ANNEXURE E

BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESSS GROUP
MATERIAL RECEIPT CERTIFICATE

a) Site:
b) LR No. with date:
c) Vehicle no.:
d) Date of receipt of material at site:
e) Material details (as mentioned below):

S.no.	Item Description	Type of Packages	Unit (MT/KM/ NO.)	Qty as per packing list	Qty Received	Remarks

Other Remarks:

Signature with date: _____

Name & Designation: _____
(With Seal)

Annexure-III- Check List for Supply bills

Name Of the Project							
Package Description							
Invoice No. & Date							
PO No. & date							
Sr. No	Documents Required	Copies	Check Points	Page no.	Vendor Remarks	Verification by MM	Verification by Fin
					(Y/N/NA)	(Y/N/NA)	(Y/N/NA)
1	Original for Buyer Invoice - GST compliant invoice	1 Original+2 Copy	1. Please ensure GST complaint invoice in original				
			2. Consignee address : BHEL C/o followed by site address				
			3. Item description and unit of quantity are matched with PO				
			4. Buyer address and GSTN No as required (TBG Noida or Nodal				
			5. PO No and date, LR No and date, Vehicle No and Project name				
			6. Invoiced quantity are not more than th PO quantity and MICC				
			7. Ex works unit rate , Taxes and F&I rates are same as per PO				
			8. Signed and stamped by vendor				
2	Receipted LR (signed & stamped)/ confirmation from site regarding receipt of packages/ Boxes	1Orignal+2 Copy	1. Consignee address : BHEL C/o followed by Site address				
			2. In case of material purchased from sub vendor , Consignee address Vendor's name C/o BHEL C/o Site address				
			3. Vendor's Invoice no and Vehicle No are mentioned				
			4. No of boxes/No of packages are same as per Packing list				
			5. In case of and adverse remark on LR (Like shortages/damages/broken etc) , clarification from site/TBMM/TBCM is nedded				
			6. LR is readable				
			7. In case of photo copy, LR is verified by TBMM				
			8. LR date is after the date of MICC/(MDCC if issued) or same date				
3	Packing List - showing number of packages, and gross weight/net Weight (if applicable)	1Orignal+2 Copy	1. PO No and date, LR No and date, Invoice No and date, Site Name and address, Consignor and consignee address are mentioned				
			2. Item description and quantity are matched with Invoice and PO				
			3. Signed and stamped by vendor				
			4. No of packages/ Item descriptions are matched with MRC and LR				
4	MICC from BHEL	1Original+2Copy	1. BHEL MICC has been issued prior to the date of dispatch or on same date				
			2. In case where MICC date is after the date of dispatch then MDCC date is same or prior to the date of dispatch				
			3. Project Name, PO,Po Date, Vendor's name and address is correct				
			4. Item description, Quantity and unit of quantity are same as per PO				
			5. All hold point in MICC , if any, have been resolved before submission of bill				
			6. Signed and stamped by BHEL Executive				
			7. MICC and MDCC quantity are not less than Invoice quantity and cover all invoiced items.				
5	Guarantee Certificate	1 Original+2 Copy	1. Project Name, PO No., Invoice No , LR No and date are mentioned .				
			2. Guarantee Certificate is strictly matched with PO T&C				
			3. Signed and stamped by vendor				
6	Bank Guarantee	1 Copy	'1. Ensure submission of BG directly from Bank before supply of material so that BG confirmation may be arranged before processing				
			2. Bill can be processed only after receipt of BG confirmation directly from bank				
			3. It should be in the name of BHEL , TBG Noida with registered office address Siri Fort, New Delhi				
			4. It should be in prescribed format.				
			5. BG value and valdity plus claim period should be minimum as specified in PO / RC. Please check before supply , If BG extension is required please arrange the same				
			6. Vendor's name address should be same as per PO				
			7. Po No / RC No and date should be correct				
7	Insurance Certifcate	1 Orignal+2 Copy	1. Invoice No and date, Vendor's Name,Place from Consignor to Consignee are mentioned				
			2. It has not been issued later than the LR date				
			3. Insured value is not less than the Invoice value				
			4. Signed and stamped by Insurance Company				
			5. In case of Open Insurance Policy, declaration has been submitted to Insurance Company as per declaration clause of Open policy and				
			6. In case of any discrepancy , consent of TBCM is required for processing the bill and amount will be deducted for invalid Insurance				
8	PVC (If applicable) Invoice is submitted along with the Despatch Invoice	1Original+2Copy	PVC (If applicable) Invoice is submitted along with the Despatch Invoice				
			1. PVC invoice is attched along with supply Invoice				
			2. Calculation sheet and applicable PVC indices are also enclosed				
			3. If delay in delivery, then PVC indicies are as per PO conditions.				
9			1. LR No and date, Invoice No and date, Vehicle No and date , Site Name an address are mentioned				
			2. Date of receipt of material				

Check List for Supply bills

Name Of the Project							
Package Description							
Invoice No. & Date							
PO No. & date							
Sr. No	Documents Required	Copies	Check Points	Page no.	Vendor Remarks	Verification by MM	Verification by Fin
					(Y/N/NA)	(Y/N/NA)	(Y/N/NA)
	Material receipt Certificate		3. Item description and quantity are same as per Invoice / Packing List				
			4. It is signed and stamped by Site executive				
			5. In case of any shortages / damages / adverse remark , clarification is needed				
10	Other Documents		To be seen as per specific requirement of PO.				
To be filled by BHEL (MM) only							
10	Date Of Submission of Last Billing Document		Date to be mentioned		Not to be filled by vendor		
11	LD Calculation, if applicable, as per PO.		Calculation Sheet of LD due to delay in delivery is attached				
12	Receipted LR (signed & stamped)/ confirmation from site regarding receipt of packages/ Boxes	1 Copy	Damages if any mentioned in the Receipted LR have been accounted for. Withhel amount if any_____				
13	Packing List - showing number of packages and gross weight & net Weight (If applicable)	1 Original	If Packing list does not match with Purchase order (with ref to sl 4 above), Engg/MM acceptance as to the completeness is enclosed.				
14	PO copy	1 Copy	PO copy with original seal and signature is attached along with amendment if any				
15	Dan	1 copy	Relevant DANs are attached duly signed by TBMM representative.				
Note*	Every Field to be ticked. If some document is not applicable, same should be mentioned, All Pages to be numbered upward from the bottom Page						
	Invoice control No				Vendor Signature	MM Signature	Finance Signature
					Date:	Date:	Date:

Item/Package Name :	
Enquiry No.:	
Project:	
Type of project	
Percentage of Local Content	***(Bidder to enter the applicable % of local content)***

Self-certification to be submitted in INR 100/- non judicial stamp paper

Format of Self certification regarding Local Content in line with PPP-MII order, 2017 & its revision dated 04.06.2020.

Date:……..

I _____S/o, D/o, W/o, _____Resident of_____ hereby solemnly affirm and declare as under:

That I will agree to abide by the terms and conditions of the Public Procurement (Preference to Make in India) Order, 2017 (*hereinafter PPP-MII order*) of Government of India issued vide Notification No: P-45021/2/2017-BE-II dated 15/06/2017, its revision dated 04/06/2020 and any subsequent modifications/Amendments**,** if any**.**

That the information furnished hereinafter is correct to the best of my knowledge and belief and I undertake to produce relevant records before the procuring entity/BHEL or any other Government authority for the purpose of assessing the local content of goods/services/works supplied by me for ……. *(Enter the name of the Equipment/Item for Project).*

That the local content for all inputs which constitute the said goods/services/works has been verified by me and I am responsible for the correctness of the claims made therein.

That the goods/services/works supplied by me for ……. *(Enter the name of the Equipment/Item for Project)* **contains…….**% (mention the Local content in %age) Local Content.

That the value addition for the purpose of meeting the 'Minimum Local Content 'has been made by me at …… (*Enter the details of the location(s) at which value addition is made).*

That in the event of the local content of the goods/services/works mentioned herein is found to be incorrect and not meeting the prescribed supplier class categorization criteria as per said order, based on the assessment of procuring agency (ies)/BHEL/Government Authorities for the purpose of assessing the local content, action shall be taken against me in line with the PPP-MII order and provisions of the Integrity pact/ Bidding Documents.

I agree to maintain the following information in the Company's record for a period of 8 years and shall make this available for verification to any statutory authority.

i Name and details of the Local Supplier
(Registered Office, Manufacturing unit location, nature of legal entity)

ii. Date on which this certificate is issued

Item/Package Name :	
Enquiry No.:	
Project:	
Type of project	
Percentage of Local Content	***(Bidder to enter the applicable % of local content)***

Self-certification to be submitted in INR 100/- non judicial stamp paper

iii. Goods/services/works for which the certificate is produced

iv. Procuring entity to whom the certificate is furnished

v. Percentage of local content claimed and whether it meets the Minimum Local Content prescribed

vi. Name and contact details of the unit of the Local Supplier (s)

vii. Sale Price of the product

viii Ex-Factory Price of the product

ix. Freight, insurance and handling

x. Total Bill of Material

xi List and total cost value of input used to manufacture the Goods/to provide services/in construction of works

xii. List and total cost of input which are domestically sourced. Value addition certificates from suppliers, if the input is not in-house to be attached

xiii. List and cost of inputs which are imported, directly or indirectly

For and on behalf of…… (Name of firm/entity)

Authorized signatory (To be duly authorized by the Board of Directors)
<Insert Name, Designation and Contact No.>

Annexure-VI

Clause regarding regarding restrictions under Rule 144 (XI) of the General Financial Rules (GFRs), 2017 as per Government of India order OM No.6/18/2019-PPD dated 23.07.2020

I. Any bidder from a country which shares a land border with India will be eligible to bid in this tender only if the bidder is registered with the Competent Authority.

II. "Bidder" (including the term 'tenderer', 'consultant' or 'service provider' in certain contexts) means any person or firm or company including any member of a consortium or joint venture (that is an association of several persons, or firms or companies), every artificial juridical person not failing in any of the descriptions of bidders stated hereinbefore, including any agency branch or office controlled by such person, participating in a procurement process.

III. "Bidder from a country which shares a land border with India" for the purpose of this Order means:

a. An entity Incorporated, established or registered in such a country; or
b. A subsidiary of an entity Incorporated, established or registered in such a country; or
c. An entity substantially controlled through entitles incorporated, established or registered in such a country; or
d. An entity whose *beneficial owner* is situated in such a country, or
e. An Indian (or other) agent of such an entity; or
f. A natural person who is a citizen of such a country; or
g. A consortium or joint venture where any member of the consortium or joint venture falls under any of the above

IV. The *beneficial owner* for the purpose of (iii) above will be as under:

1. In case of a company or Limited Liability Partnership, the beneficial owner is the natural person(s), who, whether acting alone or together, or through one or more juridical person, has a controlling ownership interest or who exercises control through other means.
   Explanation-
   a. "Controlling ownership interest" means ownership of or entitlement to more than twenty-five per cent. of shares or capital or profits of the company;
   b. "Control" shall include the right to appoint majority of the directors or to control the management or policy decisions including by virtue of their shareholding or management rights or shareholder's agreements or voting agreements;
2. In case of a partnership firm, the beneficial owner is the natural person(s) who, whether acting alone or together, or through one or more juridical person, has ownership of entitlement to more than fifteen percent of capital or profits of the partnership;
3. In case of an unincorporated association or body of individuals, the beneficial owner is the natural person(s), who, whether acting alone or together, or through one or more juridical person, has ownership of or entitlement to more than fifteen percent of the property or capital or profits of such association or body of Individuals;
4. Where no natural person is Identified under (1) or (2) or (3) above the beneficial owner is the relevant natural person who holds the position of senior managing official;
5. In case of a trust, the identification of beneficial owner(s) shall include identification of the author of the trust, the trustee, the beneficiaries with fifteen percent or more interest in the trust and any other natural person exercising ultimate effective control over the trust through a chain of control or ownership.

V. An Agent is a person employed to do any act for another or to represent another in dealings with third person.

Annexure-VI

Clause regarding regarding restrictions under Rule 144 (XI) of the General Financial Rules (GFRs), 2017 as per Government of India order OM No.6/18/2019-PPD dated 23.07.2020

VI. The successful bidder shall not be allowed to sub-contract works to any contractor from a country which shares a land border with India unless such contractor is registered with the Competent Authority.

***** *The above clause is not applicable to the bidders from those countries (even if* sharing a land border with India) to which the GoI has extended lines of credit or in which the GoI is engaged in development projects.

* List of countries to which lines of credit have been extended or in which development projects are undertaken are available on the Ministry of External affaires website (https://www.mea.gov.in/)

Annexure-VII

Compliance to be submitted in INR 100/- non judicial stamp paper

Sub: **Compliance to Government of India order OM No.6/18/2019-PPD dated 23.07.2020 regarding restrictions under Rule 144 (XI) of the General Financial Rules (GFRs), 2017**

Sl No.	Description	Bidder's confirmation
1	*We, M/s_____have read the clause regarding restrictions on procurement from a bidder of a country which shares a land border with India; We hereby certify that we are not from such a country.*	*Agreed*

(Note: Non-compliance of above said GoI Order and its subsequent amendment, (if any), by any bidder(s) shall lead for commercial rejection of their bids by BHEL)

Bidder's authorized signatory with stamp & seal

Annexure-VIII

Compliance to be submitted in INR 100/- non judicial stamp paper

Sub: **Compliance to Government of India order OM No.6/18/2019-PPD dated 23.07.2020 regarding restrictions under Rule 144 (XI) of the General Financial Rules (GFRs), 2017**

Sl No.	Description	Bidder's confirmation
1	*We, M/s_____have read the clause regarding restrictions on procurement from a bidder of a country which shares a land border with India. We are from such a country which shares a land border with India & have been registered with the Competent Authority as specified in above said order. We hereby certify that we fulfil all requirements in this regard and are eligible to be considered.* ***Evidence of valid registration by the Competent Authority is attached.***	*Agreed*

(Note: Non-compliance of above said GoI Order and its subsequent amendment, (if any), by any bidder(s) shall lead for commercial rejection of their bids by BHEL)

Bidder's authorized signatory with stamp & seal

Annexure-IX

No.25-111612018-PG

Government of India

Ministry of Power

Shram Shakti Bhawan, Rafi Marg, New Delhi • — 110001

Tele Fax: 011-23730264

Dated 02/07/2020

ORDER

Power Supply System is a sensitive and critical infrastructure that supports not only our national defence, vital emergency services including health, disaster response, critical national infrastructure including classified data & communication services, defence installations and manufacturing establishments, logistics services but also the entire economy and the day-today life of the citizens of the country. Any danger or threat to Power Supply System can have catastrophic effects and has the potential to cripple the entire country. Therefore, the Power Sector is a strategic and critical sector.

The vulnerabilities in the Power Supply System & Network mainly arise out of the possibilities of cyber attacks through malware / Trojans etc. embedded in imported equipment. Hence, to protect the security, integrity and reliability of the strategically important and critical Power Supply System & Network in the country, the following directions are hereby issued:-

1. All equipment, components, and parts imported for use in the Power Supply System and Network shall be tested in the country to check for any kind of embedded malware/trojans/cyber threat and for adherence to Indian Standards.
2. All such testings shall be done in certified laboratories that will be designated by the Ministry of Power (MOP).
3. Any import of equipment/components/parts from "prior reference" countries as specified or by persons owned by, controlled by, or subject to the jurisdiction or the directions of these "prior reference" countries will require prior permission of the Government of India
4. Where the equipment/components/parts are imported from "prior reference" countries, with special permission, the protocol for testing in certified and designated laboratories shall be approved by the Ministry of Power (MOP).

This order shall apply to any item imported for end use or to be used as a component, or as a part in manufacturing, assembling of any equipment or to be used in power supply system or any activity directly or indirectly related to power supply system.

This issues with the approval of Hon'ble Minister of State for Power and New & Renewable Energy (Independent Charge).

(Goutam Ghosh)

Director Tel: 011-23716674 To:

1. All Ministries/Departments of Government of India (As per list)
2. Secretary (Coordination),Cabinet Secretariat
3. Vice Chairman, NITI Aayog

सेवा भवन, आर. के. पुरम-I, नई दिल्ली-110066 टेली: 011-26732257 ईमेल: ce-rndcea@nic.in वेबसाइट: www.cea.nic.in

Sewa Bhawan, R.K Puram-I, New Delhi - 110066 Tele: 011-26732257 Email: ce-rndcea@nic.in Website: www.cea.nic.in

Annexure-

Vendor Compliance format in bidder letter head

In view of order No. 25-111612018-PG, Dated 02.07.2020 of Ministry of Power, GOI

En uiry No/ PO No & Date :
Pro ect :
Name of items/Package :

This is to certify that all equipment, components, and parts imported for use in the Power Supply System and Network are in strict compliance to directions issued by Ministry of Power, Govt. of India vide order No. 25-111612018-PG dated 02.07.2020. The imported component(s), part or assembly item(s) does not carry any malware/Trojan etc.

Note: Non-compliance of MoP Order and its subse uent amendment(s), (if any), by vendor shall lead to re ection of their offer or cancellation of contract, which is awarded by BHEL.

Bidder's authorized signatory

with stamp & seal

Annexure-XI

INTEGRITY PACT:

Bidders shall have to enter into Integrity Pact with BHEL, duly signed with seal in original, if specified in NIT / RFQ failing which bidder's offer shall be liable for rejection.

(a) IP is a tool to ensure that activities and transactions between the company and its bidders/contractors are handled in a fair, transparent and corruption free manner. Following Independent External Monitor (IEMs) on the present panel have been appointed by BHEL with the approval of CVC to oversee implementation of IP in BHEL.

Details of IEM for this tender is furnished below
Name: Shri Arun Chandra Verma, IPS (Retd.)
Email: acverma1@gmail.com

Name: Shri Virendra Bahadur Singh, IPS (Retd.)
E-mail: vbsinghips@gmail.com

(b) The IP as enclosed with the tender is to be submitted (duly signed by authorized signatory) along with techno-commercial bid (Part-1, in case of Two/three part bid). Only those bidders who have entered into such an IP with BHEL would be competent to participate in the bidding. In other words, entering into this pact would be a preliminary qualification.

(c)Please refer section -8 of the IP for Role and responsibilities of IEMs. In case of any complaint arising out of the tendering process, the matter may be referred to any of the above IEM(s). All correspondence with the IEM shall be done through e-mail only.

Note: No routine correspondence shall be addressed to the IEM (Phone/post/email) regarding the clarification, time extensions or any other administrative queries, etc. on the tender issued. All such clarification/issues shall be addressed directly to the tender issuing (procurement) department's officials as mentioned on Point 2 & 3.

Annexure-1

INTEGRITY PACT

Between

Bharat Heavy Electricals Ltd. (BHEL), a company registered under the Companies Act 1956 and having its registered office at "BHEL House", Siri Fort, New Delhi - 110049 (India) hereinafter referred to as "The Principal", which expression unless repugnant to the context or meaning hereof shall include its successors or assigns of the ONE PART

and

_____, (description of the party along with address), hereinafter referred to as "The Bidder/ Contractor" which expression unless repugnant to the context or meaning hereof shall include its successors or assigns of the OTHER PART

Preamble

The Principal intends to award, under laid-down organizational procedures, contract/s for _____

_____

_____ . The Principal values full compliance with all relevant laws of the land, rules and regulations, and the principles of economic use of resources, and of fairness and transparency in its relations with its Bidder(s)/ Contractor(s).

In order to achieve these goals, the Principal will appoint Independent External Monitor(s), who will monitor the tender process and the execution of the contract for compliance with the principles mentioned above.

Section 1- Commitments of the Principal

1.1 The Principal commits itself to take all measures necessary to prevent corruption and to observe the following principles:-

1.1.1 No employee of the Principal, personally or through family members, will in connection with the tender for, or the execution of a contract, demand, take a promise for or accept, for self or third person, any material or immaterial benefit which the person is not legally entitled to.

1.1.2 The Principal will, during the tender process treat all Bidder(s) with equity and reason. The Principal will in particular, before and during the tender process, provide to all Bidder(s) the same information and will not provide to any Bidder(s) confidential/ additional information through which the Bidder(s) could obtain an advantage in relation to the tender process or the contract execution.

1.1.3 The Principal will exclude from the process all known prejudiced persons.

1.2 If the Principal obtains information on the conduct of any of its employees which is a penal offence under the Indian Penal Code 1860 and Prevention of Corruption Act 1988 or any other statutory penal enactment, or if there be a substantive suspicion in this regard, the Principal will inform its Vigilance Office and in addition can initiate disciplinary actions:

Section 2 - Commitments of the Bidder(s)/ Contractor(s)

2.1 The Bidder(s)/ Contractor(s) commit himself to take all measures necessary to prevent corruption. He commits himself to observe the following principles during his participation in the tender process and during the contract execution.

2.1.1 The Bidder(s)/ Contractor(s) will not, directly or through any other person or firm, offer, promise or give to the Principal or to any of the Principal's employees involved in the tender process or the execution of the contract or to any third person any material, immaterial or any other benefit which he/ she is not legally entitled to, in order to obtain in exchange any advantage of any kind whatsoever during the tender process or during the execution of the contract.

2.1.2 The Bidder(s)/ Contractor(s) will not enter with other Bidder(s) into any illegal or undisclosed agreement or understanding, whether formal or informal. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to introduce cartelization in the bidding process.

2.1.3 The Bidder(s)/ Contractor(s) will not commit any penal offence under the relevant Indian Penal Code (IPC) and Prevention of Corruption Act; further the Bidder(s)/ Contractor(s) will not use improperly, for purposes of competition or personal gain, or pass on to others, any information or document provided by the Principal as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically.

2.1.4 Foreign Bidder(s)/ Contractor(s) shall disclose the name and address of agents and representatives in India and Indian Bidder(s)/ Contractor(s) to disclose their foreign principals or associates. The Bidder(s)/ Contractor(s) will, when presenting his bid, disclose any and all payments he has made, and is committed to or intends to make to agents, brokers or any other intermediaries in connection with the award of the contract.

2.2 The Bidder(s)/ Contractor(s) will not instigate third persons to commit offences outlined above or be an accessory to such offences.

2.3 The Bidder(s)/ Contractor(s) shall not approach the Courts while representing the matters to IEMs and will await their decision in the matter.

Section 3 - Disqualification from tender process and exclusion from future contracts

If the Bidder(s)/ Contractor(s), before award or during execution has committed a transgression through a violation of Section 2 above, or acts in any other manner such as to put his reliability or credibility in question, the Principal is entitled to disqualify the Bidder(s)/ Contractor(s) from the tender process or take action as per the separate "Guidelines on Banning of Business dealings with Suppliers/ Contractors", framed by the Principal.

Section 4 - Compensation for Damages

4.1 If the Principal has disqualified the Bidder from the tender process prior to the award according to Section 3, the Principal is entitled to demand and recover the damages equivalent Earnest Money Deposit/ Bid Security.

4.2 If the Principal has terminated the contract according to Section 3, or if the Principal is entitled to terminate the contract according to section 3, the Principal shall be entitled to

demand and recover from the Contractor liquidated damages equivalent to 5% of the contract value or the amount equivalent to Security Deposit/ Performance Bank Guarantee, whichever is higher.

Section 5 - Previous Transgression

5.1 The Bidder declares that no previous transgressions occurred in the last 3 years with any other company in any country conforming to the anti-corruption approach or with any other Public Sector Enterprise in India that could justify his exclusion from the tender process.

5.2 If the Bidder makes incorrect statement on this subject, he can be disqualified from the tender process or the contract, if already awarded, can be terminated for such reason.

Section 6 - Equal treatment of all Bidders/ Contractors / Sub-contractors

6.1 The Principal will enter into agreements with identical conditions as this one with all Bidders and Contractors. In case of sub-contracting, the Principal contractor shall be responsible for the adoption of IP by his sub-contractors and shall continue to remain responsible for any default by his sub-contractors.

6.2 The Principal will disqualify from the tender process all bidders who do not sign this pact or violate its provisions.

Section 7 - Criminal Charges against violating Bidders/ Contractors /Subcontractors

If the Principal obtains knowledge of conduct of a Bidder, Contractor or Subcontractor, or of an employee or a representative or an associate of a Bidder, Contractor or Subcontractor which constitutes corruption, or if the Principal has substantive suspicion in this regard, the Principal will inform the Vigilance Office.

Section 8 - Independent External Monitor(s)

8.1 The Principal appoints competent and credible Independent External Monitor for this Pact. The task of the Monitor is to review independently and objectively, whether and to what extent the parties comply with the obligations under this agreement.

8.2 The Monitor is not subject to instructions by the representatives of the parties and performs his functions neutrally and independently. He reports to the CMD, BHEL.

8.3 The Bidder(s)/ Contractor(s) accepts that the Monitor has the right to access without restriction to all contract documentation of the Principal including that provided by the Bidder(s)/ Contractor(s). The Bidder(s)/ Contractor(s) will grant the monitor, upon his request and demonstration of a valid interest, unrestricted and unconditional access to his contract documentation. The same is applicable to Sub-contractor(s). The Monitor is under contractual obligation to treat the information and documents of the Bidder(s)/ Contractor(s) / Sub-contractor(s) with confidentiality in line with Non- disclosure agreement.

8.4 The Principal will provide to the Monitor sufficient information about all meetings among the parties related to the contract provided such meetings could have an impact on the contractual relations between the Principal and the Contractor. The parties offer to the Monitor the option to participate in such meetings.

8.5 The role of IEMs is advisory, would not be legally binding and it is restricted to resolving issues raised by an intending bidder regarding any aspect of the tender which allegedly restricts competition or bias towards some bidders. At the same time, it must be understood that IEMs are not consultants to the Management. Their role is independent in nature and the advice once tendered would not be subject to review at the request of the organization.

8.6 For ensuring the desired transparency and objectivity in dealing with the complaints arising out of any tendering process, the matter should be examined by the full panel of IEMs jointly as far as possible, who would look into the records, conduct an investigation, and submit their joint recommendations to the Management.

8.7 The IEMs would examine all complaints received by them and give their recommendations/ views to CMD, BHEL, at the earliest. They may also send their report directly to the CVO and the Commission, in case of suspicion of serious irregularities requiring legal/ administrative action. IEMs will tender their advice on the complaints within 10 days as far as possible.

8.8 The CMD, BHEL shall decide the compensation to be paid to the Monitor and its terms and conditions.

8.9 IEM should examine the process integrity, they are not expected to concern themselves with fixing of responsibility of officers. Complaints alleging mala fide on the part of any officer of the organization should be looked into by the CVO of the concerned organisation.

8.10 If the Monitor has reported to the CMD, BHEL, a substantiated suspicion of an offence under relevant Indian Penal Code/ Prevention of Corruption Act, and the CMD, BHEL has not, within reasonable time, taken visible action to proceed against such offence or reported it to the Vigilance Office, the Monitor may also transmit this information directly to the Central Vigilance Commissioner, Government of India.

8.11 The number of Independent External Monitor(s) shall be decided by the CMD, BHEL.

8.12 The word `Monitor' would include both singular and plural.

Section 9 - Pact Duration

9.1 This Pact shall be operative from the date IP is signed by both the parties till the final completion of contract for successful bidder and for all other bidders 6 months after the contract has been awarded. Issues like warranty / guarantee etc. should be outside the purview of IEMs.

9.2 If any claim is made/ lodged during currency of IP, the same shall be binding and continue to be valid despite the lapse of this pact as specified above, unless it is discharged/ determined by the CMD, BHEL.

Section 10 - Other Provisions

10.1 This agreement is subject to Indian Laws and jurisdiction shall be registered office of the Principal, i.e. New Delhi.

10.2 Changes and supplements as well as termination notices need to be made in writing. Side agreements have not been made.

10.3 If the Contractor is a partnership or a consortium, this agreement must be signed by all partners or consortium members.

10.4 Should one or several provisions of this agreement turn out to be invalid, the remainder of this agreement remains valid. In this case, the parties will strive to come to an agreement to their original intentions.

10.5 Only those bidders / contractors who have entered into this agreement with the Principal would be competent to participate in the bidding. In other words, entering into this agreement would be a preliminary qualification.

For & On behalf of the Principal

(Office Seal)

For & On behalf of the Bidder/

Contractor

(Office Seal)

Place----------

Date----------

Witness:_____

(Name & Address) _____

_____

Witness:_____

(Name & Address) _____

_____

Annexure A - Activity Schedule

Project **OPTCL DUBURI**
Item **SAS**

SN	Activity	Activity Time (in weeks)	Scope
1	Input to Vendor from BHEL	2	BY BHEL
2	Submission of Documents necessary for getting manufacturing clearance like Drawings, Data sheet, MQP etc.		BY SUPPLIER
3	Manufacturing Clearance & CAT-A approval to Vendor after drawing submission	2	BY BHEL
4	Manufacturing time after CAT-A approval & Manufacturing Clearance till proposed inspection date(Including time of raising Inspection Call as mentioned in note#1).		BY SUPPLIER
5	BHEL/Customer Inspection & Dispatch Clearance	2	BHEL SCOPE
6	Dispatch&receipt of material at site		BY SUPPLIER
	Total		weeks

Supplier to fill yellow highlighted cell.

Notes:

1. Inspection call to be issued 2 weeks in advance.
2. Supplier must ensure the completeness and correctness of the requisite documents before submission for approval. Delay in approval on account of incomplete / inadequate information shall be the responsibility of supplier.
3. Vendor to ensure resubmission of drawings/documents within 1 week from the date of comment from BHEL. Any delay in resubmissions w.r.t 1 week shall be reduced from Activity No.4 as above.
4. Count of resubmissions shall be certified by TBEM and same shall be compensated in schedule by adding certified time or number for resubmissions.
5. Qty. to be offered for inspection should be in accordance within Delivery-schedule – lot. BHEL reserves the right not to entertain multiple inspection calls for a Delivery – lot and delay on this account shall be the responsibility of Supplier.

Signature & Seal of supplier

Annexure B - Contact details of supplier

Project **OPTCL DUBURI**
Item **SAS**

Work Address	
Communication address	
Details of contact person for clarification regarding bid:	
Contact Person Name:	
Designation:	
Email Id.:	
Mobile No.:	
Landline No.:	

Signature & Seal of supplier

Annexure C-UNPRICED BID

Project **OPTCL DUBURI**
Item **SAS**

Item number	Item Description	Item quantity	Unit of measurement	Unit Price (inclusive of Tax)	GST % applicable
1	SUPPLY- SUBSTATION AUTOMATION SYSTEM : SUB-STATION AUTOMATION SYSTEM FOR 400 KV BAY EXTENSION	1	SET	Mention as "Quoted"	Mention GST %
2	SUPPLY- SUBSTATION AUTOMATION SYSTEM : BAY CONTROL UNIT	5	SET	Mention as "Quoted"	Mention GST %
3	SUPPLY- SUBSTATION AUTOMATION SYSTEM : 400KV, LINE BAY, PROTECTION PANEL WITH AUTO RECLOSE	2	NO	Mention as "Quoted"	Mention GST %
4	SUPPLY- SUBSTATION AUTOMATION SYSTEM : 400KV, LINE REACTOR BAY, PROTECTION PANEL ALONG WITH 132KV NGR PROTECTION PANEL	2	SET	Mention as "Quoted"	Mention GST %
5	SUPPLY- SUBSTATION AUTOMATION SYSTEM : 220KV, CIRCUIT BREAKER RELAY PANEL WITHOUT AUTORECLOSE (WITH AUTOMATION)	2	SET	Mention as "Quoted"	Mention GST %
6	SUPPLY- SUBSTATION AUTOMATION SYSTEM : 400KV, TIE BAY, PROTECTION PANEL	1	NO	Mention as "Quoted"	Mention GST %
7	SUPPLY- SUBSTATION AUTOMATION SYSTEM : INTERFACING WITH EXISTING SAS	1	SET	Mention as "Quoted"	Mention GST %
8	SUPPLY- SUBSTATION AUTOMATION SYSTEM : INTERFACING WITH EXISTING BUSBAR PROTECTION SYSTEM	1	SET	Mention as "Quoted"	Mention GST %
9	SUPPLY- SUBSTATION AUTOMATION SYSTEM : RELAY TOOL KIT	1	SET	Mention as "Quoted"	Mention GST %
10	SUPPLY- SUBSTATION AUTOMATION SYSTEM : TIME SYNCHRONISING EQUIPMENT	1	SET	Mention as "Quoted"	Mention GST %
11	SUPPLY- SUBSTATION AUTOMATION SYSTEM : ARMOURED FO CABLE (6 FIBRE MULTIMODE)	2000	MTR	Mention as "Quoted"	Mention GST %
12	SUPPLY- SUBSTATION AUTOMATION SYSTEM : PRINTER (LASER) A4	1	NO	Mention as "Quoted"	Mention GST %
13	SUPPLY- SUBSTATION AUTOMATION SYSTEM : INVERTER OF SUITABLE CAPACITY FOR STATION HMI/ DISPLAYS AND PERIPHERAL DEVICES (PRINTER ETC.)	1	SET	Mention as "Quoted"	Mention GST %
14	SUPPLY- SUBSTATION AUTOMATION SYSTEM : NECESSARY ELEGANT AND ERGONOMIC FURNITURE	1	SET	Mention as "Quoted"	Mention GST %

Item number	Item Description	Item quantity	Unit of measurement	Unit Price (inclusive of Tax)	GST % applicable
15	SERVICES- SUBSTATION AUTOMATION SYSTEM : SUPERVISION (BAY-WISE) OF SITE TESTING AND COMMISSIONING OF THE COMPLETE CONTROL & PROTECTION SYSTEM AND SAS AS PER TS	5	LOT	Mention as "Quoted"	Mention GST %
16	SERVICES- SUBSTATION AUTOMATION SYSTEM : TRAINING AS PER TS	1	LOT	Mention as "Quoted"	Mention GST %
17	SERVICES- SUBSTATION AUTOMATION SYSTEM : ENGINEERING SERVICES AS PER TS	1	LOT	Mention as "Quoted"	Mention GST %

Signature & Seal of supplier

Project OPTCL DUBURI
Items SAS

SCHEDULE OF TECHNICAL DEVIATION

The following are the deviations/ variations exception from the Specification:

SL. No.	CLAUSE NO. OF GENERAL TERMS AND CONDITION	STATEMENT OF DEVIATION/ VARIATIONS/EXCEPTIONS

In case, this schedule is not submitted, it will be presumed that the equipment/ material to be supplied under this contract is deemed to be In compliance with the General Terms and Conditions & Specifications

If there is NIL deviation, even then the format to be filled as **NIL DEVIATION**.

Note: Continuation Sheets of like size and format may be used as per the Bidder's Requirement and shall be annexed to this scheduled.Deviation mentioned in this scheduled shall only be considered.

SIGNATURE & SEAL OF SUPPLIER

Project OPTCL DUBURI
Items SAS

SCHEDULE OF COMMERCIAL DEVIATION

The following are the deviations/ variations exception from the General Terms and Conditions:

SL. No.	CLAUSE NO. OF GENERAL TERMS AND CONDITION	STATEMENT OF DEVIATION

- **In case, this schedule is not submitted, it will be presumed that the equipment/ material to be supplied under this contract is deemed to be in compliance with the General Terms and Conditions**.
- If there is NIL deviation, even then the format to be filled as **NIL DEVIATION**.

Note: Continuation Sheets of like size and format may be used as per the Bidder's Requirement and shall be annexed to this scheduled.Deviation mentioned in this scheduled shall only be considered.

SIGNATURE & SEAL OF SUPPLIER

Project: 400KV AIS SUBSATION EXTENSION AT NEW DUBURI, ODISHA
Customer: Odisha Power Transmission Corporation Limited (OPTCL)
Ref. No. OPTCL/SAS/PQR REV 00

Technical Qualifying Requirements for Substation Automation System

For the purpose of qualification of the bidders, experience & type test validity period shall be reckoned as on 11-February-2022 unless otherwise specified.

The SAS shall be sourced from Original Equipment Manufacturer (OEM). SCADA Software must belong to OEM itself and hence, other out-sourced or 3rd party SCADA software are not accepted. The offered equipment# have to be designed, manufactured and tested as per relevant IS/ IEC with latest amendments. The bidder/ manufacturer should have installed/ retrofitted & commissioned the system with trouble free operation for minimum 3 (three) years, as on the originally scheduled date of bid opening of this project, i.e. 11.02.22, in any of the power system utilities in India. Further, the bidder/ Manufacturer should fulfill the following criteria & supporting documents to the effect should be accompanied with the tender document.

1) The minimum requirement of manufacturing capacity of offered type, size and rating of equipment# shall be 5 (five) times tender/ bid quantity per annum. The bidder/ Manufacturer should indicate manufacturing capacity by submitting latest updated certificate of a Chartered Engineer (CE).

2) The Substation Automation system shall be offered from a manufacturer who must have designed, manufactured, tested, installed and commissioned substation automation system which must be in satisfactory operation on 400/220/132/33KV system in India for at least 3 (Three) years as on the date of bid opening of this project, i.e. 11.02.22.

3) The bidder should furnish performance report of SAS system supplied, installed and commissioned by them/ Manufacturer indicating the quantity and Single Value Contract executed during last 5 (five) years from date of the originally scheduled date of bid opening, i.e. 11.02.22, for the offered equipment#. The details are to be submitted in following format,

SN	Name of the Utility.	Order No. & Date.	Items supplied With quantity & work done.	Date of Completion	If completed within Stipulated Period.	Performance of the system as on date.	Remark.

4) Equipment# offered shall have Type Test Certificates from accredited laboratory (accredited based on ISO/IEC Guide 25 / 17025 or EN 45001 by the National accreditation body of the country where laboratory is located), as per IEC / IS / technical specification. The type test reports shall not be older than 5 (five) years as on the date of bid opening of this project, i.e. 11.02.22.

'#' – Equipment refers to Numerical Relays and Bay Control Units.

Technical Qualifying Requirements for Substation Automation System

Requisite documents

SN	Documents/ proof required
1	Performance Certificate issued to bidder by End customer/ Owner without any adverse remark(s) as per the format mentioned in clause no. 3)
2	Proof of established manufacturing facility with details of manufacturing capacity
3	Valid type test reports of same type of equipment# as offered in this tender.

12/3/24
PREPARED BY

12/03/24
REVIEWED BY

12.3.24.
APPROVED BY

BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

NOIDA

DOCUMENT NO.	TB-420B-510-033	REV 00	Prepared	Checked	Approved
TYPE OF DOC.	TECHNICAL SPECFICATION	NAME	BY	AK	VK
Title:		SIGN			
		DATE	12.03.24	12.03.24	12.03.24
SUBSTATION AUTOMATION SYSTEM		GROUP	TBEM		
		WO No.	-		

CUSTOMER	ODISHA POWER TRANSMISSION CORPORATION LIMITED
PROJECT	**400kV SUB STATION Extn. AT NEW DUBURI, ODISHA**

Contents

Remarks: Bidder to note that data and details of guaranteed technical particulars shall not be reviewed during technical evaluation/ scrutiny, hence compliance of guaranteed technical particulars in line with technical specification shall be bidder's responsibility.

Rev. No.	Date	Altered	Checked	Approved	
01	18.01.23	AK	AK	VK	TS revised to incorporate duplicated bus bar protection for 400kV system and Backup impedance relay in Reactor bay protection panel.
Distribution				To	
				Copies	

SECTION 1

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITIES

1.0 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of Substation Automation System along with Protection Panels at 400kV OPTCL New Duburi Substation (Extn) complete with accessories as listed in this specification. Testing and Commissioning of all SAS equipments including Protective relays shall be done by the OEM Engineer.

The fitments and equipments offered shall be of approved make of OPTCL or its subsequent approval from OPTCL shall be bidder's responsibility with no commercial implications to BHEL. If any of the make offered by the bidder is not acceptable to M/s OPTCL, the bidder has to supply alternate OPTCL approved make, meeting the specification, with no commercial implications to BHEL.

All auxiliary relays, timers, counters, aux CTs, switches, LIUs, Patch Cords/Network Cables etc. required for completeness of the scheme and good engineering are deemed to be included in the offer and no claim whatsoever shall be entertained at contract stage.

The specification comprises of following sections:

Section-1: Scope, Specific Technical Requirements and Quantities
Section-2: Equipment Specification
Section-3: Project Details & General Specification
Section-4: Enclosures to Technical Specification

In case of any conflict between various sections, **order of precedence** shall be in the same order as listed above.

Note: The terms used in this specification namely, "Employer/Purchaser" refers to OPTCL & "Contractor/Sub-contractor/manufacturer" refers to successful bidder.

2.0 THE EQUIPMENT IS REQUIRED FOR THE FOLLOWING PROJECT

Name of Customer: Odisha Power Transmission Corporation Ltd (OPTCL)

Name of the Project: 400kV Substation (extn) at New Duburi

Refer Section - 3 for Project Details and General Specifications.

3.0 SPECIFIC TECHNICAL REQUIREMENTS

3.1 Refer Section–2 and Single Line Diagrams, Proposed architecture & Key Protection and Metering Single Line Diagram (Enclosed with Section-4). *{The Architecture and Key Protection and Metering Single Line Diagram is for tender purpose only}*

3.2 a) Complete Substation automation system shall be based on **IEC 61850 Edition 2 & PRP** compliant communication protocol including hardware and software along with associated equipment for the 400kV bays as shown in the SLD. As per OPTCL requirement, bidder to consider complete SAS for 400kV Bay Extension including hardware and software for the sub-station and remote-control system alongwith associated equipment and accessories as per technical specification & relay protection panel, event logger panel, busbar protection panel & Relay tool kits as per tech. specification. The SAS & Bus Bar Protection scheme shall be integrated with the existing system. All materials & equipment as required for successful completion shall be considered.

Bidder to consider one no. HMI with suitable software (OWS, EWS, DR) for control, monitoring, relay configuration and DR of 400kV Bay Extension. However, gateway panel is excluded from scope of supply. The gateway panel shall be supplied by OEM of Main SAS through OPTCL.

b) For the Circuit Breakers with **Controlled Switching Device** (To be provided in 400kV bays. Please refer project SLD attached along with Technical Specification for clarity), the CSD controller (being supplied under a separate contract) shall be mounted on the respective relay panels. Necessary space and other provisions shall be provided in the panel. The actual dimension of the CSD controller & required logic to be incorporated in panel schematic for interfacing the CSD with panel shall be furnished to successful bidder during detailed engineering stage. The contact multipliers, selector switch & contactors if required for implementation of the CSD logic shall be in bidder's scope of supply under this tender.

c) Further, the integration of IEC 61850 communication protocol-based monitoring equipment like Optical temperature sensors, Online dissolved Gas analyzer, Insulating Oil drying system provided on each of the 400kV, 80MVAR Reactor Units (being supplied under a separate contract) with the offered SAS is also included in the present scope of the bidder.

For the purpose of interfacing of offered SAS with Reactor, any necessary co-ordination with respect to I/O list of signals shall be in bidder's scope.

d) <u>Optical temperature sensors, Online Dissolved Gas analyzer, and Insulating Oil drying system for Reactors</u>

2 nos. 80MVAR, 3-Ph Reactor Units are being provided with Online Dissolved Gas analyzer, Insulating Oil drying system, Optical temperature sensors. This equipment shall be IEC 61850 compliant & required to be integrated with the offered Substation Automation System (SAS). Above equipment, being supplied in separate packages, shall be connected to Managed Ethernet Switches compliant to IEC 61850 communication protocol through fiber optic cable.

These Ethernet switches shall be mounted in Marshalling Box (MB) of Reactor. However, to connect these Ethernet switches to Bay Ethernet switch (mounted in relay panel), all accessories (including FO Cables, convertors, switches, LIUs, patch chords etc.) and Optical fiber cable from MB to SAS room in CRB shall be in the scope of Bidder under this tender.

The tentative signals from Optical sensors measuring unit and online DGA for each three-phase reactor are as follows:

i. Temperature measured by optical sensors (minimum 5 probes for each reactor)
ii. H2, CH4, C2H6, C2H4, C2H2, CO, CO2, O2, and H2O gas content
iii. Alarm, watchdog from the monitoring equipment

e) Approx. distance between MB and Relay Room shall be 300m.

f) The FO cable requirement mentioned in BOQ is tentative. The FO cable supply is in scope of bidder as per actual requirement. Sub-station layout drawing is enclosed for better understating.

g) The bidder's scope shall include all primary equipment interface with control & relay Panel/ SAS in the respective panel schematics during drawing submission at contract stage.

h) Wherever bidder offers any spare in lieu of the same being "Built-in feature" of any relay/ fitment or the same being "Not applicable" is subject to approval by OPTCL/BHEL. No price implication will be entertained by BHEL at contract stage if any separate item is insisted by OPTCL to meet the contract requirement.

i) The offered system shall be based on IEC-61850 Edition-2 & PRP, with performance credentials in power utility application.

j) The Control & Protection Panels of individual bays shall be placed in the Switchyard Panel Room (SPR) located in the switchyard. The HMI alongwith the peripherals viz., time synchronizing equipment, LIUs, station level switches, Network Panel etc shall be placed in existing control room building which is approx. 150m away from SPR.

k) Existing busbar protection is SIEMENS Make 7SS60. Necessary modules, CT summation units, aux relays, trip relays, mounting arrangement required for successful integration of proposed 400kV Bays shall be in bidders' scope.

l) Bidders shall provide ICD files and engineering support to the OEM of main SAS which is being procured separately by OPTCL.

4.0 TRAINING

The bidder shall impart training to Employer's Personnel as mentioned in section-2.

The charges for tutorials & other training materials for the trainees shall be included in the prices quoted by bidder. No price implication shall be entertained at a later stage.

5.0 PRE-COMMISSIONING & COMMISSIONING

PRE-COMMISSIONING: As per requirements specified in Section-2.

COMMISSIONING:

Charging of the facilities at rated voltage. Further, wherever appearing in this specification, the words – 'commissioning checks', 'installation checks', 'site tests', 'Performance guarantee tests', are to be considered as 'pre-commissioning checks'.

6.0 BILL OF QUANTITES

As per annexure-A, Section-1.

7.0 TYPE TEST

All equipment being supplied shall conform to type tests including additional type tests as per technical specification and shall be subject to routine tests in accordance with requirements stipulated under respective sections. The reports for all type tests and additional type tests as per technical specification shall be furnished by the bidder alongwith equipment / material drawings. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited base on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by the representatives(s) of OPTCL. The test reports submitted shall be of the tests conducted within last 5 (five) years prior to the date of originally scheduled bid opening of this project (i.e 11.02.2022). In case the test reports are of the test conducted earlier than 5 (five) years prior to 11.02.2022, the bidder shall repeat these test(s) at no extra cost to the purchaser.

In the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design / manufacturing changes (including substitution of components) or due to non-compliance with the requirement stipulated in the Technical Specification or any/all additional type tests not carried out, same shall be carried out without any additional cost implication to the Purchaser.

8.0 PACKING

8.1 All equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and outdoor storage (for a minimum period of 6 months) at site till the time of erection. While packing all the materials, the limitations from the point of view of availability of transportation facilities in India should be taken into account. The Bidder shall be responsible for any loss or damage during transportation, handling and storage.

8.2 The Bidder shall include and provide for security, protection and packing the equipment so as to avoid loss or damage during transport by any mode.

8.3 All packing shall allow for easy removal and checking at site. Wherever necessary, proper arrangement for attaching slings for lifting shall be provided. All packages shall be clearly marked for with signs showing 'UP' and 'DOWN' side of boxes, and handling and unpacking instructions as considered necessary. Special precautions shall be taken to prevent rusting of steel and iron parts during transit and storage. Gas seals or other methods proposed to be adopted for protection against moisture during transit shall be to the satisfaction of the purchaser.

8.4 The cases containing easily damageable material shall be very carefully packed and marked with appropriate caution symbols i.e. FRAGILE, HANDLE WITH CARE, USE NO HOOKS etc.

8.5 Each package delivered under the contract shall be marked by the Bidder at his expense and such marking must be distinct (all previous irrelevant marking being carefully obliterated). Such marking shall show the description and quantity of contents, the name of consignee and address, the gross and net weights of the package, the name of Bidder with a distinctive number of mark sufficient for purpose of identification. All markings shall be carried out with such materials as to ensure quickness of drying, fastness and legibility.

8.6 Each Package shall contain a note quoting specifically the name of the Bidder, the number and date of contract or order and the name of office placing the contract, nomenclature of the stores and include a schedule of parts for each complete equipment giving the parts number with reference to the General Arrangement/ Assembly drawing and the quantity of each part, drawing number and tag numbers.

8.7 All equipment/ material shall be suitably packed for transport, carriage at site and outdoor storage during transit. The Bidder shall be responsible for any damage to the equipment during transit. The contents of each package shall bear marking that can be readily identified from the package list and packing shall provide complete protection from moisture, termites and mechanical shocks etc.

8.8 Any material found short inside the packing cases shall be supplied by the Bidder without any extra cost.

8.9 Notwithstanding anything stated in this clause the Bidder shall be entirely responsible for any loss, damage or depreciation to the stores.

9.0 DEVIATIONS

The bidder shall list all the deviation from the specification separately. Offers without specific deviation will be deemed to be totally in compliance with the specification and NO DEVIATION on any account will be entertained at a later date. Further to this, bidder shall submit the compliance certification to specification also.

10.0 MANUFACTURING QUALITY PLAN

The successful bidder shall submit Quality Assurance Plan including in-process inspection methods, tests, records, etc. for BHEL/ OPTCL approval. Customer hold points will also be included in the plan, which shall be mutually agreed by the BHEL/ OPTCL. In case bidder has reference Quality Assurance Plan agreed with BHEL/ OPTCL, same shall be submitted for specific project to BHEL/ OPTCL approval. There shall be no commercial implication to BHEL/ OPTCL on account of Quality Plan approval.

Bidder has to follow OPTCL approved Manufacturing Quality Plan, SAT/ FAT procedure at contract stage.

11.0 DRAWINGS and SCHEME

The documentation requirements detailed under Section-2 and 3 shall be submitted to BHEL at various stages of contract. Softcopy of the drawings and schemes are to be submitted at contract stage. Preparation of AS- BUILT drawings is also in the scope of the bidder.

