001

Section 3: Annexures

This section covers following,

1. Annexure A-Compliance Certificate for Technical Specification
2. Annexure B-Deviation/ Change Request for Technical Specification

Bharat Heavy Electricals Limited

Project. **LSTK job for ISBL work of 220KV Grid Power Import at IOCL, Panipat Refinery**
Technical Specification. **Engineering Services for ISBL work of 220KV Grid Power Import at IOCL, Panipat Refinery**
Doc. No. **TB-CS-316-001**

Annexure-A: Compliance Certificate of Technical Specification

The bidder shall confirm compliance to the following by signing/ stamping this compliance certificate and furnishing same with the offer.

1. The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusion/ deviation with regard to same.
2. There are no deviation(s) with respect to specification other than those furnished in the 'Deviation/ Change request to technical specification'.
3. Only those technical submittals which are specifically asked for in NIT to be submitted at tender stage shall be considered as part of offer. Any other submission, even if made, shall not be considered as part of offer.
4. Any comments/ clarifications on technical/ inspection requirements furnished as part of bidder's covering letter shall not be considered by BHEL, and bidder's offer shall be construed to be in conformance with the specification.
5. Any changes made by the bidder in the price schedule with respect to the description/ quantities from those given in 'BOQ' of the specification shall not be considered (i.e., technical description & quantities as per the specification shall prevail).

Date:

Bidder's Stamp & Signature

Bharat Heavy Electricals Limited

Project. LSTK job for ISBL work of 220KV Grid Power Import at IOCL, Panipat Refinery
Technical Specification. Engineering Services for ISBL work of 220KV Grid Power Import at IOCL,
Panipat Refinery
Doc. No. TB-CS-316-001

Annexure-B: Deviation/ change Request of Technical Specification

Bidder shall list out all technical potential deviation/ change request(s) along with clause with respect to technical specification.

Sl. No.	Page No.	Clause No.	Deviation	Reason / Justification
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Any deviation not specifically brought out in this section shall not be admissible for any commercial implication at later stage. Except to the technical deviation(s) listed in this schedule, bidder's offer shall be considered in full compliance to the tender specification irrespective of any such deviation indicated / taken elsewhere in the submitted technical offer.

Date:

Bidder's Stamp & Signature