12.0 DOCUMENTS REQUIRED WITH TECHNICAL OFFER

a) Documents for compliance for Technical-PQR
b) Confirmation for compliance to technical specification, Annexure-A
c) Bill of Materials
d) Filled-up Guaranteed Technical Particulars
e) Catalogue and Technical Leaflets for the offered equipment

BILL OF QUANTITIES

Sl.No.	Description as per PI	Detailed Description/ Description as per OPTCL	Unit	Qty.
A	**Main Items**	**Main Items**		
1	SUPPLY- SUB-STATION AUTOMATION SYSTEM FOR 400kv bay extension	SUB-STATION AUTOMATION SYSTEM FOR PROPOSED 400 kv bay extension	Set	1
2	SUPPLY- SUBSTATION AUTOMATION SYSTEM : BAY CONTROL UNIT	BCU FOR CONTROLLING AND MONITORING OF THE PROPOSED (400 KV S/s)	Set	5
3	SUPPLY- SUBSTATION AUTOMATION SYSTEM : 400KV, SUPPLY- SUBSTATION AUTOMATION SYSTEM : 400KV, LINE BAY, PROTECTION PANEL WITH AUTO RECLOSE	400 KV FEEDER PROTECTION RELAY PANEL(MAIN-I WITH AUTO RECLOSURE & MAIN-II WITH AUTO RECLOSURE AND BACK-UP PROTECTION) AND TIE PROTECTION PANEL with Bus Bar Protection.	No.	2
4	SUPPLY- SUBSTATION AUTOMATION SYSTEM : 400KV, LINE REACTOR BAY, PROTECTION PANEL ALONG WITH 132KV NGR PROTECTION PANEL	400 KV LINE REACTOR AND 132 KV NGR PROTECTION RELAY PANEL	Set	2
5	SUPPLY- SUBSTATION AUTOMATION SYSTEM : 400KV, CIRCUIT BREAKER RELAY PANEL WITH AUTORECLOSE (WITH AUTOMATION)	400kV CB Panel for Switched reactor protection	Set	2
6	SUPPLY- SUBSTATION AUTOMATION SYSTEM : 400KV, TIE BAY, PROTECTION PANEL	400kV Tie Protection Panel	Nos	1
7	SUPPLY- SUBSTATION AUTOMATION SYSTEM : INTERFACING WITH EXISTING SAS	Integration with existing Busbar protection & SAS system	Set	1
8	SUPPLY- SUBSTATION AUTOMATION SYSTEM : INTERFACING WITH EXISTING BUSBAR PROTECTION SYSTEM	Integration with existing Busbar protection & SAS system	Set	1
9	SUPPLY- SUBSTATION AUTOMATION SYSTEM : RELAY TOOL KIT	As per OPTCL TS	Set	1
10	SUPPLY- SUBSTATION AUTOMATION SYSTEM : TIME SYNCHRONISING EQUIPMENT	Time Synchronization Equipment (GPS with all accessories,Antenna, Cables, Software, Lightning Arrestors for GPS, Separate time display unit display size of approx. 100 mm height. etc)	Set	1
11	SUPPLY- SUBSTATION AUTOMATION SYSTEM : ARMOURED FO CABLE (6 FIBRE MULTIMODE)	Multimode glass fibre Double jacket Armoured Fibre Optic Cable	m	2000
12	SUPPLY- SUBSTATION AUTOMATION SYSTEM : PRINTER (LASER) A4	As per OPTCL TS	No	1
13	SUPPLY- SUBSTATION AUTOMATION SYSTEM : INVERTER OF SUITABLE CAPACITY FOR STATION HMI/ DISPLAYS AND PERIPHERAL DEVICES (PRINTER ETC.)	As per OPTCL TS	Set	1
14	SUPPLY- SUBSTATION AUTOMATION SYSTEM : NECESSARY ELEGANT AND ERGONOMIC FURNITURE	Furniture (Table, Chair, Cabinet) for Printer, HMI and Monitors	Set	1

Sl.No.	Description as per PI	Detailed Description/ Description as per OPTCL	Unit	Qty.
B				
1	SERVICES- SUBSTATION AUTOMATION SYSTEM : SUPERVISION (BAY-WISE) OF SITE TESTING AND COMMISSIONING OF THE COMPLETE CONTROL & PROTECTION SYSTEM AND SAS AS PER TS	Supervision (Bay-Wise) of Site Testing and Commissioning of the Complete Control & Protection System and SAS offered, including the following: a) Testing & Commissioning of Numerical Protection Relays including Relay Parameterisation, Setting and Configuration. b) Testing & Commissioning of Busbar Protection, & SAS including termination of Network/ Optical Cables (Complete with supply of all end connectors, tees etc. as required). c) For Network/ Optical Cables which are in the bidder's scope, laying of cables shall be in BHEL's scope; However, supervision of Optical Cable laying is included in bidder's scope. d) Splicing & termination of FO cables (armoured & patch-cord). e) Arranging all necessary tools & tackles and equipment including Automatic Relay Test Kit for testing of the complete offered system (Control & Protection System/ SAS/ Communication System etc.) shall be bidder's responsibility. f) Site Acceptance Tests (SAT), Availability Tests.	Lot	5
		g) Integration of IEC 61850-based monitoring equipments (mounted on Line Reactor Units), CSD with the offered SAS as per section-1.		
2	SERVICES- SUBSTATION AUTOMATION SYSTEM : TRAINING AS PER TS	Training as per Section-2.	Lot	1
3	SERVICES- SUBSTATION AUTOMATION SYSTEM : ENGINEERING SERVICES AS PER TS	Complete Engineering of the offered System including the following: a) Diagram showing routing of FO Cables alongwith patch cords/ LAN Cables and preparation of FO Cable/patch cord/LAN Cable BOQ. b) Relay setting Calculation in OEM format c) Incorporation of complete primary equipment and auxiliary system (as per specification) interfaces in the CRP schemes prepared by the bidder.	Lot	1

Notes:

1. If any additional item as per the specification is required to be supplied for completion of the system over and above the items indicated above, the same shall be indicated clearly in the offer. Otherwise, the same shall be deemed to be included in the offer.

2. In case, inverter rating is more than 3kVA after proper sizing, same shall be provided by bidder without any commercial implication. Sizing calculation to be submitted by bidder on successful award for customer/ BHEL approval.

3. The busbar protection system of existing 400 kV New Duburi station is Siemens Make 7SS60. Bidder to consider busbar augmentation including summation CT units etc.

4. Sub-station Automation System (SAS) (Tentative list of supplies as per Annexure-B, Section-1) integration with existing SAS is included in bidder's scope under this tender. If any additional item as per the specification is required to be supplied for completion of the system over and above the items indicated above and Annexure-B, the same shall be indicated clearly in the offer. else, the same shall be deemed to be included in the offer.

5. SAS BCUs shall be provisioned for integration with station auxiliaries viz., Fire fighting, SPR Temp, Reactor auxiliary systems as infomed during detailed ingineering.

6. The overall quantity of contract may vary by ±20% of total contract value at contract stage. Some of the items may not be ordered at all.

Sl.No.	Description as per PI	Detailed Description/ Description as per OPTCL	Unit	Qty.
7. For commissioning of system may be done in phase wise manner as per availability of fronts and hence, multiple visits is envisaged as per requirement.				

ANNEXURE-B

Break-Up of Sub-station Automation System ##

Sl.No.	Description	Unit	Qty.	Remarks
1	Ethernet Switches as required for implementing redundant LANs at Station Level and Inter-Bay Level	Lot	1	*Prices to be included in Sl. No. 1 of Annexure-A.*
2	HMI (Operator & Engineering cum DR Work Station)	Set	1	*Prices to be included in Sl. No. 1 of Annexure-A.*
3	All LAN Cables/ Communication Cables/ FO Patch Cords and Cable Connectors alongwith associated cable ducts and all accessories, FO patch panels (2 Sets), media converters, LIU, Red Box etc. for completeness of the offered Control & Protection System/ SAS/ DFR System etc.	Set	1	*Prices to be included in Sl. No. 1 of Annexure-A.*
4	Temperature transducer for SAS interface and all necessary connecting cables/ accessories for room temperature measurement in Switchyard Panel Room.	No	1	*Prices to be included in Sl. No. 1 of Annexure-A.*
5	Configuration tools for SAS and Relay panels: i) SAS HMI software for Client access. ii) Software for configuration of all devices in relay panels - 1 set	Set	1	*Prices to be included in Sl. No. 1 of Annexure-A.*
Notes:				

1. Sub-station Automation System (SAS) for 400kV Bay extension is inluded in bidder's scope under this tender. If any additional item as per the specification is required to be supplied for completion of the system over and above the items indicated above, the same shall be indicated clearly in the offer. Otherwise, the same shall be deemed to be included in the offer.

OPTCL
Lifeline of Orissa

ODISHA POWER TRANSMISSION CORPORATION LTD

TECHNICAL SPECIFICATION

FOR

SUB-STATION AUTOMATION AND PROTECTION SYSTEM

FOR GRID SUBSTATION

SAS with latest IEC 61850 Edition 2 and PRP compliant numerical protection relays.

TECHNICAL SPECIFICATION FOR SUB-STATION AUTOMATION

The Substation Automation System (SAS) is proposed for Grid sub-station with installation of Bay control Unit in relay panels, work station (Main & stand by), Engineering Station, HMI, Large video screen of minimum 67 inches **or above** (as specified in relevant clause below), printers and remote transmission unit for Remote Network Control center & SLDC.

The Substation Automation System (SAS) shall be installed to control and monitor all the sub-station equipment from remote control center (RCC) as well as from local control center.

The SAS shall contain the following main functional parts:

i) Bay control Intelligence Electronic Devices (IEDs) for control and monitoring.
ii) Station Human Machine Interface (HMI)
iii) Redundant managed switched Ethernet Local Area Network communication infrastructure.
iv) Peripheral equipment like printers, display units, key boards, Mouse etc.
v) Remote HMI (Remote Control center)

It shall include communication gateway, intelligent electronic devices (IED) for bay control and inter IED communication infrastructure.

The communication gateway shall facilitate the information flow to remote control centres & Load despatch Centre. The bay level intelligent electronic devices (IED) for protection and control shall provide the direct connection to the switchgear without the need of interposing components and perform control, protection, and monitoring functions.

The substation switchyard configuration is provided in attached Single Line diagrams. The BCU & BCPU (for 33 kv side only) is to be installed in the relay panels. The substations are equipped with latest IEC61850 Edition 2 **& PRP** compliant numerical protection relays. The protection arrangements for the different voltage system for SAS of GSSs should be as envisaged below.

1. 400 kV Side: (One & half CB arrangement):

i) Line bay: The line bay shall have one Bay controller Unit (BCU), Two distance protection, one backup directional over Current & earth fault relay. The CR panels are having 'IEC61850 Edition 2' & PRP complied numerical distance, over current & earth fault protection relays and electro mechanical trip & auxiliary relays as per the technical specification. The vendor needs to provide 'IEC61850 Edition 2' & PRP compliant Bay Control unit & necessary auxiliary relays. The trip circuit supervision, electrical reset of the tripping relays & carrier supervision function will be performed by Bay Controller Unit.

ii) Transformer bay: The transformer bay shall have Bay controller Unit (BCU), Two differential protection, dedicated REF protection and one backup directional over Current & earth fault relay. The CR panels should have 'IEC61850 Edition 2' & PRP complied numerical differential, Numerical REF, over current & earth fault protection relays and electro mechanical trip & auxiliary relays as per the technical specification. The vendor needs to provide 'IEC61850 Edition 2' & PRP compliant Bay Control unit & necessary auxiliary relays. The trip circuit supervision, electrical reset of the tripping relays & Automatic voltage regulation function will be performed by Bay Controller Unit.

iii) Tie bay: Each bay shall have Bay controller Unit (BCU), LBB protection relay. The CR panels should have electro mechanical trip & auxiliary relays as per the technical specification. The vendor needs to provide 'IEC61850 Edition 2' & PRP compliant Bay Control unit & necessary auxiliary relays. The trip circuit supervision, electrical reset of the tripping relays & station DC regulation function will be performed by Bay Controller Unit.

For **Reactor bay**, backup impedance protection relay shall be provided instead of overcurrent & earth fault relay. (Refer protection Key diagram.)

400kV Bus Bar Protection: Redundant (1+1) numerical **low impedance biased differential** Bus Bar protection scheme for each Main bus (Bus1 / Bus2) for 400kV shall be provided**.** The scheme shall be engineered so as to ensure that operation of any one out of two schemes connected to faulty bus shall result in tripping of the same.

2. 220 kV Side: (Two Main bus arrangement or two main and a transfer bus arrangement or one & half CB arrangement):

i) **Line bay:** The line bay shall have one Bay controller Unit (BCU), Two distance protection, one backup directional over Current & earth fault relay. The CR panels are having 'IEC61850 Edition 2' & PRP complied numerical distance, over current & earth fault protection relays and electro mechanical trip & auxiliary relays as per the technical specification. The vendor needs to provide 'IEC61850 Edition 2' & PRP compliant Bay Control unit & necessary auxiliary relays. The trip circuit supervision, electrical reset of the tripping relays & carrier supervision function will be performed by Bay Controller Unit.

ii) Transformer bay: The transformer bay shall have Bay controller Unit (BCU), Two (for 220/132KV) or One (for 220/33KV) differential protection, dedicated REF protection and one backup directional over Current & earth fault relay. The CR panels should have 'IEC61850 Edition 2' & PRP complied numerical differential, Numerical REF, over current & earth fault protection relays and electro mechanical trip & auxiliary relays as per the technical specification. The vendor needs to provide 'IEC61850 Edition 2 & PRP compliant Bay Control unit & necessary auxiliary relays. The trip circuit supervision, electrical reset of the tripping relays & Automatic voltage regulation function will be performed by Bay Controller Unit.

iii) Bus Coupler bay: Each bay shall have Bay controller Unit (BCU), backup over Current & earth fault relay. The CR panels should have 'IEC61850 Edition 2' & PRP complied numerical over current & earth fault protection relays and electro mechanical trip & auxiliary relays as per the technical specification. The vendor needs to provide 'IEC61850 Edition 2' & PRP compliant Bay Control unit & necessary auxiliary relays. The trip circuit supervision, electrical reset of the tripping relays & station DC regulation function will be performed by Bay Controller Unit.

iv) Transfer Bus Coupler bay: Each bay shall have Bay controller Unit (BCU), backup over Current & earth fault relay. The CR panels should have 'IEC61850 Edition 2' & PRP complied numerical over current & earth fault protection relays and electro mechanical trip & auxiliary relays as per the technical specification. The vendor needs to provide 'IEC61850 Edition 2' & PRP compliant Bay Control unit & necessary auxiliary relays. The trip circuit supervision, electrical reset of the tripping relays & station DC regulation function will be performed by Bay Controller Unit.

220kV Bus Bar Protection: Single bus bar protection scheme shall be provided for each main bus and transfer bus (as applicable) for 220kV voltage level.

3. 132kV Side:

i) **Line bay:** The line bay shall have one Bay controller Unit (BCU), one distance protection, one backup directional over Current & earth fault relay. The CR panels are having 'IEC61850 Edition 2' & PRP complied numerical distance, over current & earth fault protection relays and electro mechanical trip & auxiliary relays as per the technical specification. The vendor needs to provide 'IEC61850 Edition 2' & PRP compliant Bay Control unit & necessary auxiliary relays. The trip circuit supervision, electrical reset of the tripping relays & carrier supervision function will be performed by Bay Controller Unit.

ii) Transformer bay: The transformer bay shall have Bay controller Unit (BCU), one differential protection, dedicated REF protection and one backup directional over Current & earth fault relay. The CR panels should have 'IEC61850 Edition 2' & PRP complied numerical differential, Numerical REF, over current & earth fault protection relays and electro mechanical trip & auxiliary relays as per the technical specification. The vendor needs to provide 'IEC61850 Edition 2' & PRP compliant Bay Control unit & necessary auxiliary relays. The trip circuit

supervision, electrical reset of the tripping relays & Automatic voltage regulation function will be performed by Bay Controller Unit.

iii) Bus Coupler bay: Each bay shall have Bay controller Unit (BCU), backup over Current & earth fault relay. The CR panels should have 'IEC61850 Edition 2' & PRP complied numerical over current & earth fault protection relays and electro mechanical trip & auxiliary relays as per the technical specification. The vendor needs to provide 'IEC61850 Edition 2' & PRP compliant Bay Control unit & necessary auxiliary relays. The trip circuit supervision, electrical reset of the tripping relays & station DC regulation function will be performed by Bay Controller Unit.

4. 33kV Side:

Each bay shall be provided with on Bay controller & protection Unit (BCPU). The unit should be capable of protection, measurement, control & record and shall have 'IEC61850 Edition 2' & PRP protocols for full system integration. The BCPU should be capable of following feeder protection functions.

1. Current protection (50/50N,51/51N,67/67N & 64/59N),

2. Voltage protection (59,27).

3. Frequency protection (81 U, 81O,81R)

4. Power & Power factor protection (32,55)

Additional Multifunction meter may be provided for monitoring the measurement, if monitoring of measurement is not available in BCPU.

QUALIFYING REQUIREMENT FOR SUPPLY INSTALLATION & COMMISSIONING OF THE SUBSTATION AUTOMATION SYSTEM:

The SAS shall be sourced from Original Equipment Manufacturer (OEM). SCADA Software must belong to OEM itself and other out-sourced or 3rd party SCADA software are not accepted. The offered equipment have to be designed, manufactured and tested as per relevant IS/IEC with latest amendments. The bidder/ Manufacturer should have installed/retrofitted & commissioned the system with trouble free operation for minimum three years in any of the power system utilities in India. Further, the bidder/ Manufacturer should fulfill the following criteria & supporting documents to the effect should be accompanied with the tender document.

1) The minimum requirement of manufacturing capacity of offered type, size and rating of equipment shall be FIVE times tender/ bid quantity per annum. The bidder/ Manufacturer should indicate manufacturing capacity by submitting latest updated certificate of a Chartered Engineer (CE).

2) The Substation Automation system shall be offered from a manufacturer who must have designed, manufactured, tested, installed and commissioned substation automation system which must be in satisfactory operation on 400/220/132/33KV system in India for at least 3 (Three) years as on the date of bid opening.

3) The bidder should furnish performance report of SAS system supplied installed and commissioned by them/ Manufacturer indicating the quantity and Single Value Contract executed during last FIVE (5) years, for the offered equipment. The details are to be submitted in following format,

Sl.No	Name of the	Order No. &	Items supplied With	Date of Completion.	If completed	Performance of the system as	Remark.

	Utility.	Date.	quantity & work done.		Within Stipulated Period.	on date.	

4) Equipment offered shall have Type Test Certificates from accredited laboratory (accredited based on ISO/IEC Guide 25 / 17025 or EN 45001 by the National accreditation body of the country where laboratory is located), as per IEC / IS / technical specification. The type test reports shall not be older than FIVE years and shall be valid up to expiry of validity of offer.

SPECIFICATION:

I. SCOPE:

The Substation Automation System (S.A.S) for EHV substations is to be used for the control, protection and supervision of new Air insulated (AIS) EHV substations of different voltage levels of OPTCL.

This specification covers technical, functional, configuration and testing requirements for a substation automation system for extra high voltage (EHV) substation.

The substation automation system shall be digital and shall include control, protection, monitoring, measurement functions and tele-transmission of data and commands.

II. STANDARDS:

The substation automation solutions should be future proof & compliant to international standards of latest IEC 61850, and simplify maintenance and enable interoperability.

The standards applicable for this automated digital control, protection system & communication protocol for the EHV sub- station are as follows.

1. 'IEC61850 Edition 2'.

i. IEC 61850-8-1, information is exchanged as GOOSE messages.

2. IEC 60870 set of standards which define systems used for tele-control (supervisory control and data acquisition) in electrical engineering and power system automation.

i. IEC 60870-5-1 Transmission Frame Formats

ii. IEC 60870-5-3 General Structure of Application Data

iii. IEC 60870-5-4 Definition and Coding of Information Elements

iv. IEC 60870-5-5 Basic Application Functions

v. IEC 60870-5-6 Guidelines for conformance testing for the IEC 60870-5.

Also following companion standards may be referred during the design, which shall be applicable for basic tele-control tasks, transmission of integrated totals, data exchange from protection equipment & network access of IEC101/104 respectively.

- IEC 60870-5-101 Transmission Protocols, companion standards especially for basic tele-control tasks

- IEC 60870-5-102 Companion standard for the transmission of integrated totals in electric power systems (this standard is not widely used)

- IEC 60870-5-103 Transmission Protocols, Companion standard for the informative interface of protection equipment

- IEC 60870-5-104 Transmission Protocols, Network access for IEC 60870-5-101 using standard transport profiles

III. CLIMATIC CONDITIONS

This automated digital control and protection system for EHV substations, shall be capable of withstanding the following climatic conditions:

a. Ambient temperature during operation : -5 °C to +55°C

b. Ambient temperature during storage : -5 °C to +55°C

c. Relative humidity : 5% - 90%

d. Altitude level:

IV. SUPPORT DOCUMENTS

This substation automation system for EHV substation shall be designed for AIS substation of OPTCL with the instructions contained in this technical specification and with the information provided in the following documents approved by OPTCL for the turnkey contract.

a. EHV substation single line diagram

b. EHV substation layout drawing in which the following are depicted:

- Location of EHV substation primary equipment

- EHV substation's control building

c. Switchgear interlocking arrangements.

d. List of commands to the substation equipment.

e. List of digital event and alarm signals for this hereby substation automation system.

f. List of analogue measurements for this thereby substation automation system

g. List of commands received from transmission's system Remote control center (RCC) and if applicable from the distributions peripheral control center (DCC).

h. List of events and alarms to be transmitted to the transmission's system control center and to the distribution's peripheral control center (if applicable)

i. List of measurements received from TCC and from DCC (if required).

j. Specifications for distance relays, overcurrent / Earth fault relays, autotransformer/Power transformer differential relays, bus-bar differential relays, transformer REF relays, voltage relays, Over flux & frequency relays shall be as per the technical specification under this bid document.

V. REQUIRED FUNCTIONS OF THE SUBSTATION AUTOMATION SYSTEM.

The substation automation system shall be capable of the following functions:

1. Control and supervision of the EHV substation

2. Switchgear interlocking.

3. Synchro-check with phasing.

4. Autotransformer tap-changer control

5. Power Transformer tap-changer control

7. Measurements

8. Event recording and alarm handling

9. Protection

10. Automatic switching

11. It must support the data points and integration of IEDs (to be calculated during detailed Engineering and also considering to cater for the present requirement of the tender as per SLD and additional 50% spare capacity for future use for all voltage levels such as 400/220kV S/S , 220/33 KV & 132/33 KV SS.

A. Control of the EHV substation

i. The control must handle selection of control Position

a. Locally, via control switches located on the primary equipment

b. From the bay control unit, - bay level (located in relay kiosks)

c. From the HMI, - station level (Control building of the EHV Substation)

d. From the transmission's system remote control center (RCC)

e. The commands will be issued each time only from one control place excluding at the same time the other three. The priority (switching authority) of commands shall be in the order indicated above and shall be carried out either via software or hardware. Each control level shall have proper indication indicating the selected position.

ii. Selection of equipment and type of command for control operation (opening or closing).

iii. Execution or cancellation of command.

iv. Execution of the command when the conditions of interlocks, synchro-check or other conditions are met.

v. Capability of overriding of interlocks and execution of the automatic switching sequences.

vi. The apparatuses to be controlled are the following:

a. 400 KV,220kV ,132kV & 33kV Circuit Breakers associated with transmission line bays, autotransformers, transformers, reactor & capacitor banks.

b. Dis-connectors of transmission line bays, autotransformers, Transformers, Reactors & capacitor banks.

d. Earthing Switches of the 400KV Dis-connectors (If it is required.)

e. Mechanism of increase, decrease and emergency stop of the step of the tap changer (OLTC) of the autotransformers, power transformers (if it is required).

f. At table 1 of the attached appendix, the necessary commands from the Substation Automation System (S.A.S) to the EHV substation equipment are presented, as well as the commands that required to be received from RCC (Remote Control Centre) remote control centers.

B. The supervision of the substation shall include the following:

1. The position of each circuit breakers on a continuous basis.

2. The position of each dis-connectors (isolators) on a continuous basis.

3. The position of each earthing switch on a continuous basis.

4. Every detected change shall cause a change in the single-line diagram displayed on the operator's terminal (HMI unit) located in the EHV substation control building, notation in the event list and a print-out.

5. Alarms shall be issued, in the form of lists and print-out, in case the position changes are not caused by a command.

6. At the operator's terminal and specifically at the colour visual display, the single-line diagram of the EHV substation (including the future bays of the switching station with dotted-lines), details of the status of breakers and dis-connectors (isolators) and measurements shall be depicted.

7. The naming of the equipment shall be as indicated in the single-line diagram of the EHV substation which is provided.

8. The substation automation system for EHV substation shall also allow supervision of all EHV substation circuit breaker and motor driven (electrically operated) disconnectors and earthing switches from the transmission system's Remote control center (RCC).

9. The substation automation system shall allow supervision of the transformer bay circuit breakers and Dis-connectors & transformer Tap position.

VI. COMMUNICATION PROTOCOLS AND OTHER COMMUNICATIONS.

The following protocols are acceptable for the communications within the EHV substation and also for the communication of the substation automation system (S.A.S) with the system's control centers.

1. Between bay level control units and HMI center, the acceptable communication protocol is IEC-61850.

2. Between transmission's system (network) control center and this substation automation system the only acceptable protocol is the following:

- IEC 60870-5-104
- It must (SCADA) support to integrate for the present scope with additional 50% spare capacity for future bays

3. Between protection relays and HMI center, the communication protocol is IEC- 61850.

4. Between bay level control units and protection relays the acceptable protocol is IEC-61850.

5. Security of the system, because the IEC-61850 protocol is based on an Ethernet platform, sufficient security measures, must be provided, that is beyond passwords, in order to prevent unauthorized access.

VII. PLCC (If required & specifically asked for in the tender)

PLCC panels /end equipment of OPGW for tele-protection features are to be installed in Carrier Room near Control Room. Yard IEDs to be connected to PLCC / OPGW panels through hardware. The integration of PLCC or FOTE /end equipment in the SAS is to be carried out by the contract awardee.

VIII. SOFTWARE

Any software needed for the configuration setting, parameterizing, documentation displaying and operation of the system or of the devices which is composed of (bay control units, protection relays, bus bar differential protection relays and GPS) should be Window based with latest version of Window operating software. The same should be provided on the basis of a royalty free, non-exclusive with irrevocable license to use by OPTCL. Software for the analysis of fault data shall also be provided with the same terms as above.

IX. DETAIL SCOPE OF WORK:

The Substation Automation System is envisaged for following substation of OPTCL.

1. 132/33kV Substation. in 132kV & 33kV System.
2. 220/132/33kV Substation.
3. 400/220/132 Substation.
4. 400/220/132/33kV Substation.

Bus arrangements are in general as follows.

i. 400kV : 1½ Breaker system.

ii. 220kV : Two Bus system.

iii. 220kV : Two Bus system with transfer Bus.

iv. 220kV : 1½ Breaker system

v. 132kV : Main and Reserve bus arrangement.

vi. 33kV : Main and Reserve bus arrangement.

The Remote operation and monitoring of control & protection system of above type of substation is to be executed by providing equipment's/relays as specified in the schedule.

The objective of the above work is as follows.

a. The operation & monitoring of control & protection system is as per approved SLD and conforming to technical standard envisaged in CEA regulation-2010 for Technical Standard construction of Electrical Plant & Transmission line.

b. On line capturing & monitoring of Transformer local readings & protection.

c. All the local control & protection at the sub-station for its remote operation from LDC/RCC shall be substituted by bay controller and SCADA.

d. There must be provision for down loading event logger and D/R data at Local Substation automation system at any time during the day.

e. Scope also includes one week training to the executives of each substation. The list of topics and on-site training shall be finalized during the course of execution.

f. Factory Acceptance test has to be performed before dispatching equipment in the presence of representative of OPTCL and the test report should be approved by OPTCL.

g. It is the bidders' responsibility for complete engineering/supply of necessary equipment in the substation as per specification, installation, testing & successfully commissioning of entire system as stated above including putting it to commercial operation.

X. GENERAL SYSTEM DESIGN.

- The systems shall be of the state-of-the art suitable for operation under electrical environment present in Extra High Voltage substations.

- The system shall incorporate the control, monitoring, metering, communication and protection functions specified, event recording and evaluation of disturbance records.

- The Bay level unit comprising Bay Control Unit (BCU) are to be fitted in relay and protection panels installed in the control room.

- PLCC panels are to be located in PLCC room near Control Room (if required in tender).

- The station HMI & DR Work station should be located in Control Room building connecting bay level unit through optical cables /Ethernet cable for overall optimization in respect of cabling and control room building.

- Remote control and monitoring of the substation shall be from Remote Control Centre (RCC) i. e. Remote Control Centre through OPGW communication link unless specified otherwise. Required equipment for controlling the sub-station remotely from RCC as well as transmitting all necessary Sub-station data to SLDC should also be considered.

- Maintenance, modification or extension of components may not cause a shutdown of the whole substation automation system. Self-monitoring of components, modules and communication shall be incorporated to increase the availability and the reliability of the equipment and minimize maintenance.

- Adopt the latest engineering technology, and ensure long-term compatibility requirements.

- The system shall be designed such that personnel without any background knowledge in Microprocessor-based technology are able to operate the system. The operator interface shall be intuitive such that operating personnel shall be able to operate the system easily after having received some basic training.

- The Substation Automation System (SAS) shall be suitable for operation and monitoring of the complete substation including future extensions. Interoperability with third party 'IEC61850

Edition 2' compatible IEDs to be incorporated in future with offered SAS shall be ensured and necessary data/information shall be provided in this regard.

- The offered SAS shall support remote control and monitoring from Remote Control Centre (RCC) via gateway.

XI. System architecture

The Substation Automation System (SAS) shall be based on a decentralized architecture and on a concept of bay- oriented, distributed intelligence. The Bay Control Unit (BCU), Bay Control Protection Unit (BCPU), protective relays etc. shall be connected to Ethernet Fiber Switch EFS through fiber optic /Ethernet cable with PRP (**Parallel Redundancy Protocol**) configuration (to be selected based on system design requirement).

The main process information of the station shall be stored in distributed databases. The typical SAS architecture shall be structured in two levels, i.e. in a station and a bay level. At bay level, 'IEC61850 Edition 2' compatible BCU shall be provided for 400kV, 220kV & 132kV system for all bay level functions regarding control, monitoring and I/O processing and 'IEC61850 Edition 2' compatible Protective Relays shall be provided for different system as per specifications enumerated in the relevant section. The BCU / protection IEDs shall be connected to the switchgear through TB without any need for additional transducers. The 'IEC61850 Edition 2' Bay Control & Protection Unit (BCPU) shall be provided for control, monitoring, I/O processing and protection for 33kV.

Each bay controller & IED shall be independent from each other and its functioning shall not be affected by any fault occurring in any of the other bay control units of the station.

Separate BCU / RTU for station auxiliaries shall be provided.

Substation LAN data exchange is to be realized using IEC 61850 standard having minimum speed of 100 mbps with a redundant managed switched Ethernet communication infrastructure having priority tagging. Each component/module of SAS including entire communication link shall be provided with built-in supervision and self-diagnostic features and any failures shall be alarmed to the operator.

Data exchange is to be realized using IEC 61850 protocol with a redundant managed switched Ethernet communication infrastructure by forming Dual FO Ring.

The communication shall be made in 1+1 mode, including the links between individual bay IEDs to switch in PRP mode, such that failure of one set of fiber/Ethernet link shall not affect the normal operation of the SAS. However it shall be alarmed in SAS.

At station level, the entire station shall be controlled and supervised from the station HMI. It shall also be possible to control and monitor the bay from the bay level equipment at all times.

The control priorities as described in the section (V: Sub section- A. Control of the EHV substation) shall prevent operation of a single switch at the same time from more than one of the various control levels, i.e. RCC, station HMI, bay level or apparatus level. The priority shall always be on the lowest enabled control level.

The GPS time synchronizing signal for the synchronization of the entire system shall be provided. GPS system should be compatible with SCADA protocol IEC 61850. A time accuracy of 1ms shall be achieved for all the devices within SAS.

The FOTE panels' status, Inter-tripping signals exchange between BCU and FOTE panel BCU should work on IEC 61850 protocols through GOOSE concept. Interface of the Distance protection IED directly to the PLCC's of the respective bays (hardwired) for status of PLCC & Inter Tripping signal exchange.

XII. Functional Requirements:

The Substation elements shall be operated from different locations such as:

- **Remote control centers.**
- **Station HMI.**
- **Local Bay Controller.**

But the operation shall be possible by only one operator at a time. Further, the operation shall depend on the conditions of other functions, such as interlocking, synchrocheck, etc. see description in 'Bay level control functions').

1. Select-before-execute:

For security reasons the command is always to be given in two stages:

Selection of the object and command for operation under all mode of operation except emergency operation. Final execution shall take place only when selection and command are actuated.

2. Command supervision:

Bay/station interlocking and blocking:

Software Interlocking is to be provided to ensure that inadvertent incorrect operation of switchgear causing damage and accidents in case of false operation does not take place.

In addition to software interlocking hardwired interlocking are to be provided for:

i. Bus Earth switch Interlocking.

ii. Transfer Bus Interlocking.

It shall be a simple layout, easy to test and simple to handle when upgrading the station with future bays. For software interlocking the bidder shall describe the scenario while an IED of another bay is switched off or fails.

A software interlock override function shall be provided which can be enabled to bypass the interlocking function.

3. Run Time Command cancellation:

Command execution timer (configurable) must be available for each control level connection. If the control action is not completed within a specified time, the command should get cancelled.

4. Self-supervision:

Continuous self-supervision function with self-diagnostic feature shall be included.

5. User configuration:

The monitoring, controlling and configuration of all input and output logical signals and binary inputs and relay outputs for all built-in functions and signals shall be possible both locally and remotely.

6. Functions:

The Functional requirement shall be divided into following levels:

Bay Level Functions & System Level Functions

A. Bay level functions:

In a decentralized architecture the functionality shall be as close to the process as possible. In this respect, the following functions can be allocated at bay level:

- Bay control functions including data collection functionality.
- Bay protection function.

1. Bay control functions:

a. Control mode selection

b. Select-before-execute principle

c. Command supervision:

i. Interlocking and blocking

ii. Double command

d. Synchrocheck, voltage selection

e. Run Time Command cancellation

f. Transformer tap changer control (for power transformer bays)

g. Operation counters for circuit breakers and pumps

h. Hydraulic pump/ Air compressor control and runtime supervision

i. Operating pressure supervision

j. Display of interlocking and blocking

k. Breaker position indication per phase

l. Alarm annunciation

m. Measurement display

n. Local HMI (local guided, emergency mode)

o. Interface to the station HMI.

p. Data storage for at least 200 events

q. Extension possibilities with additional I/O's inside the unit or via fiber-optic

Communication and process bus.

2. Transformer tap-changer control:

Raise and lower operation of OLTC taps of transformer shall be facilitated through Bay controller IED.

3. Bay protection functions:

The protection functions are independent of bay control function. The protection shall be provided by separate protection IEDs (numerical relays) and other protection devices as per section Relay & Protection. However, for 33kV system the bay control & protection function may be provided in one unit (BCPU).

IEDs, shall be connected to the communication infrastructure for data sharing and meet the real-time communication requirements for automatic functions. The data presentation and the configuration of the various IEDs shall be compatible with the overall system communication and data exchange requirements.

Event and disturbance recording function.

Each IED should contain an event recorder capable of storing at least 200 time-tagged events. The disturbance recorder function shall be as per protective relays. All disturbances can be viewed at Master Control Centre.

B. System level functions:

i. Status supervision

The position of each switchgear, e.g. circuit breaker, isolator, earthing switch, transformer tap changer etc., shall be supervised continuously. Every detected change of position shall be immediately displayed in the single-line diagram on the station HMI screen, recorded in the event list and a hard copy printout shall be produced. Alarms shall be initiated in the case of spontaneous position changes.

The switchgear positions shall be indicated by two auxiliary switches, normally closed (NC) and normally open (NO), which shall give ambivalent signals. An alarm shall be initiated if these position indications are inconsistent or if the time required for operating mechanism to change position exceeds a predefined limit.

The SAS shall also monitor the status of sub-station auxiliaries. The status and control of auxiliaries shall be done through separate one or more IED and all alarm and analogue values shall be monitored and recorded through this IED.

ii. Measurements

Analogue inputs for voltage and current measurements shall be connected directly to the voltage transformers (VT) and the current transformers (CT) without intermediate transducers. The values of active power (W), reactive power (VAR), frequency (Hz), and the rms values for voltage (U) and current (I) shall be calculated.

The measured values shall be displayed locally on the station HMI and in the control centre. The abnormal values must be discarded. The analogue values shall be updated every 2 seconds. Threshold limit values shall be selectable for alarm indications.

iii. Event and alarm handling

Events and alarms are generated either by the switchgear, by the control IEDs, or by the station level unit. They shall be recorded in an event list in the station HMI. Alarms shall be recorded in a separate alarm list and appear on the screen. All, or a freely selectable group of events and alarms shall also be printed out on an event printer. The alarms and events shall be time-tagged with a time resolution of 1 ms.

iv. Substation HMI:

1. Operation:

On the HMI the object has to be selected first. In case of a blocking or interlocking conditions are not met, the selection shall not be possible and an appropriate alarm annunciation shall occur. If a selection is valid the position indication will show the possible direction, and the appropriate control execution button shall be pressed in order to close or open the corresponding object.

Control operation from other places (e.g. REMOTE) shall not be possible in this operating mode. The operator station HMI shall be a redundant with hot standby and shall provide basic functions for supervision and control of the substation. The operator shall give commands to the switchgear on the screen via mouse clicks or keyboard commands. The HMI shall give the operator access to alarms and events displayed on the screen. Aside from these lists on the screen, there shall be a printout of alarms or events in an event log.

An acoustic alarm shall indicate abnormalities, and all unacknowledged alarms shall be accessible from any screen selected by the operator.

The following standard pictures shall be available from the HMI:

a. Single-line diagram showing the switchgear status and measured values.

b. Control dialogues with interlocking and blocking details. This control dialogue shall tell the operator whether the device operation is permitted or blocked.

c. Measurement dialogues

d. Alarm list, station / bay-oriented

e. Event list, station / bay-oriented

f. System status

2. HMI design principles

Consistent design principles shall be adopted with the HMI concerning labels, colours, dialogues and fonts. Non-valid selections shall be dimmed out.

The object status shall be indicated using different status colours for:

a. Selected object under command

b. Selected on the screen

c. Not updated, obsolete values, not in use or not sampled

d. Alarm or faulty state

e. Warning or blocked

f. Update blocked or manually updated

g. Control blocked

h. Normal state

Process status displays and command procedures

The process status of the substation in terms of actual values of currents, voltages, frequency, active and reactive powers as well as the positions of circuit breakers, isolators and transformer tap-changers shall be displayed in the station single-line diagram.

In order to ensure a high degree of security against undesired operation, a "select- before-execute" command procedure shall be provided. After the "selection" of a switch, the operator shall be able to recognize the selected device on the screen, and all other switchgear shall be blocked. As communication between control centre and device to be controlled is established, the operator shall be prompted to confirm the control action and only then final execute command shall be accepted. After the "execution" of the command the operated switching symbol shall flash until the switch has reached its new position.

The operator shall be in a position to execute a command only, if the switch is not blocked and if no interlocking condition is going to be violated. The interlocking statements shall be checked by the interlocking scheme implemented at bay and station level.

After command execution the operator shall receive a confirmation that the new switching position has been reached or an indication that the switching procedure was unsuccessful with the indication of the reason for non-functioning.

3. System supervision & display

The SAS system shall be comprehensively self-monitored such that faults are immediately indicated to the operator, possibly before they develop into serious situations. Such faults are recorded as a faulty status in a system supervision display. This display shall cover the status of the entire substation including all switchgear, IEDs, communication infrastructure and remote communication links, and printers at the station level, etc.

4. Event list

The event list shall contain events that are important for the control and monitoring of the substation. The event and associated time (with 1 ms resolution) of its occurrence has to be displayed for each event.

The operator shall be able to call up the chronological event list on the monitor at any time for the whole substation or sections of it.

A printout of each display shall be possible on the hard copy printer.

The events shall be registered in a chronological event list in which the type of event and its time of occurrence are specified. It shall be possible to store all events in the computer for at least one month. The information shall be obtainable also from a printed event log.

The chronological event list shall contain:

a. Position changes of circuit breakers, isolators and earthing devices

b. Indication of protective relay operations

c. Fault signals from the switchgear

d. Indication when analogue measured values exceed upper and lower limits. Suitable provision shall be made in the system to define two level of alarm on either side of the value or which shall be user defined for each measurand.

e Loss of communication.

Filters for selection of a certain type or group of events shall be available. The filters shall be designed to enable viewing of events grouped per:

f. Date & time.

g. Bay

h. Device

i. Function e.g. trips, protection operations etc.

j. Alarm class

5. Alarm list

Faults and errors occurring in the substation shall be listed in an alarm list and shall be immediately transmitted to the control centre. The alarm list shall substitute conventional alarm tableau, and shall constitute an evaluation of all station alarms. It shall contain unacknowledged alarms and persisting faults. The date and time of occurrence shall be indicated.

The alarm list shall consist of a summary display of the present alarm situation. Each alarm shall be reported on one line that contains:

a. The date and time of the alarm.

b. The name of the alarming object.

c. A descriptive text.

d. The acknowledgement state.

Whenever an alarm condition occurs, the alarm condition must be shown on the alarm list and must be displayed in a flashing state along with an audible alarm. After acknowledgement of the alarm, it should appear in a steady (i.e. not flashing) state and the audible alarm shall stop. The alarm should disappear only if the alarm condition has physically cleared and the operator has reset the alarm with a reset command. The state of the alarms shall be shown in the alarm list (Unacknowledged and persistent, unacknowledged and cleared, Acknowledged and persistent).

Filters for selection of a certain type or group of alarms shall be available as for events.

6. Object picture

When selecting an object such as a circuit breaker or isolator in the single-line diagram, the associated bay picture shall be presented first. In the selected object picture, all attributes like:

a. Type of blocking.

b. Authority.

c. Local / remote control.

d. RCC / SAS control.

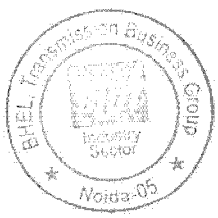
e. Errors etc. shall be displayed.

7. Control dialogues.

The operator shall give commands to the system by means of mouse click located on the single-line diagram. It shall also be possible to use the keyboard for command activation. Data entry is performed with the keyboard. Dedicated control dialogues for controlling at least the following devices shall be available:

a. Breaker and disconnector

b. Transformer tap-changer



8. User-authority levels

It shall be possible to restrict activation of the process pictures of each object (bays, apparatus...) within a certain user authorization group. Each user shall then be given access rights to each group of objects, e.g.:

Display only.

Normal operation (e.g. open/close of switchgear)

Unrestricted operation (e.g. by-passed interlocking)

System administrator

For maintenance and engineering purposes of the station HMI, the following authorization levels shall be available:

No engineering allowed

Engineering/configuration allowed

Entire system management allowed

The access rights shall be defined by passwords assigned during the login procedure. Only the system administrator shall be able to add/remove users and change access rights.

9. Reports

The reports shall provide time-related follow-ups of measured and calculated values. The data displayed shall comprise:

a. Trend reports:

- Day (mean, peak)
- Month (mean, peak)
- Semi-annual (mean, peak)
- Year (mean, peak)

b. Historical reports of selected analogue Values:

- Day (at 15 minutes interval)
- Week
- Month
- Year

. It shall be possible to select displayed values from the database in the process display on-line. Scrolling between e.g. days shall be possible. Unsure values shall be indicated. It shall be possible to select the time period for which the specific data are kept in the memory

Following printouts shall be available from the printer and shall be printed on demand:

o Daily voltage and frequency curves depicting time on X-axis and the appropriate parameters on the Y-axis. The time duration of the curve is 24 hours.

o Weekly trend curves for real and derived analogue values.

o Printouts of the maximum and minimum values and frequency of occurrence and duration of maximum and minimum values for each analogue parameter for each circuit in 24 hr period.

o Provision shall be made for logging information about breaker status like number of operation with date and time indications.

o Equipment operation details shift wise and during 24 hours.

o Printout on adjustable time period as well as on demand for MW, MVAR, Current, Voltage on each feeder and transformer as well as Tap Positions, temperature and status of pumps and fans for transformers.

o Printout on adjustable time period as well as on demand system frequency and average frequency.

o Reports in specified formats which shall be handed over to successful bidder.

c. Trend display (historical data)

It shall be possible to illustrate all types of process data as trends –input and output data, binary and analogue data. The trends shall be displayed in graphical form as column or curve diagrams with a maximum of 10 trends per screen. Adjustable time span and scaling ranges must be provided.

It shall be possible to change the type of value logging (direct, mean, sum, or difference) on-line in the window. It shall also be possible to change the update intervals on-line in the picture as well as the selection of threshold values for alarming purposes.

d. Automatic disturbance file transfer

All recorded data from the IEDs with integrated disturbance recorder as well as dedicated disturbance recording systems shall be automatically uploaded (event triggered or once per day) to a dedicated computer and be stored on the hard disc.

e. Disturbance analysis

The PC-based work station shall have necessary software to evaluate all the required information for proper fault analysis.

f. IED parameter setting

It shall be possible to access all protection and control IEDs for reading the parameters (settings) from the station HMI or from a dedicated monitoring computer. The setting of parameters or the activation of parameter sets shall only be allowed after entering a password.

g. Automatic sequences

The available automatic sequences in the system should be listed and described, (e.g. sequences related to the bus transfer). It must be possible to initiate pre-defined automatic sequences by the operator and also define new automatic sequences.

XIII. Gateway

The Gateway shall use industrial grade components. The State of the Art Gateway requires usage of fast, powerful microcontroller based systems designed to function in the process environment in a functionally decentralized manner. The tasks of such systems are manifold and shall guarantee safe and secure operation of the entire system with high availability. Gateways shall support IEC 61850 Edition 2. Gateway shall be independent and fetch data directly from Bay level devices such as BCU, BCPU & Protection IEDs. Gateway shall be utilized in substation Automation application to interface between the IEDs and the Master (control & monitoring) devices viz. SCADA. It shall be used for a real time monitoring & control operation of the switchgears and devices pertaining to a particular voltage level of the station. There shall be provision of Two Nos Gateway for redundancy purpose one shall be main& the other shall be standby.

The Gateway shall be multifunctional, designed in accordance with applicable International Electro-technical Commission (IEC), Institute of Electrical and Electronics Engineer (IEEE), American National Standards Institute (ANSI), and National Equipment Manufacturers association (NEMA) standards, unless otherwise specified in this Technical specification. Gateway shall comply with various internet security standards like – BDEW Whitepapers and integrated Krypto-Chip or other relevant IEC/IEEE standard And also provided below in-built security as:-

– IPsec VPN

– IPsec in tunnel mode: initiator

– Authentication / encryption based on pre-shared key

– Internet Key Exchange protocol: IKEv1

– Authentication algorithms: HMAC-SHA1, HMAC-MD5

– Encryption algorithms: AES-128, 3DES.

– Diffie-Hellman group: Group1, Group2

– Security Logging

– Syslog Client

In all cases the provisions of the latest edition or revision of the applicable standards in effect shall apply. The following scheme / features shall be available:

a) The system shall comprise the following in-built features namely failsafe control (i.e. in built check-before-execute feature), Control system, SOE buffer, Interfacing with third party IEDs if required (e.g. Multifunction Meters etc.), interfacing with third party computer system, direct GPS clock connectivity, through SNTP server or through the Master station (RCC/MCC) (main and standby mode) for time synchronization. Gateway shall support redundant time synchronization inputs.
b) Gateway shall be with high availability & reliability. Purchaser prefers to have gateway, which is easily expandable by addition of Processors & communication modules in existing rack to integrate with IEDs in future on open protocols. Extending the gateway software license to integrate future IEDs on open protocol.
c) Gateway shall not have any moving parts for data storage, heat dissipation etc.
d) Gateway shall have multi-processors capability. CPU, Power Supply and Communication redundancy shall be provided in the same gateway rack/chassis.
e) Gateway shall support hot swappable Processors, & Power Supplies, so that components can be replaced without need to switching off the gateway.
f) The proposed Gateway shall have the capability to support simultaneous communications with two or more independent remote master (redundant) stations.

g) Gateway shall use removable flash memory for storing program/database. The processor shall be of Intel minimum i5 or higher as per the latest available. This is to be decided during detailed Engineering.
h) Automatic start-up and initialization following power restoration.
i) Gateway shall be able to receive time synchronize packets from the master station over IEC-60870-5-104 protocol or from the slave clock provided in the respective substation on SNTP Protocol.
j) Accuracy of gateway's real time clock shall be better than +-3.5 ppm.
k) In case of power supply failure, auto start-up and restoration of the Gateway shall be possible without manual intervention.
l) Remote database downloading and uploading of Gateway from master station shall be possible.
m) It shall be possible to increase the number of communication ports in the Gateway by addition of plug-in modules, if required in future. The Gateway shall support the use of a different communication data exchange rate and scanning cycle on each port and different database for each master station.
n) The proposed Gateway shall be KEMA Certified or by equivalent certification body.
o) It shall be possible to generate events in HMI in case of failure of communication/power supply/processor module of Gateway.

B. Communication Interface

The Substation Automation System shall have the capability to support independent remote master station. The Substation Automation System shall have communication ports as follows:

(a) Redundant link for data transmission to SLDC on IEC 104.

The communication interface to the SAS shall allow scanning and control of defined points within the substation automation system independently for control centre. The substation automation system shall simultaneously respond to independent scans and commands from employer's control centers. The substation automation system shall support the use of a different communication data exchange rate (bits per second), scanning cycle, and/or communication protocol to each remote control centre. Also, each control center's data scan and control commands may be different for different data points within the substation automation system's database.

The SAS shall also allow all necessary substation data transfer to SLDC. There may require typical protocol converter depending upon SLDC system. Communication media may be leased line, PLCC, Radio or any other means.

C. Remote Control Centre Communication (NETWORK CONTROL CENTER) Interface

Communication channels between the Substation Automation System and the Remote control centre (Net Work Control Centre) will consist either of OPGW, power line carrier, microwave, optical fiber, VSAT or leased line, as the case may be, as specified.

D. Interface equipment:

The Contractor shall provide interface equipment for communicating between Substation Automation system and Remote control centre (RCC).

In case of PLCC communication any modem supplied shall not require manual equalization and shall include self-test features such as manual mark/space keying, analogue loop-back, and digital loop-back. The modems shall provide for convenient adjustment of output level and receive sensitivity. The modem should be stand alone complete in all respects including power supply to interface the SAS with communication channel. The configuration of tones and speed shall be programmable and maintained in non-volatile memory in the modem. All necessary

hardware and software shall also be in the scope of bidder except the communication link along with communication equipment between substation control room and Remote Control Centre.

E. Communication Protocol

The communication protocol for gateway to control centre must be open protocol and shall support IEC 60870-5-104 and IEC 61850 for all levels of communication for sub- station automation such as Gateway to remote station and Bay to station HMI, etc. respectively.

XIV. System hardware:

A. SCADA Equipment:

The contractor shall provide redundant station HMI in hot standby mode.

It shall be capable to perform all functions for entire substation including future requirements as indicated in the SLD. It shall use industrial grade components.

Processor and RAM shall be selected in such a manner that during normal operation not more than 30% capacity of processing and memory are used. Supplier shall demonstrate these features.

The capacity of hard disk shall be selected such that the following requirement should occupy less than 50% of disk space:

1. Storage of all analogue data (at 15 Minutes interval) and digital data including alarm, event and trend data for thirty (30) days.

2. Storage of all necessary software,

3. 500 GB space for OWNER'S use.

Supplier shall demonstrate that the capacity of hard disk is sufficient to meet the above requirement.

B. HMI (Human Machine Interface)

The VDU shall show overview diagrams (Single Line Diagrams) and complete details of the switchgear with a colour display. All event and alarm annunciation shall be selectable in the form of lists. Operation shall be by a user friendly function keyboard and a cursor positioning device. The user interface shall be based on WINDOWS concepts with graphics & facility for panning, scrolling, zooming, decluttering etc.

C. Mass Storage Unit

The mass storage unit shall be built-in to the Station HMI. All operational measured values and indications shall be stored in a mass-storage unit of CD-ROM / DVD-ROM with 700 MB or more capacity. The unit should support at least Read (48X), Write (24X), and Re-Write (10X) operations, with Multi-Session capability. It should support ISO9660, Rockridge and Joliet File systems. It should support formatting and use under the operating system provided for Station HMI. The monthly back up of data shall be taken on disc. The facility of back up of data shall be inherent in the software.

D. Visual Display Units/TFT's (Thin Film Technology)

The contractor shall provide three display units, one for station HMI, one for redundant HMI and one for DR work station. These shall have high resolution and reflection protected picture screen. High stability of the picture geometry shall be ensured. The screen shall be at least 27" diagonally in size and capable of colour graphic displays. The display shall accommodate

resolution of 1920 X 1080pixels. The HMI shall be able to switch the key board and cursor positioning device, as unit among all the monitors at a console with push button or other controls.

Large Video Wall-Full HD:

The large screen Video wall size minimum 67 inches **or above** in the control room shall be used for the display of important graphics from the pc, workstation, Images from IP video cameras. The size of the large video display unit of minimum 67 inches **or above** (for 132/33,220/33 & 220/132/33 KV S/S) & minimum 80 inches **or above** inches (for 400/220 KV S/S) (Make: Toshiba/ SONY/ SAMSUNG) and its peripherals suitably connected to SAS shall be provided in each station as per the technical specification. The Visual Display Unit shall be Full HD LED.

E. Printers

It shall be laser jet color printer & the printing operation shall be quiet with a noise level of less than 55 dB suitable for location in the control room. Printer shall accept and print all ASCII characters via master control computer unit interface.

The printer shall have in built testing facility. Failure of the printer shall be indicated in the Station HMI. The printer shall have an off line mode selector switch to enable safe maintenance. The maintenance should be simple with provisions for ease of change of print head, ribbon changing, paper insertion etc.

F. Switched Ethernet Communication Infrastructure:

The bidder shall provide the redundant switched optical Ethernet communication infrastructure for SAS. The bidder shall keep provision of 20% spare capacity for employer use.

One set of switches (two nos in case of PRP) shall be provided to connect all IEDs of one bay of 400KV, all IEDs of 2 bays 220kV & 132kV, and all IEDs of 4 bays 33kV. Ethernet switch must be Layer-2 with IP 40. it shall be -40 to 85 °C operating temperature (no fans). Ethernet switch shall have rear RJ45 & FO port and front LED.

Bidder needs to provide dual FO Substation Ring between all Ethernet switches.

G. Bay level unit (BCU)

a) Location:

The bay control units will be located inside the relay panels, which are located throughout the EHV substation's. BCUs shall be 'IEC61850 Edition 2' & PRP compliant as per IEC 62439-3.

b) Interfacing:

All bay control units shall contain an optical-fiber/ RJ45 (Selection of port by owner as per the suitability & project specific) serial interface for connection to the HMI center and RJ45 / RS232 / USB port at front for local parameterization (Selection of port by owner as per the suitability & project specific) serial interface for connection to a PC.

All optical-fiber cables/Ethernet (as per the selection by the owner) will be part of the supply as well.

c) Interfacing with the equipment of the switchyard:

The bay control units shall be capable of interfacing with the equipment of the switchyard. All digital and analog input signals from the equipment of the switchyard and out-going carrying command and control signals to the various equipment will interface with the bay control units

through terminal blocks located inside the relay kiosks. These incoming and out-going signals will be wired by PPC with conventional control cables of cross section of 2.5 mm2 (that is from the terminal blocks to and from the switchyard equipment) except for the VTs and CTs circuits, which utilize cables of 4mm2 in cross section

d) Isolation from the switchyard equipment:

The bay control units shall provide isolation from the switchyard equipment via heavy duty relay contacts or by other means.

e) Parameterization and control:

Control for the bay control units shall be performed via an integrated graphic display and keypad and Parameterization shall be done via PC/Laptop.

f) Analog inputs signals:

Analog input signals can be input to the bay control units either via analog transducers or by direct connection to CTs and VTs. If transducers are required, the supplier will supply these transducers.

g) Mounting:

The bay control units shall be suitable for panel flash mounting or ½ flash panel mounting.

The bay unit shall use industrial grade components. The bay level unit, based on microprocessor technology, shall use numerical techniques for the calculation and evaluation of externally input analogue signals. They shall incorporate select-before- operate control principles as safety measures for operation via the HMI. They shall perform all bay related functions, such as control commands, bay interlocking, data acquisition, data storage, event recording and shall provide inputs for status indication and outputs for commands. They shall be directly connected to the switchgear via TBs. Connections from BCU to switchgear should not be terminated directly on I/O boards but should be routed through Terminal Boards (TB). The bay unit shall acquire and process all data for the bay (Equipment status, fault indications, measured values, alarms etc.) and transmit these to the other devices in sub-station automation system. In addition, this shall receive the operation commands from station HMI and control centre. The bay unit shall have the capability to store all the data for at least 24 hours. One No. Bay level unit shall be provided for supervision and control of each 400, 220 and 132 & 33 KV bay (a bay comprises of one circuit breaker and associated disconnectors, earth switches, instrument transformers etc). The Bay level unit shall be equipped with analogue and binary inputs/outputs for handling the control, status monitoring and analogue measurement functions. All bay level interlocks are to be incorporated in the Bay level unit so as to permit control from the Bay level unit/ local bay mimic panel, with all bay interlocks in place, during maintenance and commissioning or in case of contingencies when the Station HMI is out of service. The Bay level unit shall meet the requirements for withstanding electromagnetic interference according to relevant parts of IEC 61850. Failure of any single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown.

Surface-mount technology (SMT) should be used for printed circuit boards (PCB) of BCU. Further a conformal coating should be applied to the PCB for ensuring optimum performance under the toughest environment conditions.

i. Input/Output (I/O) modules

The I/O modules shall form a part of the bay level unit and shall provide coupling to the substation equipment. The I/O modules shall acquire all switchgear information (i.e. data coming directly from the switchgear or from switchgear interlocking devices) and transmit commands for operation of the switchgear. The measured values of voltage and current shall be from the secondary of instrument transformers. The digital inputs shall be acquired by exception with 1

ms resolution. Contact bouncing in digital inputs shall not be assumed as change of state. Connections from BCU to switchgear should not be terminated directly on I/O boards but should be routed through Terminal Boards (TB).

ii. Technical Parameters of BCU

1. Power supply: 220 VDC, + 20%, Power consumption: < 50W Ripple (peak to peak): < 12%.

2. Protocol Capabilities: The BCU should have ethernet module to connect to the communication buses (like the station bus) that use the IEC 61850-8-1 protocol.

The module should have two optical ports with LC connectors or two Ethernet electrical RJ 45 connectors in PRP mode based on SAS design requirement.

IEC 61850-8-1 communication protocol-100BASE-FX/TX,

Transmission rate-1000Mbit, Ethernet Electrical –RJ45,Test Volt-500V AC against ground. Distance Max. 20meter.

Ethernet Optical- LC/ST connecter , Wavelength- 1300nm,Distance-Max.1.5kM.

3. IED Communication:

A. 'IEC61850 Edition 2' & PRP as per IEC 62439-3.

B. Time synchronization: External Time Synchronization from Ethernet SNTP Time Server (<1ms accuracy)

4 Binary Input processing : Hardwired Digital Input should be acquired via digital boards or IED connected by a serial link. Software Digital Input coming from configurable relays & other devices with 1 ms time tagging support GOOSE mode digital boards or IED connected by a serial link. Software Digital Input coming from configurable relays & other devices with 1 ms time tagging. Support GOOSE mode.

No of Binary Input: No. of Digital Input shall be as per the system requirement as per the standard practice, which is as decided during the detailed Engineering and with 30% spare in each BCU.

Operating Volt: 220V DC. (Max.300V)

5. Analogue Input processing:

a. Four Voltage Inputs:

Nominal AC voltage (Vn) range: 110V, 110V/√3

Frequency operating range: 50 Hz ± 10%

VT load rating: 10 seconds with no destruction 880 V r m s

b. Four Current Input:

Nominal AC current (In):1 A r m s Minimum measurable current with same accuracy :0.2 A r m s Maximum measurable current 4 A r m s (4*In) Frequency 50 Hz ± 10%.

c. Analogue Transducers input:

8 insulated transducer input (-20mA to +20mA) values on 8 independent galvanic-isolated channels for Transformer bays. This means that there is no common point of contact between

two analogue inputs. Each analogue input can be configured in the current range or voltage range.

Overload Capacity: 100mA

Sampling period 100 ms

Accuracy 0, 1% full scale for each range at 25°C

6. Measured value acquisition:

Monitoring of calculated four CT & four PT/ CVT direct primary measures.

7 Derived values: From the direct primary measures:

RMS currents & voltages, network frequency, active power, reactive power, apparent power, Power factor, Phase angles.

8 Digital Outputs: DO used for switching device in field or inside

C/R via digital boards, should also configurable & contain security, interlocks etc.

No. of Digital Output shall be as per the system requirement as per the standard practice, which is as decided during the detailed Engineering and with 30% spare in each BCU.

Note: *The data regarding Digital Input, Output, and Transducers etc. for **BCU/BCPU/Aux BCU** as indicated above are indicative. However, the Minimum Nos. of Digital Input, Output, and Transducers etc. for **BCU/BCPU/Aux BCU** as indicated below are required to be considered for **BCU/BCPU/Aux BCU**.*

(a) **BCU for 220kV side**: Numerical Bay control unit: 64 Nos. Digital input & 32 Nos. digital output, 8 AI (for Transformer only) with four CT input, four VT Input. IEC 61850 - ED2 protocol with PRP on FO. Power Supply 220V DC.
(b) **BCU for 132kV side**: Numerical Bay control unit: 48 Nos. Digital input & 28 Nos. digital output, 8 AI (for Transformer only) with four CT input, four VT Input. IEC 61850 - ED2 protocol with PRP on FO. Power Supply 220V DC.
(c) **BCPU for 33kV side**: Integrated Numerical Bay control unit with protection function: 32 Nos. Digital input & 24 Nos. digital output with four CT input, four VT Inputs .IEC 61850 - ED2 with PRP on FO. Power supply 220V DC.
(d) **Aux BCU**: 64 Digital input, 10Nos digital output, 32 insulated transducer input (-20mA to +20mA) values on 32 independent galvanic-isolated channels without CT / PT Input cards. IEC 61850 Ed-2 PRP on FO protocol For station Auxiliary monitoring

Note: GIS Monitoring signal and Any Modbus protocol devices to be directly connected to station LAN, not through any intermediate devices.

Nominal operating voltage : 220VDC (Max.300V)

Make: 5A

Carry: 5A continuously

30A for 500 mseconds.

Break DC: 50 W resistive, 15 W inductive (L/R = 40 ms).

9. Sub-station/bay: Should use logical equation and pre defined Inter-locking rules & sub-station topology for operation.

: Should use logical equation and pre defined Inter-locking rules & sub-station topology for operation.

10 Trip Circuit Supervision : Supervise trip circuits for both the conditions of Breaker.

11 Event Logging: Storage of events up to 200 in ROM.

12 Disturbance files & wave forms : Minimum Five records of waveforms and disturbance record of wave forms files stored and accessible by HMI/DR work Station.

13 Gateway support: Should interface with Gateway for Remote Control facility

14 Local control, Operation: Local control & Operation should be possible and Display using backlit LCD Display and keypad of BCU.

15 Self- monitoring: Power ON and continuous cyclic self-monitoring

tests. Abnormality result should be displayed.

16 I/O processing: As per our required I/O and I/O count provided above list with 20% extra for Capacities each bay.

17 Internal Ethernet : 1 X 10/100 Base T (RJ-45) ports or 1X10/100 Base Fx (optical) ports

18 Additional ports : 1 X RS232/USB /RJ45 in front for parameterization

Modbus, should be s/w configurable.

19 Environmental conditions : :Operating temperature: -5°C to +55 °C

Storage temperature: -5°C to + 70 °C

: 0°C to + 70 °C Humidity: 5 to 95 % (Non-condensing).

20 Mounting & design : Flush or Rack Mounted Type with modular design.

21 Warranty .:3 year of on-site comprehensive.

XV. Inverters for SAS

2 no. of inverter SCADA Compatible with static bypass switch with no separate Battery bank. Input supply: 220VDC and 230VAC and Output: 230VAC. One Inverter will be connected for Main HMI, DR PC and Another Inverter will be connected to Redundant HMI and printer. An arrangement should be made such that it should be always connected with the inverter which provides load to SCADA equipment.

INPUT SPECIFICATIONS

Voltages: 230 VAC Frequency 50 Hz & 220 V DC

Voltage Range -20% to +15%

Protection Input circuit breaker provided protection to the unit, load and personnel. Input Circuit Breaker will be higher interruption rated.

Input Current: for AC input: Sinusoidal 0.95 PF under all line/load conditions and for D.C input: as per load condition.

OUTPUT SPECIFICATION

Available Output Ratings (KVA or KW to be specified)	3 KVA / 2.1 KW
Output Voltages	230 VAC
Voltage Regulations	±3% No Load to Full Load, High Line to Low Line
Frequency	50 Hz +/-0. 5 HZ (when on inverter)
Output Wave Form	Sine Wave
Harmonic Distortion	<5 % THD; <3% Single Harmonic crest Factor 3 to 1
Overload	125% for Ten (10) Minutes; 150% Surge for 10 seconds

Protection Internal electronic overload protection. Circuit breaker provides inherent overload protection.

Efficiency	90% typical
Isolation	Complete from line. Output neutral bonded to ground
Noise Isolation	120 dB Common-Mode: -60 dB Transverse- Mode

Power Connections Hard Wired (Terminal Block) Optional Output Receptacle Panels w/NEMA Type Receptacles and Overcurrent Protection

XVI. Extendibility in future

Offered substation automation system shall be suitable for extension in future for additional bays. During such requirement, all the drawings and configurations, alarm/event list etc. displayed shall be designed in such a manner that its extension shall be easily performed by the employer. During such event, normal operation of the existing substation shall be unaffected and system shall not require a shutdown. The contractor shall provide all necessary software tools along with source codes/ device configuration files to perform addition of bays in future and complete integration with SAS by the user. These software tools shall be able to configure IED, add additional analogue variable, alarm list, event list, modify interlocking logics etc. for additional bays/equipment which shall be added in future. HMI h/w & s/w should also support extreme extendibility as per future layout.

XVII. Software structure.

The software package shall be structured according to the SAS architecture and strictly divided in various levels. Necessary firewall shall be provided at suitable points in software to protect the system. An extension of the station shall be possible with lowest possible efforts. Maintenance, modification or an extension of components of any feeder may not force a shut-down of the parts of the system which are not affected by the system adaptation.

1. Station level software:

a. Human-machine interface (HMI)

The base HMI software package for the operator station shall include the main SAS functions and it shall be independent of project specific hardware version and operating system. It shall further include tools for picture editing, engineering and system configuration. The system shall be easy to use, to maintain, and to adapt according to specific user requirements.

Systems shall contain a library with standard functions and applications.

b. System software

The system software shall be structured in various levels. This software shall be placed in a non-volatile memory. The lowest level shall assure system performance and contain basic functions, which shall not be accessible by the application and maintenance engineer for modifications. The system shall support the generation of typical control macros and a process database for user specific data storage. In case of restoration of links after failure, the software along with hardware shall be capable of automatically synchronizing with the remaining system without any manual interface. This shall be demonstrated by contractor during integrated system test.

c. Gateways Software

i. Gateway (RCC)

Software of Gateway should be suitable for controlling s/s remotely.

Software of Gateway should be suitable for controlling s/s remotely and sending station monitoring data and station Auxiliary data.

d. Application software

In order to ensure robust quality and reliable software functions, the main part of the application software shall consist of standard software modules built as functional block elements. The functional blocks shall be documented and thoroughly tested. They form part of a library. The application software within the control/protection devices shall be programmed in a functional block language.

e. Network Management System for D.R. Work Station:

The contractor/ Manufacturer shall provide network management system software for following management functions:

i. Configuration Management

ii. Fault Management

iii. Performance Monitoring.

This system shall be used for management of communication devices and other IEDs in the system. This NMS can be loaded in DR work-station and shall be easy to use, user friendly and menu based. The NMS shall monitor all the devices in the SAS and report if there is any fault in the monitored devices. The NMS shall:

i. Maintain performance, resource usage, and error statistics for all managed links and devices and present this information via displays, periodic reports and on demand reports.

ii. Maintain a graphical display of SAS connectivity and device status.

iii. Issue alarms when error conditions occur.

iv. Provide facility to add and delete addresses and links.

f. The contractor shall provide each software in two copies in CD to load into the system in case of any problem related with Hardware/Communication etc.

XVIII. TESTS

The bidder shall submit the complete type test reports as stated hereunder for the offered item along with the offer otherwise the offer shall be liable to be rejected. These tests must have been conducted in the NABL approved laboratory as per IEC 60255, IEC 60068, IEC 61000, IEC 60529, IEC 61010-1 & IEC 61850 within last 5 years prior to date of validation of the offer. Complete type test reports containing test procedure, drawings, oscillograms etc. shall be submitted.

The substation automation system offered by the bidder shall be subjected to following tests to establish compliance with IEC 61850 for EHV substation equipment installed in sheltered area in the outdoor switchyard and specified ambient conditions:

A. Type Tests:

1. Control IEDs and Communication Equipment:

a. Performance tests

i. Accuracy requirements

ii. Limits of operating range of auxiliary energizing inputs and auxiliary Voltage dependence.

iii. Limits of frequency range and frequency dependence

iv. Rated burden

v. Mechanical Endurance test

vi. Characteristic and Functional test

b. Thermal requirements

i. Maximum allowable temperature

ii. Limits of short time thermal withstand value of input energizing quantities

iii. Limiting dynamic value

c. Insulation Tests:

i. Dielectric Tests

ii. Impulse Voltage withstand Test

iii. Insulation resistance measurement

d. Influencing Quantities:

i. Permissible ripples

ii. Interruption of input voltage

e. Electromagnetic Compatibility Test:

i. 1 MHZ burst disturbance test

ii. Electrostatic Discharge Test

iii. Radiated Electromagnetic Field Disturbance Test

iv. Electrical Fast transient Disturbance Test

v. Conducted Disturbances Tests induced by Radio Frequency Field

vi. Magnetic Field Test

vii. Emission (Conducted and Radiated) Test.

viii. Surge Immunity Test

f. Contact performance Test

i. Contact making/Breaking capacity test

ii. Continuous capacity

g. Environmental tests:

i. Cold Temperature

ii. Dry Heat

iii. Storage temperature test

iv. Humidity (Damp heat Cycle)

h. Mechanical Tests:

i. Vibration response & Vibration endurance test

ii. Bump test

iii. Shock response test

iv. Seismic test

i. Enclosure Test:

i. Degree of Protection test – IP51

j. Safety Test:

i. Single fault condition assessment

ii. Earth bonding impedance test

iii. Mechanical resistance to shock and impact

iv. Protection against electrical shock

v. Protection against the spread of fire

k. IEC 61850 Compatibility tests

B. Factory Acceptance Tests:

The supplier shall submit a test specification for factory acceptance test (FAT) and commissioning tests of the station automation system for approval. For the individual bay level IED's applicable type test certificates shall be submitted. The manufacturing phase of the SAS

shall be concluded by the factory acceptance test (FAT). The purpose is to ensure that the Contractor has interpreted the specified requirements correctly and that the FAT includes checking to the degree required by the user. The general philosophy shall be to deliver a system to site only after it has been thoroughly tested and its specified performance has been verified, as far as site conditions can be simulated in a test lab. If the FAT comprises only a certain portion of the system for practical reason, it has to be assured that this test configuration contains at least one unit of each and every type of equipment incorporated in the delivered system. If the complete system consists of parts from various suppliers or some parts are already installed on site, the FAT shall be limited to sub-system tests. In such a case, the complete system test shall be performed on site together with the site acceptance test (SAT).

C. Integrated Testing:

The integrated system tests shall be performed as detailed in subsequent clauses as per following configuration:

Redundant Station HMI, DR work station, two switches (i.e. for two diameters) along with all IEDs for the Dia. and printers.

All other switches for complete sub-station as detailed in section project shall be simulated as needed.

D. Hardware Integration Tests:

The hardware integration test shall be performed on the specified systems to be used for Factory tests when the hardware has been installed in the factory. The operation of each item shall be verified as an integral part of system. Applicable hardware diagnostics shall be used to verify that each hardware component is completely operational and assembled into a configuration capable of supporting software integration and factory testing of the system. The equipment expansion capability shall also be verified during the hardware integration tests.

E. Integrated System Tests:

Integrated system tests shall verify the stability of the hardware and the software. During the tests all functions shall run concurrently and all equipment shall operate a continuous 100 Hours period. The integrated system test shall ensure the SAS is free of improper interactions between software and hardware while the system is operating as a whole.

F. Field Tests:

The field tests shall completely verify all the features of SAS hardware and software.

G. System Performance:

It shall be the responsibility of the bidder to predict and indicate in the bid, the worst case loading condition and design the system accordingly to meet the same. The worst case loading condition shall include following

- All analogue inputs scanning and processing in progress and all data is being transmitted over the system bus every one second.
- A burst of 100 alarms is generated over a period of 10 seconds.
- An operator control is generated every 10 seconds.
- Data collection for logs/reports is in progress.
- Data collection for historical storage and trend function in progress.

- Data collection of fault record is in progress.
- All health monitoring functions/diagnostics in progress.
- All output devices are in operation with rated performance/speed.
- All data are transferred to the control centre.

The updating time on the operator station under normal and calm/worst conditions in the station shall be:

Function Response Time

From Selection of object to picture colour change form object < 1 Sec.

Command Execute < 1 Sec.

Display of binary change < 0.5 Sec.

Display of Analog Value Change <1 Sec.

System Display with 100 variables Max.3 Sec.

Times taken to report the last of 50 simultaneous alarms Max. 5 Sec.

Updating Database < 1 Sec.

H. Duty cycle time

a. Under worst loading condition processor shall have

1. 40 % free time when measured over any two second period

2. 60% free time when measured over any one minute period

b. Substation network spare time

50 % spare time when measured over any two second period during worst case loading conditions.

Bidder shall furnish necessary data to fully satisfy employer that processor spare duty cycle figures quoted by the bidder are realistic and based on configuration and computational capability of the offered system and these shall be actually implemented system as commissioned at project site.

XIX. System Operation

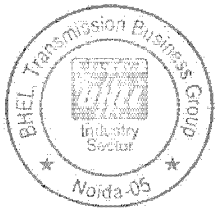
1. Substation Operation

a. Normal Operation

Operation of the system by the operator from the MCC or at the substation shall take place via industry standard HMI (Human Machine interface) subsystem consisting of graphic colour VDU, a standard keyboard and a cursor positioning device (mouse).

The coloured screen shall be divided into 3 fields:

i) Message field with display of present time and date



ii) Display field for single line diagrams

iii) Navigation bar with alarm/condition indication

For display of alarm annunciation, lists of events etc a separate HMI View node shall be provided.

All operations shall be performed with mouse and/or a minimum number of function keys and cursor keys. The function keys shall have different meanings depending on the operation. The operator shall see the relevant meanings as function tests displayed in the command field (i.e. operator prompting). For control actions, the switchgear (i.e. circuit breaker etc.) requested shall be selectable on the display by means of the cursor keys.

The switching element selected shall then appear on the background that shall be flashing in a different color. The operator prompting shall distinguish between:

Prompting of indications e.g. fault indications in the switchgear, and prompting of operational sequences e.g. execution of switching operations.

The summary information displayed in the message field shall give a rapid display of alarm/message of the system in which a fault has occurred and alarm annunciation lists in which the fault is described more fully.

Each operational sequence shall be divided into single operation steps which are initiated by means of the function keys/WINDOW command by mouse. Operator prompting shall be designed in such a manner that only the permissible keys are available in the command field related to the specific operation step. Only those switching elements shall be accessed for which control actions are possible. If the operation step is rejected by the system, the operator prompting shall be supported by additional comments in the message field. The operation status shall be reset to the corresponding preceding step in the operation sequence by pressing one of the function keys. All operations shall be verified. Incorrect operations shall be indicated by comments in the message field and must not be executed.

The offer shall include a comprehensive description of the system. The above operation shall also be possible via WINDOWS based system by mouse.

XX. Power Supply

Power for the substation automation system shall be derived UPS. Inverter of suitable capacity shall be provided for station HMIs, DR work station, Gateways and its peripheral devices e.g. printers etc. There must be redundant Inverter to feed power in case of one inverter fails. In case of failure of one Inverter supply should automatically switched over to second one. In the event of total Power failure, necessary safeguard software shall be built for proper shutdown and restart.

XXII. Documentation

The following documents shall be submitted for employer's approval during detailed engineering:

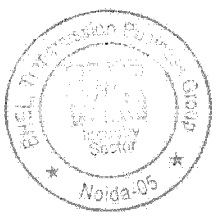
(a) System Architecture Drawing

(b) Hardware Specification

(c) Sizing Calculations of various components

(d) Response Time Calculation

(e) Functional Design Document



The following documentation to be provided for the system in the course of the project shall be consistent, CAD supported.

- List of Drawings.
- Substation automation system architecture.
- Block Diagram.
- Guaranteed technical parameters, Functional Design Specification and guaranteed availability and reliability.
- Calculation for power supply dimensioning.
- I/O Signal lists.
- Schematic diagrams.
- List of Apparatus.
- List of Labels.
- Logic Diagram (hardware & software).
- Control Room Lay-out.
- Test Specification for Factory Acceptance Test (FAT).
- Product Manuals.
- Assembly Drawing.
- Operator's Manual.
- Complete documentation of implemented protocols between various elements.
- Listing of software and loadable in CD ROM.

Other documents as may be required during detailed engineering.

Two sets of hard copy and four sets of CD ROM containing all the as built documents/drawings shall be provided.

XXII. GUARNTEE.

The availability for the complete SAS shall be guaranteed by the Manufacturer. Bidder shall include in their offer the detailed calculation for the availability. The contractor shall demonstrate their availability guaranteed by conducting the availability test on the total sub-station automation system as a whole after commissioning of total Sub-station Automation system. The test shall verify the reliability and integrity of all sub-systems. Under these conditions the test shall establish an overall availability of 99.98%. After the lapse of 1000 Hours of cumulative test time, test records shall be examined to determine the conformance with availability criterion. In case of any outage during the availability test, the contractor/ Manufacturer shall rectify the problem and after rectification, the 1000 Hours period start after such rectification. If test object has not been met the test shall continue until the specified availability is achieved.

The contractor/Manufacturer has to establish the availability in a maximum period of three months from the date of commencement of the availability test.

After the satisfactory conclusion of test both contractor and employer shall mutually agree to the test results and if these results satisfy the availability criterion, the test is considered to be completed successfully. After that the system shall be taken over by the employer and then the guarantee period shall start.

The SAS supplied under this specification shall be designed and constructed to meet all specification requirements for 15 years. Further the bidder/Manufacturer should support for hardware and software for 15 (fifteen) years to guard against obsolescence. SAS equipment or components that cannot meet this life expectancy or specified design and operational requirement or likely to become obsolete during entire service life shall be identified and their expected failure rate/obsolescence period with corrective action shall be indicated by the bidder in his proposal. Otherwise SAS shall be deemed to be suitable for above requirements. All requirements/devices not listed under recommended spares shall have a normal expectancy exceeding the specified expected life of SAS

XXIII. TRAINING, SUPPORT SERVICES, MAINTENANCE AND SPARES

A. TRAINING

The contractor/ Manufacturer shall impart training for 1 week for the engineers of OPTCL and cover following topics of SAS as listed below.

1. SAS Computer System Hardware Course

A SAS computer system hardware course shall be offered, but at the system level only. The training course shall be designed to give Employer hardware personnel sufficient knowledge of the overall design and operation of the system so that they can correct obvious problems, configure the hardware, perform preventive maintenance, run diagnostic programs, and communicate with contract maintenance personnel. The following subjects shall be covered:

a. System Hardware Overview: Configuration of the system hardware.

b. Equipment Maintenance: Basic theory of operation, maintenance techniques and diagnostic procedures for each element of the computer system, e.g., processors, auxiliary memories, LANs, routers and printers. Configuration of all the hardware equipment.

c. System Expansion: Techniques and procedures to expand and add equipment such as loggers, monitors, and communication channels.

d. System Maintenance: Theory of operation and maintenance of the redundant hardware configuration, failover hardware, configuration control panels, and failover switches. Maintenance of protective devices and power supplies.

e. Subsystem Maintenance: Theory of design and operation, maintenance techniques and practices, diagnostic procedures, and (where applicable) expansion techniques and procedures. Classes shall include hands-on training for the specific subsystems that are part of Employer's equipment or part of similarly designed and configured subsystems. All interfaces to the computing equipment shall be taught in detail.

f. Operational Training: Practical training on preventive and corrective maintenance of all equipment, including use of special tools and instruments. This training shall be provided on Employer equipment, or on similarly configured systems.

2. SAS Computer System Software Course

The Contractor/ Manufacturer shall provide a computer system software course that covers the following subjects:

a. System Programming: Including all applicable programming languages and all stand-alone service and utility packages provided with the system. An introduction to software architecture, Effect of tuning parameters (OS software, Network software, database software etc.) on the performance of the system.

b. Operating System: Including the user aspects of the operating system, such as program loading and integrating procedures; scheduling, management, service, and utility functions; and system expansion techniques and procedures.

c. System Initialization and Failover: Including design, theory of operation, and practice

d. Diagnostics: Including the execution of diagnostic procedures and the interpretation of diagnostic outputs,

e. Software Documentation: Orientation in the organization and use of system software documentation.

f. Hands-on Training: with allocated computer time for trainee performance of unstructured exercises and with the course instructor available for assistance as necessary.

3. SAS Application Software Course:

The Contractor shall provide a comprehensive application software courses covering all applications including the database and display building course. The training shall include:

a. Overview: Block diagrams of the application software and data flows. Programming standards and program interface conventions.

b. Application Functions: Functional capabilities, design, and major algorithms. Associated maintenance and expansion techniques.

c. Software Development: Techniques and conventions to be used for the preparation and integration of new software functions.

d. Software Generation: Generation of application software from source code and associated software configuration control procedures.

e. Software Documentation: Orientation in the organization and use of functional and detailed design documentation and of programmer and user manuals.

f. Hands-on Training: with allocated computer time for trainee performance of unstructured exercises and with the course instructor available for assistance as necessary.

B. MAINTENANCE

Maintenance Responsibility during the Guaranteed Availability Period. During guaranteed Availability Period, the Contractor shall take continual actions to ensure the guaranteed availability and shall make available all the necessary resources such as specialist personnel, spare parts, tools, test devices etc. for replacement or repair of all defective parts and shall have prime responsibility for keeping the system operational.

C. Reliability and availability.

The SAS shall be designed so that the failure of any single component, processor, or device shall not render the system unavailable. Each component and equipment offered by the bidder shall be of established reliability. The minimum target reliability of each piece or equipment like each electronic module/card Power supply, Peripherals etc. shall be established by bidder considering its failure rates/mean time between failures (MTBF), meantime to repair (MTTR), such that the availability of complete system is assured. The guaranteed annual system

availability shall not be less that 99.9%. This shall be supported by detailed calculation according to availability calculations specified in IEEE standard –1046 or equivalent. This shall be submitted by bidder along with offer. The SAS shall be designed to satisfy the very high demands for reliability and availability concerning:

i. Mechanical and electrical design

ii. Security against electrical interference (EMI)

iii. High quality components and boards

iv. Modular, well-tested hardware

v. Thoroughly developed and tested modular software

vi. Easy-to-understand programming language for application programming

vii. Detailed graphical documentation and application software

viii. Built-in supervision and diagnostic functions

ix. Security

x. Experience of security requirements

xi. Process know-how

xii. Select before execute at operation

xiii. Process status representation as double indications

xiv. Distributed solution

xv. Independent units connected to the local area network

xvi. Back-up functions

xvii. Panel design appropriate to the harsh electrical environment and ambient

xviii. conditions

xix. Panel grounding immune against transient ground potential rise

Outage terms

i. Outage: The state in which substation automation system or a unit of SAS is unavailable for Normal Operation due to an event directly related to the SAS or unit of SAS. In the event, the owner has taken any equipment/ systems other than Sub-station Automation System for schedule/forced maintenance, the consequent outage to SAS shall not be considered as outage for the purpose of availability.

ii. Actual outage duration (AOD)

The time elapsed in hours between the start and the end of an outage. The time shall be counted to the nearest 1/4th of an hour. Time less than 1/4th of an hour shall be counted as having duration of 1/4th of an hour.

iii. Period Hours (PH)

The number of hours in the reporting period. In a full year the period hour are 8760h (8784h for a leap year).

iv. Actual Outage hours (AOH)

The sum of actual outage duration within the reporting period AOH = S AOD

v. Availability:

Each SAS shall have a total availability of 99.98 % i.e. the ratio of total time duration minus the actual outage duration to total time duration.

D. SPARES:

The contractor shall make a list of spares which may be required for ensuring the guaranteed availability of the system. The contractor should keep the same at site for free replacement during the guaranteed period. Further, the contractor shall make a list of spares for running the system with guaranteed availability beyond the guaranteed period. The said spares list shall form the part of scope of supply and accordingly the price thereof shall be quoted by the bidder and shall be considered.

All consumables such as paper, cartridges shall be supplied by the contractor till the SAS is taken over by the owner.

XXIV. ADDITIONAL REQUIRED DESIGN CHARACTERISTICS OF THE SUBSTATION AUTOMATION SYSTEM FOR THE EHV SUBSTATION

1. All wording appearing on the VDU with regard the single line diagrams of the ehv substation shall be in English language.

2. Care shall be taken so that the system can be expanded in the future, if needed.

3. The database, after it has been created, will be delivered on CD-ROMs.

4. Due to IEC-61850 communication protocol implementation, the following should be applied:

4.1 For all "functions" within the substation, an object oriented data model will be provided grouping the data into the smallest possible independent functions named Logical Nodes (LN). Entire functionality of S.A.S split into LNs.

The LNs and all data attributes contained therein will be named according to standardized "semantic". The Substation Configuration Language used to configure the S.A.S and individual IEDs is the SCL language.

4.2 Complete S.A.S will be formally documented within SCL especially through SCD (Substation Configuration Description) files.

The SCD files will ensure that all system engineering work has been recorded for re-use in future adaptations, extensions and refurbishment of the S.A.S. The SCD files is part of the documentation that PPC will receive with the delivery of the System.

ANNEXURE-I

DATA ON EXPERIENCE

[a] Name of the manufacturer.

[b] Standing of the firm as manufacturer of equipment quoted.

[c] Description of equipment similar to that quoted [supplied and installed during the last two years with the name of the organizations to whom supply was made].

[d] Details as to where installed etc.

[e] Testing facilities at manufacturer's works.

[f] If the manufacturer is having collaboration with another firm, details regarding the same and present status.

[g] A list of purchase orders, executed during last three years.

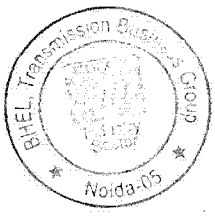
[h] A list of similar equipments of specified MVA rating, voltage class, Impulse level, short circuit rating, Designed, manufactured, tested and commissioned which are in successful operation for at least two years from the date of commissioning with legible user's certificate. User's full complete postal address/fax/phone must be indicated.

Place:

Date:

Signature of tenderer

Name, Designation, Seal



ANNEXURE-II

SCHEDULE OF INSTALLATIONS.

Rated MVA	Rated Voltage	Place of installation and complete postal address	Year of commissioning

Place: -

Date

Signature of Tenderer:

Name, Designation, Seal

BHEL, Transmission Business Group
Industry Sector
Noida-05

PROTECTION PANELS

1.0 Panels

General

Simplex panels shall be provided to suite the substations site. Panels shall be free standing mounted on floors fitted with embedded channels, insert plates or foundation bolts. The panels shall be made vibration and shock proof by providing anti vibration strips. The base frame of all panels shall have a smooth bearing surface such that when fixed on the embedded foundation channels/insert plates it shall be free standing and provide a level surface. The panels shall be completely metal enclosed, dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than IP-54 in accordance with IS 13947.The design, materials selection and workmanship shall be such that it provides a neat appearance both inside and outside without signs of welds, rivets or bolt heads from outside. The exterior surfaces shall be smooth and sleek. The panels of modern modular construction in 19 inch hinged racks would also be acceptable. Cable entry to the panels shall be from the bottom. The provision of all cable glands and shrouds of the panel shall be part of the scope of supply. Cable gland plate fitted on the bottom of the panel shall be connected to earthing of the panel/station through a flexible braided copper conductor.

Bidder shall be fully responsible for his bids to match the dimensions, colour and fittings with those in the existing control rooms where the extensions are required. In no case any proposal for increase in price at a later date shall be entertained by the Employer. However, panels not matching those already installed may be acceptable & only after Specific approvals will be required on a case by case basis

1.1 Simplex Panel

Simplex panels shall be provided with equipment mounted on front panel vertically. The wiring access shall be from rear for control panels and either from front or rear for relay panels. Where panel width is more than 800 mm, double leafed doors shall be provided. Doors shall be fitted with either built-in locking facility or with padlock.

1.2 Constructional Features

It is the responsibility of the Contractor to ensure that the equipment specified and such unspecified complementary equipment required for completeness of the protective/control schemes can be properly accommodated in the panels without congestion. Panels shall be free standing, floor mounting type and shall comprise of structural frames completely enclosed with smooth finished, cold rolled sheet steel of thickness not less than 3 mm for all weight bearing members such as base frame, front panel, door frames. All other parts may be provided with 2.0 mm thick steel sheet. There shall be sufficient reinforcement to provide level surfaces, resistance to vibration and rigidity during transportation and installation. All doors, removable covers and panels shall be gasketted all around with neoprene or superior material. Ventilating louvres, where provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.

1.3 Mounting

All equipment on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipment on front of panel shall be mounted flush. Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent devices. Equipment shall be readily accessible without use of special tools. Terminal marking on the equipment shall be clearly visible. The Contractor shall carry out cut-out, mounting and wiring of all equipment and items which are to be mounted in his panel. Cut-outs if any, provided for future mounting of equipment shall be properly blanked off with blanking plates. The center lines of switches, push buttons and indicating lamps shall be not less than 750 mm from the bottom of the panel. The center lines of relays, meters and recorders shall be not less than 450 mm from the bottom of the panel. The center lines of switches, push buttons and indicating lamps shall be matched to give a neat and

uniform appearance. The top lines of all meters, relays and recorders etc. shall be matched. No equipment shall be mounted on the doors. All the equipment connections and cabling shall be designed and arranged to minimise the risk of fire and damage which may be caused by fire.

1.4 Terminal Blocks

Terminal blocks and boards shall conform to the requirements of the relevant sections of this Specification. De-link type terminal blocks shall be provided in all the circuits and Terminals.

1.5 Supporting steel

All necessary embedded levelling steel, sills, anchor bolts, channels and other parts for supporting and fastenings the panels and vibration damping shall be supplied by the Contractor.

1.6 Panel internal wiring

Panels shall be supplied complete with interconnecting wiring provided between all electrical devices mounted and wired in the panels and between the devices and terminal blocks for the devices to be connected to equipment outside the panels. When panels are arranged to be located adjacent to each other all inter panel wiring and connections between the panels shall be furnished and the wiring shall be carried out internally. All wiring shall be carried out with 1100V grade, single core, stranded copper conductor wires with PVC (with FRLS) insulation. The minimum size of the multi-stranded copper conductor used for internal wiring shall be as follows.

a) All CT/ CVT/VT circuits shall be using 4.0 sq. mm lead.

b) All other circuits shall be using 2.5 sq. mm lead

All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters & troughs shall be used for this purpose. Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panels running throughout the entire length of the panels. Wire germination shall be made with solder less crimping type and tinned copper lugs, which firmly grip the conductor. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. All wires directly connected to trip circuit breaker or device shall be distinguished by the addition of red coloured unlettered ferrule. Longitudinal troughs extending throughout the full length of the panel shall be preferred for inter panel wiring. Inter-connections to adjacent panel shall be brought out to a separate set of terminal blocks located near the slots of holes meant for taking the inter-connecting wires. Contractor shall be solely responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipment.

All wiring shall be switch board type single flexible conductor tinned annealed copper wire insulated with varnished cambric, faulted asbestos, single braided cotton cover painted overall with flame proof moisture resistant paint and suitable for 660 volt service or equivalent polyncychloride insulation which has proved its utility in tropical regions against hot and moist climate and vermin (Misc. white ants and cockroaches etc) Rubber insulated wiring will not be accepted. The sizes of wiring in different circuits shall not be less than those specified below

The following colour scheme shall be used for the wiring.

Circuit where use. Colour of wire and ferrule.

Red phase of instrument transformer circuit:	Red.
Yellow phase of instrument transformer:	Yellow.
Blue phase of instrument transformer circuits:	Blue.
Neutral connections earthed or not earthed in the instrument transformer circuit:	Green.
A.C. Control wiring circuits using D.C. supply:	Grey

Wiring connected to the space heaters in the cubicles shall have porcelain braided insulation over a safe length from the heater terminals.

Each wire shall be continuous from end to end without having any joint within itself. Individual wires shall be connected only at the connection terminals or studs of the terminal blocks, meters, relays, instruments and other switchboard devices.

Terminal ends of all wires shall be provided with numbered ferrules suitable coloured for phase identification. At point of inter/connection where a change of number is necessary, duplicate ferrules shall be provided with the appropriate numbers on the changing end.

At the terminal connection, washers shall be interposed between terminals, wire terminals and the holding nuts. All holding nuts shall be secured by locking nuts. The connection stud shall project at least 6 mm. from the lock nut surface.

Wire ends shall be so connected at the terminal studs that no wire terminal number ferruled gets masked due to succeeding connections. All wires shall be suitable for bending to meet the terminal stud at rectangles with the stud axis, and they shall not be skewed.

All studs, nuts, bolts, scores, etc. shall be threaded according to the British Standard practice unless Employer's prior approval to any other practice of threading is obtained. Spare quantities of nuts, lock nuts and washers of all varieties used on the panel board shall be supplied to the extent of 10% of the used quantities.

1.7 TERMINAL BLOCKS

All the terminal blocks to be used in the panel shall be provided with 1100V grade stud type terminal block of Polyamide material of **Phoenix/Elmex / Connectwell**. At least 20% spare terminals shall be provided.

(i) All internal wiring to be connected to external equipment shall terminate on terminal blocks. Disconnecting type Terminal blocks shall be 1100 V grade and have 20 Amps. Continuous rating, molded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts, Markings on the terminal blocks shall correspond to wire number and terminal numbers on the wiring diagrams. All terminal blocks shall have shrouding with transparent unbreakable material. Terminal Block connectors built from cells of moulded dielectric and brass stud inserts shall be provided for terminating the outgoing ends of the cubicle wiring and the corresponding incoming tail ends of the control cables. All the terminal connectors shall have de-link (disconnecting) facilities.

(ii) Disconnecting type terminal blocks for current transformer and voltage transformer secondary leads shall be provided. Also current transformer secondary leads shall be provided with short-circuiting and earthling facilities.

(iii) At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.

(iv) Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors of external cable on each side.

(v) There shall be a minimum clearance of 250mm between the first row of terminal blocks and the associated cable gland plate or panel sidewall. Also the clearance between two rows of terminal blocks edges shall be minimum of 150mm

(vi) Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run in parallels and close proximity along each side of the wiring duct to provide for convenient attachment of internal panel wiring. The side of the terminal block opposite the wiring duct shall be reserved for the owner's external cable connections. All adjacent terminal blocks shall also share this field-wiring corridor. All wiring shall be provided with adequate support inside the panels to hold them firmly and to enable free and flexible termination without causing strain on terminals.

(vii) The number and sizes of the Owner's multi core incoming external cables will be furnished to the contractor after placement of the order. All necessary cable-terminating accessories such as gland plates, supporting clamps & brackets, wiring troughs and gutters etc. (except glands & lugs) for external cables shall be provided.

1.8 SPACE FOR CONTROL CABLES AND CABLE GLANDS

Sufficient space for receiving the control cables inside the board at the bottom of the cubicles and mounting arrangement for the terminal cable glands shall be provided. The specification does not cover supply of control cables and cable glands for which the employer will make separate arrangement.

1.9 SPACE HEATERS

60 W. 240 V. 50 HZ tubular space heaters with thermostat auto suitable for connection to the single phase AC supply complete with on-off switches located at convenient positions shall be provided at the bottom of the switch board cubicle to prevent condensation of moisture. The watt loss per unit surface of heater shall be low enough to keep surface temperature well below sensible heat.

2.0 DISTRIBUTION AND CONTROL OF AUXILIARY POWER CIRCUIT

2. 1 D.C. CIRCUIT

There shall be separate D.C. supply source from the main DCDB to be connected to each panel. The incoming DC supply sources (source I and source II) circuits in the panel shall be controlled by the two pole DC MCB's as incoming to the panels and the sub circuits shall be controlled by HRC fuses of different circuits having both "+" ve and "-" ve control. A continuous D.C. bus shall be provided in the panel for control, protection, supervision and indication circuit and other equipments shall be teed off in each panel from D.C. bus through a set of HRC Fuse (both on +ve and –ve side) D.C. supply to individual panel thus teed off shall be distributed within the panel as below.

2. 2 SWITCHES

Each panel shall be provided with necessary arrangement for receiving, distributing and isolating of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with required rating DC & AC MCB's. The selection of the main and sub circuit MCB rating shall be such as to ensure selective clearance of sub-circuit faults. Voltage transformer circuits for relaying and metering shall be protected by MCB. All MCB shall be confirming to relevant IEC/IS standard. The short time MCB rating of shall be more than 10 KA. The MCB shall have imprints of the fuse rating and voltage.

DC supply source1 & 2 supervision SCADA compatibility relays are to be mounted in the panel. Provision of DC illumination lamp with switch to be provided in each panel.

2.3 A.C. CIRCUIT

240 volts, single phase, A.C. auxiliary supply to the control and relay board will be fed from A.C. distribution board through a suitable fuse switch provided thereof. A continuous A.C. bus shall be provided the panel where from A.C. supply to each panel shall be teed off through a set of links. One 16 Amp rated M.C.B. shall be provided for the incoming A.C. supply. A set of fuse and link rated for 6 amps for 3 pin plug circuit, 6 amps for 2 pin ply circuit and 6 amps for heater and illuminating lamp circuits shall also be provided.

AC supply supervision SCADA compatibility relays are to be mounted in the panel.

2.4 TEST BLOCKS

Switchboard type, back connected, test blocks with contacts shall be provided with links or other devices for shorting terminals of C.T. leads before interrupting testing instruments in the circuit without causing open circuit of the C.T. The potential testing studs shall preferably be housed in narrow recesses of the, block molding insulation to prevent accidental short-circuit across the studs. All Test Blocks for meters, relays, etc. shall be placed as close to the respective equipment as possible.

2.5 SAFETY EARTHING FOR THE PANEL

All panels shall be equipped with an earth bus securely fixed. Location of earth bus shall ensure no radiation interference for earth system under various switching conditions of isolators and breakers. The materials and size of the bus shall be at least 25X6 sq.mm perforated copper threaded holes at gap of 50mm with a provision of bolts and nuts for connection with cable armours and mounted equipment etc for effective earthing. When several panels are mounted

adjoining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply. Provision shall be made for extending the earth bus bars to future adjoining panels on either side.

Provision shall be made on each bus bar of the end panels for connecting substation earth grid. Necessary clamps and connectors shall be included in the scope of contract.

All metallic case of the relays, instruments and other panel mounted equipment including gland plate shall be connected to the earth bus by copper wires of size not less than 2.5 sq mm.The colour code of earthing shall be green.

Looping of earth connections, which would result in loss of earth connections to other devices when loop is broken shall not be permitted. However looping of earth connections between equipment to provide alternative path to earth bus shall be provided.

VT and CT secondary neutral or common lead shall be earthed at one place only at the terminal blocks where they enter the panel. Such earthing shall be made through links so that earthing may be removed from one group without disturbing the continuity of earthing syatem for other groups.

2.6 PANEL BOARD LIGHTING

The panel interior shall be illuminated by 20W, CFL tube light connected to 240 V. single phase A.C. The illumination of the interior shall be free from hand shadows and shall be planned to avoid any strain or fatigue to the fireman likely to be caused due to subnormal or non-uniform illumination. One emergency D.C. light (CFL type) shall also be provided for each relay panel with individual switch, with proper identification mark.

A door operated button switch shall be provided for control of the A.C. lighting for all the control and relay panel interiors.

One 5 amps. two pin socket and one 15 amps. 3 pin power socket outlets together with plugs shall be provided at convenient points in the panel board for A.C. supply.

3.0 Relays

General

The Numerical Relays in general shall comply with the following requirements:

1. All relays shall conform to the requirements of IS: 3231/IEC60255/IEC 61000 or other applicable standards. Relays shall be suitable for flush or semi flush mounting on the front with connections from the rear.

2. The offered relays shall be completely numerical.
- The communication protocol shall be as per 'IEC61850 Edition 2'
- The test levels of EMI as indicated in IEC 61850 shall be applicable to these relays.
- Protection elements should be realized using software algorithm.
- Hardware based measurement shall not be acceptable.

3. The relay shall be provided with both 1A and 5A CT inputs and shall be selectable at site.
4. It shall be possible to energize the relay from either AC or DC auxiliary supply.

5. The offered relay shall have a comprehensive local HMI for interface. It shall have the following minimum elements so that the features of the relay can be accessed and setting changes can be done locally for configuration software.
- At least 20 character alphanumeric backlit LCD display unit Fixed LEDs (for trip, Alarm, Relay available & Relay out of service) & programmable LEDs which can be assigned to Tactile keypad for browsing and setting the relay menu and protection function for local annunciation.

6. The minimum pickup threshold voltage of relay for 220 V DC systems must be min 138 V for binary input in order to prevent pick up during DC earth fault condition.
7. The relays supplied should be compatible to redundant communication architecture, shall be complied with the IEC 62439-3 standards of parallel redundancy protocol (PRP).

8. The relays provided should be complied with the international standards of NERC CIP or BDEW for cyber security to provide protection against unauthorized disclosure, transfer,

modification, or destruction of information and/or information systems, whether accidental or intentional.

9. All PCB used in relays should have harsh environmental tested as per standard IEC 60068-2 (HEC) to increase the particle repellency and thereby increasing the life of relay.

10. The offered relays shall be completely numerical and should comply to 'IEC61850 Edition 2' protocol. The relay must support following requirements for communication ports and protocols,

- The relays shall generate GOOSE messages as per latest IEC 61850 standards for interlocking and also to ensure interoperability with third party relays.
- The relay must have front RS232/USB/RJ45 port for local communication with the device
- The communication protocol shall be as per 'IEC61850 Edition 2'
- The relay should be compatible to redundant communication architecture and shall be complied with IEC 62439-3 standards of parallel redundancy protocol (PRP)
- The relays shall generate GOOSE messages as per IEC 61850 standards for interlocking and also to ensure interoperability with third party relays.
- Necessary user friendly configuration tool shall be provided to configure the relays. It should be compatible with SCL/SCD files generated by a third party system.
- GOOSE signals shall be freely configurable for any kind of signals using graphic tool/user friendly software.
- The offered relay must support at least 4 no's or more of 61850 clients
- The relay must support time synchronization through SNTP/IRIG B demodulated.
- The relays provided should be complied with the international standards of NERC CIP or BDEW for cyber security to provide protection against unauthorized disclosure, transfer, modification, or destruction of information and/or information systems, whether accidental or intentional.
- The relay settings shall be provided with adequate password protection. The password of the relay should be of 4 character upper case text to provide security to setting parameter.

11. The relays shall have the following tools for fault diagnostics

- Fault record – The relay shall have the facility to store at least 5 last fault records with information on cause of trip, date, time, trip values of electrical parameters.
- Event record – The relay shall have the facility to store at least 200 time stamped event records with 1ms resolution.
- Disturbance records – The relay shall have capacity to store the waveforms for a minimum duration of at least 5 secs with settable pre and post fault duration times at a minimum sampling rate of 800 Hz or Higher.
- Except for differential protection the disturbance recorder must have capability to capture at least 8 analogue channels (IA, IB, IC, IN, VA, VB, VC, and VN) and 15 digital channels (start of protection element, trip of protection element, binary input, trip output etc) selectable at site.
- For differential protection relay, the disturbance recorder must have capability to capture at least 12 analogue channels and 30 digital channels.
- Necessary software shall be provided for retrieving and analyzing the records.

12. The relay settings shall be provided with adequate password protection. The password of the relay should be of at least 4 character to provide security to setting parameter

13. The relay shall have comprehensive self-diagnostic feature. This feature shall continuously monitor the healthiness of all the hardware and software elements of the relay. Any failure detected shall be annunciated through a output watchdog contact. The fault diagnosis information shall be displayed on the LCD and also through the communication port.

14. The Numerical Relays shall be provided with 1 Set of common support software compatible with both Windows 7 and higher which will allow easy settings of relays in addition to

uploading of event, fault, disturbance records, and measurements.

- The relay settings shall also be changed from local or remote using the same software.
- Additional functions can be added to relay by software upgradation and downloading this upgraded software to the relays by simple communication through PC.

15. All protective relays shall be in draw out or plugin type/modular cases with proper testing facilities. Necessary test plugs/test handles shall be supplied loose and shall be included in contractor's scope of supply.

16. All AC operated relays shall be suitable for operation at 50 Hz. AC Voltage operated relays shall be suitable for 110 Volts VT secondary and current operated relays for 1 amp CT secondary. All DC operated relays and timers shall be designed for the DC voltage specified, and shall operate satisfactorily between 80% and 110% of rated voltage. Voltage operated relays shall have adequate thermal capacity for continuous operation.

17. The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification. Necessary auxiliary relays and timers required for interlocking schemes for multiplying of contacts suiting contact duties of protective relays and monitoring of control supplies and circuits, lockout relay monitoring circuits etc. also required for the complete protection schemes described in the specification shall be provided. All protective relays shall be provided with at least two pairs of potential free isolated output contacts. Auxiliary relays and timers shall have pairs of contacts as required to complete the scheme; contacts shall be silver faced with spring action. Relay case shall have adequate number of terminals for making potential free external connections to the relay coils and contacts, including spare contacts.

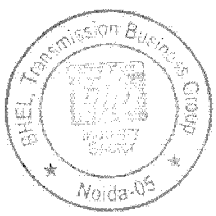
18. Timers shall be of solid state type. Time delay in terms of milliseconds obtained by the external capacitor resistor combination is not preferred and shall be avoided.

a. No control relay, which shall trip the power circuit breaker when the relay is deenergized, shall be employed in the circuits.
b. Provision shall be made for easy isolation of trip circuits of each relay for the purpose of testing and maintenance.
c. Auxiliary seal in units provided on the protective relays shall preferably be of shunt reinforcement type.
d. The setting ranges of the relays offered, if different from the ones specified shall also be acceptable if they meet the functional requirements.

19. Any alternative/additional protections or relays considered necessary for providing complete effective and reliable protection shall also be offered separately. The acceptance of this alternative/ additional equipment shall lie with the OPTCL

20. The relay must be able to continuously measure following parameters with a typical accuracy of ± 1%.

- Current (0.05 to 3 In) +/- 1.5% of reading,
- Voltage (0.05 to 2 Vn) +/- 1.0% of reading
- Frequency (40 to 70 Hz) +/- 0.03 Hz
- Phase 0° to 360° +/- 5.0%
- Power (W) +/- 5.0% of reading at unity power factor
- Reactive power (VARS) +/- 5.0% of reading at zero power factor
- Apparent power (VA) +/- 5.0% of reading



4.0 PROTECTION SYSTEM

4.1 PROTECTIVE SYSTEM

4.1.1 Protection discrimination

On the occurrence of a fault on the power system network the high speed discriminating protection systems (main protection) shall rapidly detect the fault and initiate the opening of only those circuit breakers which are necessary to disconnect the faulted electrical element from the network. Protection equipment associated with adjacent electrical elements may detect the fault, but must be able to discriminate between an external fault and a fault on the electrical element which it is designed to protect. Sequential time delayed tripping is not permitted except in the following specific circumstances:

- Protection for short connections between post current transformer housings and circuit breakers when the technical advantages of complete overlapping of the protection are outweighed by economic considerations, (i.e. short-zone protection)
- Operation of time graded back-up protection takes place as a result of either the complete failure of the communication links associated with the main protection systems, or the fault resistance is substantially greater than a value which can be detected by main protection systems.
- Operation of line back-up protection to disconnect primary system faults in the case of a circuit breaker failing to operate, (i.e. circuit breaker failure protection)
- All back-up protection systems shall be able to discriminate with main protection systems, circuit breaker fail protection and with other back-up protection systems installed elsewhere on the transmission system.

4.1.2 Protection settings

A list of the settings to be applied to all protection systems together with all associated calculations, shall be provided for review and approval not less than three months prior to the first programmed date for commissioning. The settings for line protection shall be such as to permit correct operation of the protection for earth faults with up to 100 ohms fault resistance. Any limitations imposed on the power system as a result of the settings proposed shall be explicitly stated. In the absence of system data required for calculation purposes, assumptions may be made providing these are clearly identified as such in the relevant calculations.

4.1.3 Fault clearing time

The protection equipment shall be capable of achieving the following discriminative fault clearing times, inclusive of circuit breaker and signaling times:

- One millisecond for all electrical elements whose boundary connections are defined by circuit breakers located within a given substation.
- For interconnecting tie lines in which the boundary connections of the electrical element being protected are defined by circuit breakers located in adjacent switching stations, an additional 20 ms fault clearance time is allowed at the substation remote from the fault point. This additional fault clearance time is permitted subject to the requirement that the positive sequence impedance of the primary circuit from the switching terminal to the point of fault shall not be less than ten ohms.

The Contractor shall supply the Project Manager with details of the operating times under defined conditions of all protection equipment proposed. Any limitation in operating time performance shall be declared by the Contractor, e.g. end of zone faults where distance protection is applied, high resistance faults, faults at high X/R with significant DC component and time constant, faults coincident with communication channel noise. The Contractor shall specify the increase in operating time which could occur under such conditions.

4.1.4 Signaling equipment operating times:

For design purposes the operating times of signaling equipment to provide a contact signal for use with associated distance protection shall be assumed to be as follows:

- Intercropping (transfer trip) not greater than: 20 milliseconds
- Permissive transfer trip: 15 to 20 milliseconds
- Blocking signal operate time: 10 milliseconds
- Blocking signal reset time: 10 milliseconds

4.2 PROTECTION SCHEMES

4.2.1 Line protection

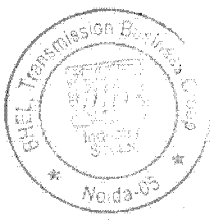
General requirement for line protection relays:

The line protection relays shall protect the line and clear faults on line in the shortest possible time with reliability, selectivity and full sensitivity to all types of line fault. The general concept for

1. 400kV and 220kV levels is to have primary and back-up protection systems having equal performance requirement especially in respect of time as would be provided by two Main protections called **Main-I** and **Main-II.** It is desirable that Main-I and Main-II protection should work on two different principles of operation and one back up dir O/C & E/F protn is envisaged.
2. For 132 kV level the concept of one main distance protection and one backup directional O/C and E/F protection is envisaged.
3. For 33 kV level, the requirement is that of modular directional O/C and E/F protection.

The protection requirements are summarised below, and illustrated in the single line diagrams in the schedules.

- **400kV and 220kV lines**
  - Main I Numerical non switched distance protection meeting performance levels.
  - Main II Numerical non switched phase comparison, carrier aided or of numerical distance using a different principle of operation
  - Phase segregated tele protection facility
  - Power swing detection blocking and tripping
  - Synchronizing.
  - Line overvoltage (Only for 400kV and 220kV line □ 200kM long)
  - Autoreclosure
  - Numerical directional overcurrent and earth fault
  - Three phase to ground
  - Numerical local breaker back up
  - Pole discrepancy protection



4.2.2 Distance Protection Relay

a. The IEC 60255-121 standard "Functional requirements for distance protection" published in March 2014, specifies the minimum requirements for functional and performance evaluation of distance protection relays, describes the tests to be performed and how to publish the test results. The relay should conform to above standard.

b. The protection should be fully numerical and be based on a non-switched scheme.

c. Provide protection for the transmission line from all types of faults-phase to earth faults as well as multiphase faults. The protection algorithm shall have dual redundant distance protection algorithms to detect all types of power system faults so as to arrive at a secure trip decision with correct phase selection and proper direction discrimination in the shortest possible time.

d. The protection should have non-switched measurement, which implies processing of six possible fault loops (six –loop measurement).

e. It should have polygonal characteristics with independently adjustable reactive and resistive reaches for maximum selectivity and maximum fault resistance coverage. The zones shall have independent settable earth fault compensation factors to cater to adjacent lines with different zero sequence to positive sequence ratios.

f. Selection shall be so that the first zone of the relay can be set to about 80% - 85% of the protected line without any risk of non-selective tripping.

g. The second and third zone elements shall provide backup protection in the event of the carrier protection or the first zone element failing to clear the fault, zone-2 shall cover full protected section plus 50 % of the next section, zone-3 shall normally cover the two adjacent sections completely.

h. It must have load encroachment features and must support blocking of the selected zones during heavy load condition.

i. It should have adequate number of forward zones (minimum three) and a reverse zone. The zone reach setting ranges shall be sufficient to cover line lengths appropriate to each zone. Carrier aided scheme options such as permissive under reach, over reach, & blocking and non-carrier aided schemes of zone 1 extension and Loss of load accelerated tripping schemes shall be available as standard. Weak in feed logic and current reversal guard also shall be provided.

j. In case the carrier channel fails, one out of the non-carrier based schemes cited above should come into operation automatically to ensure high speed and simultaneous opening of breakers at both ends of the line.

k. In addition to the conventional impedance measuring algorithm the distance protection relay should have a separate measuring technique in the same hardware completely different to the conventional impedance measuring principal. Both the algorithms should run in parallel and should take trip decisions independently.

l. Have a maximum operating time up to trip impulse to circuit breaker (complete protection time including applicable carrier and trip relay time) with CVT being used on the line :

- For SIR 0.01-4 : as 35ms at the nearest end and 55ms at the other end of line
- For SIR 4-15 : as 40ms at the nearest end and 60ms at the other end of line
- With carrier transmission time taken as 18ms.
- Relay should have **sub cycle tripping** facility for any zone1 fault i.e. max. relay operating time for any zone 1 fault should not be more than **19ms.**

m. Have a secure directional response under all conditions, achieved by memory voltage polarizing and/or healthy phase voltage polarizing as appropriate.

n. Shall have an independent Directional Earth Fault (DEF) protection element to detect highly resistive faults. This element shall have an inverse time/definite time characteristic with a possibility to configure the DEF as a channel-aided DEF or a channel-independent DEF.

o. Have logic to detect loss of single/two phase voltage input as well as three phase voltage loss during energisation and normal load conditions. The voltage circuit monitoring logic should in addition to blocking the distance protection element, enable an emergency overcurrent element to provide a standby protection to the feeder till the re-appearance of voltage signal.

- The VT fuse failure function shall function properly irrespective of the loading on the line. In other words the function shall not be inhibited during operation of line under very low load conditions.

p. Have necessary logic to take care of switch-on-to-fault condition. Energisation of transformers at remote line ends and the accompanying inrush current shall not cause any instability to the operation of relay.

q. The line protection IED should have power swing blocking feature, with facilities for :

i. fast detection of power swing
ii. selective blocking of zones
iii. Settable unblocking criteria for earth faults, phase faults and three phase faults.

r. Also the Distance protection IED should have following features in built in it.

- Suitable for single pole or three pole tripping.
- Shall have inbuilt CT supervision facility. A time-delayed alarm shall be issued if a CT open circuit is detected.
- Shall have inbuilt Trip circuit supervision facility to monitor both pre- and post close supervision facilities. An alarm shall be generated.

Shall have inbuilt Circuit Breaker Failure protection based on undercurrent detection and/or circuit breaker auxiliary contact status and/or distance protection reset status. Provision shall be given to initiate the breaker fail logic using a digital input from external protection devices.

- Shall have inbuilt in broken conductor detection by measuring the ratio of I 2 & I1. The sensitivity of the logic shall not be affected during operation under low load.
- Shall have a fault locator with an accuracy of ±3%. The display shall be in kilometers, miles or percentage impedance. The fault locator should have built in mutual compensation for parallel circuit.

s. Be capable of performing basic instrumentation functions and display various instantaneous parameters like Voltage, current, active power, reactive power etc. in primary values. Additionally all sequence current and voltage values shall be displayed on-line. Also the direction of power flow shall be displayed.

t. The relay shall have a built-in auto-reclose function with facilities for single pole / three pole / single and three pole tripping. It shall be possible to trigger the A/R function from an external protection. A voltage check function which can be programmed for dead line charging/dead bus charging / check synchronising shall be included.

u. Records containing discrete data on the last five faults shall be made available. In particular the fault resistance value shall be available for each record.

v. Facility for developing customized logic schemes inside the relay based on Boolean logic gates and timers should be available. Facility for renaming the menu texts as required by operating staff at site should be provided.

w. The protection relay should have the following additional elements

i. Under / over voltage protection. The relay shall have two stages of voltage protections where each stage can be set as under/over voltage. The drop off/Pickup ratio can be set up to 99%.

ii. The relay shall have built in Circuit Breaker Supervision Functions for Condition based Circuit Breaker Maintenance
iii. The relay shall be able to detect any discrepancy found between NO & NC contacts of breaker
iv. The relay shall monitor number of breaker trip operations
v. The relay shall record the sum of the broken current quantity
vi. The relay shall also monitor the breaker operating time
vii. In all the above cases the relay shall generate an alarm if the value crosses the threshold value.

4.2.2 Numerical transformer differential relay

a. **General requirements for transformer protection scheme : The differential protection IED**

- The offered relay must be suitable providing complete protection for 2 winding

transformer, 3 winding transformer and auto transformer

- **Category-A:** For 3 winding differential Protection, it must have 12 CT input, 3 for phase CT HV side, 3 for phase CT LV side, 3 for Phase CT TV side,1 for neutral CT HV, 1 for neutral CT LV, 1 for neutral CT TV.
- **Category-B:** For 2 winding differential protection, it must have 8 CT input, 3 for phase CT HV side, 3 for phase CT LV side, 1 Neutral CT HV side, 1 Neutral CT LV side.
- The relay must be suitable for providing low impedance REF protection for auto transformer.
- For 2 Winding & 3 winding transformer 4 VT inputs are required.
- The protection function requirement for Transformer protection relays are as mentioned below,
- Differential protection (Low Impedance type with 3 slope characteristic)
- 2 elements of REF Protection for 2 winding transformer and must have option of Low Impedance and High impedance REF as per the site requirements.
- 3 elements of REF protection for 3 winding transformer and must be selectable between Low and High impedance REF
- REF protection for autotransformers.
- Backup Over current and Earth fault for each winding
- Thermal overload protection
- Over excitation protection
- Over and Under frequency protection
- CB Fail protection for each Winding (CT) input
- Shall be stable during magnetizing inrush and over fluxing conditions. Stabilization under inrush conditions shall be based on the presence of second harmonic components in the differential currents. The second harmonic blocking threshold shall be programmable one.
- Shall have facility to deactivate harmonic restraint and over fluxing restraint functions.
- Shall have saturation discriminator as an additional safeguard for stability under through fault conditions.
- The relay should be capable of detecting the CT saturation. Relay should use appropriate algorithm to detect light saturation condition.
- It shall be possible in the relay to individually set MVA rating of transformer per winding.
- Relay should have vector group and magnitude correction. Relay should have facility for filtering zero seq. current for stability of X-mer differential protection (87T) during through fault.
- Thermal overload protection as per IEC 60255.
- The relay shall have through fault monitoring element to monitor the HV, the LV or the TV winding to give the fault current level, the duration of the faulty condition, the date & time for each through fault.
- The relay shall have REF protection, be selectable separately for each winding and programmable as either high or low impedance. The REF function should be able to share CT's with the biased differential function. The REF protection provided should be suitable for auto transformer also.
- Shall have all output relays suitable for both signals and trip duties.
- Shall be stable during magnetizing inrush and over fluxing conditions. Stabilization under inrush conditions shall be based on the presence of second harmonic components in the differential currents. The second harmonic blocking threshold shall be programmable one.
- Shall have facility to deactivate harmonic restraint and over fluxing restraint Functions.
- Shall have saturation discriminator as an additional safeguard for stability under through fault conditions.
- Shall have software for interposing current transformers for angle and ratio correction to take care of the angle & ratio correction.

- Shall have all output relays suitable for both signals and trip duties.
- Shall have transient bias to enhance the stability of differential element during external fault condition.
- The relay should have combined harmonic blocking and restraint features to provide maximum security during transformer magnetizing inrush conditions

b. Functional Description.

i. Differential Protection:

- The relay shall be biased differential protection with triple slope tripping characteristics with faulty phase identification / indication. The range for the differential pick-up shall be from 0.1 to 2.5 pu. Its operating time shall not exceed 30 ms at 5 times rated current.
- The relay shall have adjustable bias slopes m1 from 0 % to 150 % and slope m2 from 15% to 150 % so as to provide maximum sensitivity for internal faults with high stability for through faults.
- The relay shall have an unrestrained highest element to back up the biased differential function and the setting range for it shall have a minimum setting of 5pu and a maximum setting of 30pu.
- The relay shall have the stability under inrush conditions. The ratio of the second harmonic component to the fundamental wave for the differential currents of the measuring system shall serve as the criterion.
- The device shall have reliable detection technique, preferably no gap detection technique to ensure stability during inrush. Any type of time delay is not acceptable to differentiate inrush and fault condition.
- The relay shall provide restraint for over fluxing condition for the transformer by measuring the ratio of the fifth harmonic to the fundamental for the differential current if subjected to transient over fluxing. The fifth harmonic blocking feature should have variable percentage setting.

ii. Restricted Earth fault Protection (64 R)

This function should be provided to maximise the sensitivity of the protection of earth faults The REF function should be selected separately for each winding and programmable as either high or low impedance. The REF function should be able to share CT's with the biased differential function. As in traditional REF protections, the function should respond only to the fundamental frequency component of the currents. The REF protection provided should be suitable for auto transformer also.

iii. Over fluxing Protection (99 GT)

The relay shall over fluxing protection Volts/Hertz protection to the transformers protected. By pairs of v/f and t, it shall be possible to plot the over fluxing characteristics in the relay so that accurate adaptation of the power transformer Over fluxing characteristics is ensured. In addition the relay should have a definite time element for alarm. The reset ratio for over fluxing Protection shall be 98%.

iv. Overload Protection.

Shall have thermal overload protection for alarm and trip condition with continuously adjustable setting range of 10-400% of rated current

v. Overcurrent Protection (50,51)

The relay shall have three stages of definite time overcurrent protection as backup operating with separate measuring systems for the evaluation of the three phase currents, the negative sequence current and the residual current. In addition the relay shall have three stages of Inverse time overcurrent protection operating on the basis of one measuring system each for the three phase currents, the negative sequence current and

the residual current.

vi. Over / Under frequency

The relay shall have four stages of frequency protections where each stage can be set as under/over frequency, under/over frequency.

vii. Over / Under Voltage

The relay shall have two stages of voltage protections where each stage can be set as under/over voltage. The adjustable drop off/Pickup ratio better than 97% should be available.

viii. Local Breaker Back up protection:

The relay shall in built LBB protection to detect the failure in the local breaker using the undercurrent criteria and trip the upstream breaker.

4.2.3: FEEDER MANAGEMENT RELAY

Protection and Control function requirements for feeder Management Relay.

- The Relay provides the following current based protection functions:
- Phase/Neutral/Ground instantaneous overcurrent
  - Phase/neutral/ground time overcurrent
  - Negative sequence Timed overcurrent
  - Phase/neutral directional overcurrent
  - Restricted Ground Fault (87REF)
  - Breaker Failure (50BF)
  - Thermal Model (49)
  - Cold Load Pickup (CLP)
- The Relay provides the following voltage based functions:
  - Phase Over and Under Voltage
  - Neutral Over Voltage
  - Directional Power
  - Forward Power
- The Relay provides the following control functions:
  - 4 Shot Auto Reclose (79)
  - VT Fuse failure (VTFF)
  - Over/Under Frequency (81O/81U)
  - Rate of change of Frequency (81df/dt)
  - Synchrocheck (25)
  - Breaker Failure (50BF)
- At least 5 user configurable commands for local and remote (Remote through SCADA on MMS)
- Configurable Single line diagram for the substation bay.
- The relay should have 2 switchable setting groups for dynamic reconfiguration of the protection elements due to changed conditions
- Programmable LOGIC
- Relay supports user defined logic to build control schemes supporting logic gates, timers, nonvolatile latches.
- The Relay configuration tool has an embedded graphical user interface to build programmable logic.

Front-Panel Visualization

- The front panel includes user-programmable LEDs and pushbuttons and navigation keys.
- For bay information that includes user programmable screens for:
  - Single line diagram displaying
  - Switchgear operation
  - Access to metering information

- Alarm panel display.
- I/O status display.
- Relay settings

4.2.4 BACKUP RELAYS (Current Protection).

The combined overcurrent and earth-fault relay is connected to the current transformers of the object to be protected. The overcurrent unit and the earth-fault unit continuously measure the phase currents and the neutral current of the object. On detection of a fault, the relay will start, trip the circuit breaker, provide alarms, record fault data, etc., in accordance with the application and the configured relay functions.

i. Functional description:

(a) Three-Phase Overcurrent (50/51) & Earth Overcurrent (50N/51N)

Three independent stages are available either for phase and earth fault protection. For the first and second stage the user may independently select definite time delay (DTOC) or inverse time delay (IDMT) with different type of curves (IEC, IEEE/ANSI, IS 3231:1987).

(b) Three-Phase & Earth-Fault Directional Overcurrent (67/67N)

Each of the three-phase overcurrent stages & earth fault stages can be independently configured as directional protection and with specific characteristic angle (RCA) and boundaries as per IEC, IEEE/ANSI,IS . The phase fault directional elements should be internally polarised by quadrature phase to phase voltages. A synchronous polarising function or any other suitable algorithm may be provided to ensure a correct operation of the overcurrent elements for close-up three phase faults where the collapse of the polarising line voltages occurs.

(c)Under / Over Voltage (27/59)

Independent under-voltage stage and two or more over-voltage stages may be provided. They should be definite time elements. Each stage can be configured to operate from either phase-neutral or phase-phase voltages. The drop off to pick up ratio should be 99.5%.

(d) Under / Over Frequency (81U/O)

Time delayed under and over frequency protection on the fundamental form of frequency protection is to be provided When the frequency measured is crossed 6 pre-defined thresholds, the relays should generate a start signal and after a user settable time delay, a trip signal.

(e) Circuit Breaker Failure Protection (50BF)

The circuit breaker failure verifies the effective opening of the CB by a dedicated undercurrent threshold. The circuit breaker failure function can be activated by trip of a generic protection or/and external command by the relevant digital input. The circuit breaker failure protection can be used for tripping upstream circuit breakers too.

4.2.5 BUS BAR PROTECTION:

Bus bar protection schemes shall be provided for each main and transfer bus of 400 KV and 200 KV provided in the switch yard/GIS S/S. This shall constitute main and check features. The overall scheme shall be engineered such that operation of both main and check features connected to the faulty bus shall result in tripping of the same. The scheme shall be provided with necessary expansion capacity and interfaces for adding features when the switch yard is

extended in future to its ultimate capacity. The bus bar relay shall be of latest numerical relay having IEC protocol 61850 compliance.

(a) Bus-bar protection (Latest version numerical having IEC-61850 protocol compliance)
Bus bar protection schemes shall be provided for each main bus of 400kV and 220kV switchyard. The overall scheme shall be engineered so as to ensure that operation of any one out of two schemes connected to main faulty bus shall result in tripping of the same. However in case of transfer bus, where provided, only one bus-bar protection scheme shall be required.

(b) Each bus-bar protection scheme shall:

1. Be of modular construction and have features of self-monitoring facility to ensure maximum availability of scheme. The scheme shall be Numerical based.
2. Have maximum operating time up to trip impulse to trip relay for all types of faults of 15 milli seconds at 5 times setting value.
3. Operate selectively for each busbar.
4. Give hundred percent security up to 40kA fault level.
5. Incorporate a check feature.
6. Incorporate continuous supervision for CT secondary against any possible open circuit and if it occurs, shall render the relevant zone of protection inoperative and initiate alarm.
7. Not give false operation during normal load flow in bus-bars.
8. Incorporate clear zone indication.
9. Be of phase segregated and triple pole type and provide independent zones of protection for each bus (including transfer bus if any). If a bus section is provided then each side of the bus section shall have separate bus-bar protection scheme.
10. Include individual high speed hand reset tripping relays for each feeder, including future ones.
11. Be of low/medium impedance biased differential type and have operate and restraint characteristics.
12. Be transient free in operation
13. Include continuous DC supplies supervision.
14. Shall include multitap auxiliary CT's for each bay including future bays as per SLD and also include necessary CT switching relays wherever CT switching is involved.
15. Include protection 'in/out' switch for each zone with at least six contacts for each switch.
16. Shall have CT selection incomplete alarm wherever CT switching is involved.
17. Have necessary auxiliary relays to make a comprehensive scheme.

At existing substations bus-bar scheme with independent zones for each bus will be available. All necessary co-ordination for 'CT' and 'DC' interconnections between existing schemes (panels) and the bays proposed under the scope of this contract shall be fully covered by the bidder. Any auxiliary relays, trip relays, flag relays required to facilitate the operation of bays covered under this contract shall be fully covered in the scope of the bidder.

4.2.6 TIME SYNCHRONIZATION EQUIPMENT FOR SUBSTATION

The Bidder shall offer necessary time synchronisation equipment complete in all respects including antenna, all cables, processing equipment etc. required to receive co-ordinated universal time (UTC), transmitted through GEO Positioning Satellite System (GPS).

The time synchronising system should be compatible for synchronisation with event loggers, disturbance recorders, relays, computer systems and all other equipment provided in the protection, control and metering system of the substation wherever required.

Equipment should operate up to an ambient temperature of 50C and 100% humidity. The synchronisation equipment shall have two microsecond accuracy. Equipment should give real time corresponding to IST (taking into consideration all factors such as voltage and temperature variations, propagation and processing delays etc.

Equipment should meet the requirement of IEC 255 for storage and operation. The system should be able to track the satellites to ensure no interruption of synchronisation signal.

The output signal from each port shall be programmable at site for either one hour, half hour, minute or second pulse, as per requirement.

The equipment offered shall have six output ports. Various combinations of output ports shall be selected by the Project Manager, during detailed engineering, from the following:

1. Voltage signal : 0-5V continuously settable, with 50 ms. minimum pulse duration.
2. Potential free contact : minimum pulse duration of 50 ms
3. IRIG-B OR SNTP
4. RS232C

The equipment should have a periodic time correction facility of one second periodicity.

Time synchronisation equipment shall be suitable for operation from 220V DC as available at substation with a voltage variation of +10% and -20%. Any other power supply that may be required for proper functioning of the equipment shall be derived by the Bidder from his own equipment which shall form an integral part of the system.

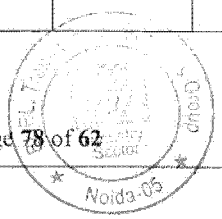
Equipment shall have real time digital display in hour, minute, second (24 hour mode) and have a separate time display unit to be mounted on the top of panels having display size of approximately 100 mm height.

4.2.7 No. of Devices in different protection panels:

(a) Line Feeder Protection Panel

The line protection panel or panels may be a single panel or more panels to accommodate all the equipment listed below.

		Quantities required			
Sl. No	**Equipment**	**400kV**	**220kV**	**132kV**	**33kv**
1	Main-I protection scheme (composite numerical distance protection relay with auto reclosing and check syncronising facility)	1 set	1 set	1 set	Not required
2	Main-II protection scheme (composite numerical distance protection or phase comparison relay with auto reclosing and check syncronising facility)	1 set	1 set	Not required	Not required
3	Composite numerical directional & or non-directional over current and earth fault relay.(selectable Features Dir & Non Dir)	1 set	1 set	1 set	1 set
4	Over voltage/ Under voltage/Frequency protection scheme (if not available in the main-I& II or Back-up protection relay)	1 set	1 set	1 set	1 set



5	Selector switch for carrier in/out for main-I and main-II protection scheme	2 Nos.	2 Nos.	1No.	Not required
7	Disturbance recorder (if not available in the main-I& II and Back-up protection relay)	1 set	1 set	1 set	1set
8	Distant-to-fault locator for phase and earth faults(if not available in the distance protection or main protection module)	1 set	1 set	1 set	Not required
9	CVT/VT selecting relays or switches (depending on switching scheme)	1 set	1set	1set	required for two bus scheme
10	Test terminal blocks for Main-I/ Main II/other protection relay	1 set for each module	1 set for each module	1 set for each module	1 set for each module
11	Auxiliary relays for carrier supervision of Main-I and Main II protection relays (depending on its application)	1 set	1 set	1 set	Not required
12	Carrier receive lockout relay (depending on its application)	1 set	1 set	1 set	Not required
13	Breaker failure protection scheme (if not available in the main-I& II or Back-up protection relay)	1 set	1 set	1 set	1 set
14	Trip circuit pre and post supervision relays for trip coil I and II	1 set	1 set	1 set	1 set
15	DC and AC supply supervision relay	1 set	1 set	1 set	1 set
16	Electrical reset relays for circuit breaker trouble shooting	1 set	1 set	1 set	1 set
17	Trip relays single/three phase for group-A	1 set	1 set	1 set	1 set
18	Trip relays single/three phase for group-B	1 set	1 set	1 set	~~1 set~~
19	Trip relays single/three phase for LBB	1 set	1 set	1 set	1 set
20	Under Frequency Relay(in built feature of Main-I&II or O/C & E/F relay)	1 set	1 set	1 set	1 set
21	Numerical Bay Control Unit of adequate BI, BO, Transducers etc as per the site requirement & detailed Engg. done.	1 No	1 No	1 No	* 1 No * BCPU can be considered.

(b) Transformer Protection Panel:

The transformer protection panel or panels may be a single panel or more panels to accommodate all the equipments listed below.

		Quantities required		
Sl. No	**Equipment**	**For each High Voltage panel of 400/220kV and 220/132kV transformers**	**For each High Voltage panel of 220/33kV and 132/33kV transformers**	**For each Low Voltage Panel of transformers**
1	Main-I Transformer composite numerical protection comprising of the following: • Differential protection • earth fault protection • Over fluxing protection	1 set	1 set	Not required
2	Main-II Duplicated numerical protection as Main-I	1 set	Not required	Not required
3	Composite numerical directional over current and earth fault protection relay(selectable Features Dir & Non Dir)	1 set	1 set	1 set
	Numerical earth fault protection (high impedance with Stabilising resistor & metrosil)	2 set	1 set	1 set
4	Over load protection (if not included in sl.no. 1 ,2 & 3 above)	1 set	1 set	1 set
5	Over voltage / Under voltage/Frequency protection scheme (if not available in the main protection & back-up protection module)	1 set	1 set	1set
6	Auxiliary relays for thermal imaging, MOG, WTI, OTI, Buchholtz, PRV, OSR and status indication etc.. (1.MOG-AI, 2.WTI,BUCH,OTI – AI & Trip,3. PRV,OSR – Trip)	1 set	1 set	Not required
7	CVT/PT selection relays (depending upon the switching scheme of the system)	1 set	1 set	1 set
8	Breaker failure protection scheme (if not available in the main protection & back-up protection module)	1 set	1 set	1 set
9	Trip circuit pre and post supervision relays for trip coil I and II.	1 set	1 set	1 set
10	DC / AC supply supervision relay	1 No for each panel	1 set	1 set

11	Aux relays for circuit breaker trouble shooting	1 set	1 set	1 set
12	Trip relays three phase for group-A	1 set	1 set	1 set
13	Trip relays three phase for group-B	1 set	1 set	1 set
14	Test terminal blocks for all protection relays	1 set for each module	1 set for each module	1 set for each module
15	Numerical Bay Control Unit of adequate BI, BO, Transducers etc as per the site requirement & detailed Engg. done.	1 No	1 No	* 1 No * BCPU can be considered.

(c) **Transfer bus coupler / Bus coupler and Busbar protection panel**

Bus bar protection panel shall be equipped to accommodate all present and future bays.

Sl. No	Equipment	Quantities required			
		400kV	220kV	132kV	33kv
1.	Composite numerical Directional Over current and earth fault protection (selectable Features Dir & Non Dir)	1 set	1 set	1 set	1 set
2.	Test terminal block for all protection relays	1 set for each module	1 set for each module	1 set for each module	1 set for each module
3.	Trip circuit pre and post supervision relays for trip coil I and II	1 set	1 set	1 set	1 set
4.	DC supply supervision relay	Not required	1 set	1 set	1 set
5.	Flag relays for circuit breaker trouble and status indication etc.	Not required	1 set	1 set	1 set
6.	Breaker failure protection scheme	Not required	1 set	1 set	1 set
7.	Trip relays single/three phase for group-A	Not required	1 set	1 set	1 set
8.	Trip relays single/three phase for group-B	Not required	1 set	1 set	1 set
9.	Numerical Bus bar differential relay for Bus-1, Bus-II and Transfer Bus (if required depending on the Bus configuration) having check zone features with SCADA	2 sets (Duplicated)	1 set	Not required	Not required

	compatibility.				
10.	Numerical Bay Control Unit of adequate BI, BO, Transducers etc as per the site requirement & detailed Engg. done.	1 No	1 No	1 No	* 1 No * BCPU can be considered.

(d) Bus sectionalizer protection panel

Sl. No	Equipment	Quantities required
1.	Composite numerical directional Over current and earth fault protection relay(selectable Features Dir & Non Dir)	2 sets
2.	Test terminal block for all protection relays	1 set or as required
3.	Trip circuit pre and post-supervision relay for trip coil I and II	2 sets or as required
4.	DC supply supervision relay	1 set or as required
5.	Aux relays for circuit breaker trouble and status indication etc.	1 set or as required
6.	Breaker failure protection scheme (if not available in the back-up protection relay	1 set or as required
7.	Trip relays three phase for group-A	2 set
8.	Trip relays three phase for group-B	2 set
9.	Busbar protection relay shall cover all the bus sections	1 set

NOTE: Any other protection device/relays/equipment besides above required to complete the scheme as per standard practice of OPTCL are also required to be considered. The SAS shall be in the PRP based.

4.2.8 RELAY TEST KIT:

(a) One relay test kit of OMICRON make (latest model & to be decided during detailed Engineering) suitable for conducting testing of protection devices with different techniques, report preparation, memory etc duly adopted to be provided. (Optional, if specifically asked in tender BoQ)

(b) Other tools as required for testing, attending to the troubles in the panel, suitable screwdriver set, nose plier/plier set, cutter, soldering kits, testing cords, etc: 3 Sets

(c)Test plugs: 2 set.

OPTCL
Lifeline of Odisha

ODISHA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

CONTROL AND RELAY PANEL

Conventional hard wired control panels are not applicable for this project. However, clauses relevant to SAS & Relay panels are applicable.

PROTECTION AND CONTROL PANELS

1.0 Panels

General

Simplex and/or duplex panels shall be provided to suite the substations site. Bidder shall be fully responsible for his bids to match the dimensions, colour and fittings with those in the existing control rooms where the extensions are required. In no case any proposal for increase in price at a later date shall be entertained by the Employer. However panels not matching those already installed may be acceptable to the Project Manager. Specific approvals will be required on a case by case basis.

Panels shall be free standing mounted on floors fitted with embedded channels, insert plates or foundation bolts. The panels shall be made vibration and shock proof by providing anti vibration strips.

The base frame of all panels shall have a smooth bearing surface such that when fixed on the embedded foundation channels/insert plates it shall be free standing and provide a level surface.

The panels shall be completely metal enclosed, dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than IP-31 in accordance with IS 13947

The design, materials selection and workmanship shall be such that it provides a neat appearance both inside and outside without signs of welds, rivets or bolt heads from outside. The exterior surfaces shall be smooth and sleek.

Relay panels of modern modular construction in 19 inch hinged racks would also be acceptable.

Cable entry to the panels shall be from the bottom. The provision of all cable glands and shrouds of the panel shall be part of the scope of supply. Cable gland plate fitted on the bottom of the panel shall be connected to earthing of the panel/station through a flexible braided copper conductor.

1.1 Simplex Panel

Simplex panels shall be provided with equipment mounted on front panel vertically. The wiring access shall be from rear for control panels and either from front or rear for relay panels. Where panel width is more than 800 mm, double leafed doors shall be provided. Doors shall be fitted with either built-in locking facility or with padlock.

1.2 Duplex Panel

Duplex panels shall be walk-in, tunnel type comprising of two vertical front and rear panels connected back to back by formed sheet steel roof as tie members and a central corridor in between. The corridor shall facilitate access to internal wiring and external cable connections. Where a number of duplex panels are located in a row side by side, the central corridor shall be aligned to form a continuous passage. Both ends of the corridor shall be provided with double leaf doors with lift off hinges. Doors shall be fitted with either built-in locking facility or with padlock. Separate bottom cable entries shall be provided for the front and rear panels. The inter-connections between front and back panels shall be established by providing wiring at the top of the panel.

IMP: Only Relay panel front side should be provided with protective front door with PRESPEX cover with flush type handle with locking facility to protect the relays from the external.

1.3 Constructional Features

It is the responsibility of the Contractor to ensure that the equipment specified and such unspecified complementary equipment required for completeness of the protective/control schemes can be properly accommodated in the panels without congestion. Panels shall be free standing, floor mounting type and shall comprise of structural frames completely enclosed with smooth finished, cold rolled sheet steel of thickness not less than 3 mm for all weight bearing members such as base frame, front panel, door frames. All other parts may be provided with 3.0 mm thick steel sheet. There shall be sufficient reinforcement to provide level surfaces, resistance to vibration and rigidity during transportation and installation. All doors, removable covers and panels shall be gasketted all around with neoprene or superior material. Ventilating louvres, where provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.

1.4 Mounting

All equipment on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipment on front of panel shall be mounted flush. Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent devices. Equipment shall be readily accessible without use of special tools. Terminal marking on the equipment shall be clearly visible. The Contractor shall carry out cut-out,

mounting and wiring of all equipment and items which are to be mounted in his panel. Cut-outs if any, provided for future mounting of equipment shall be properly blanked off with blanking plates. The center lines of switches, push buttons and indicating lamps shall be not less than 750 mm from the bottom of the panel. The center lines of relays, meters and recorders shall be not less than 450 mm from the bottom of the panel. The center lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. The top lines of all meters, relays and recorders etc. shall be matched. No equipment shall be mounted on the doors. All the equipment connections and cabling shall be designed and arranged to minimise the risk of fire and damage which may be caused by fire.

1.5 Terminal Blocks

Terminal blocks and boards shall conform to the requirements of the relevant sections of this Specification. De-link type terminal blocks shall be provided in all the circuits and Terminals.

1.6 Supporting steel

All necessary embedded levelling steel, sills, anchor bolts, channels and other parts for supporting and fastenings the panels and vibration damping shall be supplied by the Contractor.

Instruments, Meters, Recorders and Transducers: (applicable for Non-SAS system)

2.0 General

All instruments, meters, recorders and transducers shall be enclosed in dust proof, moisture resistant, black finished cases and shall be suitable for tropical use. All indicating instruments and recorders shall be digital type and provided with individual transducers and shall be calibrated along with the transducers to read directly the primary quantities. They shall be accurately adjusted and calibrated at works and shall have a means of calibrations check and adjustment at site. The Contractor shall confirm that the indicating instruments, recorders along with transducers and energy meters offered by him are suitable for connecting to the instrument transformers having the technical particulars given in reference drawing. Synchronizing Instruments shall also meet the requirements of the relevant clause of this section of the Specification. Digital bus voltage and frequency meters shall be of class 0.5 and shall have digital readouts of five and four digits respectively, with display size, not less than 50 mm (height)

2.1 Metering Instruments

Energy-meters **(NOT REQUIRED)**

Energy meters shall be provided on all line feeders, transformer feeders, buscoupler and bus transfer bays as per the requirements stated in the schedule of requirement of this specification.

On 400/220/132 kV feeders emanating from various substations, where commercial metering is required redundant energy metering in form of MAIN shall be employed.

All 33 kV feeders emanating from various substations shall be treated as feeders with commercial metering requirements. Only single energy meters shall be employed.

Energy meters shall be solid state tri vector type. The energy meters are intended to measure, record and display active energy (kWh/MWh), reactive energy (kVARh/MVARh), apparent energy (kVAh/MVAh), Maximum Demand (MVA/kVA/MW/kW/ etc. They should be of three phase two element type or three element type suitable for measurement of unbalanced loads in three phase, three wire circuits. The meters shall be provided with at least six registers for TOD metering purposes. The meters shall have LCD or cyclometer type registers.

Energy meters shall be of draw out or non-drawout type and suitable for flush mounting with back connected terminals.

Energy meters shall be suitable for operation from the secondary of CT's and VT's. Separate test blocks for the testing of the meters (without disturbing the CT and VT secondary connections) shall be provided.

Energy Meters shall have reverse running stops. Meters shall conform to IEC 687 /IS 13779. All watt-hour meters shall have accuracy class of 0.2. All VARh-hour meters shall have accuracy class of 3.0. The energy meters shall also conform the requirements stipulated in Technical Report of Central Board of Irrigation and Power, India.

Energy Meters shall be compensated for temperature errors and factory calibrated to read the secondary quantities. The number of digits provided shall be adequate to cover at least 1500 hours of operation.

The combined overcurrent and earth-fault relay is connected to the current transformers of the object to be protected. The overcurrent unit and the earth-fault unit continuously measure the phase currents and the neutral current of the object. On detection of a fault, the relay will start, trip the circuit breaker, provide alarms, record fault data, etc., in accordance with the application and the configured relay functions.

FUNCTIONAL DESCRIPTION;

Three-Phase Overcurrent (50/51) & Earth Overcurrent (50N/51N)

Three independent stages are available either for phase and earth fault protection. For the first and second stage the user may independently select definite time delay (DTOC) or inverse time delay (IDMT) with different type of curves (IEC, IEEE/ANSI, IS 3231:1987).

Three-Phase & Earth-Fault Directional Overcurrent (67/67N)

Each of the three-phase overcurrent stages & earth fault stages can be independently configured as directional protection and with specific characteristic angle (RCA) and boundaries as per IEC, IEEE/ANSI,IS . The phase fault directional elements should be internally polarised by quadrature phase to phase voltages. A synchronous polarising function or any other suitable algorithm may be provided to ensure a correct operation of the overcurrent elements for close-up three phase faults where the collapse of the polarising line voltages occurs.

Under / Over Voltage (27/59)

Independent under-voltage stage and two or more over-voltage stages may be provided. They should be definite time elements. Each stage can be configured to operate from either phase-neutral or phase-phase voltages. The drop off to pick up ratio should be 99.5%.

Under / Over Frequency (81U/O)

Time delayed under and over frequency protection on the fundamental form of frequency protection is to be provided When the frequency measured is crossed 6 pre-defined thresholds, the relays should generate a start signal and after a user settable time delay, a trip signal.

Circuit Breaker Failure Protection (50BF)

The circuit breaker failure verifies the effective opening of the CB by a dedicated undercurrent threshold. The circuit breaker failure function can be activated by trip of a generic protection or/and external command by the relevant digital input. The circuit breaker failure protection can be used for tripping upstream circuit breakers too.

6.5.5: For numerical relays, the scope shall include the following:

1. Necessary software and hardware to up/down load the data to/from the relay from/to the personal computer installed in the substation. However, the supply of PC is not covered under this clause.
2. The relay shall have suitable communication facility for connectivity to SCADA.
3. IED should be IEC 61850 compliant.
4. IED should support PRP (Parallel Redundancy Protocol)
5. In case of line protection and transformer/reactor protection, the features like fault recorder and event logging function as available including available as optional feature in these relays shall be supplied and activated at no extra cost to the owner. Also necessary software/ hardware for automatic uploading to station HMI/DR work station (as applicable) shall be supplied.
6. All the IED's must have redundant Communication Port. All Relays shall be complied to IEC 61850 Ed.2 protocol and certified from KEMA. The protective relays shall be of numerical type and communication protocol shall be as per IEC 61850.

6.5.6. Technical Particulars of IED: The protective relays shall be of numerical type and communication protocol shall be as per IEC 61850.

1. **Standards and regulations**:

IEEE/IEC/ANSI/CE/IS	IS: 3231/IEC60255/IEC 61000

2. Analogue Inputs and Outputs

Nominal Frequency fN	50 Hz
Nominal Current	1A/5A
Power Consumption	0.05VAat IN=1A, 0.3VAat IN=5A
Current Overload Capability per Current Input thermal (rms)	100* IN for 1Sec. 30*IN for 10Sec 4*IN continuous
Dynamic (pulse Current)	1250A (half cycle)
Nominal Voltage Ph-Ph rms (VN)	110V
Operating range Ph-Ph rms	0-200V
Continuous	2*VN
10 seconds	2.6*VN

3. Auxiliary voltage

Nominal Range	Operative Range
220V dc	180-300Vdc
Power Consumption dc	< 50W
Ripple superimposed AC Voltage	≤ 15% auxiliary nominal voltage.
230VAC	90-270VAC
Power Input AC	< 30VA

4. Input / output modules

Binary inputs	
a) number of input	No. of Digital Input shall be as per the system requirement as per the standard practice, which is as decided during the detailed Engineering and with 30% spare in each IED.
b) voltage range	220V ±20%
c) power consumption	< 0.4W
Output contacts	
1. number of output contact	No. of Digital Output shall be as per the system requirement as per the standard practice, which is as decided during the detailed Engineering and with 30% spare in each IED.
2. Nominal Voltage	240V DC ±20

3. permissible current	Make & carry 30A for 0.2sec. ANSI C37.90
	Continuous; 5A IEEE C37.90

5. **LED**

LED displays:	
Status LED	17.2. Relay Healthy
	17.3. Relay Start
	17.4. Relay Trip
Alarm Indication	Configurable LED for indication. Minimum 8Nos for Backup relays. Minimum 8 Nos for feeder management relays Minimum 8 Nos for Transformer Differential Relays. Minimum 14Nos for Distance Protection Relays.

6. **Protection Function**

DISTANCE PROTECTION RELAY :	
21P	Distance protection 21
21G	Distance protection zones (PDIS)
25	Synchocheck
27/59	Under/Over Voltage (2 stage over voltages)
46	Negative Phase Sequence
46BC	Broken Conductor
50/51,50N/51N	Instantaneous/Time overcurrent.
50BF	Breaker failure
67/67N	Direction Over current
79	Auto Reclose
81	Frequency Function.
FL	Fault Locator
DR	Disturbance Recorder
EL	Event Log.
MES.	Measurement.
CTS	CT Supervision
VTS	VT Supervision
TCS	Trip Ckt Super vision
TRANSFORMER DIFFERENTIAL RELAY	
24	Over-excitation.
27/59	Under/Over Voltage
49	Thermal Overload
46	Negative Phase Sequence
50/51,50N/51N	Instantaneous/Time overcurrent.
50BF	Breaker failure
87G	Restricted Earthfault.
~~67/67N~~	~~Direction Over current~~
87	Differential Protection.
81	Frequency Function.
FL	Fault Locator
DR	Disturbance Recorder
EL	Event Log.
MES.	Measurement.
CTS	CT Supervision
VTS	VT Supervision
TCS	Trip Ckt Super vision
BACK UP RELAYS(CURRENT PROTECTION)	
50	Instantaneous phase overcurrent protection
51/67	Four step phase overcurrent protection
50N	Instantaneous residual overcurrent protection

51N/67N	Four step residual overcurrent protection
50BF	Breaker failure protection (RBR
81	Under frequency
FEEDER MANGEMENT RELAY	
50	Instantaneous phase overcurrent protection
51/67	Four step phase overcurrent protection
50N	Instantaneous residual overcurrent protection
51N/67N	Four step residual overcurrent protection
27 /59	Under Over Voltage
50BF	Breaker failure protection
81U	Under frequency
81R	df/dt
25	Check synchronise
32	Power Protection
79	Multi shot Auto Recloser
Control	Switchgear Control Capability.

7. Secondary Supervision & Communication

Secondary system supervision	
	Current circuit supervision Fuse failure supervision
Monitoring	
	Measurements Event counter Disturbance report Fault locator
Communication	
	IEC61850-8-1 Communication IEC60870-5-103 communication protocol Single command, 16 signals Multiple command and transmit. PRP compliant.
a)Synchronization facility with GPS Cloak b)Front port communication c)Rear port d)Optional port	a) IRIG-B/ SNTP b) RS 232/Ethernet/USB c) FO and RJ45 port for IEC 61850-8-1 d) RS232/485
Process Bus Interface IEC 61850-9-2LE	
	If asked.

8. **Mechanical design**

1. type of mounting	Rack or panel mounting
2. degree of protection	IP52 & above
iii. permissible mechanical stress during operation b. permissible mechanical stress during transport Impedance starter	•Vibration IEC 60255-21-1:1996 Response Class 2 Endurance Class 2 •Shock and bump IEC 60255-21-2:1995 Shock response Class 2 Shock withstand Class 1 •Seismic IEC 60255-21-3:1995 Class 2

9. **Insulation test:**

	As per IEC 60255-5:1977
a) high voltage test on all circuits except auxiliary voltage	2KV for 1 min
b) high voltage test on voltage circuit only	2KV for 1 min
c) impulse voltage test on all circuits	5KV peak,1.2/50 micro s ,0.5

10. **Noise immunity test**

1.	
2. high frequency	IEC 60255-22-1:1988 Class III At 1MHz,for 2s with 200 Source Impedance: 2.5kV peak between independent circuits and independent circuits and case earth. 1.0kV peak across terminals of the same circuit.
3. electrostatic discharge	Electrostatic discharge IEC 60255-22-2:1996 Class 4 15kV discharge in air to user interface, display and exposed metal work. IEC 60255-22-2:1996 Class 3 8kV discharge in air to all communication ports.6kV point contact discharge to any part of the front of the product.
4. radio frequency electromagnetic field, non modulated	C37.90.2:1995 25MHz to 1000MHz,zero and 100%square wave modulated. Field strength of 35V/m.
5. radio frequency electromagnetic field, amplitude modulated	
6. power frequency magnetic field	
7. radio frequency electromagnetic field, pulse modulated	
8. fast transient	IEC 60255-22-4 :1992 Class IV 4kV,2.5kHz applied directly to auxiliary supply 4kV,2.5kHz applied to all inputs.
9. conducted disturbance induced by radio frequency field, amplitude modulated	IEC 61000-4-6:1996 Level 3 10V,150kHz to 80MHz at 1kHz 80%am
Interference emission test a. radio interference voltage b. radio interference field strength	89/336/EEC EN50081-2:1994 EN50082-2:1995

11. Climate stress test

1. permissible ambient temperature during operation	–25 °C to +55 °C

2. permissible ambient temperature during storage	–25 °C to +55 °C
3. permissible ambient temperature during transport	–25 °C to +70 °C
4. permissible humidity	56 days at 93%RH and +40 °C

ELECTROMECHANICAL AUXILIARY RELAYS:-

Relays shall be suitable for semi flush mounting on the panel board. All the relays shall be back connected, protected with dust tight cases for tropical use and finished with dull black enamel paint. The adjusting devices, shall be accessible with the relay mounted on the panel board. Flag type operating indicators and flag indicator reset devices shall be provided. The latter shall be suitable for operation from the front of the relay case, without opening the cover. The relays shall comply in all respects with the requirements of IS: 3231 (latest edition) or equivalent standards and shall be suitable for operation under the climatic condition specified. The relays shall be suitable for operation within a temperature range of 0 deg. to50 deg. C. The current coils shall be rated for a continuous current of 1 ampere and the voltage coils for 110 V normal. The contacts of the relays shall be silvered and precautions shall be taken to prevent or minimize damage due to arc which have to be successfully broken against 240 V D.C. When open, the contacts shall withstand a voltage of 115% of the normal circuit voltage. The relays shall preferably be provided with suitable seal-in-devices.

OTHER PARTICULARS OF AUXILIARY RELAYS:-

1. The auxiliary relays shall be, designed for continuous operation at 250 V. D.C. and shall withstand 110% rated voltage continuously. This shall also be suitable for satisfactory operation at 85% rated Voltage.

2. All protective relays, auxiliary relays and timers except the lock out relays and interlocking relays specified shall be provided with self reset type contacts. All protective relays and timers shall be provided with externally hand reset positive action operation indicators with inscription subject to Purchaser's approval. All protective relays which do not have built-in hand-reset operation indicators shall have additional auxiliary relays with operating indicators (Flag relays) for this purpose. Similar separate operating indicator (auxiliary relays) shall also be provided in the trip circuits of protections located outside the board such as buchholtz relays, oil and winding temperature protection, sudden pressure devices, fire protection etc.

3. Self reset auxiliary voltage relays rated for specified D.C voltage shall be provided for use in the interlocking schemes for multiplication of contacts suiting contact duties of protective relays and for monitoring of control supplies and circuits. Monitoring relays for lockout relay circuits shall be connected in series with lockout relays coils. The Bidder shall be responsible to ensure that the monitoring relay ratings are such that they shall positively pick-up through the breaker coils / lockout relays coils monitored, but the breakers / lockout relays shall not operate with such a connection.

d) The supply and circuit monitoring relay shall be connected to initiate an alarm upto failure of respective supply / circuit . They shall preferably have reverse flags, which drop when relay is de-energised. Otherwise, an indicating lamp shall be provided with each monitoring relay for indication of its operation.

e) Close positions relays of main supply circuit beakers initiating automatic closure of stand by supply breakers shall have adequate time delay on drop out so that complete closure of stand by supply breaker is ensured . This feature will be used for obtaining limitation of duration of impulse for automatic closure of stand by supply breakers. In case the close position relays with such time delay are not available, additional slugged D.C auxiliary with adequate time delay on drop out may be supplied for automatic reverse closure . The exact arrangement will depend on the actual control schemes and shall be subject to the approval of purchaser.

6. The lockout trip relays shall be multi contact, hand reset type . The latching mechanism shall be positive and insensitive to vibration and shock. The reset devices on the front of the relay panel shall not permit manual tripping . Each lock-out relay shall be furnished with a panel mounted isolating arrangement to permit opening of trip circuits for testing .

1. **AUX. Relay Type- (ALARM ANNUNCIATION), 250 V DC**

Case Size-**3 element**
20 Terminal
Flag -Required
Mounting -Flush
Aux. Contacts-4 N/O

THREE POLE VOLTAGE OPERATED AUXILIARY RELAY.
Technical specification

Relay type

Aux.current or voltage	220 - 230V dc
Contacts - unit L.H	3 N/O 1 N/C H/R
Contacts - unit CTR	3 N/O 1 N/C H/R
Contacts - unit R.H	3 N/O 1 N/C H/R
Flag	Yes
Mounting	Flush

COIL RATING
D.C.75%-120% of rated voltage
AC.80%-115% of rated voltage
Operating voltage- not greater than 70% of voltage rating.
Operating time-15-20ms typical minimum at nominal voltage.
Burden-
2watts for 30,125v
6watts for 50,250v.
Operation indicator
Hand reset operation indicator provided

1. **RESTRICTED EARTH FAULT RELAY (ATTRACTED TYPE ELECTRO- MECHANICAL):**

(NOT APPLICABLE)

TYPE: Electro-mechanical

The REF relay (attracted armature type) to be used along with a stabilising resistor & Metrosil, which is designed for applications where sensitive settings with stability on heavy

through faults are required. It is recommended for balanced and restricted earth fault, bus-zone and certain forms of differential protection for auto-transformers, Power Transformers etc. The relay shall operate as a high impedance unit protection scheme & to be connected in the system accordingly. The relay shall be attracted armature unit of simple and robust construction.
The operating coil shall be provided with the accessories like series resonant circuit. Current tapping should be provided for different current setting by making suitable arrangement. The construction of the relay should be simple & electromechanical construction, detection element, and the output contacts should be in the same device, which will make the Operation fast and highly reliable.
The relay circuit, connected & tuned to the supply frequency must rejects the harmonics produced by current transformer saturation & due to system disturbances.
The current transformers may develop voltages during maximum internal faults and the relay may be damaged. Therefore total impedance of the relay to be decided by using external series stabilising resistor (non-linear resistor) to prevent over voltage developed.
The relay shall be single pole operated.

Features:
- High stability on external faults
- Tuned to rated frequency
- 25ms operating time at 5 times current setting
- Simple and robust construction.
- High stability on external faults.
- Sensitive high speed protection on internal faults.
- Tuned to rated frequency.

Application
- Differential/REF protection of Power Transformers, auto-transformers and busbars.
- Balanced and restricted earth fault protection of transformer windings.
- Transverse differential protection of generators and parallel feeders.

General description
In circulating current protection schemes, the sudden and often asymmetrical growth of the system current during external fault conditions can cause the protective current transformers to go into saturation, resulting in a high unbalance current. To ensure stability under these conditions the relay should be designed to take care, may be by using a voltage operated, high impedance relay, set to operate at a voltage slightly higher than that developed by the current transformers under maximum external fault conditions.
The stabilising resistor to be designed for such applications where sensitive settings with stability on heavy through faults are required.
A slight time delay on operation of relay helps to provide stability on heavy external faults and is to be taken care. This limits the current supplied, and the output unit operates only on the slower part of its time/current curve. The external stabilising resistor to be supplied separately with the relay allows continuous adjustment of the relay voltage setting over a wide range. y spaced current settings. The relay circuit, tuned to the supply frequency, rejects the harmonics produced by CT saturation. A slight time delay on operation helps to provide stability on heavy external faults and is obtain

TECHNICAL DATA
Current rating : 1A
Frequency : 50 Hz
Settings : 10 - 40% in seven equal steps as standard. Continuously variable external stabilising resistors of 200 ohms or any suitable value for 1A.
Operating time :
25 milliseconds at 5 times the current setting (see time/current characteristic in Figure 1).
Burdens :
0.9VA at current setting on lowest tap. 1.0VA at current setting on high set tap.
Accuracy :
Error class Index E 5.0 as per BS 142-1966 and 5.0 as per IS 3231-1965.

Operation indicator :
Hand reset operation indicator provided.
Contacts :
Two pairs of make self-resetting contacts are provided on single element relays.
Short time :
20 times the setting current for 3 seconds.

Thermal rating continuous :
(for 60 degree C rise in coil temperature): Times current setting To be furnished for different taps.
Case and finish :
Single pole relays fitted in size 3 MIDOS cases. The relay comply fully with the requirements of IS 3231-1965 and are suitable for use in normal tropical environments

Provision of Thermistor/ Metrosil :
To protect from high voltage- Suitable rating thermistor shall be provided.
Insulation :
The relay meets the requirements of IS 3231-1965/IEC 255-5 Series C-2 KV for 1 minute

3. HIGH SPEED TRIP RELAY

A. General
The relay should be multi-contact attracted armature relays conforming to IEC 60255-1 and ESI 48 – 4 EB 2.

1. The relay should be of high speed, high burden, positive action, instantaneous cutoff type.
2. It should be of high burden to give immunity to capacitance discharge current.
3. It should be of robust design for reliable service.
4. Should be draw out type.
5. The number of contacts:

i. 10 contacts (8NO+ 2NC)

6. It should have hand and electrical contact reset and hand flag reset.
7. The trip relay should be suitable for use in Substation Automation System.

A. Technical Data

Rated voltage VN	220 V DC
Operating range	50% to 120% of rated voltage
Operating time	10 ms at rated voltage
Reset time	< 20 ms at rated voltage VN
Contacts	Hand reset and Electrical reset
Flag	Hand reset
No of contacts	10 (8 NO + 2 NC)
Nominal Burden	Operating Coil: < 170 Watts
	Reset Coil: < 70 watts for 10 contacts
Contact Rating	Make and carry continuously 1250 VA AC or 1250 W DC within limits of 660 V and 5 A
	Make and carry for 3 s 7500 VA AC or 7500 W DC within limits of 250 V and 30 A
	Break 1250 VA AC or 100 W (resistive) DC or 50 W (inductive) DC within limits of 250 V and 5 A
Case type & Size.	Panel Cut out Max for i. 10 contacts : (50 X 170mm) ii. 20 contacts : (100 X 170mm) depth should be less than 250mm.

B. Tests.

i. Temperature :IEC 60068-2-1/ IEC 60068-2-2

Operating	-10°C to +55°C
Storage	-25°C to +70°C

ii. Humidity : IEC 60068-2-30/IEC 60068-2-78

Damp heat test, Cyclic	6 days at 250C to 400C and 93% relative humidity
Maximum Altitude of Operation	Up to 2000 m

iii. Mechanical Test

Test	Reference	Requirement
Vibration	IEC60255-21-1	Response Class I
Shock and Bump	IEC60255-21-2	Shock response and withstand Class I, Bump Class I
Seismic test	IEC60255-21-3	Class I
Degree of protection	IEC60529	IP50 – Front IP20 – Rear IP40 – Side
Electrical Endurance	IEC 60255-1	10,000 operations at the rate of 600 operations per hour at 250 VAC, 5A (Ref: Std IEC 61810-1)

iv Electrical Test

Test	**Standard**
Insulation Resistance	IEC 60255-27# 500 V DC, >100M Ohms Between all terminals & earth Between coil terminals & contacts
Impulse Voltage Withstand	IEC 60255-27# 5.0 kV, 1.2/50 µs, 0.5J Between all terminals & earth Between coil terminals & contacts
High Voltage (Dielectric)	IEC 60255-27# 2 kV, 50Hz@1min (2.2 kV for 1 s) Between all terminals & earth Between coil terminals & contacts 1 kV AC RMS for 1 min across normally open contacts
Thermal Withstand Continuous	IEC 60255-6 1.2 VN
Thermal withstand for 10 s	IEC60255-6 1.30 VN
Functional	IEC 60255-1
Maximum Allowable Temperature	IEC 60255-6 Max. temperature limit +1000C
AC Ripple on DC supply	IEC 60255-11 Withstand 15% AC ripple on DC

Power Frequency Magnetic Field Immunity	IEC 61000-4-8 Level 4, 30 A/m applied continuously 300 A/m applied for 3 s
Switching Rate	600 Operations per hour
Immunity to capacitance discharge	ENA TS 48-4 Issue 4 2010, Table

Protective system

6.7 Unit and backup protection

Power system elements and the network shall be provided with independent high speed discriminative protection systems. Duplicate schemes (Main I and Main II) shall be provided for all 400kV and 220kV systems. For all other systems up to 132kV, the protection equipment shall be divided into 'Main' and 'Backup' systems.

Protection schemes of different philosophy (Main I and Main II or Main and Back-up) shall preferably be fed from different DC supplies when available in the substation. This shall include energisation of trip coil circuits in case of 400 kV and 220 kV breakers. However in case of 132kV system where a duplicate DC source is available, the two trip coils shall be energised from the different sources.

Protection equipment shall not initiate a trip signal following the normal and correct discharge operation of one or more surge arresters.

Measurement functions relays must be achieved through electronic circuits. Auxiliary relays, repeat relays, trip relays and any other simple auxiliary or contact multiplication function may be based on standard attracted armature or other electromechanical techniques.

Relays based on numerical design technique shall constitute all primary protections. The Employers intends to avail the improved benefits in the functionality, design, reliability and cost effectiveness of integrated substation control systems in future for which relays with numeric design only shall be required. It is the responsibility of the Contractor to demonstrate that all relay equipment offered has a reasonable level of in-service experience. For numerical relays, the following conditions apply :

1. The Bidder must be able to demonstrate that a minimum of 10 relays of each type offered have been in full service without relay failures for a minimum of three years in two different countries, one of which may be the country of manufacture. Experience involving trial installations is not acceptable.
2. The Bidder must include a statement of the number of years of guaranteed manufacturing and parts support which will be provided for the relays offered.
3. The Bidder is be required to state the full firmware version together with the version of relays for which experience records are offered.

   For relays which are provided with communication facilities, the communications facility should allow all information which is available locally at the relay front panel to be accessed remotely. It should also be possible to carry out bulk transfer of settings and fault record information using the appropriate PC based software.

6.8 Protection discrimination

On the occurrence of a fault on the power system network the high speed discriminating protection systems (main protection) shall rapidly detect the fault and initiate the opening of only those circuit breakers which are necessary to disconnect the faulted electrical element from the network. Protection equipment associated with adjacent electrical elements may detect the fault, but must be able to discriminate between an external fault and a fault on the electrical element which it is designed to protect. Sequential time delayed tripping is not permitted except in the following specific circumstances:

- Protection for short connections between post current transformer housings and circuit breakers when the technical advantages of complete overlapping of the protection are outweighed by economic considerations, (i.e. short-zone protection)
- Operation of time graded back-up protection takes place as a result of either the complete failure of the communication links associated with the main protection systems, or the fault resistance is substantially greater than a value which can be detected by main protection systems.

- Operation of line back-up protection to disconnect primary system faults in the case of a circuit breaker failing to operate, (i.e. circuit breaker failure protection)
- All back-up protection systems shall be able to discriminate with main protection systems, circuit breaker fail protection and with other back-up protection systems installed elsewhere on the transmission system.

6.8.1 Codes and Standards

The equipment supplied shall generally comply with the codes and standards indicated in relevant sections of this specification. Additionally the equipment shall also conform the requirements of this specification.

6.8.2 Environmental requirement

The protection, control and metering equipment shall operate satisfactorily under the various atmospheric, mechanical, electrical and environmental conditions as stipulated in the relevant sections of this Specification. The equipment shall conform to EMC Class III.

6.8.3 Future network scada system

At some time in the future the Employer intends to introduce a network SCADA system. All equipment to be installed under this Specification shall be suitable for future remote operation and remote data acquisition.

The limit of responsibility with regard to this contract shall be to provide equipment suitable for future connection to and communication with a SCADA system, either by means of RTU or modem. Neither the RTU nor the modems form part of the scope of this Specification.

The proposed protocol for the SCADA system is IEC 61850 compliance. Equipment necessary to interface the Integrated Substation Control System with the SCADA system are part of the scope of this Specification.

6.8.4 Control and monitoring levels

The substation control and monitoring system shall allow for three levels of man machine interface. The number of levels initially employed will be limited to one i.e. substation levels. Provision shall be made for the future implementation of the second and third level of network control and monitoring from a system control centre via SCADA.

Selection of substation control shall be from the individual equipment basis i.e., from the control panels.

At the station level, control panels should be located in the main control room.

A mimic diagram representing the substation lay-out in single line diagram form should be provided. The mimic board is intended to give operating personnel an overall view of the switchgear state. It shall be made up from the individual circuit control panels mounted side by side. The arrangement should correspond to the primary equipment layout.

Alarm annunciation equipment should be mounted adjacent to the mimic diagram, or form an integral part of the control panel. Operation of an alarm should cause the appropriate window to flash and sound an audible warning. Operation of an accept button will silence the audible warning, steady the flashing window and prepare the annunciation to respond to subsequent initiation. A reset button should be provided to extinguish alarms which have reset.

A lamp test button shall be provided which will initiate steady state illumination of all alarm windows. Trip or protection initiated alarms should have windows distinct from others (e.g. red display instead of white). Control and selector switches should be of approved types complying with accepted standards such as IEC 337. Control switches shall have two independent motions or two handed operation to effect operation. Indicating instruments should be of approved types complying with accepted standards such as IEC 5 1.

6.9 *Enclosures*

Protection systems shall preferably be accommodated in rack or hinged rack cubicles and be of modular construction with factory assembled and tested wiring. Conventional analogue relays may be mounted on conventional relay panels which must be mounted to allow access to the front and rear of the panel. Relays mounted on such panels shall be flush mounted. The construction method shall offer the benefits of minimum site construction times and circuit outage requirements.

Interconnections shall be identified in accordance with the requirements for dependent local end marking as specified in IEC Publication 391 Sections 3.4.1.a.1 and 5.1.2. The interconnections shall be recorded on an appropriate schedule or diagram.

For modular protection systems, means shall be provided to lock positively each withdrawable module or unit in the "service" position. It shall not be possible to remove any module without first short-circuiting all associated current transformer circuits.

6.10 Operator interface

6.10.1General

All numerical protection systems shall be provided with an integral local operator interface facility to enable communication with the relay without the use of external equipment. Any facilities provided for connection to an external computer shall be an additional feature to the local operator interface. No exceptions to this requirement shall be accepted.

6.10.2 Identification

Each protection system shall have a unique identifier which is clearly visible. If the protection system is software operated the software reference and issue level shall be identified.

6.10.3 Settings

Each protection system shall provide a means by which the user can easily access the protection system to apply the required settings. This facility shall be secure from inadvertent operation. A display of the selected settings shall be provided on the protection system.

6.10.4 Indications

Each relay or protection scheme shall be provided with an adequate number of indications to ensure that the appropriate faulted phase, zone, etc. can be easily identified after a fault condition. Each indicator shall be visible and capable of being reset without removing the relay cover.

For relays based upon numerical techniques, indication shall be provided for failures detected in the protection relay or communications equipment. The indications provided shall be designed to allow the defective item to be quickly identified. The status of the DC power supplies shall be permanently indicated.

Details of the indication required for specific types of relay are provided in the individual parts of this section of the specification covering particular types of relay.

6.11 Protection system output contacts

All protection systems shall be provided with an adequate number of contacts of suitable rating to carry out the required tripping functions, alarm indications, fault recorder functions and such supplementary signalling functions as may be necessary for initiation of automatic switching control, inter tripping etc. In all cases contacts intended for tripping duty shall be designed such that they cannot inadvertently interrupt trip coil current.

6.12 Testing and isolating facilities

Each functional protection system shall be so arranged that operational and calibration checks can be carried out with the associated primary circuit(s) in service.

Adequate test facilities shall be provided within the protection system to enable the protection and auto-reclosing equipment to be tested from the front of the protection equipment panel with the primary circuit(s) in service. The test points shall be clearly identified and labelled.

Relays based on digital and numerical design techniques shall include supervision facilities which provide a periodic self check of the key elements within the relay and also provide continuous self monitoring of all internal power supplies and microprocessor operation. A defect in any of the self supervision facilities shall not cause maloperation of the protection relay internal self-test facilities and shall give an alarm should an internal fault occur.

Adequate facilities shall be provided, preferably at the front of each protection equipment panel, to isolate all DC and AC incoming and outgoing circuits so that work may be carried out on the equipment with complete safety for personnel and without loss of security in the operation of the switching station. The isolation points shall be clearly identified and labelled. The labels on the isolation points shall either describe the function or be uniquely numbered.

The Contractor shall provide a list of all of the protection and auto-reclose equipment being offered under the contract.

The Contractor shall also provide a list of all of the test and ancillary equipment required for commissioning and routine testing of all protection and auto-reclose equipment.

6.13 Service life and support

The protection systems shall be designed for a service life of at least 15 years, and preferably 20 years, given that normal maintenance in accordance with manufacturers recommendations is carried out during the lifetime of the protection system.

The Contractor shall state the service life of the protection system equipment in relation to that of the main HV plant and apparatus so that Employer can assess the cost of any replacement during the life of the substation.

The Contractor shall state the period for which lifetime support will be provided for the protection system equipment and shall make recommendations for the provision of spare parts.

The Contractor shall supply circuit diagrams for each protection system and the associated tripping system(s). The diagrams shall provide sufficient information to enable fault finding and maintenance to be carried out and shall not consist solely of information used for equipment manufacture.

When the Contractor has been notified of incorrect operation, or failure to operate when required, of any protection system supplied under the contract, the Contractor shall investigate the incident and inform Employer of any such incidents if they result in the necessity to modify the equipment. The Contractor shall also inform Employer of the details of the modifications required to prevent such incidents re-occurring.

The Contractor shall offer a service to enable any faulty item of protection equipment to be rectified or replaced within a stated period of the fault being reported. The Contractor shall state the repair/replacement period.

The Contractor shall, when requested, offer the Employer a maintenance contract for the protection equipment supplied under the contract. The Contractor shall supply details of the cost of the maintenance contract and information on test procedures and test frequencies that would be supplied under the maintenance contract.

The Contractor shall offer training for Employer's personnel in the operation and maintenance of the protection equipment.

6.14 Thermal rating of equipment

Relay equipment intended to perform a current measurement function shall be capable of continuous operation at a current of not less than 2.4 times the nominal rating or twice the setting value, whichever is the more onerous.

Relay equipment intended for use in a normally quiescent mode and having a short time rating - for example, high impedance differential protection - shall be rated in accordance with the intended function and taking account of such inherent protective devices as may be incorporated in the design.

The short time rating for all protection relaying schemes shall be 100 times the nominal relay rating for a duration of one second.

Voltage sensitive equipment intended for use on effectively earthed networks shall have a continuous withstand of not less than 1.2 times nominal voltage and a short duration withstand of not less than 1.5 times nominal phase-to-ground voltage for 30 s.

6.15 Insulation

The rated insulation voltage of circuits connected to current transformers of high impedance relays shall be 1000 V. All other circuits shall have an insulation voltage of 2500V.

All open contacts of the protection system shall withstand a voltage of 1000V. The protection system shall comply with the dielectric test requirements of IEC 255-5. The test voltage shall be selected according to the rated insulation voltage of the circuits being tested form SeriesC of Table1 of IEC 255-5. The protection system shall comply with the impulse test requirements of IEC 255-5 with test voltage of 5kV.

6.16 Test requirements

6.16.1 General requirements

The Contractor shall supply test results and/or in service operating evidence to confirm compliance with the general and performance requirements as detailed in this Specification.

6.16.2 Pre-commissioning and energisation tests

The Contractor shall submit details of all pre-commissioning and energisation tests to the Project Manager for approval prior to the tests, and shall provide the Project Manager with the opportunity to witness the commissioning tests.

6.16.3 Testing, inspection and test certificates

The Bidder shall enclose with his bid the reports of type and routine tests conducted on similar equipment earlier as a proof of designing and developing similar equipment. Bid documents, furnished without these test reports shall be considered as incomplete and shall be liable for rejection.
All equipment furnished shall conform to the type tests and shall be subject to routine tests in accordance with the requirements stipulated for control and relay panel equipment. The Project Manager reserves the option to call for any or all the type tests to be repeated on the equipment. The Project Manager further reserves the option to intimate the type tests to be carried out on the equipment up to six months after the award of contract. Payments would be made for the type tests actually carried out in accordance with the rates given in the Bid Price Schedule.
The Project Manager will have the right to call for any other tests of reasonable nature to be carried out at the Contractor's premises or at site or in any other place, in addition to the aforesaid type and routine tests, to satisfy that the materials comply with the Specification.
The Contractor shall advise the Project Manager three months in advance of the type tests to be conducted on the finished equipment giving a programme for conducting the tests and shall proceed to test the equipment only after approval of the Project Manager. All type tests shall be performed in presence of Project Manager should he so desire.
The Contractor shall give one months notice of routine tests and inspection to be carried out on the finished equipment. A programme for conducting the tests shall be furnished and the Contractor shall proceed to test the equipment after approval of the Project Manager. The tests shall be witnessed by the Project Manager should he so desire.
All inspections, type tests and routine tests shall be carried out after approval of all the relevant drawings required under the contract.
None of the equipment to be furnished or used in connection with this contract shall be despatched until factory tests are satisfactorily completed. Such factory tests on the equipment shall not however relieve the Contractor from full responsibility for furnishing equipment conforming to the requirements of this contract, nor prejudice any claim right or privilege which the Employer may have because of the use of defective or unsatisfactory equipment. Should the Project Manager waive the rights to inspect and test any equipment, such a waiver shall not relieve the Contractor, in any way, of his obligations under this contract.
Six (6) copies of test reports of successful tests shall be submitted by the Contractor to the Project Manager for approval before shipment of equipment.
For equipment tests for which IEC recommendations or Indian Standards are available, test reports confirming that the equipment has passed the specified type and routine tests shall be furnished for the approval of the Project Manager by the Contractor before shipment of the equipment.
For equipment/tests for which IEC/IS specifications do not exist, the Contractor shall propose a test procedure for the approval of the Project Manager before conducting tests. Test certificates for tests carried out shall be submitted for approval of the Project Manager before shipment of the equipment.
Failure of any equipment to meet the requirements of tests carried out at works or at site shall be sufficient cause for rejection of the equipment. Rejection of any equipment will not be held as a valid reason for delay in the completion of the works in accordance with the agreed programme.
The Employer reserves the right to call for field tests on the completely assembled equipment at site.
The price for conducting all the type tests in accordance with relevant standards and specifications shall be indicated in Bid Price Schedule and these would be considered for bid evaluation. The break-up price of type tests shall be given in the relevant price schedule for payment purpose only. In case Bidder does not indicate charges for any of the type tests or does not specifically identify any test in the price schedules, it will be assumed that the particular test has been offered free of charge. Further, in case any Bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to rejection.
Six (6) copies of all test reports shall be supplied for approval before shipment of equipment. The reports shall indicate clearly the standard values specified for each test, to facilitate checking of the test reports. Fourteen (14) bound copies of test reports shall be submitted along with the equipment after approval of test results.

6.16.4 Soak test

All solid state equipment/system panels shall be subject to the Hot Soak Test as a routine test in accordance with the procedure detailed in the following paragraph.

All solid state equipment shall be burn-in tested for minimum of 120 hours continuously under operational conditions. During the last 48 hours of testing, the ambient temperature of the test chamber shall be 50C. Each panel shall be complete with all associated sub-systems and the same shall be in operation during the above test. During the last 48 hours of the above test, the temperature inside the panel shall be monitored with all the doors closed. The temperature of the panel interior shall not exceed 65C.

6.16.5 Type tests

Impulse voltage withstand test as per Clause 6.1 of IS 8686 (for a test voltage appropriate to Class III as per Clause 3.2 of IS-8686)

High Frequency Disturbance test as per Clause 5.2 of IS 8686 (for a test voltage appropriate to Class III as per Clause 3.2 of IS 8686)

Type tests listed under IEC-Technical Committees recommendation `TEC-57' and functional type tests listed under **CIGRE Study Committee 34** (Protection) Report on simulator, Network analyser or PTL as applicable.

6.16.6 Routine tests

Contact insulation resistance test as per Clause 10.5 of IS-3231.

Insulation withstand capability as per Clause 10.5 of IS-3231 on all AC/DC relays.

7.0 Protection Schemes

7.1 General

The following sections of this specification identify the protection requirements for specific schemes. Drawings showing single line diagrams for each type of circuit are included in this Specification. The arrangements shown on these drawings represent the minimum requirements. Other protection arrangements may be provided but the Bidder must clearly state the reasons for offering supplementary protection schemes.

7.2 Technical requirements

Technical requirements of the protection and auxiliary relays, recorders and meters to be provided as part of the scope are detailed I the following sub clauses.

The setting ranges of the equipment offered, if different from that specified shall be acceptable if they meet the functional requirements. The Bidder shall quote for protection equipment meeting the requirements given in these sub clauses.

The Bidder may also quote alternative or additional protections or relays considered necessary by him for providing an effective and reliable protection scheme. These equipments shall be quoted separately as an alternative or addition to the main offer. The Employer reserves the right to accept or otherwise such equipment.

7.3 400kV Reactor protection

Protection requirement

The 400 kV reactors provided with the lines shall have the following protections.

- Differential protection.
- Restricted earth fault protection.
- Backup impedance protection.

7.3.1 Differential protection relay (87R)

This relay shall :

1. Be triple pole type
2. Have operation time less than 25 milliseconds at five times setting.
3. Be tuned to system frequency.

4. Have three instantaneous high set units to ensure rapid clearance of heavy faults with saturated CT's.

5. Have current setting range of 10 to 40% of 1 Amp.

6. Be Low impedance type.

7. Be stable for all external faults.

8. Be provided with suitable non-linear resistors to limit the peak voltage to 1000 volts.

7.3.2 Restricted earth fault protection relay (64 R)

This relay shall:

1. Be single pole type

2. Be of current/voltage operated high impedance type

3. Have a current setting of 10-40% of 1A and a suitable voltage setting range.

4. Be tuned to system frequency.

5. Be fitted with suitable non-linear resistors to limit the peak voltage to 1000 volts.

7.3.3 Back up impedance protection relay (21 R)

This relay shall:

1. Be triple pole type

2. Be single step polarised `mho' distance relay or impedance relay suitable for measuring phase to ground and phase to phase faults.

3. Have an ohmic setting range of 20-320 ohms and shall be continuously variable.

4. Have an adjustable characteristic angle of 30 to 80 degree.

5. Have a definite time delay with a continuously adjustable setting range of 0.2 - 2.0 seconds. Shall initiate three phase tripping

7.4 BUS BAR PROTECTION:

Bus bar protection schemes shall be provided for each main and transfer bus of 400 KV and 200 KV provided in the switch yard/in GIS S/S. This shall constitute main and check features. The overall scheme shall be engineered such that operation of both main and check features connected to the faulty bus shall result in tripping of the same. The scheme shall be provided with necessary expansion capacity and interfaces for adding features when the switch yard is extended in future to its ultimate capacity. The bus bar relay shall be of latest numerical relay having IEC protocol 61850 compliance.

7.4.1 Busbar protection (Latest version numerical relays having IEC-61850 protocol compliance)

Bus bar protection schemes shall be provided for each main bus of 400kV and 220kV switchyard/in GIS S/S. The overall scheme shall be engineered so as to ensure that operation of the Bus-Bar Protection Scheme connected to main faulty bus shall result in tripping of the same. The scheme shall be engineered in such a manner that the tripping shall be selective depending on the location of fault including end-fault. The operation of the protective relay in no case shall trip the healthy part the system. However in case of transfer bus, where provided, only one busbar protection scheme shall be required.

Provision of Bus-bar Protection scheme as per the following:

(a) 400 KV System: Single Bus bar Protection scheme for all Buses as per the System configuration. Double Bus Bar Protection Scheme for redundancy purpose where specifically asked in the Price Schedule.

(b) 220 KV System: Single Bus bar Protection scheme for all Buses as per the System configuration.

(c) 132 KV System: Single Bus bar Protection scheme for all Buses as per the System configuration.

Each busbar protection scheme shall:

1. Be of modular construction and have features of self monitoring facility to ensure maximum availability of scheme. The scheme shall be static/ microprocessor/ Numerical based.

2. Have maximum operating time up to trip impulse to trip relay for all types of faults of 15 milli seconds at 5 times setting value.
3. Operate selectively for each busbar.
4. Give hundred percent security up to 40kA fault level.
5. Incorporate a check feature.
6. Incorporate continuous supervision for CT secondaries against any possible open circuit and if it occurs, shall render the relevant zone of protection inoperative and initiate alarm.
7. Not give false operation during normal load flow in busbars.
8. Incorporate clear zone indication.
9. Be of phase segregated and triple pole type and provide independent zones of protection for each bus (including transfer bus if any). If a bus section is provided then each side of the bus section shall have separate busbar protection scheme.
10. The protective relays shall be of numerical type and communication protocol shall be as per IEC 61850. LBB be acceptable as Built-in protection function of bus bar protection relay.
11. Include individual high speed hand reset tripping relays for each feeder, including future ones.
12. Be of low/medium impedance biased differential type and have operate and restraint characteristics.
13. Be transient free in operation
14. Include continuous DC supplies supervision.
15. Shall include multitap auxiliary CT's for each bay including future bays as per SLD and also include necessary CT switching relays wherever CT switching is involved.
16. Include protection 'in/out' switch for each zone with at least six contacts for each switch.
17. Shall have CT selection incomplete alarm wherever CT switching is involved.
18. Have necessary auxiliary relays to make a comprehensive scheme.
    At existing substations busbar scheme with independent zones for each bus will be available. All necessary co-ordination for 'CT' and 'DC' interconnections between existing schemes (panels) and the bays proposed under the scope of this contract shall be fully covered by the bidder. Any auxiliary relays, trip relays, flag relays required to facilitate the operation of bays covered under this contract shall be fully covered in the scope of the bidder.
    The Contractor shall offer all equipment to meet the requirements as above to make the scheme full and comprehensive.

7.4.2 Weatherproof relay panels

Where required these panels shall be provided for busbar differential protection. The panels shall include necessary number of electrically reset relays each with at least eight contacts for isolator auxiliary contact multiplication and for changing the CT and DC circuits to relevant zone of protection.

The panel shall be sheet steel enclosed and shall be dust, weather and vermin proof. Sheet steel used shall be at least 3.0 mm thick and properly braced to prevent movement. The enclosures of the panel shall provide a degree of protection of not less than IP55 (as per IS 2147). The constructional requirements shall comply with the relevant section of this Specification.

Two test terminal blocks required for bus coupler bay CT connection shall be supplied and mounted inside the panel of adjacent bay.

The test terminal blocks shall be fully enclosed with removable covers and made of moulded, non-inflammable plastic material with boxes and barriers moulded integrally. Such blocks shall have washer and binding screws for external circuit wire connections, a white marking strip for circuit identification and moulded plastic cover. All terminals shall be clearly marked with identification numbers or letters to facilitate connection to external wiring. Terminal block shall have shorting, disconnecting and testing facilities for CT circuits.

7.5 Bus coupler / transfer bus coupler protection

disconnecting and testing facilities for CT circuits

The protection scheme for the above are to be provided with directional numerical over current and earth fault protection scheme . The relay shall be latest version numerical and IEC 61850 compliant for future SCADA purpose.The details as indicated under unit back up protection relay.
All 220 kV substations shall be of Double Main (DM) or Double Main and Transfer (DMT) busbar configuration and shall be provided with a single bus coupler circuit breaker. In addition 220 kV DMT busbar configurations shall be provided with a transfer bus coupler circuit breaker. The required protection equipment for these breakers comprises overcurrent and earth fault relays. These relays shall comply with the requirements for backup over current and earth fault protection as described elsewhere in this section, except that the relays shall not be directional. The earth fault element shall have a current setting range of at least 20 - 80 per cent in six equal steps.

All 132 and 33 kV substations shall be of Single Main and Transfer (SMT) busbar configuration and a bus section isolator. Overcurrent and earth fault protection, complying with the requirements as given elsewhere in this section but without directional feature, shall be provided.

In DMT/SMT configurations, whenever the main breaker of a feeder or transformer is substituted by the bus coupler or transfer bus coupler breaker, a facility for switching over of the trip function of the feeder or transformer relays from the main breaker to the bus coupler or transfer bus coupler breaker, shall be provided through provision of a lockable protection transfer switch. The provision of a key interlock on the above switch is to be so arranged that at one time only one feeder or transformer can be taken to transfer mode.

7.6 Circuit breaker monitoring auxiliary relays

All circuit breakers shall be provided with several relay contacts for annunciation of circuit breaker conditions such as :

- Low air/hydraulic oil/gas pressure.
- Lockout conditions due to abnormally low air/hydraulic oil/gas pressure.
- Pole discrepancy trip.
- Compressor/hydraulic pump trouble.

The exact requirements for this shall be available in the circuit breaker drawings to be provided by the manufacturer. The programmable Inputs/Outputs of the numeric relays shall be used as much as possible for providing annunciation in the control room for such cases. In case this is found inadequate, suitable auxiliary flag relays may be provided in the relay panels to provide annunciation.

8.0 Event logger (**) **(Built-in part of main numerical device)**

**As per the customers requirement
All 400 and 220 KV sub-station shall have separate Event Logger panel provision.

8.1 General

The event logger shall be used to record the open and close states of switch yard equipment, relays and changes of alarms.
The function of the equipment should be based on programmes stored in it. The stored programmes should permit some degree of flexibility of operation. Facility should be provided to erase the existing programme and reprogram allowing changes to be made very easily.
The number of modules and different types of modules should be minimised. The modules should be of plug-in type and should be easily accessible to simplify maintenance and repair.
The equipment should be designed to operate satisfactorily in severely hostile electrical environment such as in 400kV/220kV switchyard which are prone to various interference signals, typically from large switching transients.
The equipment should be carefully screened, shielded, earthed and protected.
Input/ Output circuits should withstand the following tests:

- Impulse test in accordance with IEC 255, Part-IV.
- High frequency disturbance test in accordance with IEC 255, Part-IV.

Since the equipment will be used in dedicated non-attended situations, programme stability is vitally important. Programme must not be capable of being changed unintentionally during normal operation.

8.2 Construction

The equipment should be constructed in clearly defined plug-in modules. A monitor module should be provided for indicating internal faults such as processor failure, memory failure, other internal hardware failures, and also external plant failures. These failures should be displayed on the LED's mounted on the monitor module. The equipment is used to record changes in digital points, i.e. operations and resetting of alarms and switching of primary equipment within a substation. Approximately 500 points should be accommodated in a single equipment. When such changes occur, a print out on a local teletype writer, which forms a part of this contract, should result.

The date and time should be printed to the nearest 10 ms followed by a message describing the point which has operated. Such messages may be abbreviated or in full English forms. Events occurring whilst a previous event is in process of being printed are to be stored to await printing. Over 100 such events must be stored. Facility shall exist to synchronise the internal clock system which will give a pulse output every half an hour with a pulse duration of at least 50 milliseconds through potential free contracts. However, if master clock system is not available, time generator of any one of the disturbance recorder shall be taken as master and event logger(s) in that station will be synchronised with it. The event logger shall give annunciation in case of absence of synchronising pulse within a specified time window. The internal clock of the event logger shall be such that the drift is limited to □0.5 seconds per day, if allowed to run without time synchronisation. The print out of current alarm and plant stages must be available on request by the operator. the operator should also be able to enter the date and time from the key board.

8.3 Technical requirements

The event recorder shall record all changes of alarms and plant states of switchyard equipment, along with the date and time of all alarms and plant state changes to the nearest 10 ms.

Facility shall be provided to commit 50 points of sequential memory or 25% of alarm whichever is the greater. In addition the unit shall be capable of handling up to 40 changes in any one 10 ms interval and 500 alarms and changes of state of switchyard equipment.

On receipt of an alarm the equipment must:

- Print out a message on Printer
- Set off an audible alarm.
- Set off a beacon.

Allow normal inputs of

- Accept
- Alarm demand log
- Plant state demand log
- Date and time

The Bidder shall furnish along with the offer a two copies on original paper typical print out for simulated conditions.

Only plain paper readily available in India shall be used for the printer. The arrangement of feeding and removing paper rolls or stacks shall be quick and simple. The width of paper shall be 216 mm approximately. The Bidder shall provide as part of his scope of supply, consumables for up to six months operation.

Event printout of the shall contain as a minimum the following:

- Station identification.
- Date and time (in hour, minutes, seconds and milliseconds).
- Event number.
- Event description (at least 40 characters).

The auxiliary power supply required for the event logger, VDU and printer shall be either 220V DC or 110V DC (as available in the station) with voltage variation of + 10% to -20%. Any other power supply

that may be required for proper functioning of the equipment has to be derived by the Bidder from his own equipment which shall form an integral part of the event logger station.
Bidder shall supply VDU, printer and keyboard arrangement.
At existing substations where an event logger is provided, Bidder shall provide necessary potential free contracts of various relays/equipment for plant and alarm states and shall co-ordinate with existing event logger for proper logging of events.
A combined solution of disturbance recorder and event logger function with a VDU, key board and a printer is also acceptable.

9.0 Synchronising equipment

Where required synchronising equipment shall be provided along with this Contract.
The synchronising instruments shall be mounted on a synchronising trolley. The trolley shall be equipped with double voltmeter, double frequency meter, synchroscope and lamps fully wired. The trolley shall be of mobile type with four rubber padding wheels capable of rotating in 360 degree around the vertical axis. Suitable bumpers with rubber padding shall be provided around the trolley to prevent any accidental damage to any panel in the control room while the trolley is in movement.
The trolley shall have two metre long flexible cord fully wired to the instruments and terminated in a plug in order to facilitate connecting the trolley to any of the panels. The receptacle to accept the plug shall be provided on the panel.
Synchronising check relay with necessary ancillary equipment shall be provided. This shall permit breakers to close after checking the requirements of synchronising of incoming and running supply. The phase angle setting shall not exceed 35 degree and have voltage difference setting not exceeding 10%. This relay shall have a response time of less than 200 milliseconds when the two system conditions are met within present limits and with the timer disconnected. The relay shall have a frequency difference setting not exceeding 0.45% at rated value and at the minimum time setting. The relay shall have a continuously adjustable time setting range of 0.5-3 seconds. A guard relay shall be provided to prevent a closing attempt by means of synchronising check relay when control switch is kept in closed position before the two systems are in synchronism.
Suitable auxiliary voltage transformers, wherever necessary, shall also be provided for synchronising condition. In case the synchroscope is not continuously rated, a synchroscope cut-off switch shall be provided and an indicating lamp to indicate that the synchroscope is energised, shall also be provided.
Each circuit for which a synchronous closure is required shall be provided with a lockable synchronising selector switch which shall be used to select the voltage signals (incoming and running voltage) appropriate for that circuit. The provision of a key interlock shall ensure that at any one time only one feeder / transformer can be synchronised.

10.0 Time synchronisation equipment for substation

The Bidder shall offer necessary time synchronisation equipment complete in all respects including antenna, all cables, processing equipment etc. required to receive co-ordinated universal time (UTC), transmitted through GEO Positioning Satellite System (GPS).
The time synchronising system should be compatible for synchronisation with event loggers, disturbance recorders, relays, computer systems and all other equipment provided in the protection, control and metering system of the substation wherever required.
Equipment should operate up to an ambient temperature of 50C and 100% humidity. The synchronisation equipment shall have two microsecond accuracy. Equipment should give real time corresponding to IST (taking into consideration all factors such as voltage and temperature variations, propagation and processing delays etc.
Equipment should meet the requirement of IEC 255 for storage and operation. The system should be able to track the satellites to ensure no interruption of synchronisation signal.
The output signal from each port shall be programmable at site for either one hour, half hour, minute or second pulse, as per requirement.
The equipment offered shall have six output ports. Various combinations of output ports shall be selected by the Project Manager, during detailed engineering, from the following:

1. Voltage signal : 0-5V continuously settable, with 50 ms. minimum pulse duration.
2. Potential free contact : minimum pulse duration of 50 ms
3. IRIG-B & SNTP

4. RS232C

The equipment should have a periodic time correction facility of one second periodicity.

Time synchronisation equipment shall be suitable for operation from 220V DC as available at substation with a voltage variation of +10% and -20%. Any other power supply that may be required for proper functioning of the equipment shall be derived by the Bidder from his own equipment which shall form an integral part of the system.

Equipment shall have real time digital display in hour, minute, second (24 hour mode) and have a separate time display unit to be mounted on the top of control panels having display size of approximately 100 mm height.

Bidder shall quote unit rates for each type of output port for the purpose of addition/deletion.

Schedule of Quantities

11.0 General

Protection, control, metering panels and associated equipment to be located in switchyard control rooms at various substations shall be offered as panels/systems/modules of following description. The quantities are given at the end of this section.

Sl. No.	Description of Panels	Control Panel type and designtation	Relay Panels type and designtation
1	Line protection panel:		
1.1	400kV line-4CT,5CT (1 $^1/_2$ breaker scheme)	CPF4H	RPF4H
1.2	220kV line-DMT	CPF2D	RPF2D
1.3	132kV line—MT	CPF1M	RPF1M
1.4	33kV line—MT	CPF0M	RPF0M
2	Transformer protection panel:		
2.1	400/220kV Auto-	CPH4H	RPH4H
	Transformer	CPL2D	RPL2D
2.2	220/132kV Auto-	CPH2D	RPH2D
	Transformer	CPL1M	RPL1M
2.3	220/33kV power	CPH2D	RPH2D
	Transformer	CPL0M	RPL0M
2.4	132/33kV power	CPH1M	RPH1M
	Transformer	CPL0M	RPL0M
3	Reactor protection panel:		
3.1	Bus reactor	CPR4H	RPR4H
3.2	Line reactor	CPS4H	RPS4H
4.1	Transfer bus coupler		
	220kV line-DMT	CPT2D	RPT2D
	220kV line-T	CPT2T	RPT2T
4.2	Bus coupler		
	220kV line-DMT	CPB2D	RPB2D
	132kV line—MT	CPB1M	RPB1M
	33kV line—MT	CPB0M	RPB0M
4.5	Bus sectionaliser	CPZ2D	RPZ2D

11.1 Type designations for the various panels

The panels are designated by a alpha-numeric code consisting of five characters (AAANA) through out this schedule in this specification to represent their use for various applications. Their representation shall be as here under:

Character position	1 2	3	4	5
Character representation	AA	A	N	A

H	$1^1/_2$ breaker scheme
D	Double main and transfer switching scheme
M	Main and transfer switching scheme
S	Single bus
T	Two mains bus switching scheme
R	Ring main bus switching scheme

0	33kV
1	132kV
2	220kV
4	400kV
F	Feeder
H	Transformer High Voltage Side
L	Transformer Low Voltage Side
R	Bus reactor
S	Shunt(line) reactor
T	Transfer bus coupler
B	Bus coupler and Bus bar
Z	Bus sectionaliser
C	Capacitor bank protection
V	Bus bar
M	Diameter with Transformer and Feeder
N	Diameter with Feeder and Feeder
O	Diameter with Feeder and Feeder
P	1/2 Diameter with Single Feeder
Q	1/2 Diameter with Single Feeder with Reactor

CP	Control panel
RP	Relay panel
KP	Common panel

11.2 Bill of quantities for individual panels

Each panel described above shall constitute the equipment as detailed here under . The quantities of each type of equipment are minimum. The bidder may include additional devices in the panels depending upon the design and requirements as per stipulations of the specification.

Control panel (CPANA)

		CPA4H / CPA2H	CPA2D /CPA1M /CPA2T	CPA1M /CPA0S / CPA0T
Sl. no	**List of equipment**	**Quantities required for each panel**		
		For 400kV / 220kV and 1 $^1/_2$ breaker scheme	**For 220kV and 132kV**	**For 33kV**
1.	Ammeter (Digital)	3 Nos. for each bay (1 for each bay in case of 220 kV) + 1No. for reactor (as per requirement)	1No (2 Nos. for Bus section coupler)	1No.

** **ALL THE RELAYS SHALL BE OF NUMERICAL VERSION HAVING IEC 61850 PROTOCOL COMPLIANCE. ALL CARE SHALL BE TAKEN IN DESIGNING THE PROTECTION SYSTEM FOR FUTURE SCADA PROVISION. THERE SHALL BE ADEQUATE NO OF INPUT AND OUT PUT CONTACTS FOR USE. SHALL HAVE SELF SUPERVISING AND INTERNAL FAULT DETECTING/DIAGNOSING FACILTY. SUFFICIENT FAULT /DISTURBANCE RECORDING FACILITIES.**

12.0 ERECTION AND MAINTENANCE TOOL EQUIPMENT:

All special testing equipment required for the installation and maintenance of the apparatus, instruments devices shall be furnished. The testing plug shall be supplied along with the panels for conducting testing of relays. These testing plug should be suitable for test terminal box provided in the panel.

12.1 TROPICALISATION:

Control room will be normally air-conditioned. All equipments shall however be suitable for installation in a tropical monsoon area having hot,humid climate and dry and dusty seasons with ambient conditions specified in the specification. All control wiring,equipment and accessories shall be protected against fungus growth, condensation, vermin and other harmful effects due to tropical environment.

12.2 RELAY TEST KIT

One relay test kit shall comprise of the following equipment as detailed hereunder.

1. Relay tools kits: 3 Sets
2. Test plugs: 2 Nos
3. Special type test plugs for using with modular type cases(if applicable): 1 No

13.0 ADDITIONAL INFORMATION ON SWITCHES ETC.

13.1 SWITCHES:

1. Control and instrument switches shall be rotary operated type with escutcheon plates clearly marked to show operating position and circuit designation plates and suitable for flush mounting with only switch front plate and operating handle projecting out.
2. The selection of operating handles for the different types of switches shall be as follows.

Purpose	Type
Breaker, Isolator control switches	Discrepancy type
~~Synchronizing switches~~	~~Oval, Black, keyed handle (having common key for a group of switches)~~
~~Synchronizing selector switch~~	~~Oval or knob, block~~
Instrument switches	Round, knurled, black
Protection transfer switch	Pistol grip, lockable & black

** In case the rotary switches are provided for breaker and isolator control Semaphores are also to be provided along with the switches.

3. The control switch of breaker and isolator shall be of spring return to neutral type. The switch shall have spring return from close and trip position to "after close" and "after trip" position respectively.
4. Instrument selection switches shall be of maintained contact (stay put) type. Ammeter selection switches shall have make before break type contacts so as to prevent open circuiting of CT secondary when charging the position of the switch. Voltmeter transfer switch for AC shall be suitable for reading all line to line and line to neutral voltage for non effectively earthed systems and for reading all line to line voltages for effectively earthed systems.
5. Synchronising switches shall be of maintained contact (stay put) type having a common removable handle for a group of switches. The handle shall be removable only in the off position and it shall be coordinated to fit into all the synchronizing switches. These shall be arranged to connect the synchronizing equipment when turned to the "on" position. One contact of each switch shall be connected in the closing circuit of the respective breaker so that the breaker cannot be closed until the switch is turned to the ON position.

6. Lockable type switches which can be locked in particular position shall be provided when specified. The key locks shall be fitted on the operating handles.
7. The contacts of all the switches shall preferably open and close with snap action to minimizing the arcing. Contacts of switches shall be spring assisted and contact faces shall be with rivets of pure silver or silver alloy Springs shall not be used as current carrying parts.
8. The contact combination and their operation shall be such as to give completeness to the interlock and function of the scheme.
9. The contact rating of the switches shall be as follows.

Description	Contact Rating In Amperes		
	220 V DC	50 V DC	230 V AC
Make & carry continuously	10	10	10
Make & carry for 0.5 sec	30	30	30
Break for			
i) Resistive load	3	20	7
ii) Inductive load (L/R=40ms)	0.2	-	-

13.`2 INDICATING INSTRUMENTS, RECORDERS & TRANSDUCERS:

All instruments, meters, recorders and transducers shall be enclosed in dust proof, moisture resistant, black finished cases and shall be suitable for tropical use. All megawatt, megavar, bus voltage and frequency indicating instruments shall be provided with individual transducers and these shall be calibrated along with the transducers to read directly the primary quantities. They shall be accurately adjusted and calibrated at works and shall have means of calibration check and adjustment at site. The supplier shall submit calibration certificates at the time of delivery. However no separate transducers are envisaged for digital bus voltmeters and digital frequency meters and the indicating meters provided in the synchronizing equipment.

13.2.1 Indicating Instruments:

1. All electrical indicating instruments shall be of digital type suitable for flush mounting.
2. Shall have 4 digit display, display height being not less than 25mm.
3. Shall confirm to relevant IS and shall have an accuracy class 1.5and or better watt and Var meters shall have an indication of (+) and (-) to indicate Export and Import respectively.
4. Digital voltage and frequency meters shall be of 0.5 class and shall have digital display of 5 and 4 digits respectively, with display size not less than 25mm height.

13.14.2 Bus voltage & Frequency recording instruments:

1. Shall be static/digital type frequency and voltage recorder either as individual units or composite unit for total sub-station with time tagged information shall also be applicable if it meets the accuracy of ± 1.0% span and full span response time of less than 2 seconds. The static/digital shall also meet the high voltage susceptibility test, impulse voltage with stand test ,high frequency disturbance test-class III and fast transient disturbance test level III as per IEC -60255.

13.2.3 Transducers:

1. Transducers shall in general confirm to IEC-688-1
2. Shall be suitable for measurement of active power, reactive power, voltage, current and frequency in three phase four wire unbalanced system.
3. Transducers shall have input from sub-station current and voltage from the instrument transformers. The output shall be in miliampere D.C proportional to the input and shall feed the output current to the indicating instruments /telemetry terminals.
4. Characteristic shall be linier throughout the measuring range.
5. Output shall be load independent.
6. Input and output shall be galvanically isolated.
7. Transducers should work satisfactorily at 120% of rated value continuously.
8. Shall have 4-20mAmp.
9. Response time shall be less than 1 sec.
10. Accuracy class shall be 1 or better voltage/current, 0.5 or better for watt/var and 0.2 or better for frequency transducers.
11. Shall have a low AC ripple on output less than 1%.
12. Shall be suitable for load resistance of 1000 – 1500.
13. Shall have dual output.

Test programme for distance relays

General Comments:

1. These test cases are evolved from the report of working group 04 of study committee 34 (Protection) on evaluation of characteristics and performance of power system protection relays and protective systems. For any further guidelines required for carrying out the tests, reference may be made to the above document.
2. The test shall be carried out using network configuration and system parameters as shown in the figure-1
3. All denotations regarding fault location, breakers etc are referred in figure –1
4. The fault inception angles are referred to R- N voltage for all types of faults
5. The fault inception angle is zero degree unless otherwise specified
6. Where not stated specifically, the fault resistance (Rf) shall be zero or minimum as possible in simulator
7. Single pole circuit breakers are to be used
8. The power flow in double source test is 500 MW

System Parameters System voltage =400KV; CTR= 1000/1

PTR = 400000/110 (with CVT, the parameters of CVT model are shown in figure –2)

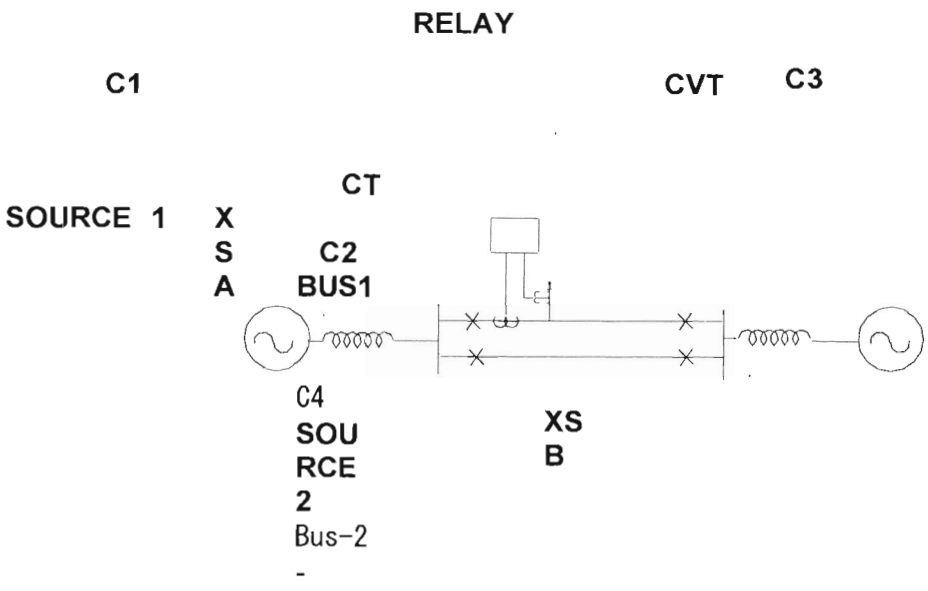


Figure-1

Line parameters/km

Positive Sequence Resistance, (r1)	= 0. 02897 Ω
Positive Sequence Reactance (x1)	= 0.3072 Ω Zero Sequence
Resistance (r0)	= 0.2597 Ω Zero Sequence
Reactance (x1)	= 1.0223 Ω Zero Sequence
Mutual Resistance (rm)	= 0.2281 Ω Zero Sequence
Mutual Reactance (xm)	= 0.6221 Ω Zero Sequence
succeptance (bo)	= 2.347 μ mho Positive
Sequence succeptance (b1)	=3.630 μmho

Types of Line	Short		Long
Secondary Line Impedance	2 Ω		20 Ω*
Length of Line in Km	23.57		235.7
SIR	4	15	4
Source impedance (pry) (at a time constant of 50 ms)	29.09 Ω (5500 MVA)	109.09 Ω (1467 MVA)	290.9 Ω (550 MVA)

* Alternatively , the tests can be done with 10 Ω secondary impedance and source impedance may accordingly be modified.

CVT Model:

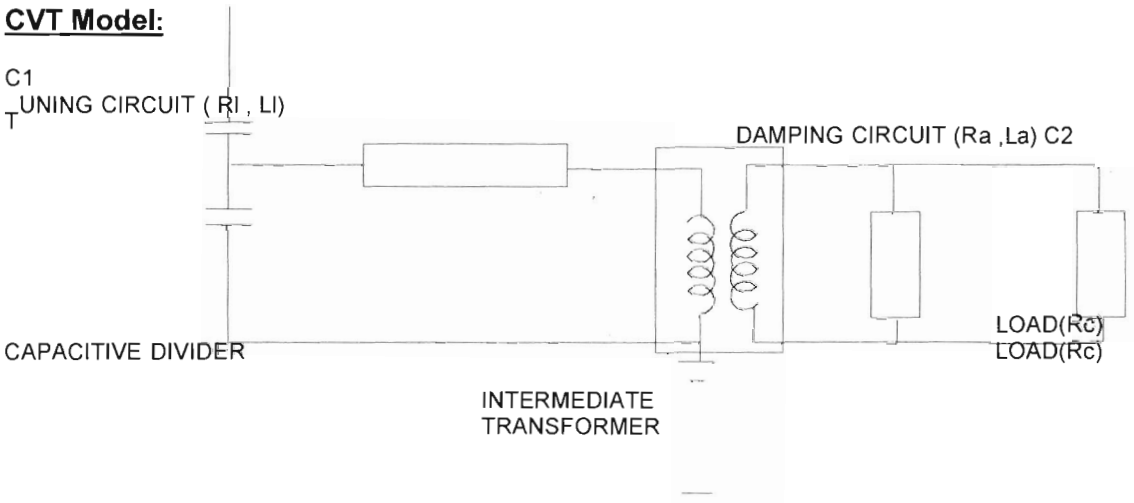
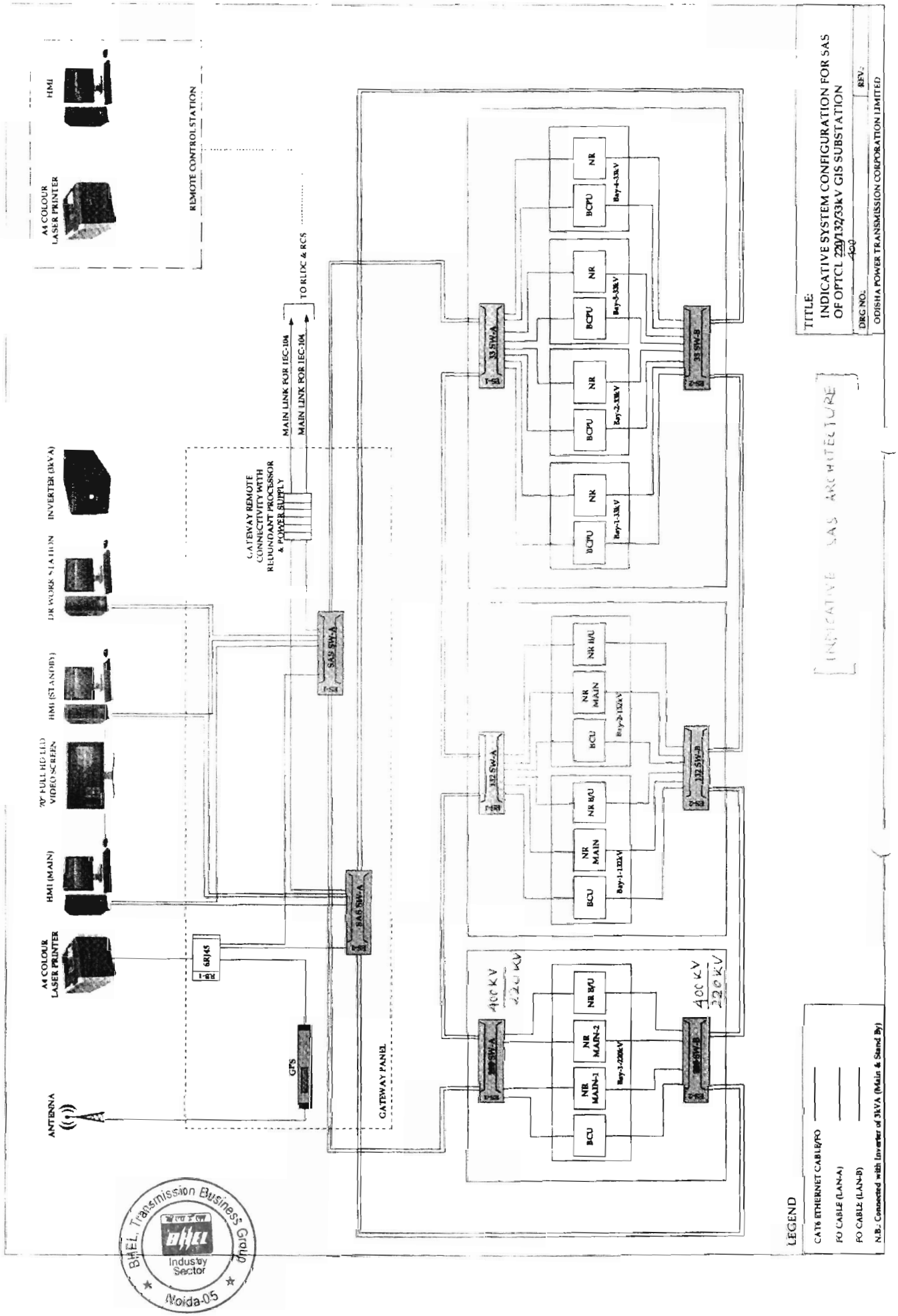


Figure-2

XC1 : 1.455 μ mho,XC2 : 27.646 μ mho

RI : 320 Ω , XII : 34243 Ω, Ra : 4.200 Ω, Xla : 197.92 Ω,Rc : 14.00 Ω, Transformation ratio of : 181.8 Intermediate transformer.



7	The kits shall measure Ratio Range from 0.8 to 45,000
8	Does Accuracy and resolution is meeting as per specification?
9	The lengths of test leads for connection to transformer are of **15 meters**.
10	Technical data sheet, literature is enclosed along with the offer which is as per GTP
11	The equipment shall have facility to perform auto **vector group detection** with provided software
12	The equipment shall have capability to perform **magnetic balance test** with provided software
13	The Equipment shall be Equipped with remote test switch for single person operation & to perform **the test with Load Tap Changer Quickly.**
14	The kit meets the GENERAL Technical specification of Annexure I.
15	The kit full fills safety, EMI/EMC compatibility for safe working at substation of equipment and human being.
16	Specify the Make, Model, Details of accessories considered & Origin of Manufacturer of the equipment

8. UNIVERSAL RELAY TEST KIT

1.1 RELAY TEST KIT

1.1.1 General

Each relay test kit shall comprise the equipment as detailed here under.

The relay test kit shall be a computer based fully automatic type and shall have following features. Relay test kit should be already supplied to our utility. Manufacturer should have a calibration set-up and service centre in India. Also, manufacturer would be having registered office for technical support in India.

1.2 Functional requirement

The equipment is required functionally to test the following electromechanical, solid state and numerical protection relays.

- Distance relays (ground and phase distance)
- Over current relays (directional and non-directional, definite time and inverse time)
- Frequency relays (over-and under)
- Voltage relays (over and under)
- Power relays (directional)
- Differential relays (including harmonic restraint feature)
- Bus bar protection relays (biased low/high impedance)
- Other associated protection relay functions: auto-reclose function, power swing, Sync-check, etc.
- Single and three phase transducers (voltage, current, power (W, VA, VAR), phase and frequency)

1.3 Hardware Specification

- Relay test kit should not exceed more than 20 KG and portable unit to carry & capable of testing Electromechanical relays, static Relays & Microprocessor Based relays.
- **Voltage outputs shall be protected from short circuits and prolonged overloads. Current outputs shall be protected from open circuit and overloads. During Open Circuit & short circuit, kit should detect automatically as safety precautions.**

- **The testing system must generate at least 4 independent voltages and 6 independent current sources, with the facility to control their amplitudes and phase angles independently. The kit should have facility to test df/dt (i.e. frequency variation with respect to time).**
- The amplifier neutrals, the measurement inputs and the main power supply to be galvanic ally isolated from each other.
- The setting range of voltage generators shall be as under or better. Setting ranges 0-300 V for 4-phase AC (Ph-N), 0-300V for 1-phase AC (Ph-Ph), 0-300V for DC (L-N).Output power- Setting range 50VA for 4-phase AC (Ph-N), 250VA for1-phase AC (Ph-Ph) . Accuracy requirements for the voltage generators are error < 0.08 % rd. + 0.02 % rg. guar. (0...300 V) as guaranteed deviation and resolution should be 5mV for lower range below 10V & 10mV for 10 -300V
- The setting range and output of current amplifiers shall be continuous 6 x 25A at 400VA(Ph-N), 3 x 0-50A at 800VA(Ph-N), 1 x 0-120A(Ph-N) at 1000VA,6 x 0-20A DC at 250W Guaranteed(L-N). Accuracy for current source should be < 0.15 % rd. + 0.05 % rg. as guaranteed deviation and resolution should be 1mA
- The auxiliary DC supply must provide a power of 50 W and with the following ranges: 0 ... 264 VDC, 0.2 A / 0 ... 132 VDC, 0.4 A / 0 ... 66 VDC, 0.8 A. The auxiliary DC supply error shall not exceed 2% typically and 5% guaranteed
- Distortion (THD+N) not to exceed 0.15% for both current and voltage generators
- Shall be able to generate continuous sine waves with a frequency between 0.1 and 1000 Hz and to generate transient files with a bandwidth from dc up to 3.1 kHz. Frequency accuracy and drift shall not exceed: ±0.5 ppm / ±1 ppm and resolution shall not exceed 10 µHz
- Phase angle range must cover from -360° to 360° with a resolution of 0.001°. Phase error to be less than ±0.2 deg Guaranteed for both current and voltage generators.
- Minimum number of out puts shall be 4 and are completely independent from internal amplifier (voltage & current Source) outputs.
- Minimum number of binary inputs shall be 10nos, should sense both potential (Upto300V AC/DC) and potential free contacts. Resolution of time measurement shall be 1 ms or better
- Kit shall have 2 nos of Ethernet ports & USB for PC communication.

1.4 SOFTWARE SPECIFICATION:

A. General functions:

- The software must be compatible to RIO & XRIO Standard. Software should have provision to Import Direct software settings which should eliminate to feeding settings. All manufacturers templates should be available with respect to various protections like Distance, Differential, OC and Generator protections. It should be upgradeable free-of charge
- The testing software must have the possibility of adding test points in manual and automatic mode directly as Symmetrical components values (Direct, Inverse (Positive, Negative and Zero sequence)
- The testing software must have Vector Diagram representation that shows the test point quantities during the test and at any time after the test is finished if the specific test point is selected. The vector diagram must also be part of the report.
- The testing software must have the possibility of fault quantity ramping (voltage or current, amplitude or phase) for all fault loops Ph-E, Ph-Ph, Ph-Ph-Ph
- The testing software must have the possibility of creating sequence of minimum 100 states for typical prefault, fault postfault applications with flexible trigger conditions time, binary inputs with logical AND and OR, Key Pressed, or External Triggers from GPS. The sequence must be executed in real time, delays between the states are not

permissible. When working with a sequence of states it must be possible to trigger them with a GPS signal

- The testing software must have the possibility of adding test points in manual and automatic mode directly as Power (input values as power)
- The testing software must have possibility of power S,P,Q quantity ramping as 3-phase or single –phase powers
- Control of the GPS satellite receiver must be possible within test software. PTP protocol must be supported to perform end-to-end testing.
- Test software must have possibility to operate in primary or secondary values (Z, R, X, S, P, Q, V, I) and allow toggling between theses 2 operation modes at any time (before during or after the test)
- The testing software must have the possibility of Impedance quantity ramping as IZI, Phi, R, and X for fault loops LE, LL, and LLL
- The test software must have the possibility to export the automatically generated test report as .rtf (Rich Text Format) file, csv format (Comma Separated Values) & .xml format (Extensible Mark up Language)
- **Relay software should have a facility to vary 2 parameters or more like Voltage Amplitude & Current Amplitude at a time to create a real fault simulation.**
- **Kit should have internal PTP source.**

B. COMTRADE Playback:

- The test software must provide a signal view that shows the analog signals and the binary inputs and outputs. This signal view must be exportable to COMTRADE format and also it must be possible to insert the graphics in the test report
- The software must include a tool to playback IEEE COMTRADE files and WAV files. The tool must allow scaling of the signals. It must be possible to play back files that have a recording duration longer than 60 minutes at a sampling rate of 3kHz. It must be possible to select multiple transient files that will be played back as a sequence.
- The test software must reproduce transient playback supporting COMTRADE (Binary or ASCII), TRF and PL4 formats. SW must allow also simulation with user defined binary signals
- It must be possible to generate repetitions for the transient playback
- It must be possible to insert a prefault sine simulation with a definable length before the actual COMTRADE playback
- The test software must provide a possibility to create flexible reference signals (binary) at any time in the transient file. And then create measurement conditions to check any binary input with tolerances for automatic pass/fail conditions comparing the actual binary signals to the binary reference signals
- It must be possible to see the state of all the binary inputs and outputs of the test set at any time. In case of fast changes, the software must indicate it with a visual alarm.

C. DISTANCES RELAY TESTING:

- Manual and automatic tests for impedance plane, starter characteristic, auto recloser, Z/ t grading diagram shall be possible.
- The test software must have a functionality to define and perform tests of distance relays by impedance element evaluations using single-shot definitions in the Z-plane with graphical characteristic display
- Test models to be supported: constant current, constant voltage.
- Software must have the possibility of importing relay characteristic from relay manufacturer which are supporting RIO/XRIO export
- Testing of relays with simulation of the arc resistance must be possible & The software must have the possibility of simulating DC offset and setting the fault inception angle
- XRIO file format for the transfer of relay setting parameters to be supported.

- It must be possible to add sequence of prefault, fault & postfault shots and then to execute this automatically including automatic assessment of the correct trip time according to given tolerances
- Adding test points as Z and Phi or as R and X must be possible
- The testing device must provide the voltage and current terminals as 4 mm banana plugs and (at least 3 voltages ad 3 currents plus neutrals) in a common connector. It should be connected to the generator combination Socket where 3 voltages and 3 currents can be used directly for the testing.

D. DIFFERENTIAL RELAY TESTING:

- **Templates for all manufacturers should be available to perform automatic testing**
- **Kit software should import the relay settings from Relay software using XRIO**
- **Kit should perform automatic Slope characteristics testing by Shot test as well as reach test**
- **Kit should capable to inject 25A both sides (Primary and secondary) for Generator slope test in automated method for 5A Secondary ratio**
- **Kit should perform automatic harmonics testing**
- **Kit software should have provision to inject 1phase fault (L1-E, L2,E and L3-E), 2-Phase faults(L-L) and 3-phase faults on slope characteristics and verify it.**

E. OVER CURRENT RELAY TESTING:

- Manual and automatic test modes shall be available.
- Feeder Protection /OC protection templates for respective manufacturer should be available for automatic testing to avoid settings complications.
- The test software must have a functionality for testing overcurrent protection covering ground fault, phase fault, positive, negative and zero sequence fault models
- It must be possible to test directional and non-directional overcurrent relays and provide test points in backward direction that are automatically assessed positive if the relay blocks
- Library with all standard definite and inverse characteristic (IEC, ANSI, IAC, I2t) must be available and it must be possible to model a non-standard characteristic easily point by point
- It must be possible to extract (digitize) overcurrent inverse-time characteristics from graphical representations (e.g. from a relay manual image)
- Relay test kit Software must test both IDMT Characteristics as well as Directional feature at a time and same should display characteristics of both IDMT as well as Direction during testing.
- Templates should be available for feeder protection to perform automatic testing which should eliminate on understanding Relay Characteristics angle as per relay and possible to perform the faults automatically with respect to different relay manufacturers like Siemens, ABB, Alstom, GE & Etc

H. Automatic test plan creation to easy maintenance testing:

- Test Plans can easily be built, maintained and distributed.
- Common test object data, hardware configuration, and test modules for the different device functions can be collected in one test plan which eliminate testing time during periodic maintenance time.
- *The test plan automatically executes the test modules – one by one, results being stored in the included dynamic report*
- The modules Pause, Execute, and Text View make the test plan interactive and let it include the
  power of other programs
- Test Plan should be one-time investment and later stages it should help to test the respective protection IEDS without feeding settings, creating different faults & etc.
- All major Protections to be available in the template

F. Energy Meter Testing:

- The software must have the functionality of testing all kind of energy meters according to IEC 62053 with or without additional reference meter (reference meters pulse frequency up to 100 kHz and accuracy 0.05class or more)
- The following test modes must be available: load test, mechanism test, gated mechanism test, injection test, no-load test, creep test
- It must be possible to test single and three phase meters (3 & 4 wire) exporting and importing
- The testing of meters measuring the iron and copper losses of transformers (I2h, V2h) must be supported.
- Testing of the meter harmonic behaviour with sine+DC and sine+Harmonic must be possible
- Scanning head hardware must be supported with the software which can sense pulses
- It must be possible to calibrate the test hardware against a highly accurate energy standard saving the test sets error at the various test points. It must be possible to load these correction data into a test performed with the meter to be tested. By applying these data to the error calculation of the meter it shall be possible to obtain an error compensated test result.

1.5 Power supply requirements to the equipment shall be as follows:

Nominal input voltage - 100 – 240 VAC, 1-phase

Permissible input voltage - 85 ... 264 VAC

Nominal frequency - 50/60 Hz

Permissible frequency range -45 ... 65 Hz

Rated current -12 A at 115 V / 10 A at 230 V

Connection Standard AC socket (IEC 60320)

Operation temperature - 3 0 ... +50 °C (+32 ... +122 °F)

Storage temperature -25 ... +70 °C (-13 ... +158 °F)

Humidity range Relative humidity 5 ... 95 %, non-condensing

CONFORMANCE Standards:

Safety: IEC 61010-1

Shock: MIL-PRF-28800F (30 g/11ms half-sine)

IEC 60068-2-27 (15 g/11 ms half-sine)

Vibration: MIL-PRF-28800F (10-500 Hz, 2.05 g rms)

IEC 60068-2-6 (10-150 Hz, 2 g)

Transit Drop: MIL-PRF-28800F (10 drops, 46 cm), ISTA 1A

Electromagnetic Compatibility

Emissions: IEC 61326-2-1, IEC 61000-3-2/3,

FCC Subpart B of Part 15 Class A

Immunity: IEC 61000-4-2/3/4/5/6/8/11

Oil sampling bottles shall be suitable for collecting oil samples from transformers, for testing of the oils (BDV, Dissolved Gas Analysis, resistivity etc). Bottles shall be robust enough, so that no damage occurs during frequent transportation of samples from site to laboratory.

Oil sampling bottles shall be made of stainless steel having a capacity of 1 litre.

Oil sampling bottles shall be capable of being sealed gas-tight and shall be fitted with cocks on both ends.

The design of bottle and seal shall be such that loss of hydrogen shall not exceed 5% per week.

An impermeable oil-proof, plastic or rubber tube of about 5 mm diameter, and of sufficient length shall also be provided with each bottle along with suitable connectors to fit the tube on to the oil sampling valve of the equipment and the oil collecting bottles respectively.

12. RELAY TOOLS KITS (ALSO REFER THE SPECIFICATION OF PCM)

The relay test kit shall consist of the following minimum items: **(Quantity: 3 sets)**

1. Test plugs for use with testing equipment
2. Special type test plugs for using with modular type cases
3. Screw driver set with multiple fixing feature
4. Long nose pliers
5. Wire cutting pliers and stripper
6. Ordinary pliers
7. Adjustable wrench
8. Soldering irons of
   - Watts rating - 1 No.
   - Watts rating - 1 No.
   - Watts rating - 1 No.
9. De-soldering pump
10. Printed Circuit Card-extender; Printed circuit card - `Puller' Suitable for all supplied relays
11. Test leads (Pair with 2 Mts. length) - 1 set
12. Shorting plugs, `pistol' prods (2 Nos.) - 1 set

13. SF6 GAS LEAK DETECTOR

The SF6 gas leak detector shall meet the following requirements

The detector shall be free from induced voltage effects.

The sensing probe shall be such that it can reach all the points on the breaker where leakage is to be sensed .Latest standard in this effect may be followed.

The detector shall be portable, battery operated with built in battery charger, hand held type and having a minimum SF6 gas leakage sensitivity of 5gm/year. The sensor shall be connected through a flexible wand for easy accessibility to joints, seals and couplings in GIS equipment and provided with a protection filter. The equipment shall have on/off switch & suitable indicating lamps/LEDs, variable pitch audible signal for leakage indication, and a head phone jack. The equipment shall have automatic zeroing of background signals suitable for detecting SF6 gas leakage in charged switchyard AIS/GIS. The test kit shall be compatible for EMI/EMC environment as per IEC 1000.

SECTION- 3

PROJECT DETAILS AND GENERAL SPECIFICATIONS

3.0 GENERAL

This section stipulates the General Technical Requirements under the Contract and will form an integral part of the Technical Specification.

The provisions under this section are intended to supplement general requirements for the materials, equipment and services covered under other sections of tender documents and are not exclusive. However, in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall prevail.

3.1 PROJECT DETAILS

	Particular	**Details**
a)	Customer	ODISHA POWER TRANSMISSION CORPORATION LIMITED (OPTCL)
b)	Engineer/Consultant/ Inspector	-
c)	Project Title	2X500 MVA, 400/220 KV GIS S/S AT ERSAMA & ASSOCIATED 2 NOS 400 KV BAY EXTN AT DUBURI
d)	Project Location	**400/220kV GIS S/S** Place: Erasama, Paradeep District: Jagatsingha State: Odisha **400kV AIS S/S Bay Extn.** Place: Duburi District: Jajpur State: Odisha
e)	Latitude & Longitude	**400/220kV GIS S/S** North: 20°12'32" and East: 86°21'44" **400kV AIS S/S Bay Extn.** North: 20°56'14" and East: 86°00'23"
f)	Nearest Railway Station	Erasama – At a distance of about 32 km from Paradeep station Duburi – At a distance of about 14 km from Jajpur Road station
g)	Distance of project location from the Railway station	Erasama – At a distance of about 32 km from Paradeep station Duburi – At a distance of about 14 km from Jajpur Road station
h)	Nearest Major Town	Bhubaneswar
i)	Distance of the town from the project site	86 Km from Erasama & 120 Km from Duburi
j)	Nearest commercial airport	Biju Patnaik International Airport, Bhubaneswar

k)	Distance of airport from the project site	86 Km from Erasama & 120 Km from Duburi
	SITE CONDITIONS (for design purposes)	
a)	Annual mean if maximum monthly average temperature	50°C
b)	Annual mean if minimum monthly temperature	5°C
c)	Design ambient temperature	50°C
d)	Average Rainfall in mm	1500 mm
e)	Average thunderstorm days per year	77 days
f)	Maximum Relative humidity	100 %
g)	Average Relative humidity	85 %
h)	Height above mean sea level	Less than 1000 meters
i)	Pollution Severity	Heavily polluted
j)	Criteria for Wind Resistant design of structures and equipment	Standard Applicable - IS 875 (Part 3)
k)	Basic Wind speed "Vb" at ten meters above the mean ground level.	55m/ sec for Erasama 50 m/ sec for Duburi
l)	Risk Coefficient "K1"	1
m)	Seismic Co-efficient	0.06g Horizontal 0.01g Vertical

3.1.1 SYSTEM PARAMETERS

Sl.No.	Parameters	**400 kV**	**220 kV**	**33 kV**
1	Highest system voltage	420 kV rms	245 kVrms	36
2	System Frequency	50 Hz		
3	Variation in Frequency	+ - 2.5 %		
5	Lightning Impulse voltage	±1425kVp	± 1050kVp	170
6	Switching impulse voltage	±1050kVp	-	
7	Power frequency withstand for 1 min (rms)	630 kV (rms)	460 kV (rms)	70 kV (rms)
8	Max. fault level (3/1 sec.)	63 kA	50kA	31.5kA
9	Minimum creepage distance	13020 mm (Erasama) 10500 mm (Duburi)	7595mm (Erasama) -	1116mm (Ersama) 900mm (Duburi)
10	System Neutral Earthing	Effectively Earthed		
11	Corona Extinction Voltage	320kV	156kV	-
12	Radio Interference Voltage	500µV at 266kV	500µV at 167kV	-

3.1.2 AUXILIARY POWER

Nominal Voltage V	**Variation**	**Frequency Hz or DC**	**Phase**	**Wires**	**Neutral Connection**
430	±10%	50±5%	3	4	Solidly earthed
240	±10%	50±5%	1	2	Solidly earthed
220	187V - 242V	DC	DC	2	Isolated 2 wires
50	45V - 55V	DC	DC	2	+ve earthed

3.1.3 The minimum electrical clearances for 400/220/33kV switchyard shall be as given below:

	400kV	**220kV**	**33kV**
Phase to earth clearance	3400 mm	2160mm	320mm
Phase to phase clearance	3900 mm	2160mm	320mm
Section clearance	6500 mm	5000mm	3000mm
Ground Clearance	8000 mm	5500mm	4000mm

3.2 INSTRUCTION TO BIDDERS:

The bidders shall furnish technical data sheets, catalogues, engineering data, technical information, design documents, drawings etc. fully in conformity with the technical specification.

The supplier should be approved by Employer (OPTCL). If not, it is the responsibility of the vendor to be assessed and approved by Employer, before placement of order by BHEL. Any cost involved in vendor assessment/approval must be borne by the vendor himself.

The Bidder's proposal shall be based upon the use of equipment and material complying fully with the requirements specified herein. It is recognized that the Bidder may have standardized on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered, provided the base offer is in line with technical specifications and such proposals meet the specified design standards and performance requirement and are acceptable to the Purchaser. Sufficient amount of information for justifying such proposals shall be furnished to Purchaser along with the bid to enable the Purchaser to determine the acceptability of these proposals.

Wherever a material or article is specified or defined by the name of a particular brand, Manufacturer or Vendor, the specific name mentioned shall be understood to be indicative of the function and quality desired and not restrictive. Other manufacturer's products may be considered provided sufficient information is furnished to enable the Employer to determine that the products proposed are equivalent to those named.

Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/ or needed for erection, completion and safe operation of the equipment as required by applicable codes, though they may not have been specifically detailed in the Technical Specifications unless included in the list of exclusions. Materials and components not specifically stated in the specification but which are necessary for commissioning and satisfactory operation of the switchyard unless specifically excluded shall be deemed to be included in the scope of the specification and shall be supplied without any extra cost. All similar standard components/parts of similar standard equipment under supply shall be inter-changeable with one another.

The bidder shall supply type tested (including special tests as per tech. specification) equipment and materials. The test reports shall be furnished by the bidder along with equipment/ material drawings. In the event of any discrepancy in the test reports, (i.e., if any test report is not acceptable due to any design/ manufacturing changes or due to non-compliance with the Technical Specification and/ or applicable standard), the tests shall be carried out without any additional cost implication to the BHEL. BHEL reserves the right to get any or all type/tests conducted/repeated.

3.3 CODES AND STANDARDS

In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India as well as of the locality where they will be installed.

Except where otherwise specified or implied, the bidder shall comply with the latest edition of the relevant Indian Standards, International Electrotechnical Commission (IEC) standards and any other standards mentioned in this Specification. The Bidder may submit for approval, equipment or materials conforming to technically equivalent National Standards. In such cases copies of the relevant Standards or part thereof, in the English language shall be submitted with the Tender.

In case of conflict the order of precedence shall be (1) IEC, (2) IS and (3) other alternative standard.

Reference to a particular standard or recommendation in this Specification does not relieve the Bidder of the necessity of providing the Contract Works complying with other relevant standards or recommendations.

The list of standards provided in the schedules of this Specification is not to be considered exhaustive and the Bidder shall ensure that equipment supplied under this contract meets the requirements of the relevant standard whether or not it is mentioned therein.

Other International/ National standards such as DIN, VDI, BS, GOST etc. shall also be accepted for only material codes and manufacturing standards, subject to the Employer's approval, for which the Bidder shall furnish, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases the Bidder shall furnish specifically the variations and deviations from the standards mentioned elsewhere in the specification together with the complete word to word translation of the standard that is normally not published in English.

3.4 LANGUAGE AND SYSTEM OF UNITS

The English language shall be used in all written communications between the Employer, the BHEL/OPTCL and the Bidder with respect to the services to be rendered and with respect to all documents and drawings procured or prepared by the Bidder pertaining to the work, unless otherwise agreed by the Employer.

It is required that danger plates, equipment designation labels or plates, instruction notices on plant and general substation notices be written in English, Hindi and Oriya. Control switch and lamp labels, indicator lamp and annunciator inscriptions shall be in English only.

The Bidder must furnish a schedule giving the English, Hindi and Oriya version of all labels, notices, etc., for approval.

The design features of all equipment shall be based on the SI system of units.

3.5 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

The 400 kV system is being designed to limit the power frequency over voltage of 1.5 p.u. and the switching surge over voltage to 2.5 p.u. In 400 kV system the initial value of temporary over voltage could be 2.0 p.u. for 1-2 cycles. All the equipment/materials covered in this specification shall perform all its function satisfactorily without undue strain, restrike etc. under such over voltage conditions.

All equipment shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation. All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow (not applicable for this project), short circuit etc for the equipment.

3.6 CORRESPONDENCE, DRAWINGS, APPROVAL PROCEDURE AND SAMPLES

3.6.1 Drawings & Document Submission

All drawings submitted by the supplier including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, the external connections, fixing arrangement required. The dimensions required for installation and interconnections with other equipment and materials, clearances and spaces required for installation and interconnections between various portions of equipment and any other information specifically requested in the specifications.

Each drawing submitted by the bidder (including those of sub-vendors) shall bear project specific title block at the right hand bottom corner with clear mention of the name of the Employer, the system designation, the specifications title, the specification number, the name of the Project, drawing number and revisions. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

All dimensions marked on drawings shall be considered correct although measurement by scale may differ from general arrangement drawings. Detailed drawings shall be worked to where they differ from general arrangement drawings.

All drawings for approval shall have the OPTCL-LOGO and the name of the Employer.

For presentation of design drawings and circuit documents IEC Publication 617 or equivalent standards for graphical symbols are to be followed.

The review of these document/data/drawings by the purchaser will cover only general conformance of the document/data/drawings to the specification and contract, interfaces with the equipment provided under specification, external connections and of the dimensions which might affect plan layout. This review by the purchaser may not indicate a thorough review of the dimensions, quantities and details of the equipment, material, any devices or items indicated or the accuracy of the information submitted. The review and/or approval by the purchaser shall not be considered by the bidder, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

All manufacturing, fabrication and execution of work in connection with the equipment/system prior to the approval of the drawings shall be at the bidder's risk. The bidder is expected not to make any changes in the design of the equipment /system, once they are approved by the Purchaser. However, if some changes are necessitated in the design of the equipment/system at a later date, the bidder may do so, but such changes shall promptly be brought to the notice of the Purchaser indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification. Approval of bidder’s drawing or work by the Purchaser shall not relieve the bidder of any of his responsibilities and liabilities under the Contract.

3.6.2 Bidder’s Drawing Submission and Approval Procedure

The following procedure for submission and review/approval of the drawings, data reports, information, etc. shall be followed by the bidder:

a. All data/information furnished by Vendor in the form of drawings, documents, Catalogues or in any other form for Employer's information/interface and/or review and approval are referred by the general term "drawings".

b. The 'Master drawings list' indicating titles, Drawing Number, Date of submission and approval etc. shall be furnished by the bidder. This list shall be updated if required at suitable interval during detailed engineering.

c. All drawings (including those of sub-vendor) shall bear at the right hand bottom corner the 'title plate' with all relevant information duly filled in. The bidder shall furnish this format to his sub-vendor along with his purchase order for sub-vendor's compliance.

d. Three copies of all drawings shall be submitted for approval and three copies for any subsequent revision. Employer shall forward their comments within four (4) weeks of receipt of drawings.

e. The OPTCL/BHEL reserves the right to request any additional information that may be considered necessary in order to fully review the drawings. Drawings for approval shall be submitted as paper prints and shall bear the approved contract references.

f. Upon review of each drawings, depending on the correctness and completeness of the drawings, the same will be categorised and approval accorded in one of the following categories:

CATEGORY I	Approved
CATEGORY II	Approved, subject to incorporation of comments/modification as noted. Resubmit revised drawing incorporating the comments
CATEGORY III	Not approved. Resubmit revised drawings for Approval after incorporating comments/modifications as noted
CATEGORY IV	For information and records

g. Bidder shall resubmit the drawings approved under Category II, III within one (1) week of receipt of comments on the drawings, incorporating all comments. Every revision of the drawing shall bear a revision index wherein such revisions shall be highlighted in the form of description or marked up in the drawing identifying the same with relevant revision number enclosed in a triangle (e.g 1.2.3. etc.).

h. In case Bidder does not agree with any specific comment, he shall furnish the explanation for the same to Employer for consideration. In all such cases Bidder shall necessarily enclose explanations along with the revised drawing (taking care of balance comments) to avoid any delay and/or duplication in review work.

i. It is the responsibility of the Bidder to get all the drawings approved in the Category I or IV (as the case may be) and complete engineering activities within the agreed schedule. Any delay arising out of submission and modification of drawings shall not alter the contract completion schedule.

j. Bidder shall not make any changes in the portions of the drawing other than those commented. If changes are required to be made in the portions already approved, the Bidder shall resubmit the drawings identifying the changes (along with reasons for changes) for Employer's review and approval. **Drawings resubmitted shall show clearly the portions where the same are revised marking the relevant revision numbers and Employer shall review only such revised portion of documents.**

3.6.3 As Built Drawings

After completion of work on site all drawings shall be revised where necessary to show the equipment as installed and three copies submitted duly signed by site-in-charge. Following approval, two reproducible transparencies and twenty prints shall then be provided as required by the OPTCL/BHEL and shall be of sufficient detail to enable all parts to be identified. The bidder shall also submit, where possible, digitally stored copies of all as-built drawings on disc or CD-ROM in a format compatible with the Employer's drawing system.

Approval of drawings will not in any way relieve the Bidder of his obligations of furnishing the equipment in accordance with the specification and shall not prevent subsequent rejection if such equipment is later found to be defective.

3.6.4 Operation and Maintenance Manual

a. The Bidder shall submit to the Employer preliminary instruction manuals for all the equipment for review. The final instructions manuals incorporating Employer's comments and complete in all respect shall be submitted at least sixty (60) days before the first shipment of the equipment. The instruction manuals shall contain full details and drawings of all the equipment, the transportation, storage, installation, testing, commissioning, operation and maintenance procedures, etc. separately for each component/equipment along with log record format. After approval by the Engg. In charge the Bidder shall deliver ten (10) copies of the complete manual.

b. If after commissioning and initial operation of the plant, the instruction manuals require any modifications/additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted.

c. The operating and maintenance instructions together with drawings (other than shop drawings) of the equipment, as completed, shall have sufficient details to enable the Employer to maintain, dismantle, reassemble and adjust all parts of the equipment. They shall give a step by step procedure for all operations likely to be carried out during the life of the plant/equipment, including erection, testing, commissioning, operation, maintenance dismantling and repair. Each manual shall also include a complete set of approved drawings together with performance/rating curves of the equipment and test certificates, wherever applicable. The contract shall not be considered completed for purpose of taking over until such instructions and drawings have been supplied to the Employer.

d. A separate section of the manual shall be for each size/type of equipment and shall contain a detailed description of construction and operation, together will all relevant pamphlets.

e. The manuals shall include the following
   a) List of spare parts along with their drawing and catalogues and procedure for ordering spares.
   b) Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation.

The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals (both erection and O & M manuals) have been supplied to the Employer.

3.6.5 Final Submission of drawings and documents

The Bidder shall furnish the following after approval of all drawings /documents and test reports:
a. List of drawings bearing the Employer's and Bidder's drawing number.

b. Six (6) bound sets along-with two (2) sets of CD-ROMs/ DVD/Portable hard disk of all final drawings/documents.
c. Bidder shall also furnish six (6) bound sets of all as-built drawings including the list of all as-built drawings bearing drawing numbers. The Bidder shall also furnish two (2) sets of CD-ROMs/ DVD/Portable hard disk of all as-built drawings as decided by the Employer.
d. The Bidder shall also furnish four (4) copies and two (2) sets of CD-ROMs/ DVD/Portable hard disk of instruction/ operations & maintenance manuals (after approval) for all the equipment.

3.6.6 Test Reports

Two (2) copies of all test reports shall be supplied for approval before shipment of Equipment. The report shall indicate clearly the standard value specified for each test to facilitate checking of the reports. After final approval six (6) bound copies and two (2) sets of CD-ROMs/ DVD/Portable hard disk of all type and routine test reports shall be submitted to Employer.

3.7 MATERIAL /WORKMANSHIP

Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended and shall ensure satisfactory performance throughout the service life.

In case where the equipment, materials or components are indicated in the specification as "similar" to any special standard the purchaser shall decide upon the question of similarity. When required by the specification or when required by the purchaser the bidder shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Bidder.

The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the Purchaser.

Whenever possible, all similar part of the works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the equipment supplied under the specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.
The equipment offered in the bid only shall be accepted for supply, with the minimum modifications as agreed/accepted.

3.8 PROVISIONS FOR EXPOSURE TO HOT AND HUMID CLIMATE

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity' heavy rainfall and environment favorable to the growth of fungi and mildew. The indoor equipment located in non-air-conditioned areas shall also be of same type.

3.8.1 Space Heaters

Space heaters where provided shall be suitable for continuous operation at 240V supply voltage. On-off switch and fuse shall be provided.

One or more adequately rated permanently or thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heaters to minimise deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature at approximately 10C, above the outside air temperature to prevent condensation. This shall be demonstrated by tests.

3.8.2 Fungi Static Varnish

Besides the space heaters, special moisture and fungus resistance varnish shall be applied on parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

3.8.3 Ventilation Openings

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

3.9 CLEANING, PAINTING AND TROPICALASATION

3.9.2 General

All paints shall be applied in strict accordance with the paint manufacturer's instructions.

All painting shall be carried out on dry and clean surfaces and under suitable atmospheric and other conditions in accordance with the paint manufacturer's recommendations.

An alternative method of coating equipment such as with epoxy resin-based coating powders will be permitted, subject to the approval of the Engg. In charge (Divisional Engr.), and such powders shall comply with the requirements of IEC 455. The Bidder shall provide full details of the coating process to the Engg. In charge (Divisional Engr.) for approval.

It is the responsibility of the Bidder to ensure that the quality of paints used shall withstand the tropical heat and extremes of weather conditions specified in the schedules. The paint shall not peel off, wrinkle, be removed by wind, storm and handling on site and the surface finish shall neither rust nor fade during the service life of the equipment.

The colors of paints for external and internal surfaces shall be in accordance with the approved color schemes.

3.9.3 Works Painting Process

All steelworks, plant supporting steelworks and metalwork, except galvanised surfaces or where otherwise specified, shall be shot blasted to BS 7079 or the equivalent ISO standard. All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS 6005 "Code of Practice for phosphating iron and sheet steel". All surfaces shall then be painted with one coat of epoxy zinc rich primer, two pack type, to a film thickness of 50 microns. This primer shall be applied preferably by airless spray and within twenty minutes but not exceeding one hour of shot blasting.
All rough surfaces of coatings shall be filled with an approved two pack filler and rubbed down to a smooth surface.
The interior surfaces of all steel tanks and oil filled chambers shall be shot blasted in accordance with BS 7079 or the equivalent ISO, and painted within a period of preferably twenty minutes, but not exceeding one hour with an oil resisting coating of a type and make to the approval of the BHEL/OPTCL.
The interior surfaces of mechanism chambers, boxes and kiosks, after preparation, cleaning and priming as required above, shall be painted with one coat zinc chromate primer, one coat phenolic based undercoating, followed by one coat phenolic based finishing paint to a light or white colour. For equipment for outdoor use this shall be followed by a final coat of anti-condensation paint of a type and make to the approval of the BHEL/OPTCL, to a light or white colour. A minimum overall paint film thickness of 150 microns shall be maintained throughout.
All steelworks and metalwork, except where otherwise specified, after preparation and priming as required above shall be painted with one coat metallic zinc primer and two coats of micaceous iron oxide paint followed by two coats of either phenolic based or enamel hard gloss finished coloured paint to the approval to an overall minimum paint film thickness of 150 microns.
Galvanised surfaces shall not be painted in the works.
All nuts, bolts, washers etc., which may be fitted after fabrication of the plant shall be painted as described above after fabrication.
The painted metal works shall be subjected to paint qualification test as per draft ANSI/IEEE-Std 37.21 - 1985 clause 5.2.5.

3.9.4 Colour Schemes

The Bidder shall propose a colour scheme for the sub-station for the approval of BHEL/OPTCL. The decision of BHEL/OPTCL shall be final. The scheme shall include:

- Finishing colour of indoor equipment
- Finishing colour of outdoor equipment
- Finish colour of all cubicles
- Finishing colour of various auxiliary system equipment including piping.
- Finishing colour of various building items.

All steel structures, plates etc. shall be painted with non-corrosive paint on a suitable primer. It may be noted that normally all Employer"s electrical equipment in Employer"s switchyard are painted with shade 631 of IS: 5 and Employer will prefer to follow the same for this project also. All indoor cubicles shall be of same colour scheme and for other miscellaneous items colour scheme will be subject to the approval of the BHEL/OPTCL.

Sl. No.	Equipment	Application Environment			
		Indoor		Outdoor	
		Colour	Code IS:5	Colour	Code IS:5
400kV/220kV/132kV Class Equipment					
1	Transformers	—	—	Light grey	631
2	Marshalling boxes, CTs, PT's, CVT's, surge counter casings, junction boxes etc.	Light Admiralty grey.	697	Light Admiralty grey.	697
3	Control and relay panels, PLCC cabinets etc.	Smoke grey	692	—	—
4	Porcelain parts i.e. insulators	Dark brown	412	Dark brown	412
5	All structures/ metallic parts exposed to atmosphere	Hot dip galvanised			
33kV Class equipment					
6	Switchgear cubicles	Smoke grey	692	Light grey	631
7	Control and relay panels	Smoke grey	692	—	—
	LT switchgear				
8	LT switchgear exterior	Smoke grey	692	Light grey	631
9	ACDB/ MCC	Smoke grey	692	Light grey	631
10	DCDB	Smoke grey	692	—	—
11	LT bus duct in side enclosure	Matt Paint		—	—
12	LT bus duct outside enclosure	Smoke grey	692	—	—
13	Motors	Smoke grey	692	Light grey	631
14	Diesel generator engine	Smoke grey	692	—	—
15	Diesel generator	Smoke grey	692	—	—
16	LT transformers	Smoke grey	692	Light grey	631
17	Battery charger	Smoke grey	692	—	—
18	Mimic diagram 400kV 220kV 132kV 33kV 11kV 415V	 Dark violet Golden yellow Sky blue Signal red Canary yellow Middle brown	 796 356 101 537 309 411	 — — — — — —	 — — — — — —
	Miscellaneous				
19	Control modules and console inserts	Smoke grey	692	Light grey	631
20	Lighting package equipment outside	Light grey	631	Light grey	631
21	Lighting package equipment inside	Glossy white		Glossy white	
22	Water pipes	sea green	217	sea green	217
23	Air pipes	Sky blue	101	Sky blue	101
24	Transformer oil pipes	Light brown	410	Light brown	410
25	Fire Installations	Fire red	536	Fire red	536
26	Insulating oil/ gas treatment plant	Gulf red	473	Gulf red	473

Table 10.3.4. Recommended color schemes

3.10 DEGREES OF PROTECTION

Degrees of protection shall be provided in accordance with IEC 144 and IEC 529 and be as follows:

- For outdoor applications, IP 55.
- For indoor applications where purpose built accommodation is provided, e.g. switch and control and relay rooms in auxiliary plant buildings, IP 41.
- Where dust can adversely affect equipment within the enclosure, this equipment should be separately housed with a degree of protection of IP 51.

- For indoor applications where the equipment is housed in the same building as that enclosing water and steam operated equipment, the degrees of protection stated in the previous paragraph shall be up-rated to IP 44 and IP 54 respectively.

Where more severe environments exist, e.g. steam and oil vapour or other deleterious chemical environments, special measures will be necessary and the degree of protection required will be specified separately.
The Bidder shall submit a schedule for providing the degree protection to various control boxes, junction boxes etc. for the BHEL/OPTCL's approval.

3.11 RATING PLATES, NAME PLATES AND LABELS

a) All apparatus shall be clearly labelled indicating, where necessary, its purpose and service positions. Each phase of alternating current and each pole of direct current equipment and connections shall be coloured in an approved manner to distinguish phase or polarity.

b) The material of all labels and the dimensions, legend, and method of printing shall be to approval. The surface of indoor labels shall have a matt or satin finish to avoid dazzle from reflected light.

c) Colours shall be permanent and free from fading. Labels mounted on black surfaces shall have white lettering. „Danger" plates shall have red lettering on a white background.

d) All labels and plates for outdoor use shall be of non-corroding material. Where the use of enamelled iron plates is approved, the whole surface including the back and edges, shall be properly covered and resistant to corrosion. Protective washers of suitable material shall be provided front and back on the securing screws.

e) Labels shall be engraved in Hindi, English and Oriya. Name plates shall be white with black engraved lettering and shall carry all the applicable information specified in the applicable items of the Standards.

f) Any other relevant information which may be required for groups of smaller items for which this is not possible e.g. switch bays etc. a common name plate in Oriya with the title and special instructions on it shall be provided.

g) No scratching, corrections or changes will be allowed on name plates.

h) All equipment mounted on front and rear sides as well as equipment mounted inside the panels shall be provided with individual name plates with equipment designation engraved.

i) On the top of each panel on front as well as rear sides large name plates with bold size lettering shall be provided for circuit/ feeder/ cubicle box designation.

j) All front mounted equipment shall be also provided, at the rear, with individual name plates engraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate tracing of the wiring. The name plates shall be mounted directly by the side of the respective equipment wiring.

k) Name plates of cubicles and panels may be made of non rusting metal or 3 ply lamicoid. These name plates may be black with white engraved lettering.

l) The name plate inscription and size of name plates and letters shall be submitted to the BHEL/OPTCL/ Engineer for approval.

m) The nameplates of the apparatus shall include, at least, the information listed below, together with any other relevant information specified in the applicable standards:
- Concise descriptive title of the equipment
- Rating and circuit diagrams
- Manufacturer's name, trade-mark, model type, serial number
- Instruction book number
- Year of manufacture
- Total weight (for capacitor racks indicate weight, for capacitors indicate quantity of liquid)
- Special instructions, if any, about storage, transportation, handling etc.

n) Each measuring instrument and meter shall be prominently marked with the quantity measured e.g. kV, A, MW etc. All relays and other devices shall be clearly marked with manufacturers name, manufacturer's type, serial number and electrical rating data.

o) Danger plates and plates for phase colours shall be provided as per requirement. The Bidder shall devise a system to designate equipment and sub-systems. The nameplates/labels displaying these designations shall be installed at appropriate locations. Whenever motion or flow of fluids is involved, plates showing direction of motion or flow shall also be provided.

3.12 BOLTS AND NUTS

All bolts, studs, screw threads, pipe threads, bolt heads and nuts shall comply with the appropriate national standards for metric threads, or the technical equivalent.
Except for small wiring, current carrying terminal bolts or studs, for mechanical reasons, shall not be less than 6 mm in diameter.

All nuts and pins shall be adequately locked. Wherever possible bolts shall be fitted in such a manner that in the event of failure of locking resulting in the nuts working loose and falling off, the bolt will remain in position.

All bolts, nuts and washers placed in outdoor positions shall be treated to prevent corrosion, by hot dip galvanising or electro galvanising to service condition 4. Appropriate precautions shall be taken to prevent electrolytic action between dissimilar metals.

Where bolts are used on external horizontal surfaces where water can collect, methods of preventing the ingress of moisture to the threads shall be provided.

Each bolt or stud shall project at least one thread but not more than three threads through its nut, except when otherwise approved for terminal board studs or relay stems. If bolts and nuts are placed so that they are inaccessible by means of ordinary spanners, special spanners shall be provided.

The length of the screwed portion of the bolts shall be such that no screw thread may form part of a shear plane between members. Taper washers shall be provided where necessary.

Protective washers of suitable material shall be provided front and back on the securing screws.

3.13 GALVANISING:

3.13.1 General

All machining, drilling, welding, engraving, scribing or other manufacturing activities which would damage the final surface treatment shall be completed before the specified surface treatment is carried out.

3.13.2 Galvanising

All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use shall be hot dip galvanised. High tensile steel nuts, bolts and spring washers shall be electro galvanised to service condition 4. All steel conductors including those used for earthing and grounding (above ground level) shall also be galvanised according to IS 2629.

All galvanising shall be applied by the hot dip process and shall comply with IS 2629, IS 2633, IS 4759, IS 1367 or IS 6745.

All welds shall be de-scaled, all machining carried out and all parts shall be adequately cleaned prior to galvanising. The preparation for galvanising and the galvanising itself shall not adversely affect the mechanical properties of the coated material.

The threads of all galvanised bolts and screwed rods shall be cleared of spelter by spinning or brushing. A die shall not be used for cleaning the threads unless specially approved by the BHEL/OPTCL. All nuts shall be galvanised with the exception of the threads which shall be oiled. Surfaces which are in contact with oil shall not be galvanised or cadmium plated.

Partial immersion of the work will not be permitted and the galvanising tank must therefore be sufficiently large to permit galvanising to be carried out by one immersion.

Galvanising of wires shall be applied by the hot dip process and shall meet the requirements of IS 2141.

The minimum weight of the zinc coating and minimum thickness of coating for outdoor equipment shall be as follows:

a)	For sections & plates above 5mm of thickness	910 gm/sq.m	127 microns
b)	For sections & plates below 5mm of thickness	610 gm/sq.m	87 microns
c)	For surfaces embedded in concrete	800 gm/sq.m.	

The galvanised surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects such as discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

After galvanising no drilling or welding shall be performed on the galvanised parts of the equipment excepting that nuts may be threaded after galvanising. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanisation.

The galvanised steel shall be subjected to six one minute dips in copper sulphate solution as per IS 2633.

Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanising tests should essentially be performed as per relevant Indian Standards.

- Coating thickness
- Uniformity of zinc
- Adhesion test
- Mass of zinc coating

Galvanised material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

3.14 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

The terminal connectors shall conform strictly to the requirements if the latest versions of following standards as amended up-to-date, except otherwise,

i)	IS: 5561	Power Connectors
ii)	IS: 617	Aluminium & Aluminium Alloy
iii)	IS: 2629	Recommended Practice for HDG of iron & steel
iv)	IS: 2633	Method of testing uniformity of coating of zinc coated articles

The material of clamps and connectors shall be Aluminium alloy casting conforming to designation A6 of IS: 617 for connecting to equipment terminals and conductors of aluminium. In case the terminals are of copper, the same clamps/connectors shall be used with 4mm thick bimetallic liner.

The material of clamps and connectors shall be Galvanised mild steel for connecting to shield wire.

Bolts, nuts and plain washers shall be hot dip galvanised mild steel for sizes M12 and above. For sizes below M12, they shall be electro-galvanised mild steel. The spring washers shall be electro-galvanised mild steel.

All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be rounded off to meet specified corona and radio interference requirements.

They shall have same current rating as that of the connected equipment. All current carrying parts shall be at least 10 mm thick. The connectors shall be manufactured to have minimum contact resistance.

Flexible connectors, braids or laminated strips shall be made up of copper/aluminium.

Current rating and size of terminal/conductor for which connector is suitable shall be put on a suitable sticker on each component which should last at least till erection time.

3.15 CABLE GLANDS AND LUGS/FERRULES

Cable shall be terminated using double compression type cable glands. Testing requirements of Cable glands shall conform to BS:6121 and gland shall be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene or better synthetic material and of tested quality. Cable glands shall be suitable for the sizes of cable supplied/erected.

Cable lugs/ferrules for power cables shall be tinned copper solderless crimping type suitable for aluminium compacted conductor cables. Cable lugs and ferrules for control cables shall be tinned copper type. The cable lugs for control cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipment. Cable lugs and ferrule shall conform to DIN standards.

3.16 WIRING, CABLING AND CABLE INSTALLATION

3.16.1 Cubicle wiring

Panels shall be complete with interconnecting wiring between all electrical devices in the panels. External connections shall be achieved through terminal blocks. Where panels are required to be located adjacent to each other all inter panel wiring and connections between the panels shall be carried out internally. The Bidder shall furnish a detailed drawing of such inter panel wiring. The Bidder shall ensure the completeness and correctness of the internal wiring and the proper functioning of the connected equipment.
All wiring shall be carried out with 1.1 kV grade, PVC insulated, single core, stranded copper wires. The PVC shall have oxygen index not less than '29' and Temperature index not less than 250C. The wires shall have annealed copper conductors of adequate size comprise not less than three strands
The minimum cross sectional area of the stranded copper conductor used for internal wiring shall be as follows:

- All circuits excepting CT circuits and energy metering circuit of VT 2.5 sq.mm
- All CT circuits and metering circuit of VT 2.5 sq. mm

All internal wiring shall be supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters and troughs shall be used for this purpose.
Cubicle connections shall be insulated with PVC to IEC 227. Wires shall not be jointed or teed between terminal points.
Bus wires shall be fully insulated and run separately from one another. Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panels running throughout the entire length of the panel suite. Longitudinal troughs extending throughout the full length of panel shall be preferred for inter panel wiring.
All inter connecting wires between adjacent panels shall be brought to a separate set of terminal blocks located near the slots of holes meant for the passage of the interconnecting wires. Interconnection of adjacent panels on site shall be straightforward and simple. The bus wires for this purposes shall be bunched properly inside each panel.
Wire termination shall be made with solderless crimping type and tinned copper lugs which firmly grip the conductor. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. Numbers 6 and 9 shall not be included for ferrules purposes unless the ferrules have numbers underscored to enable differentiation. (i.e. 6 and 9).
Fuses and links shall be provided to enable all circuits in a cubicle, except a lighting circuit, to be isolated from the bus wires.
The DC trip and AC voltage supplies and wiring to main protective gear shall be segregated from those for back-up protection and also from protective apparatus for special purposes. Each such group shall be fed through separate fuses from the bus wires. There shall not be more than one set of supplies to the apparatus comprising each group. All wires associated with the tripping circuits shall be provided with red ferrules marked "**Trip**".
It shall be possible to work on small wiring for maintenance or test purposes without making a switchboard dead.
The insulation material shall be suitably coloured in order to distinguish between the relevant phases of the circuit.

When connections rated at 380 volt and above are taken through junction boxes they shall be adequately screened and "**DANGE**R" notices shall be affixed to the outsides of junction boxes or marshalling kiosk.
Where connections to other equipment and supervisory equipment are required the connections shall be grouped together.

3.16.2 LV power cabling

LVAC cable terminals shall be provided with adequately sized, hot pressed, cast or crimp type lugs.
Where sweating sockets are provided they shall be without additional clamping or pinch bolts. Where crimp type lugs are provided they shall be applied with the correct tool and the crimping tool shall be checked regularly for correct calibration. Bi-metallic joints between the terminals and lugs shall be provided where necessary.
Terminals shall be marked with the phase colour in a clear and permanent manner.
A removable gland plate shall be provided by the Bidder. The Bidder shall be responsible for drilling the cable gland plate. ere
Armoured cables shall be provided with suitable glands for terminating the cable armour and shall be provided with an earthing ring and lug to facilitate connection of the gland to the earth bar.

3.17 PRODUCTION PROCESS REQUIREMENTS

3.17.1 CASTINGS

GENERAL

All castings shall be true to pattern, free from defects and of uniform quality and condition. The surfaces of castings which do not undergo machining, shall be free from foundry irregularities. The castings shall be subject to NDT, chemical, mechanical and metallographic tests. Details of the same shall be furnished to BHEL/OPTCLfor review/approval. Magnetic particle inspection (MPI) test, wherever applicable, shall be carried out in longitudinal and transverse direction to detect radial and axial cracks.

IRON CASTINGS

Iron casting material shall be in accordance with ASTM A 126 Class B. A copy of the ladle analysis shall be sent to the BHEL/OPTCL. Each casting shall have a test bar from which tension test specimens may be taken. Test specimen shall be in accordance with ASTM A 370 and tested in accordance with ASTM E8. The Bidder shall submit his procedures for testing and acceptance for iron castings for approval by the BHEL/OPTCL.

STEEL CASTINGS

Steel castings shall be manufactured in accordance with ASTM A 27 and shall be subjected to appropriate tests and inspection as detailed herein.
Copies of mandatory documentation, such as ladle analyses and mechanical test results, shall be sent to the BHEL/OPTCL. (Non-ferrous casting material and castings shall be manufactured in accordance with the appropriate ASTM standards for the material concerned).

3.17.2 FORGINGS

When requested by the BHEL/OPTCL, forgings will be subjected to inspection in the regions of fillets and changes of section by suitable method. Magnetic particle, dye-penetration, radiographic or ultrasonic, or any combination of these methods may be used to suit material type and forging design.
The testing is to be carried out after the rough machining operation and is to be conducted according to the appropriate ASTM standards.
MPI test on forging shall be carried out to detect both radial and axial cracks. Ferrous forgings shall be demagnetised after such tests.

Any indentations which prove to penetrate deeper than 2.5% of the finished thickness of the forging shall be reported to the BHEL/OPTCLgiving location, length, width and depth. Any indentations which will not machine out during final machining shall be gouged out and repaired using an approved repair procedure. Repair of rotating elements by welding will only be accepted subject to detailed examination of the proposal by the BHEL/OPTCLprior to the repair being carried out.
The forging shall be tested for mechanical and metallographic tests as per ASTM. The details shall be mutually discussed/agreed upon.

3.17.3 FABRICATED COMPONENTS

All components machined or fabricated from plate, sheet or bar stock shall meet the material requirements of ASTM or material specification approved by the BHEL/OPTCL.
Structural steel, rolled shapes, bars, etc. shall comply with the latest ASTM for A36.
Plate steel shall be of a designation and quality suitable for the function it is intended to perform. Insofar as it is compatible with its function, it shall comply with ASTM A283 structural quality.
All, or a representative number of such components, shall be subjected to one or more of the following tests: visual, dye penetration, magnetic particle (transverse and longitudinal), ultrasonic or radiographic. These tests shall be in accordance with the recommended practices of the ASTM. The terms of reference for acceptance shall be the applicable ASTM Specifications.

3.17.4 WELDING AND WELDERS QUALIFICATIONS

General

All welding shall be carried out by qualified welders only.

All welding shall be in accordance with the corresponding standards of the American Welding Society or the American Society of Mechanical Engineers.
Other standards to determine the quality of welding process and qualifications of welders may be considered, provided that sufficient information is first submitted for the approval of the BHEL/OPTCL.
Prior to the start of fabrication, the Bidder shall submit to the BHEL/OPTCLfor approval, a description of each of the welding procedures which he proposes to adopt, together with certified copies of reports of the results from tests made in accordance with these procedures.
The Bidder shall be responsible for the quality of the work performed by his welding organisation. All welding operators, to be assigned work, including repair of casting, shall pass the required tests for qualification of welding procedures and operators. The BHEL/OPTCL reserves the right to witness the qualification tests for welding procedures and operators and the mechanical tests at the samples.
The Bidder shall bear all his own expenses in connection with the qualification tests. If the work of any operator at any time appears questionable, such operator will be required to pass appropriate prequalification tests as specified by the Inspector and at the expense of the Bidder.

Welding

All welding shall be performed in accordance with the appropriate standards. The design and construction of welded joints subject to hydraulic pressure shall conform to the applicable requirement of ASME "Boiler and Pressure Vessel Code" shall be qualified in accordance with Section IX of this Code. The design and construction of welded joints not subjected to hydraulic pressure shall, as a minimum, conform to the requirements of AWS "Specification for Welded Highway and Railway Bridge" D2.0. Except for minor parts and items specifically exempted from stress relieving, all shop welded joints shall be stress relieved in accordance with the requirements of the ASME "Boiler and Pressure Vessel Code" Section VIII.
In addition to satisfying the procedural and quality requirements set forth in the applicable code and/or these Specifications, all welding shall meet the following requirements for workmanship and visual quality:

- Butt welds shall be slightly convex, of uniform height and shall have full penetration.
- Fillet welds shall be of the specified size, with full throat and legs of equal length.

- Repairing, chipping and grinding of welds shall be done in a manner which will not gouge, groove or reduce the thickness of the base metal.
- The edges of the member to be joined shall expose sound metal, free from laminations, surface defects caused by shearing or flame-cutting operations or other injurious defects.

Welded joints subject to critical working stress shall be tested by approved methods of non-destructive testing, such as radiographic and ultrasonic examination, magnetic particle and liquid penetration inspection. All expenses in connection with these tests shall be borne by the Bidder. The extent of testing shall be as stipulated by the ASME „Boiler and Pressure Vessel Code", Section VIII, but without prejudice to the rights of the Inspector or the BHEL/OPTCL to ask for additional tests,
The arc-welding process to be used and the welding qualifications of the welders employed on the work shall be used in accordance with AWS requirements and Section VIII and IX of the ASME (American Society of Mechanical Engineers) Code, latest edition, as they may apply. All welding rods shall conform to the requirements of the latest issue of Section It, part C of the ASME Code.
Gas shielded welding (TIG or MIG) used as appropriate for aluminium, stainless steel or other material shall be carried out in accordance with the best commercial practice and the following standard specifications:

- Specifications for copper and copper-alloy welding rods (AWS A5.7, ASTM B259)
- Specification for corrosion-resisting chromium and chromium-nickel steel welding rods and bare electrodes (AWS A5.9, ASTM A371)
- Specifications for aluminium and aluminium alloy rods and bare electrodes (AWS A5.10, ASTM B285).
- Specifications for nickel and nickel-base alloy bare welding filler metal (AWS A5.14, ASTM B304).

Gas welding will not normally be used in the equipment. When a particular equipment manufacture requires the use of gas welding, the proposed process and the welder"s qualification shall be in accordance with AWS B3.0.
Welding of galvanised components will not be allowed in the equipment.
Strict measures of quality control shall be exercised throughout the Equipment/ Works. The BHEL/OPTCL may call for an adequate NDT test of the work of any operator, who in his opinion is not maintaining the standard of workmanship. Should this NDT test prove defective, all work done by that operator, since his last test shall be tested at the Bidder"s expense. If three or more of these tests prove defective, the operator shall be removed from the project.
A procedure for the repair of defects shall be submitted to the BHEL/OPTCL for his approval prior to any repairs being made.

Welding of pipes
Before welding, the ends shall be cleaned by wire brushing, filing or machine grinding. Each weld-run shall be cleaned of slag before the next run is deposited.
Welding at any joint shall be completed uninterrupted. If this cannot be followed for some reason, the weld shall be insulated for slow and uniform cooling.
Welding shall be done by manual oxy-acetylene or manual shielded metal are process. Automatic or semi-automatic welding processes may be done only with the specific approval of BHEL/OPTCL.
As far as possible welding shall be carried out in flat position. If not possible, welding shall be done in a position as close to flat position as possible.
Downward technique is not allowed while welding pipes in horizontal position, unless permitted by the BHEL/OPTCL.
Combination of welding processes or usage of electrodes of different classes or makes in a particular joint shall be allowed only after the welding procedure has been duly qualified and approved by the BHEL/OPTCL.
No backing ring shall be used for circumferential butt welds.
Welding carried out in ambient temperature of 5C or below shall be heat treated.

A spacer wire of proper diameter may be used for weld root opening but must be removed after tack welding and before applying root run.
Tack welding for the alignment of pipe joints shall be done only by qualified welders. Since tack welds form part of final welding, they shall be executed carefully and shall be free from defects. Defective welds shall be removed prior to the welding of joints.
Electrodes size for tack welding shall be selected depending upon the root opening.
Tack welds should be equally spaced.
Root run shall be made with respective electrodes/filler wires. The size of the electrodes shall not be greater than 3.25 mm (10 SWG) and should preferably be 2.3 mm (12 SWG). Welding shall be done with direct current values recommended by the electrode manufacturers.
Upward technique shall be adopted for welding pipes in horizontally fixed position. For pipes with wall thickness less than 3 mm, oxyacetylene welding is recommended.
The root run of butt joints shall be such as to achieve full penetration with the complete fusion of root edges. The weld projection shall not exceed 3 mm inside the pipe.
On completion of each run craters, weld irregularities, slag etc. shall be removed by grinding or chipping.
During the process of welding, all movements, shocks, vibration or stresses shall be carefully avoided in order to prevent weld cracks.
Fillet welds shall be made by shielded metal arc process regardless of thickness and class of piping. Electrode size shall not exceed 10 SWG. (3.25 mm). At least two runs shall be made on socket weld joints.

3.18 QUALITY ASSURANCE

3.18.1 GENERAL

To ensure that the supply and services under the scope of this Contract, whether manufactured or performed within the Bidder's works or at his Sub-Bidder's premises or at Site or at any other place of work are in accordance with the Specification, with the Regulations and with relevant Indian or otherwise Authorized Standards the Bidder shall adopt suitable Quality Assurance Programs and Procedures to ensure that all activities are being controlled as necessary.

The quality assurance arrangements shall conform to the relevant requirements of ISO 9001 or ISO 9002 as appropriate.

Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Bidder's/ Sub-bidder's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media e.g. E-mail in addition to hard copy, for review. Once the same is finalised, hard copies shall be submitted for approval. After approval the same shall be submitted in compiled form on CD ROM.

The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Employer's approval without which manufacturer shall not proceed.

These approved documents shall form a part of the contract. In these approved Quality Plans, Employer shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Employer's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Employer/Authorised representative in writing. All deviations to this specification,

approved quality plans and applicable standards must be documented and referred to Employer along with technical justification for approval and dispositioning.

No material shall be despatched from the manufacturer's works before the same is accepted subsequent to pre-despatch final inspection including verification of records of all previous tests/inspections by Employer's Project Manager/Authorised representative and duly authorised for despatch by issuance of Material Dispatch Clearance Certificate (MDCC).

All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties, chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.

For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.

Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Employer/ authorised representative.

3.18.2 SUB-VENDOR

The Bidder shall ensure that the Quality Assurance requirements of this Specification are followed by any sub-vendor appointed by him under the Contract.
The Bidder shall assess the sub-vendor's Quality Assurance arrangements prior to his appointment to ensure its compliance with the appropriate ISO 9000 standard and the Specification.
Auditing of the sub-vendor's Quality Assurance arrangements shall be carried out by the Bidder and recorded in such a manner that demonstrates to the OPTCL/BHEL the extent of the audits and their effectiveness.

3.18.3 QUALITY ASSURANCE DOCUMENTS

The Bidder shall be required to submit two hard copies and two sets on CDROM of the following Quality Assurance Documents as identified in respective quality plan with tick (√) mark.

Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.

The QA Documentation file shall be progressively completed by the Supplier's sub-supplier to allow regular reviews by all parties during the manufacturing.

The final quality document will be compiled and issued at the final assembly place of equipment before dispatch. However CD-Rom may be issued not later than three weeks.
Typical contents of Quality Assurance Document are as below:-

i) Quality Plan,
ii) Material mill test reports on components as specified by the specification and approved Quality Plans.
iii) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.

iv) Non-destructive examination results /reports including radiography interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
v) Heat Treatment Certificate/Record (Time- temperature Chart)
vi) All the accepted Non-conformance Reports (Major/Minor) / deviation, including complete technical details / repair procedure).
vii) CHP / Inspection reports duly signed by the Inspector of the Employer and Bidder for the agreed Customer Hold Points.
viii) Certificate of Conformance (COC) whoever applicable.
ix) MDCC

Before dispatch/ commissioning of any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

i) If the result of the review carried out by the Inspector of the Quality document (or applicable section) is satisfactory, the Inspector shall stamp the quality document (or applicable section) for release.
ii) If the quality document is unsatisfactory, the Supplier shall endeavour to correct the incompleteness, thus allowing to finalize the quality document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.
iii) If a decision is made for dispatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time, the supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the dispatch of equipment.

3.18.4 TRANSMISSION OF QUALITY DOCUMENTS

As a general rule, two hard copies of the quality document and Two CD ROMs shall be issued to the Employer on release of QA Documentation by Inspector. One set of quality document shall be forwarded to Corporate Quality Assurance Department and other set to respective Site.
For the particular case of phased deliveries, the complete quality document to the Employer shall be issued not later than 3 weeks after the date of the last delivery similarly as stated above.

3.18.5 INSPECTION, TESTING & INSPECTION CERTIFICATE

i. The word 'Inspector' shall mean the Project Manager and/or his authorised representative and/or an outside inspection agency acting on behalf of the Employer to inspect and examine the materials and workmanship of the works during its manufacture or erection.

ii. The Project Manager or his duly authorised representative and/or an outside inspection agency acting on behalf of the Employer shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Bidder shall obtain for the Project Manager and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Bidder's own premises or works.

iii. The Bidder shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Bidder's account except for the expenses of the Inspector's. The Project Manager/Inspector, unless the witnessing of the tests is virtually waived and confirmed in writing, will attend such tests within fifteen (15) days of the date on which the equipment is noticed as being ready for test/inspection failing which the Bidder may proceed with test which shall be deemed to have been made in the inspector's presence and he shall forthwith forward to the inspector duly certified copies of test reports in two (2) copies.

iv. The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Bidder, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Bidder shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Project Manager/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.

v. When the factory tests have been completed at the Bidder's or sub-bidder's works, the Project Manager /Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Project Manager /Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Bidder's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Bidder from proceeding with the works. The completion of these tests or the issue of the certificates shall not bind the Employer to accept the equipment should it, on further tests after erection be found not to comply with the contract.

vi. In all cases where the contract provides for tests whether at the premises or works of the Bidder or any sub-bidder, the Bidder, except where otherwise specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Project Manager /Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Bidder and shall give facilities to the Project Manager/Inspector or to his authorised representative to accomplish testing.

vii. The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Bidder in respect of the agreed Quality Assurance Programme forming a part of the contract.

viii. To facilitate advance planning of inspection in addition to giving inspection notice, the Bidder shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.

ix. All inspection, measuring and test equipment used by bidder shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Bidder shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by NTPC. Wherever asked specifically, the bidder shall re-calibrate the measuring/test equipment in the presence of Project Manager / Inspector.

3.19 TYPE, ROUTINE & ACCEPTANCE TESTS:

The Bidder shall carry out the tests stated in accordance with the conditions of this Specification, without extra charge for such additional tests as in the opinion of the BHEL/OPTCL are necessary to determine that the Contract Works comply with this Specification. The tests shall be carried out generally in accordance

with the relevant IEC"s or IS or equivalent standards. The specific details of testing and inspection are given in the appropriate section of this Specification.

The Bidder shall submit Type Test Reports for all equipment being supplied by him for the BHEL/OPTCL"s approval. The BHEL/OPTCL may also give instruction to carry out Type Tests, routine tests or acceptance tests. Type Test Charges shall be paid as per the rates indicated in the Price Schedules.

All materials used shall be subjected to such routine tests as are customary in the manufacture of the types of plant included in the Contract Works. These materials shall withstand satisfactorily all such tests.

All tests shall be carried out to the satisfaction of the BHEL/OPTCL, in his presence, at such reasonable times as he may require, unless agreed otherwise. Not less than three weeks' notice of all tests shall be given to the BHEL/OPTCL in order that he may be represented if he so desires. As many tests as possible shall be arranged together. Six copies of the Bidder"s test reports and test sheets shall be supplied to the BHEL/OPTCL for approval.
Measuring apparatus shall be approved by the OPTCL/BHEL (Divisional Engr) and if required shall be calibrated at the expense of the Bidder at an approved laboratory.

The Bidder shall be responsible for the proper testing of the work completed or plant or materials supplied by a sub-bidder to the same extent as if the work, plant or materials were completed or supplied by the Bidder himself.

All apparatus, instruments and connections required for the above tests shall be provided by the Bidder, but the BHEL/OPTCL may permit the use for the tests on site, any instruments and apparatus which may be provided permanently on site as part of the contract works conditional upon the Bidder accepting liability for any damage which may be sustained by such equipment during the test.

The bidder shall supply suitable test pieces of all materials as required by the BHEL/OPTCL. If required by the BHEL/OPTCL, test specimens shall be prepared for check testing and forwarded at the expense of the Bidder to an independent testing authority selected by the BHEL/OPTCL.

Any costs incurred by the Employer in connection with inspection and re-testing as a result of a failure of the subject under test, or damage during transport, or erection on site before take-over by the Employer, shall be to the account of the Bidder.

No inspection or lack of inspection or passing by the BHEL/OPTCLof work, plant or materials, whether carried out or supplied by the Bidder or sub-bidder, shall relieve the Bidder from his liability to complete the Contract Works in accordance with the Contract or exonerate him from any of his guarantees.

3.20.1 TYPE TEST REQUIREMENTS FOR EQUIPMENTS OTHER THAN GIS

a) All equipment to be supplied shall be of type tested design. During detail engineering, the bidder shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out not earlier than ten years prior to the date of techno-commercial bid opening (03-March-2017). These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a Client.
b) However if bidder is not able to submit report of the type test(s) conducted not earlier than ten years prior to the date of techno-commercial bid opening **(11-February-2022),** or in the case of type test report(s) are not found to be meeting the specification requirements, the bidder shall conduct all such

tests under this contract at no additional cost to the owner either at third party lab or in presence of client/ owners representative and submit the reports for approval.

c) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

3.20 PACKAGING & TRANSPORTATION

The Bidder shall be responsible for the packing, loading and transport of the plant and equipment from the place of manufacture, whether this is at his own works or those of any Bidder, to Site, and for off-loading at site.

All apparatus and equipment shall be carefully packed for transport by air, sea, rail and road as necessary and in such a manner that it is protected against tropical climate conditions and transport in rough terrain and cross country road conditions. The method of packing shall provide complete protection to all apparatus and equipment during transport and storage at site in heavy rain. The method of packing shall provide adequate protection to main items of plant and those parts contained within and attached without, for transportation.

Precautions shall be taken to protect parts containing electrical insulation against the ingress of moisture.

All bright parts liable to rust shall receive a coat of anti-rusting composition and shall be suitably protected.

The machined face of all flanges shall be protected by means of a blank disc bolted to each face.

Where appropriate all parts shall be boxed in substantial crates or containers to facilitate handling in a safe and secure manner. Each crate or container shall be marked clearly on the outside of the case to show "TOP" and "BOTTOM" positions with appropriate signs, and where the mass is bearing and the correct position for slings. Each crate or container shall also be marked with the notation of the part or parts contained therein, contract number and port of destination. It shall be the Bidder"s responsibility to dispose of all such packing.

Any damage due to defective or insufficient packing shall be made good by the Bidder at his own expense and within reasonable time when called upon by the BHEL/OPTCL to do so. Four (4) copies of complete packing lists showing the number, size, marks, mass and contents of each package shall be delivered to the BHEL/OPTCL immediately the material is despatched.

The Bidder shall inform himself fully as to all relevant transport facilities and requirements and loading gauges and ensure that the equipment as packed for transport shall conform to these limitations. The Bidder shall also be responsible for verifying the access facilities specified.

The Bidder shall be responsible for all costs of repair or replacement of the equipment, including those incurred by the Employer, arising from damage during transport, off-loading or erection on site, until take-over by the Employer.

The Bidder shall be responsible for the transportation of all loads associated with the contract works and shall take all reasonable steps to prevent any highways or bridges from being damaged by his traffic and shall select routes, choose and use vehicles and restrict and distribute loads so that the risk of damage shall be avoided. The Bidder shall immediately report to the BHEL/OPTCL any claims made against the Bidder arising out of alleged damage to a highway or bridge.

3.21 ENCLOSURES:

1. ANNEXURE – A: SPECIFICATION FOR ELECTRICAL COMPONENTS

NOTE:
Contractor is to be replaced with subcontractor/vendor.

1. MOTORS

1.1 General

All motors shall comply with IEC 34 / IS 335 and dimensions with IEC 72, however they shall be capable of operating continuously under actual service conditions without exceeding the specified temperature rises, determined by resistance, at any frequency between 48 and 51.5Hertz together with any voltage between ±10per cent of the nominal value.

All motors shall be totally enclosed, and if situated in the open they shall be weatherproof and suitable for outdoor working. They shall be provided with a suitable means of drainage to prevent accumulation of water due to condensation and with suitable means of breathing.

Motors operating in an ambient temperature not exceeding 40°C shall have insulation to at least ClassB and preferably ClassF standards. The temperature rise shall be restricted to that associated with ClassB insulation. Where the motor may be appreciably affected by conducted heat the class of insulation shall be to approval.

All motors shall be suitable for direct starting at full voltage.

Motors shall have sealed ball or roller bearings.

The three line connections of AC motors shall be brought out to a terminal box. The terminal arrangement shall be suitable for the reception of aluminium cable. Terminal markings shall be made in a clear and permanent manner and shall comply with IEC 34. A permanently attached diagram or instruction sheet shall be provided giving the connections for the required direction of rotation. All terminal boxes shall be of the totally enclosed type designed to exclude the entry of dust and moisture and sealed from the internal air circuit of the motor. All joints shall be flanged with gaskets of neoprene or other approved material. Natural rubber insulation shall not be used.

Motors rated above 1 kW shall be three phase motors. Where single phase motors are employed the motors shall be grouped so as to form an approximately balanced three phase load.

1.2 Motor control gear

Control gear shall comply with the requirements of IEC292, the control gear being rated according to the duty imposed by the particular application.

Motor contactors shall comply with IEC158 class of intermittent duty 0-3 with type 52 enclosure protection. Apparatus shall be capable of switching the stalled current, and shall have a continuous current rating of at least 50per cent greater than the full load current of the motors they control.

The operating currents of overload trips fitted to motor contactors shall be substantially independent of ambient temperature conditions, including the effect of direct sunlight on the enclosure in which the contactors are installed.

Where small motors are connected in groups, the group protection shall be arranged so that it will operate satisfactorily in the event of a fault occurring on a single motor. The control and protection equipment shall be accommodated in the control cabinet or marshalling kiosk.

Each motor or group of motors shall be provided with control gear for starting and stopping by hand and automatically. Overload and single-phasing protection shall be provided.

2.0 CABLE BOXES

Cable boxes shall be suitable for cables entering from above or below as may be required. They shall be weatherproof, rodent and insect-proof and be complete with all gaskets, compression glands, wiping glands and all associated fittings as may be required to make-off the cables.

Gland plates shall be insulated from the cable boxes and, in the case of single core cables, shall be of non-magnetic or insulating material. If metallic gland plates are used, single core cable glands shall be insulated from the gland plate. Gland plate insulation shall be capable of withstanding a dry high voltage test of 2000volts ac for one minute.

Where cable boxes are provided for three core cables, the sockets on the outer phases shall be inclined towards the centre to minimise opening of the cable cores. Cable sockets shall be supplied under this Contract.

Cable boxes for voltages up to and including 11kV shall be suitable for PVC or XLPE insulated steel wire-armoured PVC served cables. The boxes shall be air insulated and designed to accommodate all the fittings required by the cable manufacturer. Front covers and gland plates shall be removable and a 12mm diameter breathing hole covered with a wire gauze shall be provided.

Cable boxes shall be capable of withstanding on site the cable high voltage test level in accordance with IEC 502.

The drilling of gland plates, supply and fitting of compression glands and connecting up of power cables not included in the Contract scope of work shall be carried out under a separate contract.

Connection of the power cables included in the Contract scope of works shall be carried out under this Contract.

3.0 TERMINAL BOARDS AND TERMINAL BLOCKS

Terminal boards shall be of good quality non-flammable insulating material with a comparative tracking index (CTI) of not less than 500 to IEC112.

Terminal boards shall be spaced not less than 150 mm apart. For relay panels, they shall be mounted at the sides of the cubicle, and set obliquely towards the rear doors to give easy access to termination and to enable ferrule numbers to be read without difficulty.

Studs of stud type terminal boards shall be locked in the base to prevent turning and all connections shall be made on the front of the terminal board using lock nuts or lock washers. Where crimped type termination are provided at least two sets of crimping tools for each size of crimp must be supplied for each installation.

Terminals shall be of the insertion clamp type incorporating captive pressure screws which do not bear directly on the wire but on a serrated clamping plate. The pressure screws shall have an inherent locking feature.

Where connections are to be made between multi-core cables and telephone type multi-pair cables, the terminal blocks shall be of the insulation displacement type and shall have a withdrawable insulated link in order to facilitate isolation (or busy out in the case of the apparatus associated with the telephone system) of the individual circuits. These terminals shall also be provided with facilities for the insertion of test probes on both sides of the link.

All terminations shall be numbered for identification and grouped according to function. Engraved white on black labels shall be provided on the terminal blocks.

Terminals for connections which exceed 110 Volts shall be separated from those of other circuits and shall be fitted with insulating screens and “DANGER” notices.

The use of terminal blocks as junction points for wires which are not required in the associated cubicle shall be avoided wherever practicable.

All termination racks shall have a minimum of 20 per cent spare terminals blocks. At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.

All internal wiring to be connected to external equipments shall terminate on terminal blocks, preferably vertically mounted on the side of each panel. Terminal blocks shall be 650 V grade and have

10A continuous rating. Terminal blocks shall be moulded in one piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Terminal blocks shall include a white fibre marking strip with clear plastic, slip-on/clip-on terminal covers. Markings on the terminal strips shall correspond to terminal numbers on the wiring diagrams.

Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. Current transformer secondary leads shall be provided with short circuiting and earthing facilities.

All terminal blocks shall be suitable for terminating on each side, two by 2.5 mm^2 standard copper conductors.

Wherever duplication of a terminal block is necessary it shall be achieved by solid bonding links.

Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors on each side :

- All CT and VT circuits : Minimum of two 2.5 mm^2 copper stranded.
- AC/DC power supply circuits : One 16 mm^2 aluminium.
- All other circuits : Minimum of one of 2.5 mm^2 copper stranded

There shall be a minimum clearance of 250 mm between the first row of terminal blocks and the associated cable gland plate or panel side wall, as per the terminal block mounting arrangement adopted. Also the clearance between the edges of two rows of terminal blocks shall be minimum of 150 mm.

Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run in parallel and close proximity along each side of the wiring duct to provide for convenient attachment of internal panel wiring. The side of the terminal blocks opposite the wiring duct shall be reserved for external cable connections. All adjacent terminal blocks shall also share this field wiring corridor. All wiring shall be provided with adequate support inside the panels to hold it firmly and to enable free and flexible termination without causing strain on terminals.

All necessary cable terminating accessories such as gland plates, supporting clamps and brackets, wiring troughs and gutters etc. including glands and lugs for cable shall be in bidders scope of supply.

4.0 FUSES AND LINKS

Carriers and bases for fuses and links shall be in accordance with IEC 269 and colour coded to permit identification of the circuit rating.

The fuses and links mounted in cubicles for tripping circuits and protective gear test links shall be mounted on the front of the panel. Other links and fuses shall be accommodated within the cubicle or above the cubicle doors. Fuses and links shall be grouped and spaced according to their function in order to facilitate identification.

All incoming circuits in which the voltage exceeds 125V shall be fed through insulated fuses and/or links, the supplies being connected to the bottom terminal. The contacts of the fixed portion of the fuse or link shall be shrouded so that accidental contact with live metal cannot be made when the moving portion is withdrawn.

Main supply fuse links shall be of the high rupturing capacity cartridge type.

Where fuse carriers are mounted vertically the incoming (supply) side shall be the bottom terminal.

Where either fuses or circuit breakers are used it should be ensured that proper discrimination between main and sub-circuits is maintained.

5.0 COMMUNICATIONS CABLES

All cables and wiring shall have copper conductors and PVC insulation and shall comply with IEC 227. Telephone type cables shall comply with IEC 96 and IEC 189.

Cabling and wiring installations shall be arranged to minimise the risk of fire and damage which may be caused in the event of fire.

For telephone type cables conductor wires with a cross sectional area of less than 0.2 mm^2 shall not be used. Where twin or quad make up is required in any cable the cores shall be uniformly twisted and the lays arranged such that crosstalk is reduced to a minimum.

No conductor smaller than 32/0.2mm (1mm^2), or having less than three strands shall be used for interconnecting cabling except in the case of telephone cables. All cables shall have insulation which will withstand the highest temperature to be experienced in service.

Each conductor of a multi-core cable shall be readily identified by a numbered marker tape or, in the case of telephone type cables, colour coded insulation.

The Bidder shall submit full details of all loading on cables and in the case of interposing current transformer connections, the loop resistance of each circuit.

Apparatus cubicles, cabinets, racks and panels shall be provided with gland plates and all necessary equipment for the termination of cables. The Contract Works shall include for the checking, termination and ferruling of the cable cores and their lacing into cable forms and connection to the equipment terminal boards or tag blocks using claw washers. Crimping ferrules shall be used for each conductor.

6.0 MARSHALLING KIOSKS AND CONTROL CABINETS

The bidder shall provide within every bay of the switch yard a bay marshalling kiosk to which all incoming and outgoing connections to and from the associated bay equipment will be run. The terminal blocks within the kiosks shall be grouped together by function and shall be properly labelled and segregated. Transformer and circuit breaker control/marshalling kiosks will be provided under a separate contract, but it shall be the contractor"s responsibility to cable up to the control/marshalling kiosks as provided by the transformer and circuit breaker suppliers. The Contractor shall provide a separate stand alone kiosk for busbar protection CT marshalling and the kiosk shall house the CT shorting and switching relays required for the correct function of the busbar protection scheme.

All outdoor cabinets and kiosks shall be protected in accordance with Class IP55 of IEC 947-1 and shall be insect and rodent proof. The minimum sheet steel thickness for all cubicles, kiosks and panels shall be not less than 2 mm cold rolled or 2.5 mm hot rolled sheet steel. The top of the outdoor boxes/kiosks shall be provided with Aluminium alloy sheets having 2 mm thick with proper sloping for easy discharge of water.

Anti-condensation heaters, 240V AC single phase, shall be provided and shall be controlled by a watertight switch mounted externally. Ventilation louvres shall be provided, suitably lined internally with a mesh screen, and divisions between compartments shall be perforated.

Control cabinets shall be illuminated with a switch operated and fused 240V CFL tube. Control cabinets shall be provided with a switch operated single phase 240V 15A power socket.

All cables shall enter cabinets and kiosks at the base.

Each compartment of all kiosks and cabinets shall be provided with access doors at the front and rear. Doors and access covers shall not be secured by nuts and bolts but shall be fastened with integral handles with provision for locking with a padlock.

Doors for kiosks shall be of the lift off and hinged type and shall be provided with glazed windows of adequate size to facilitate reading of indicators from outside the kiosk. Facilities shall be provided to permit removal of the temperature indicators without the need to pass the capillary tubing and bulb through the various compartments.

Doors and covers under 15kg mass may be of the slide on pattern, but above this mass hinged doors shall be used. Door shall be provided with padlocking facilities.

When three phase connections rated at 380V and above are taken through cabinets or kiosks, the terminal blocks shall be adequately screened, insulated and suitably marked with the phase colour; "DANGER" notices shall be affixed to the terminal blocks and a DANGER notice stating the voltage shall be fixed on the inside and outside of the kiosk or cabinet. Exterior DANGER notices shall be stove enamelled and shall be written in English and Oriya and shall be of an approved class/grade.

A durable copy of the circuit wiring diagram shall be affixed to the back of the kiosk door and labels shall be provided inside each kiosk or box to describe the functions of the various items of equipment.

When the marshalling kiosks are positioned in side the switchyard , flood water shall not ingress in to the marshalling kisok. The contractor/bidder may achieve the same either positioning the marshalling kiosk appropriately or providing adequate water proof arrangement.

CT, CVT & IVT outdoor kiosks shall be of Aluminium alloy sheets having 3mm thickness. It shall have proper slop canopy for easy drainage of water.

7.0 AUXILIARY SWITCHES

With each disconnector, contactor and earthing device, there shall be supplied all necessary auxiliary switches and mechanisms for indication, protection, control, interlocking, supervisory and other services as specified. Not less than four spare auxiliary switches of each type shall be provided.

All auxiliary switches shall be wired up to a suitable terminal board on the fixed portion of the switchgear whether they are in use or not in the first instance, and shall be arranged in the same sequence on all similar items of equipment. Switches shall be provided to interrupt the supply of current to the tripping mechanism of the circuit breakers and latched contactors. All such switches and mechanisms shall be mounted in accessible positions clear of the operating mechanism, and shall be adequately protected.

The contacts of all auxiliary switches shall be strong and be capable of adjustment in relation to the movement of the circuit breaker or other item of equipment. Auxiliary switches and auxiliary circuits shall be capable of carrying a continuous current of 10 Amps.

8.0 MINIATURE OR MOULDED CASE CIRCUIT BREAKERS

Miniature or moulded case circuit breakers (MCB"s or MCCB"s) shall be designed and tested in accordance with IEC 157 and supplementary requirements of this specification. They shall be suitable for use over the full range of expected voltage variation as specified in the Schedules.

MCB"s and MCCB"s shall be suitably rated for both the continuous and short circuit loading of the circuits they are protecting under all service and atmospheric conditions stated in the specification. The bidder shall ensure that correct discrimination is maintained between main and sub-circuits.

For three phase circuits, the miniature circuit breakers shall be of the three pole type; for single phase circuits they shall be of the single pole type and for dc circuits they shall be of the double pole type.

Where miniature circuit breakers are used in circuits containing inductive loads, e.g. operating coils, it is essential that they are suitable for satisfactory operation in the circuit in which they are used, i.e. account is taken of the circuit time constant.

All miniature circuit breakers shall be provided with an auxiliary contact for remote indication of circuit breaker operation.

Means shall be provided to prevent the miniature circuit breakers being inadvertently switched to the „OFF" position.

Miniature circuit breakers shall be mounted in such a manner so as to give easily visible indication of breaker position and shall be grouped and spaced according to their function in order to facilitate identification and easy replacement.

9.0 SPACE HEATERS

Heaters shall be suitably designed to prevent any contact between the heater wire and the air. They shall consist of coiled resistance wire centred in a metal sheath and completely encased in a highly compacted powder of magnesium oxide or other material having equal heat conducting and electrical insulation properties, or they shall consist of resistance wire wound on a ceramic and completely covered with a ceramic material to prevent any contact between the wire and the air.

Alternatively, they may consist of a resistance wire mounted into a tubular ceramic body built into an envelop of stainless steel or the resistance wire wound on a tubular ceramic body and embedded in vitreous glaze. The surface temperature of the heaters shall be restricted to a value which will not shorten the life of the heater sheaths or that of insulated wire or other component in the compartments.

10.0 LVAC CABLES (NOT APPLICABLE)

10.1 General

LVAC power cables shall have aluminium conductors with XLPE insulation, galvanised steel wire armour and PVC oversheath and shall comply with the requirements of IEC 227, 228 and 502 as applicable. Cables shall be sized to carry the highest anticipated load under the worst case ambient conditions. Where a three, three and a half or four core power cable is provided, the cores shall be coloured to distinguish the relevant phases.

All sheaths shall be free from defects and impervious to water.

10.2 1.1kV grade power and control cables

10.2.1 Codes and Standards

The design, manufacture, testing and performance of cables covered under this specification shall comply with latest edition of the standards including amendments as indicated in the relevant schedules attached to this specification.

10.2.2 Technical requirements

The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled backfill and chances of flooding by water.

They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions. The XLPE insulated LV power cables shall withstand without damage a three phase fault current of at least 45 kA for a minimum of 0.12 seconds, with an initial peak of 105 kA in one of the phases. The armour for XLPE insulated power cables shall be capable of carrying 45 kA for at least 0.12 seconds without exceeding the maximum allowable temperature of PVC outer sheath.

Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of all cables.

Strip wire armouring following method (a) of the relevant IS shall not be accepted for any of the cables. For control cables round wire armouring only shall be used.

Cables shall have outer sheath of a material with an oxygen index of not less than 29 and a temperature index of not less than 250°C.

All the cables shall pass fire resistance test as per IS 1554 (Part-I)

The normal current rating of all PVC insulated cables shall be as per IS 3961.

Repaired cables shall not be accepted.

10.3 LV XLPE power cables

XLPE insulated cables shall conform to IS 7098 (Part-I) and its amendments read along with this Specification. The conductor shall be stranded aluminium circular/sector shaped and compacted. In multi-core cables, the core shall be identified by red, yellow, blue and black coloured strips or colouring of insulation. A distinct inner sheath shall be provided in all multi-core cables even if they are unarmoured. For armoured or unarmoured cables, the inner sheath shall be of extruded PVC to type ST-2 of IS 5831. When armouring is specified for single core cables, the same shall consist of aluminium wires/strips.

10.4 LV XLPE power cables

PVC (70C) insulated 1100V grade power cables shall conform to IS 1554 (Part-I) and its amendments, read along with this Specification and shall be suitable for a steady conductor temperature of 70°C . The conductor shall be stranded aluminium. Insulation shall be extruded PVC to type-A of IS 5831. A distinct inner sheath shall be provided in all multi-core cables. For multi-core armoured cables, the inner sheath shall be of extruded PVC. The outer sheath shall be extruded PVC to Type ST-1 of IS 5831 for all cables.

10.5 LV PVC control cables

The 1100V grade control cables shall conform to IS 1554 (Part-1) and its amendments, read along with this specification. The conductor shall be stranded copper. The insulation shall be extruded PVC to type A of IS 5831. A distinct inner sheath shall be provided in all cables whether armoured or not. The oversheath shall be extruded PVC to type ST-1 of IS 5831 and shall be grey in colour except where specifically advised by the Project Manager to be black.

Cores shall be identified as per IS 1554 (Part-1) for cables up to five cores and for cables with more than five cores the identification of cores shall additionally be done by printing legible alphabets on all cores. The alphabets shall be white and shall be printed at approximately 100 mm intervals along the cable length. Cables without such core identifications will not be accepted.

10.6 Cable drums

Cables shall be supplied non-returnable wooden or steel drums of heavy construction. Wooden drums shall be properly seasoned sound and free from defects. Wood preservative shall be applied to the entire drum.

Standard lengths for each size of power and control cables shall be 500/1000 meters. The cable length per drum shall be subject to a tolerance of plus or minus 5% of the standard drum length. The Project Manager shall have the option of rejecting cable drums with shorter lengths. However, the total quantity of cables after taking into consideration of all cable drums for each size shall be within the tolerance of ± 2%.

A layer of water proof paper shall be applied to the surface of the drums and over the outer most cable layer.

10.7 Tests

All cables shall conform to all type, routine and acceptance tests listed in the relevant IS.

The temperature index tests shall be carried out as per ASTM-D-2863.

All cables shall meet the fire-resistance test as per IS 1554 (Part-I)

10.8 Cable sizes

Following standard sizes of cables shall be considered by Bidder for various power distribution and protection,control and metering purposes in the system:

- XLPE power cables: 1c 630 mm^2, 1c 300 mm^2, 3 $^1/_2$c 300 mm^2. (armoured)
- LV XLPE power cables: (armoured)1c 150 mm^2, 3½ c70 mm^2, 3½c 35 mm^2, 4c 16 mm^2, 4c 6 mm^2, 2c 6 mm^2.
- PVC control cables: 2c 2.5 mm^2, 3c 2.5 mm^2, 5c 2.5 mm^2, 7c 2.5 mm^2, 10c 2.5 mm^2, 14c 2.5 mm^2, 19c 2.5 mm^2, 27c 2.5 mm^2

11.0 BUSHINGS

All bushings shall comply with the requirements of IEC 137 and the associated barrel porcelains shall comply with IEC 233 together with the requirements of this Specification. Provision shall be made for the fitting of arcing horns.

Transformer bushings rated at 66 kV and above shall be either of the oil impregnated paper or resin impregnated type. When filled with transformer oil there shall be no connection with the oil in the transformer and an oil gauge shall be provided. The visible oil levels in the gauge shall correspond to the range of average oil temperatures, from the minimum ambient stated in the Schedules to plus 70C. The oil level at 15C shall be marked. Connections from the main windings to bushings shall be flexible and shall be such that undue mechanical stresses are not imposed on them during assembly on site.

Terminal clamps shall be supplied with each bushing for flexible or rigid busbars as may be required. The material of the clamps shall be as stated in the Schedules.

12.0 BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS

Bushings shall be manufactured and tested in accordance with IS 2099 and IEC 137 while hollow column insulators shall be manufactured and tested in accordance with IEC 233/IS 5621. The support insulators shall be manufactured and tested as per IS 2544/IEC 168 and IS 2099/IEC 273. The insulators shall also conform to IEC 815 as applicable.

The bidder may also offer composite silicon insulators conforming to IEC 36.

Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.

Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and other similar defects.

Support insulators, bushings and hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators or bushings when operating at the normal rated voltage.

Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued up, porcelain parts by grinding and metal parts by machining. Insulator and bushing design shall be such as to ensure a uniform compressive pressure on the joints.

12.1 Tests

In accordance with the requirements stipulated above bushing, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests in accordance with IS 2099 and IS 2544.

All routine tests shall be conducted on hollow column insulators as per IEC 233. In addition the following tests shall also be conducted

1. Ultrasonic test as a routine test.
2. Pressure test as a routine test.
3. Bending load test in four directions at 50% specified bending load, as a routine test.
4. Bending load test in four directions at 100% specified bending load, as a sample test on each lot.
5. Burst pressure test as a sample test on each lot.
6. Hollow porcelain insulators should be in one integral piece in green and fired stage. No jointed porcelain will be acceptable.

12.2 Technical parameters of bushings, hollow column insulators and support insulators:

Parameter	420kV	245kV	145kV	36kV
Rated voltage kV	420	245	145	36
Impulse withstand (wet and dry) kVp	±1425	±1050	±650	±170
Switching surge withstand (wet and dry) kVp	±1050			
Power frequency withstand (wet and dry) kVrms	630	460	275	70
Total creepage distance mm	10500	6125	3625	900

Pollution level shall be Class III Heavy as per IEC 71, and as specified in Schedules for all classes of equipment.

Insulators shall also meet the requirements of IEC 815 for 420kV, 245kV and 145kV systems as applicable having alternate long and short sheds.

13.0 CIRCUIT BREAKERS

13.1 General

Circuit breakers shall be of three pole air break design, horizontal draw out type in accordance with IEC 947-2. In particular, evidence shall be provided of the performance when switching currents in the critical current range. They shall be capable of the ratings specified in the Schedules, when mounted in the switchboard.

Circuit breakers shall be fitted with trip-free, spring-operated mechanisms of the independent manually operated type and be provided with making and over current release facilities. A push-button shall be provided to trip the breaker electrically.

The breaker shall be provided with **`OPEN'. `CLOSE', `SERVICE', `TEST'** and **`SPRING CHARGED'** position indicators and shall be provided with the necessary number of auxiliary contacts for interlocking, indication and tripping purposes plus two spare.

Each incoming circuit shall be provided with thermal overload relays and short circuit protection relays; they shall also be provided with an undervoltage relay to trip breaker in the event of a supply failure.

There shall be `**SERVICE**', `**TEST**' and fully withdrawn positions for the breakers. It shall be possible to close the door in „**TEST'** position.

Movement of a circuit breaker between „**SERVICE'** and „**TEST'** positions shall not be possible unless it is in „**OPEN'** position. Attempted withdrawal of a closed circuit breaker shall not trip the circuit breaker.

Closing of a circuit breaker shall not be possible unless it is in „**SERVICE'**, „**TEST'** or fully withdrawn positions.

A breaker of particular rating shall be prevented from insertion in a cubicle of a different rating.

Circuit breakers shall be provided with electrical anti-pumping and trip free feature.

Means shall be provided to slowly close the circuit breaker in withdrawn position if required for inspection and setting of contacts. In service position slow closing shall not be possible.

Circuit breakers shall be provided with the following mechanism as specified in the Bill of Material.

13.2 Power operated mechanism

Power operated mechanism shall be provided with a universal motor suitable for operation 220V DC control supply with voltage variation from 90% to 110% rated voltage. Motor insulation shall be class `E' or better.

The motor shall be such that it requires not more than 30 seconds for fully charging the closing spring.

Once the closing springs are discharged, after the one closing operation of circuit breaker, it shall automatically initiate, recharging of the spring.

The mechanism shall be such that as long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. After failure of power supply at least one open-close-open operation shall be possible.

Provision shall be made for emergency manual charging and as soon as this manual charging handle is coupled, the motor shall automatically be mechanically decoupled.

All circuit breakers shall be provided with closing and tripping coils. The closing coils shall operate correctly at all values of voltage between 85% to 110% at rated control voltage. Tripping coils shall operate satisfactorily under all values of supply voltage between 70% to 110% of rated control voltage.

Provision for mechanical closing of the breaker only in `**TEST**' and withdrawn positions shall be made.

14.0 RELAYS

All relays and timers in protective circuits shall be flush mounted on panel front with connections from the inside. They shall have transparent dust tight covers removable from the front. All protective relays shall have a drawout construction for easy replacement from the front. They shall either have built-in test facilities, or shall be provided with necessary test blocks and test switches located immediately below each relay. Auxiliary relays and timers may be furnished in non-drawout cases.

All AC relays shall be suitable for operation at 50 Hz with 110 volts VT secondary and 1A or 5A CT secondary.

All protective relays and timers shall have at least two potential free output contacts. Relays shall have contacts as required for protection schemes. Contacts of relays and timers shall be silver faced and shall have a spring action. Adequate numbers of terminals shall be available on the relay cases for applicable relaying schemes.

All protective relays, auxiliary relays and timers shall be provided with hand reset operation indicators (flags) for analysing the cause of operation.

All relays shall withstand a test voltage of 2kV (rms) for one minute.

Motor starters shall be provided with three element, ambient temperature compensated, time lagged, hand reset type terminal overload relays with adjustable settings. The setting ranges shall be properly selected to suit the motor ratings. These relays shall have a separate black coloured hand reset push button mounted on compartment door and shall have at least one changeover contact.

All fuse protected, contactor controlled motors shall have single phasing protection, either as a distinct feature in the overload relays (by differential movement of bi-metallic strips), or as a separate device. The single phasing protection shall operate with 80% of the set current flowing in two of the phases.

15.0 CONTACTORS

Motor starter contactors shall be of air break, electromagnetic type rated for uninterrupted duty as per IS 2959.

Contactors shall be double break, non-gravity type and their main contacts shall be silver faced.

Direct line starter contactors shall be of utilisation category AC2. These contactors shall be as per IS 1822.

Each contactor shall be provided with two normally open (NO) and two normally close (NC) auxiliary contacts.

Operating coils of contactors shall be of 240V AC unless otherwise specified elsewhere. The Contactors shall operate satisfactorily between 85% to 110% of the rated voltage. Contactors shall drop out at 70% of the rated voltage.

16.0 INSTRUMENT TRANSFORMERS

All current and voltage transformers shall be completely encapsulated cast resin insulated type suitable for continuous operation at the temperature prevailing inside the switchgear enclosure, when the switchboard is operating at its rated condition and the outside ambient temperature is 50°C.

All instrument transformers shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit and momentary current ratings of the associated switchgear.

All instrument transformer shall have clear indelible polarity markings. All secondary terminals shall be wired to a separate terminal on an accessible terminal block where star-point formation and earthing shall be done.

Current transformers may be multi or single core type. All voltage transformers shall be single phase type. Busbar VT"s shall be housed in a separate compartment.

All VT"s shall have readily accessible HRC current limiting fuses on both primary and secondary sides.

17.0 INDICATING INSTRUMENTS

All indicating and integrating meters shall be flush mounted on panel front. The instruments shall be of at least 96 mm square size with 90 degree scales, and shall have an accuracy class of 2.5 or better. The covers and cases of instruments and meters shall provide a dust and vermin proof construction.

All instruments shall be compensated for temperature errors and factory calibrated to directly read the primary quantities. Means shall be provided for zero adjustment without removing or dismantling the instruments.

All instruments shall have white dials with black numerals and lettering. Black knife edge pointer with parallax free dials will be preferred.

Ammeters provided on motor feeders shall have a compressed scale at the upper current region to cover the starting current.

Watt-hour meters shall be of three phase, three element type. Maximum demand indicators need not be provided.

18.0 CONTROL AND SELECTOR SWITCHES

Control and instrument switches shall be rotary operated type with escutcheon plates clearly marked to show the function and positions. Switches shall be suitable for flush mounting with only switch front plate and operating handle projecting from the panel front. Switches shall be of sturdy construction suitable for mounting on panel front. Switches with shrouding of live parts and sealing of contacts against dust ingress shall be preferred. Handles of different shapes along with suitable inscriptions on switches shall be provided as an aid to switch identification. The selection of operating handles for the different types of switches shall be as follows :

Switch Type	Application	Specification
Switchgear control switches	For closing and opening of breakers and isolators.	Pistol grip, black, three position type.
Synchronising switches	For synchronising check bypass facilities	Oval, black, keyed (common removable handle, or with locking facility and common key).
Selector switches	Auto, manual, local, remote and test facilities	Oval or knob, black
Instrument switches	Phase or meter selection	Round, knurled, black
Protection transfer switch	Transfer of protection.	Pistol grip, lockable and black.

TABLE 18.1 Switch operating handles

The control switches of breakers and isolators shall be of spring return to neutral type. The control springs shall be strong and robust enough to prevent inadvertent operation due to light touch. The spring return type switch shall have spring return from close and trip positions to "after close" and "after trip" positions respectively. They shall have at least two (2) contacts closing in close positions, and two (2) contacts closing in Trip positions unless specified otherwise.

Circuit breaker selector switches for breaker controlled motors shall have three stay put positions marked „**AUTO'**, „**MANUAL'** and „**TEST'** respectively. They shall have two contacts each of three positions and shall have black, pistol grip handles.

Instrument selection switches shall be of maintained contact stayput type. Ammeter selection switches shall have make-before-break type contacts so as to prevent open circuiting of CT secondaries when changing the position of the switch. Voltmeter transfer switches for AC shall be suitable for reading all line-to-line and line-to-neutral voltages for non effectively earthed systems, and for reading all line to line voltages for effectively earthed systems. Ammeter and voltmeter selector switches shall have four stayput positions with an adequate number of contacts for three phase four wire systems. These shall have black oval handles

Synchronising switches shall be of maintained contact stayput type having a common removable handle for a group of switches. The handle shall be removable only in the „**OFF'** position and it shall be co-ordinated to fit in to all the synchronising switches. These switches shall be arranged to connect the synchronising equipment when turned to the „**ON**" position. One contact of each switch shall be connected in the closing circuit of the respective breaker so that the breaker cannot be closed until the switch is turned to the „**ON**" position.

Lockable type switches which can be locked in particular positions shall be provided when specified. The key locks shall be fitted on the operating handles.

The contacts of all switches shall preferably open and close with snap action to minimise arcing. Contacts of switches shall be spring assisted and contact faces shall be with rivets of pure silver or silver alloy. Springs shall not be used as current carrying parts.

The contact combination and their operation shall be such as to give completeness to the interlocking and function of the scheme. The contact rating of the switches shall be as follows :

	Contact rating in Amps		
Description	**220V DC**	**50V DC**	**240V AC**
Make and carry continuously	10A	10A	10A
Make and carry Make and carry for 0.5 sec.	30A	30A	30A
Break			
Resistive load	3A	20A	7A
Inductive Load with L/R=40ms	0.2A	—	—

TABLE 18.2 Contact ratings of switches

19.0 AIR BREAK SWITCHES

Air breaker switches shall be of the heavy duty, single throw group operated, load break, fault make type complying with IS 4064.

The Bidder shall ensure that all switches are adequately rated so as to be fully protected by the associated fuses during all abnormal operating conditions such as overload, locked motor, short circuit etc.

Switch operating handles shall be provided with padlocking facilities to lock them in `OFF' position.

Interlocks shall be provided such that it is possible to open the cubicle door only when the switch is in `OFF' position and to close the switch only when the door is closed. However suitable means shall be provided to intentionally defeat the interlocks explained above.

Switches and fuses for AC/DC control supply and heater supply wherever required shall be mounted inside and cubicles.

20.0 PUSH BUTTONS

Push-buttons shall be of spring return, push to actuate type. Their contacts shall be rated to make, continuously carry and break 10A at 240V and 0.5A (inductive) at 220V DC.

All push-buttons shall have one normally open and one normally closed contact, unless specified otherwise. The contact faces shall be of silver or silver alloy.

All push-buttons shall be provided with integral escutcheon plates marked with the appropriate function.

The colour of the button shall be as follows :

GREEN : For motor **START**, breaker **CLOSE,** valve /damper **OPEN**

RED : For motor **TRIP**, breaker **OPEN,** valve /damper **CLOSE**

BLACK : For overload reset, all annunciator and miscellaneous functions.

All push-buttons on panels shall be located in such a way that red push buttons shall always be to the left of green push buttons.

21.0 INDICATING LAMPS

Indicating lamps shall be of the panel mounting filament type and low watt consumption. Lamps shall be provided with series resistors, preferably built-in the lamps assembly. The lamps shall have

escutcheon plates marked with its function, wherever necessary. Lamps shall have translucent lamp covers of colours appropriate to the application as indicated in Table 21.1

Colour	Indication
RED	For motor **ON**, breaker/isolator **CLOSED**, valve/damper **OPEN**
GREEN	For motor **OFF**, breaker /isolator **OPEN**, valve/damper **CLOSE**
WHITE	For motor **Auto-Trip**
BLUE	For all healthy conditions (e.g. control supply) and also for **'SPRING CHARGED"**
AMBER	For all alarm conditions (e.g. overload) Also for `**SERVICE**' and `**TEST**' positions indicators.

TABLE 21.1 Indicating lamp colours

Indication lamps should be located just above the associated push buttons/control switches. Red lamps shall invariable be located to the right of green lamps. In case a white lamp is also provided, it shall be placed between the red and green lamps along with the centre line of control switch/push button pair. Blue and amber lamps should normally be located above the red and green lamps.

When associated with push-buttons, red lamps shall be directly above the green push button, and green lamps shall be directly above the red push-button.

The wattage and resistance of the lamps shall be as follows:

- 220/250V 5 - 10W 4000 - 8000 ohms
- 110V 5 - 10W 1000 - 2000 ohms

Neon indicating lamps or LED"s shall be provided when specified. The wattage of the neon lamp shall be 0.25 to 0.5W.

Bulbs and lenses shall be interchangeable and easily replaceable from the front of the panel. Tools, if required for replacing the bulbs and lenses shall also be included in the scope of supply.

All indicating lamps shall be suitable for continuous operation at 90 to 110% of their rated voltage.

22.0 FUSES

All fuses shall be of HRC cartridge fuse link type. Screw type fuses shall not be accepted. Fuses for AC circuits shall be of Class 2 type, 20kA (RMS) breaking current at 415V AC, and for DC circuits Class 1 type 4kA breaking current.

Fuses shall have visible operation indicators.

Fuses shall be mounted on fuse carriers, which are mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, they shall be directly mounted on plug in type bases. In such cases one set of insulated fuse pulling handles shall be supplied with each switchgear.

Fuse ratings shall be chosen by the bidder depending upon the circuit requirements and these shall be subject to approval of Project Manager.

23.0 NAME PLATES AND LABELS

All switchgears and ACDC distribution boards etc. shall be provided with prominent, engraved identification plates. The module identification plate shall clearly give the feeder number and feeder designation. For single front switchboards, similar panel and board identification labels shall be provided at the rear also. Language shall coform to the requirements stipulated elsewhere in the technical specification..

All name plates shall be of non-rusting metal or 3-ply lamicoid with white engraved lettering on black back ground. Inscriptions and lettering sizes shall be subject to Project Manager"s approval.

Suitable plastic sticker labels shall be provided for easy identification of all equipment, located inside the panel or module. These labels shall be positioned so as to be clearly visible and shall give the device number as mentioned in the module wiring drawings.

24.0 ELECTRIC MOTORS (LV)

24.1 Codes and Standards

All motors shall conform to the latest revisions of the relevant IEC, Indian Standards, British Standards given in the schedules, except where modified or supplemented by this Specification.

The design, manufacture, installation and performance of motors shall conform to the provisions of latest Indian Electricity Act and Indian Electricity Rules. Nothing in these specifications shall be construed to relieve the bidder of his responsibility in this regard.

In case of contradiction between this specification and IS or BS or IEC, the stipulations on this specification shall prevail.

National Electrical Code for Hazardous locations and relevant NEMA standard shall also be applicable for motors located in hazardous location.

24.2 Service conditions and temperature rise

Unless otherwise specified, machines shall be designed for a maximum ambient air temperature of 50C. Accordingly the temperature rise of the stator winding by resistance method over the ambient air temperature shall not exceed 70C.

For applications where the motor temperatures may be appreciably affected by conducted or radiated heat, the amount of heat must be specified by the bidder and the appropriate temperature rises agreed.

24.3 AC Motors

24.3.1 General

All AC motors shall be of squirrel cage type, unless otherwise specified and shall be suitable for direct on line starting.

Each motor shall be assigned a maximum continuous rating (MCR) corresponding to 70C temperature. Maximum continuous motor rating shall be at least ten percent above the maximum load demand of the driven equipment at designed capacity.

Rated voltage for AC motors shall be as given below for various MCR"s of the motor, unless specified otherwise:

- From 0.2 kW to 220 kW 415 V, three phase, 50 Hz
- Below 0.2 kW 240 V, single phase, 50 Hz

Voltage and frequency variations shall be as per clause 3.3 of IS 325.

The lowest voltage at the motor terminals throughout the starting period, with which the driven equipment shall satisfactorily start up even under the most arduous conditions specified, shall be 85% for motors rated up to 110 kW, and 80% for motors rated above.

The accelerating torque at any speed with the lowest starting voltage shall be at least ten (10) percent of rated full load torque of the motor.

The motors shall be suitable for two starts in succession under the specified conditions of load, torque and inertia, with the motor initially at its normal running temperature.

The ratio of locked rotor kVA at rated voltage to rated kW (MCR corresponding to 70C temperature rises) shall not exceed the following (without any further tolerance):

Motor MCR kW	Start kVA/Rated kW
Up to 110kW	1.0
Above 110kW	10.0

When tests to determine the breakaway starting current of cage induction motors are taken at reduced voltage, due allowance shall be made for the effect of saturation. The estimated value of breakaway starting current at rated voltage shall be given on all test certificates.

All motors shall be so designed that the maximum inrush currents and locked rotor and pull out torque, developed by them at 110% of the rated voltage, do not endanger the motor or the driven equipment.

The pull out torque at rated voltage shall not be less than 200 percent of the full load torque.

Motors for reciprocating compressors etc. shall be specially designed/rated to withstand the torque pulsation produced by the driven equipment.

24.3.2 Transient recovery

The motors shall be capable of resuming normal operation after a system disturbance causing temporary loss of supply voltage for periods of up to 0.2 second (fault clearance time), followed by sudden restoration to 70 percent rated voltage. From this voltage the motors shall be capable of acceleration and ultimate recovery under the most arduous load conditions.

24.4 DC Motors

DC motors shall comply with IS 4722 and shall be shunt wound type rated for 220V. Motor MCR kW rating at 50C ambient shall be at least ten percent higher than the power requirement of the driven equipment under the most onerous operating conditions foreseen during the plant's life.

DC motors which are to operate from batteries shall be capable of operating continuously under actual service conditions at any voltage between 190V and 240V.

DC motors supplied from rectifier equipment connected to AC power supplies shall meet the voltage and frequency variations specified for AC motors.

Rectifier equipment shall be capable of meeting the condition of transient recovery given above for AC motors and shall be provided with the necessary current limiting devices.

The pull-out torque of DC motors at the rated voltage shall not be less than 200 percent of the full load torque.

24.5 Enclosure and method of cooling

The following types of enclosure may be supplied:

- Totally enclosed, fan ventilated.
- Totally enclosed, closed air circuit, integral heat exchanger.
- Totally enclosed, closed air circuit, machine mounted heat exchanger.

In all cases protective enclosure and method of cooling of motors shall be IP 54 and IC 0141 in accordance with IS 4691 and IS 6362 respectively.

Cooling fans shall be directly driven from the motor shaft.

Motors situated outdoors or exposed to the weather shall be weather protected (IPW-55).

All totally enclosed type of motors shall have a dust tight construction with suitable means of breathing and of drainage to prevent accumulation of water from condensation. Drain holes shall exclude bodies greater than 6 mm diameter.

24.6 Constructional features

All components shall be of adequate mechanical strength and robustness and shall be constructed of metal unless otherwise approved. Glass fibre or plastic components, where employed, shall be of adequate design and robustness taking into account the conditions of service required and the effects of operating temperatures, ageing and thermal stability of the material. The material shall be resistant to flame propagation.

Rotors shall be so designed as to keep the combined critical speeds with the driven equipment away from the running speed by at least 20%.

Motors and their major components such as stators, rotors, terminal boxes, bearings and heat exchangers shall be designed to be readily interchangeable as integral units.

All motor rotors shall be dynamically balanced.

The enclosures shall be designed to provide an effective sealing between the primary and secondary air circuits.

The radial air gap between stator and rotor shall have an adequate margin to minimise the possibility of rubbing between the stator and rotor due to eccentric positioning, play and wear, shaft deflection due to rotor weight and unbalanced magnetic pull etc. The minimum radial air gap for all motors shall be in accordance with Clause 5.1.5 of IS 6381.

All requirements of clause 5.1.4 of IS 6381 shall also be complied with.

All the induction motors shall be capable of running at 75% of rated voltage for a period of 5 minutes.

Induction motors shall be designed to be capable of withstanding the voltage and torque stresses developed due to the difference between motor residual voltage and incoming supply voltage equal to 150% of the rated motor voltage during fast changeover of buses. The necessary features incorporated in the design to comply with this requirement shall be clearly indicated in this proposal.

24.7 Variable speed motors

Variable speed motors shall be such that the speed can be continuously adjusted over the required range. The speed control gear shall be provided with an interlock to ensure that the motor can only be started when its control sequence is at the correct setting. When the motor is switched off, the speed control sequence shall automatically return to this position.

24.8 Brush gear, commutators and slip-rings

Brush gear, commutators and slip-rings shall be designed to operate without injurious sparking and to run for at least three months without the need for adjustment or replacement of brushes.

Brushes shall be of electro graphite or metal graphite type. Adequate precautions shall be taken to protect the windings, commutators, slip-rings and brush gear against deposits of entrained carbon dust.

Removable covers shall be fitted to provide access to the brush gear, commutators and slip-rings. For totally enclosed type motors, windows shall be provided to permit observation of the brush gear whilst the motor is running.

Brush holders shall be of non-ferrous materials and located securely to accurately position the brushes on the commutator. Means for adjusting brush pressure and brush assembly shall be provided.

24.9 Internal electric heaters

Internal electric heaters shall be provided on motors rated above 30 kW, to maintain the windings in a dry condition during periods of standstill. The heater shall be suitable for use on a 240V, 50 Hz, AC supply.

24.10 Lifting facilities

All heavy parts of the motors shall be provided with adequate arrangements for lifting or handling during erection or overhaul.

All material used for equipment construction including castings and forging etc. shall be of tested quality as per relevant codes and standards. No welding shall be carried out on cast iron components for repair or any other purpose.

24.11 Winding and insulation

Winding insulation shall be of class B or better and of proven high quality and reliability.

All winding insulation shall be non-hygroscopic, oil resistant and of materials resistant to flame propagation. All windings shall be impregnated and suitably processed to effectively seal them to prevent deterioration from adverse environmental conditions at site during the installation period and also during normal operation.

All winding overhangs and leads shall be adequately supported, braced and blocked to provide sufficient rigidity during all normal conditions of service.

Cage windings and all joints shall be designed to give an adequate safety factor on fatigue due to thermal and mechanical stresses, taking into account the specified starting and running conditions. The short-circuiting and rings shall be of joint less construction. All electrical joints and connections shall be of brazed or welded construction.

Motors shall be designed to give a life endurance of at least 18000 starts.

24.12 Bearings

Bearings shall be of rolling type. Vertical motors shall normally have rolling type guide and thrust bearings.

Bearings shall be designed to prevent ingress of dust and water and shall be sealed against leakage of lubricant along the shaft.

When the motor shaft is not located axially by its own bearings, it shall be permanently marked to indicate its normal running position and the extent of float in either direction.

Bearings shall comply with the relevant Indian or International Standards. The bearing housing shall be correctly packed with lithium based grease at the time of assembly. Construction shall be such that the bearings can be dismantled without risk of damage.

For direct drives, bearings shall have an expected life of at least 40,000 running hours. For motors with significant external radial or axial loads, e.g. belt drives, bearing shall have a life of at least 15000 running hours. The bearing assembly shall be provided with a grease relief device to eject any surplus grease in to a separate container.

Lubrication shall be possible without removal of the guarding. All grease nipples, oil cups and dip sticks shall be readily accessible.

24.13 Heat exchangers

An adequate margin shall be included in the design of heat exchangers to allow for fouling of cooling tubes or ducts under service conditions. Provision shall be made for the easy cleaning of the cooling tubes or ducts, preferably on load.

The cooling tubes or ducts shall be adequately braced and supported to prevent vibration and premature fatigue or fracture.

24.14 Noise level

Noise levels shall comply with BS 4999, Part-51.

24.15 Vibration level

The double amplitude of vibrations as measured at motor bearings shall be within the limits specified in IS 4729, and the limits specified for the driven equipment.

24.16 Earthing terminals

Two independent earthing points shall be provided in accordance with IS 3043(1966), on opposite sides of the motor for bolted connection of Employer's earthing conductor.

24.17 Terminal boxes and associated fittings

Terminal boxes for motors rated above 110 kW shall be capable of withstanding a system fault level of 31 MVA for 0.12 seconds.

Unless otherwise approved, the terminal box shall be capable of being turned through 360 degrees in steps of 90 degrees.

415 volt terminals shall be suitable for receiving 1.1 kV grade PVC or XLPE, unarmoured or armoured power cables.

Only three line terminals need be brought out from each three phase primary winding. All inter phase connections whether star or delta shall be made inside the machine.

Marking of all terminals shall be in accordance with IS 4728.

Leads from terminals to the windings shall be adequately sized and braced to withstand heating and forces produced by maximum fault current.

Cable boxes and terminations shall be designed to enable easy disconnection and replacement of cables.

All joints other than those on cable glands shall be gasketted with neoprene, neoprene bonded cork or other approved material.

For single core cables, gland plates shall be effectively non-magnetic.

The following shall be supplied along with each motor :

1. Crimping type tinned copper lugs for power cables, with all necessary hardware.
2. Compression type tinned brass cable glands for power cables (to be supplied loose).
3. Removable type undrilled gland plate.
4. Terminal boxes shall of weather proof construction with a degree of protection of IP-55. At least one motor of each batch shall be type tested to comply with the following : the terminal boxes shall be subject to an internal air pressure of 0.207 bar g for 12 hours. After this period the pressure shall not be less than 0.104 bar g (after correcting for any change in temperature).

24.18 Rating plate

In addition to the requirements as called for in General Technical Clauses and relevant IS, the rating plate shall indicate the following:

- Maximum continuous rating in kW for 70C temperature rise.
- Bearing identification numbers (in case of ball or roller bearings) and recommended lubricant.

24.19 Paint and finish

All external parts shall be finished and painted to produce a neat and durable surface which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, and sharp edges and scales removed and treated with one coat of primer and two coats of grey enamel paint. Motor colour codes shall comply with the requirements indicated elsewhere in this Specification.

All fasteners used in the construction of the equipment shall be either of corrosion resistant material or electro galvanised to service condition 4. Current carrying fasteners shall be either of stainless steel or high tensile brass or copper.

24.20 Tests

Induction motors shall be subjected to the following routine and type tests.

24.20.1 Routine Tests

Visual Checks of the following:

- Marking on rating plates
- Appearance and painting
- Location and details of terminal boxes and accessories.
- In order to observe compliance to degree of protection, following test will be performed. It shall not be possible to insert a feeler gauge of 1 mm thick in the enclosure or flange faces.

Dimensional checks

Measurement of Insulation Resistance (IR) of windings, and space heaters.

Measurement of winding resistance, and space heater resistance at ambient temperature.

High voltage test on main windings, and space heaters.

IR measurement after HV test in main windings, and space heaters.

No load running test (reading of current, voltage input and speed measurement).

Measurement of bearing temperature during steady state conditions.

Vibration measurement at rated speed and rated voltage, also measurement of vibration during coasting down.

Reduced voltage running test at no load

Locked rotor test.

Phase sequence polarity check and check for terminal markings.

Over speed test

Measurement of air gap

Functional check on auxiliaries

24.20.2 Type Tests

All tests as listed under routine tests

Measurement of noise at no load

Locked rotor test - measurement of VA power input

Momentary overload test

Temperature rise test at rated conditions as well as at maximum input conditions (during heat run test, measurement of bearing temperature, winding temperature, core temperature, coolant flow and coolant temperature). In case the temperature rise test is carried at other load than rated load, specified approval for the test method and procedure shall be obtained from the Project Manager.

Degree of protection test for the enclosure followed by IR, HV and no load run test.

Terminal box - fault level withstand test and pressure test.

Pull out torque measurement

Measurement of no-load starting time.

24.20.3 DC motors

DC motors shall be subjected to all routine and type tests as per IS 4722. In addition, following tests shall be carried out:

- Noise level measurement as type test.
- Vibration measurement as routine test
- Degree of protection test as per IS 4691 as type test.

24.21 Junction boxes and cables

Design and selection of all the components shall be made with a good margin of safety factor.

The equipment shall be installed indoor.

The reference ambient temperature outside the equipment shall be taken as 50C and relative humidity as 100%.

25.0 JUNCTION BOXES

25.1 Construction

Bidder shall supply and install junction boxes complete with terminals as required.

Junction boxes shall be suitable for mounting on walls, columns, structures etc. The brackets, bolts, nuts, cable-glands, screws and all other accessories required for the erection shall be included in the Bidders scope.

Junction boxes shall be of square or rectangular type of 2.0 mm CRCA sheet steel and shall have bolted cover with good quality gasket lining.

Junction box and covers shall be hot dip galvanised.

All the terminals blocks of ESSEN make or equivalent shall be rated for 1100V and shall be of stud type. Each terminal shall be suitable for connecting two 2.5 mm^2 copper conductor.

All terminals shall be complete with insulated barriers, terminals studs, washers, nuts, locknuts, identification strips etc.

Junction boxes located inside shall have IP-54 protection as per IS 2147. Junction boxes located outside shall have IP-55 protection as per IS 2147.

Junction boxes shall be provided with one earthing terminal suitable for galvanised steel conductor.

The general arrangement, cross sectional details and other technical details are to be submitted in the form of drawing for Project Manager‟s approval.

25.2 Interconnecting cables

All cables between junction box and field devices shall be stranded copper conductor, PVC insulated, extruded PVC inner sheathed, single galvanised steel wire armoured and overall PVC sheathed 1.1 kV grade and shall conform to IS 1554. The minimum size of cable used shall be 2.5 mm^2 copper conductor. All cables shall be supplied by the Contractor.

26.0 CONDUIT AND CONDUIT ACCESSORIES

The bidder shall supply and install all rigid steel conduit, flexible conduits, Hume pipes etc. complete with accessories such as tees, bends, adaptors and couplings as required for cabling work between various field devices to junction boxes.

SECTION 4

List of Enclosures with Technical Specification:

1. **Single Line Diagram:**

   Single Line Diagram for for 400kV AIS at Duburi - Dwg. No. TB-3-420-510-001-D
   (3 SHEETS)

2. **Layout Plan:**

   Electrical Layout Plan of 400kV AIS at Duburi - Dwg. No. TB-2-420-316-001-D
   (1 SHEET)

3. **Key Protection and Metering Single Line Diagrams (For tender purpose only):**

   Key Protection Diagram of Key Protection Diagram of 400kV AIS at Duburi - Dwg. No. TB-3-420-510-001-D Rev 00
   (1 SHEET)

4. Preliminary SAS Architecture of 400kV AIS at Duburi - Dwg. No. TB-3-420-510-001-D Rev 01
   (1 SHEET)

5. **Annexure-A: Confirmation for compliance to technical specification**

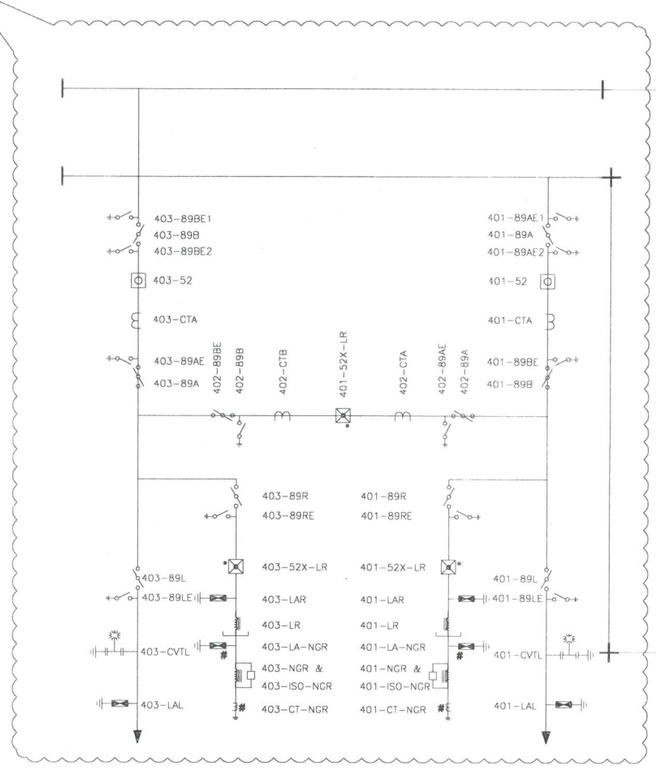
FIRST ANGLE PROJECTION

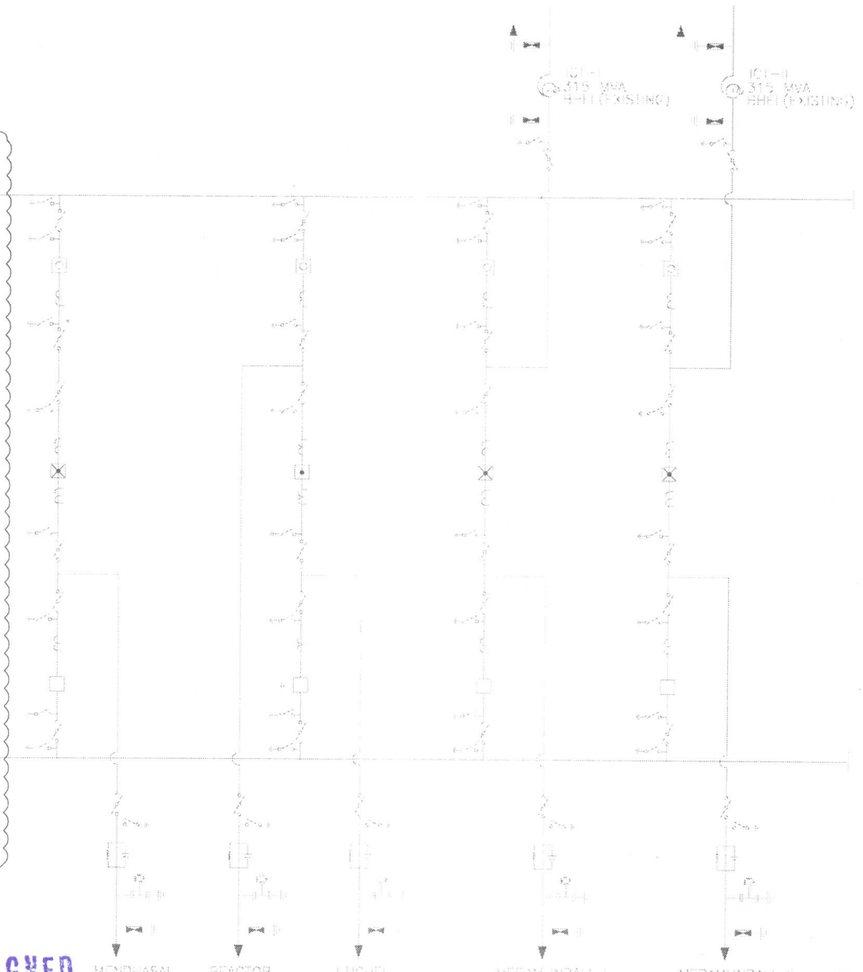
(ALL DIMENSIONS ARE IN m/m)

DRG. NO. TB-3-420-610-001-D

OPTION 1

PRESENT SCOPE



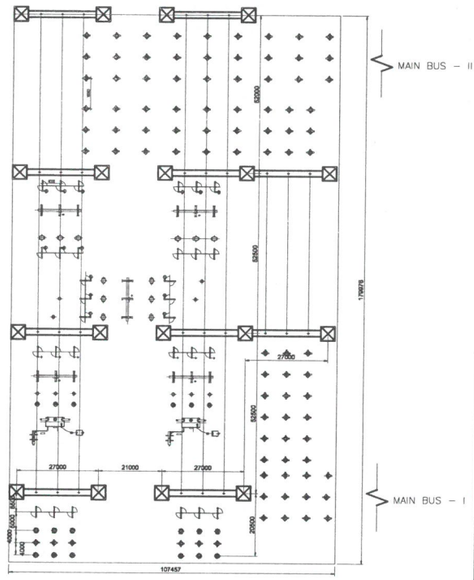


EQUIPMENT DESIGNATION FOR SLD

4	–	1	89	A/B	E

- E: EARTH SWITCH
- A/B: A–EQUIPMENT CONNECTED TO BUS–1; B–EQUIPMENT CONNECTED TO BUS–2; L–DEVICE CONNECTED TO LINE SIDE; R–DEVICE CONNECTED TO REACTOR SIDE
- 89: EQUIPMENT IDENTIFICATION (ISOLATOR)
- 1: BAY NO. :01,02..N
- 4: VOLTAGE LEVEL –400kV

APPROVED
13.04.2023
Executive Director
Zonal Office, OPTCL, BBSR



TYPICAL PLAN LAYOUT FOR OPTION 1
108m X 180m

EXISTING/FUTURE - NOT IN BHEL SCOPE

BHEL SCOPE

Deputy General Manager (Elect.)
E.H.T. Construction Division,
OPTCL, Paradeep

Manager(Elect.)
EHT (Const.) Circle,
OPTCL, Bhubaneswar

COUNTERSIGNED
23/3/23
General Manager (ELC.)
EHT, Construction Circle
OPTCL, Bhubaneswar

NOTES :

1. PARAMETERS OF BUSHING CT OF LINE REACTOR & NGR WILL BE PROVIDED LATER.
2. POLARITY OF THE CT'S TO BE MATCHED WITH EXISTING.

REV.	DATE	ALTERED / CHD/APPD	REV.	DATE	ALTERED / CHD/APPD	REV.	DATE	ALTERED / CHD/APPD	REV.	DATE	ALTERED / CHD/APPD
ZONE			ZONE			ZONE			ZONE		

PROJECT:	400/220kVGIS SUBSTION AT ERASAMA, ODISHA & 400kV AIS FEEDER BAY EXTENSION AT DUBURI, ODISHA							
OWNER:	ODISHA POWER TRANSMIISSHON CORPORATION LIMITED							
BHEL / भेल — BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION BUSINESS GROUP NOIDA		NAME	SIGN.	DATE	NO.OF VAR.			
	DRN.	NS	–sd–	13-01-23	N.A.			
	CHD.	SKS	–sd–	13-01-23				
	APPD.	SKS	–sd–	13-01-23				
DEPT. TBG	UNTOL. DIMS. GR.	SCALE	WEIGHT (KG)	REF. TO ASSY. DRG.	ITEM NO.	NO.OF ITEMS		
CODE		N.T.S	N.A.	N.A.	N.A.	N.A.		
TITLE: SINGLE LINE DIAGRAM OF 400kV AIS SUB STATION EXTN. AT DUBURI		CARD CODE: NA	DRG.NO.: TB-3-420-510-001-D			REV.: 00		
			SHT. No 01	NO. OF SHT. 03				

SIZE–A3

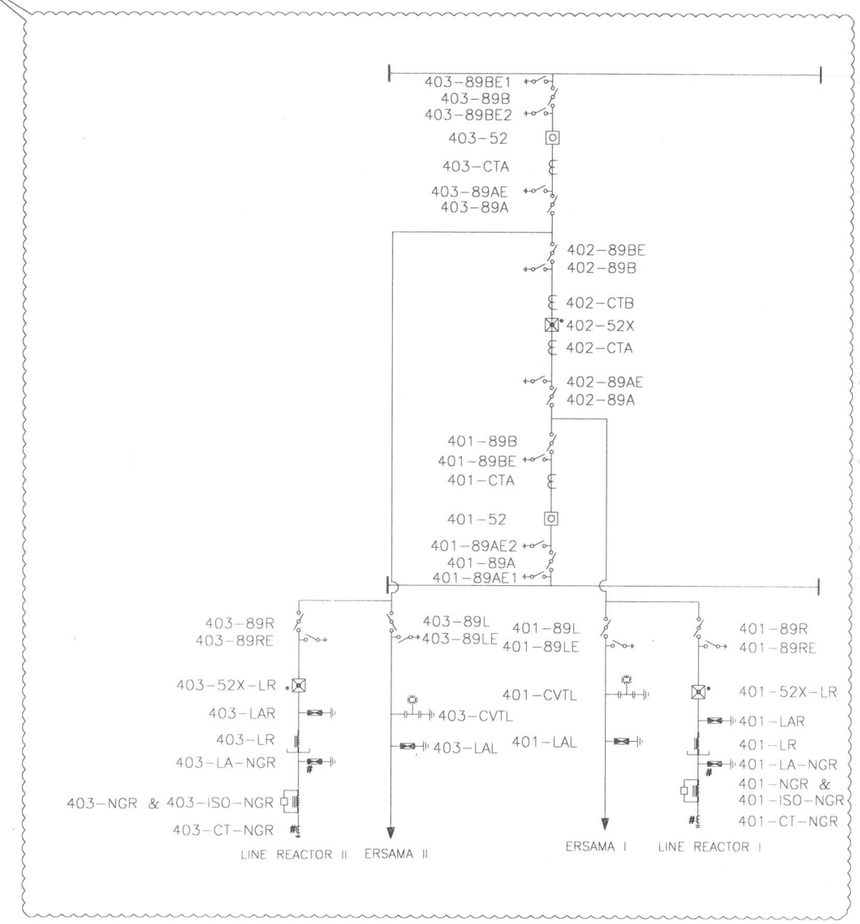
FIRST ANGLE PROJECTION

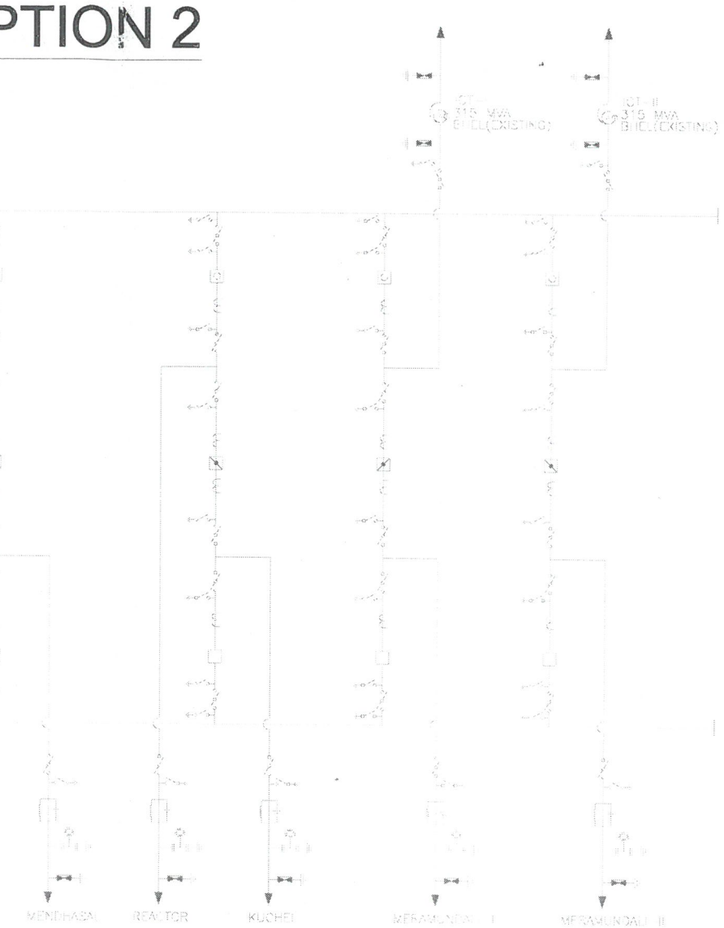
(ALL DIMENSIONS ARE IN mm)

DRG. NO. TB-3-420-610-001-D

OPTION 2

PRESENT SCOPE

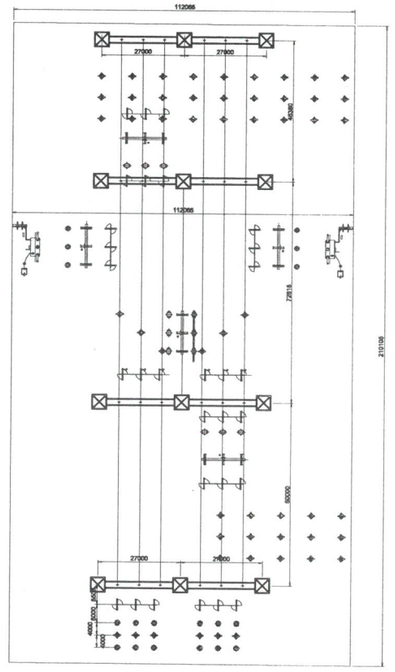




EQUIPMENT DESIGNATION FOR SLD

4	–	1	89	A/B	E

- E: EARTH SWITCH
- A/B: A–EQUIPMENT CONNECTED TO BUS–1; B–EQUIPMENT CONNECTED TO BUS–2; L–DEVICE CONNECTED TO LINE SIDE; R–DEVICE CONNECTED TO REACTOR SIDE
- 89: EQUIPMENT IDENTIFICATION (ISOLATOR)
- 1: BAY NO. :01,02..N
- 4: VOLTAGE LEVEL –400kV



NOTES :

1. PARAMETERS OF BUSHING CT OF LINE REACTOR & NGR WILL BE PROVIDED LATER.
2. POLARITY OF THE CT'S TO BE MATCHED WITH EXISTING.

EXISTING/FUTURE - NOT IN BHEL SCOPE

BHEL SCOPE

TYPICAL PLAN LAYOUT FOR OPTION 2
112m X 210m

REV.	DATE	ALTERED	CHD/APPD
ZONE			

PROJECT:	400/220kVGIS SUBSTION AT ERASAMA, ODISHA & 400kV AIS FEEDER BAY EXTENSION AT DUBURI, ODISHA
OWNER:	ODISHA POWER TRANSMIISSIION CORPORATION LIMITED

BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION BUSINESS GROUP NOIDA

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	NS	–sd–	13-01-23	N.A.
CHD.	SKS	–sd–	13-01-23	
APPD.	SKS	–sd–	13-01-23	

DEPT. TBG / CODE	UNTOL. DIMS. GR.	SCALE	WEIGHT (KG)	REF. TO ASSY. DRG.	ITEM NO.	NO.OF ITEMS
	g/m/f	N.T.S	N.A.	N.A.	N.A.	N.A.

TITLE: SINGLE LINE DIAGRAM OF 400kV AIS SUB STATION EXTN. AT DUBURI

CARD CODE: NA

DRG.NO. TB-3-420-510-001-D REV. 00

SHT. No 02 NO. OF SHT. 03

SIZE-A3

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN mm)

DRG. NO. TB-3-420-610-001-D

400kV AIS CT Details (CTA, CTB)

Core No.	Current Ratio	Output Burden VA	Acc: class as per IS: 2705	Minimum knee point voltage (Vk) at all ratios in volts.	Maximum CT resistance RCT in ohms at 75 0C at all ratios	Maximum excitation current at Vk in mA at all ratios.	Instrum-ent security factor at all ratios	Purpose
1	2000-1000-500/1A	--	PX	2000-1000-500	10-5-2.5	30-60-120	--	Bus diff: check
2	2000-1000-500/1A	--	PX	2000-1000-500	10-5-2.5	30-60-120	--	Bus diff: check
3	2000-1000-500/1A	30-30-30	0.2S	--	--	--	5 or less	Metering
4	2000-1000-500/1A	--	PX	2000-1000-500	10-5-2.5	30-60-120	--	Trans: back B/U –Line Prot:
5	2000-1000-500/1A	--	PX	2000-1000-500	10-5-2.5	30-60-120	--	Trans: back B/U –Line Prot:

A. LINE REACTOR: –

S.N.	DESCRIPTION	SYMBOL	LEGEND	BAY NO/LOCATION	UNIT	QTY AS PER BPS	ENGG. QTY.
1.	80 MVAR, 400 kV Line Reactor - 3 PH.	—	LR	401,403	NOS	2	2

B. 400kV OUTDOOR EQUIPMENT: –

S.N.	DESCRIPTION	SYMBOL	LEGEND	BAY NO/LOCATION	UNIT	QTY AS PER BPS	ENGG. QTY.
1.	420KV,3150A,63KA,SF6,CIRCUIT BREAKER WITH Terminal Connector SUPPORT STRUCTURE etc. WITH CSD (For Tie & reactor switching)-3PH.		52X	401,402,403	NOS	3	3
2.	420KV,3150A,63KA,SF6,CIRCUIT BREAKER WITH Terminal Connector SUPPORT STRUCTURE etc WITH OUT CSD-3PH.		52	401,403	NOS	2	2
3.	420 KV, 3150 A, 63 KA, ISOLATORS WITH ONE EARTH SWITCH-3PH.		89A, 89B 89L, 89R	401,402,403	NOS	8	8
4.	420 KV, 3150 A, 63 KA, ISOLATORS WITH TWO EARTH SWITCH-3PH.		89A, 89B	401,403	NOS	2	2
5.	420 KV,2000-1000-500A,63 KA,5CORE SINGLE PHASE CURRENT TRANSFORMER-1PH.		CTA,CTB	401,402,403	NOS	12	12
6.	420 KV,4400pF,63 KA,3CORE,SINGLE PHASE CAPACITOR VOLTAGE TRANSFORMER-1PH.		CVTL	401,403	NOS	6	6
7.	390KV metal oxide polymer housed surge arrestor, 20 KA , Long duration discharge class IV ,pressure relief Design A, thermal energy (kJ/kV) & Repetitive charge transfer(Coulomb) as per latest IEC, as per technical specification COMPLETE WITH INSULATING BASE & SURGE MONITOR -1PH.		LAL,LAR	401,403	NOS	12	12

C. 145kV OUTDOOR EQUIPMENT (NGR RELATED): –

S.N.	DESCRIPTION	SYMBOL	LEGEND	BAY NO/LOCATION	UNIT	QTY AS PER BPS	ENGG. QTY.
1.	NGR, 132KV for Line Reactor - 1PH.		NGR	401,403	NOS	2	2
2.	120KV metal oxide polymer housed surge arrestor, 10 KA , Long duration discharge class III ,pressure relief Design A, thermal energy (kJ/kV) & Repetitive charge transfer(Coulomb) as per latest IEC, as per technical COMPLETE WITH INSULATING BASE & SURGE MONITOR - 1PH.		LA-NGR	401,403	NOS	2	2
3.	145 KV CT (800-400-200/1-1-1) FOR NGR - 1PH.		CT-NGR	401,403	NOS	2	2
4.	132kV, 2000A, 40kA,ISOLATORS WITHOUT EARTH SWITCH (1-Pole)		ISO-NGR	401,403	NOS	2	2

SYSTEM PARAMETERS: –

S.N.	SYSTEM PARAMETERS	400kV	132kV
1.	NOMINAL VOLTAGE	400kV	132kV
2.	HIGHEST SYSTEM VOLTAGE	420kV	145kV
3.	RATED FREQUENCY	50Hz	50Hz
4.	RATED SHORT TIME CURRENT	63kA for 3s/1s (as applicable)	40kA For 1s
5.	POWER FREQUENCY WITHSTAND VOLTAGE	630kV (rms)	275kV (rms)
6.	LIGHTNING IMPULSE WITHSTAND VOLTAGE	±1425 kV peak	±650 kV peak
7.	SWITCHING IMPULSE WITHSTAND VOLTAGE	±1050 kV peak	N.A
8.	CREEPAGE	25mm/kV (10500mm)	25mm/kV (3625mm)
9.	GROUNDING	Effectively earthed	Effectively earthed

REV.	DATE	ALTERED CHD/APPD	REV.	DATE	ALTERED CHD/APPD	REV.	DATE	ALTERED CHD/APPD	REV.	DATE	ALTERED CHD/APPD
ZONE			ZONE			ZONE			ZONE		

PROJECT:	400/220kVGIS SUBSTION AT ERASAMA, ODISHA & 400kV AIS FEEDER BAY EXTENSION AT DUBURI, ODISHA						
OWNER:	—	ODISHA POWER TRANSMIISSION CORPORATION LIMITED					
BHEL	BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION BUSINESS GROUP NOIDA		NAME	SIGN.	DATE	NO.OF VAR.	
		DRN.	NS	-sd-	13-01-23	N.A.	
		CHD.	SKS	-sd-	13-01-23		
		APPD.	SKS	-sd-	13-01-23		
DEPT. TBG CODE	UNTOL. DIMS. GR. f/M/f		SCALE N.T.S	WEIGHT (KG) N.A.	REF. TO ASSY. DRG. N.A.	ITEM NO. N.A.	NO.OF ITEMS N.A.
TITLE: SINGLE LINE DIAGRAM OF 400kV AIS SUB STATION EXTN. AT DUBURI			CARD CODE NA	DRG.NO. TB-3-420-510-001-D		REV. 00	
				SHT. No 03	NO. OF SHT. 03		

SIZE-A3

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG. NO. TB-2-420-316-001-D

PLANT NORTH

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. LAYOUT IS DEVELOPED AS PER SITE SURVEY CARRIED OUT DATED 02.03.2023.
3. SUITABLE QUANTITY AMENDMENT ALONGWITH ADDITIONAL REQUIREMENT, IF ANY, OVER & ABOVE EXISTING CONTRACT BOQ TO BE SETTLED COMMERCIALLY BASED ON THIS LAYOUT AS PER PROVISIONS IN CONTRACT.
4. EXISTING FACILITIES ARE MARKED IN GREY.
5. SWITCHYARD KIOSK ROOM SIZE IS 9Mx4.5M
6. EARTHMAT DESIGN SHALL BE MATCHED WITH EXISTING S/S GRID EARTHMAT.

EXISTING FENCE

EXISTING BUS BPI AS PER SURVEY

EXISTING MAIN BUS 2

EXISTING TATA BAY TOWER 3

EXISTING TATA BAY TOWER 2

EXISTING MAIN BUS 1

EXISTING TATA BAY TOWER 1

TOWARDS EXISTING ROAD

EXISTING LINE BAY

EXISTING 400 KV LINE

HOUSE

HOUSE

SPR

3.75m WIDE ROAD

3.75m WIDE ROAD

7.0m WIDE ROAD

DUBURI SS BOUNDARY WALL

DUBURI SS BOUNDARY WALL

400kV LINE-I TO ERASAMA

400kV LINE-II TO ERASAMA

15000

23000

11500

11000

CONDUCTOR QUANTITY = 4.2KM

EXISTING
PRESENT SCOPE

APPROVED
08.11.2023
Executive Director
Zonal Office, OPTCL, BBSR

हरेंद्र कुमार सा
Harendra Kumar Sa
अपर महाप्रबंधक
Additional General Manager
बी.एच.ई.एल, क्षे.प.प्र, BHEL, ROD
भुवनेश्वर, BHUBANESWAR-751001

A. LINE REACTOR:-

S.N.	DESCRIPTION	SYMBOL	LEGEND	BAY NO/LOCATION	UNIT	QTY AS PER BPS	DESG. QTY.
1.	80 MVAR, 400 KV Line Reactor - 3 PH.		LR	401,403	NOS	2	2

B. 400kV OUTDOOR EQUIPMENT:-

S.N.	DESCRIPTION	SYMBOL	LEGEND	BAY NO/LOCATION	UNIT	QTY AS PER BPS	DESG. QTY.
1.	420KV,3150A,63KA,SF6,CIRCUIT BREAKER WITH Terminal Connector SUPPORT STRUCTURE etc. WITH CSD (For Tie & reactor switchbay)-3PH.		52X	401,402,403	NOS	3	3
2.	420KV,3150A,63KA,SF6,CIRCUIT BREAKER WITH Terminal Connector SUPPORT STRUCTURE etc. WITH OUT CSD-3PH.		52	401,403	NOS	2	2
3.	420 KV, 3150 A, 63 KA, ISOLATORS WITH ONE EARTH SWITCH-3PH.		89A, 89B 89L, 89R	401,402,403	NOS	8	8
4.	420 KV, 3150 A, 63 KA, ISOLATORS WITH TWO EARTH SWITCH-3PH.		89A, 89B	401,403	NOS	2	2
5.	420 KV,2000-1000-500A,63 KA,SCORE SINGLE PHASE CURRENT TRANSFORMER-1PH.		CTA,CTB	401,402,403	NOS	12	12
6.	420 KV,4400pF,63 KA,3SCORE,SINGLE PHASE CAPACITOR VOLTAGE TRANSFORMER- 1PH.		CVTL	401,403	NOS	6	6
7.	360KV,metal oxide polymer housed surge arrester, 20 KA, 1200 duration of current impulse, Nominal discharge current (8/20 micro sec) & Repetitive charge transfer(Qrs) as per latest IEC , as per technical specification COMPLETE WITH INSULATING BASE & SURGE MONITOR - 1PH		LAL,LAR	401,403	NOS	12	12
8.	420 KV,BPI		--	--	NOS	48	71

C. 145kV OUTDOOR EQUIPMENT (NGR RELATED):-

S.N.	DESCRIPTION	SYMBOL	LEGEND	BAY NO/LOCATION	UNIT	QTY AS PER BPS	DESG. QTY.
1	NGR, 132KV Ne/ Line Reactor - 1PH.		NGR	401,403	NOS	2	2
2.	120KV metal oxide polymer housed surge arrester, 10 KA, 1200 duration of current impulse, Nominal discharge current (8/20 micro sec) & Repetitive charge transfer(Qrs) as per latest IEC , as per technical specification COMPLETE WITH INSULATING BASE & SURGE MONITOR - 1PH		LA-NGR	401,403	NOS	2	2
3.	145 KV CT (800-400-200/1-1-1) FOR NGR - 1PH		CT-NGR	401,403	NOS	2	2
4.	132kV, 2000A, 40kA,ISOLATORS WITHOUT EARTH SWITCH (1-Pole)		ISO-NGR	401,403	NOS	2	2

Revised Layout Plan

Deputy General Manager (Elect.)
E.H.T. Construction Division,
OPTCL, Paradeep

COUNTERSIGNED

Sr. General Manager (Elect.)
EHT Construction Circle
OPTCL, Bhubaneswar

Deputy General Manager (Elect.)
Zonal Office, OPTCL
Bhubaneswar
03/11/2023

REV.	DATE	ALTERED CHD/APPD	REV.	DATE	ALTERED CHD/APPD	REV.	DATE	ALTERED CHD/APPD	REV.	DATE	ALTERED CHD/APPD
ZONE			ZONE			ZONE			ZONE		

PROJECT:	400/220kVGIS SUBSTION AT ERASAMA, ODISHA & 400kV AIS FEEDER BAY EXTENSION AT DUBURI, ODISHA					
OWNER:	ODISHA POWER TRANSMIISSION CORPORATION LIMITED					
BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION BUSINESS GROUP NOIDA		NAME	SIGN.	DATE	NO.OF VAR.	
	DRN.	NS	-sd-	09-10-23		
	CHD.	SKS	-sd-	09-10-23	N.A.	
	APPD.	SKS	-sd-	09-10-23		
DEPT. TBG CODE	UNTOL. DIMS. CR. ±/M/F	SCALE N.T.S	WEIGHT (KG) N.A.	REF. TO ASSY. DRG. N.A.	ITEM NO. N.A.	NO.OF ITEMS N.A.
TITLE: ELECTRICAL LAYOUT PLAN OF 400kV AIS SUB STATION EXTN. AT DUBURI	CARD CODE NA	DRG.NO. TB-2-420-316-001-D			REV. 00	
		SHT. No 01	NO. OF SHT. 01			

SIZE-A2

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

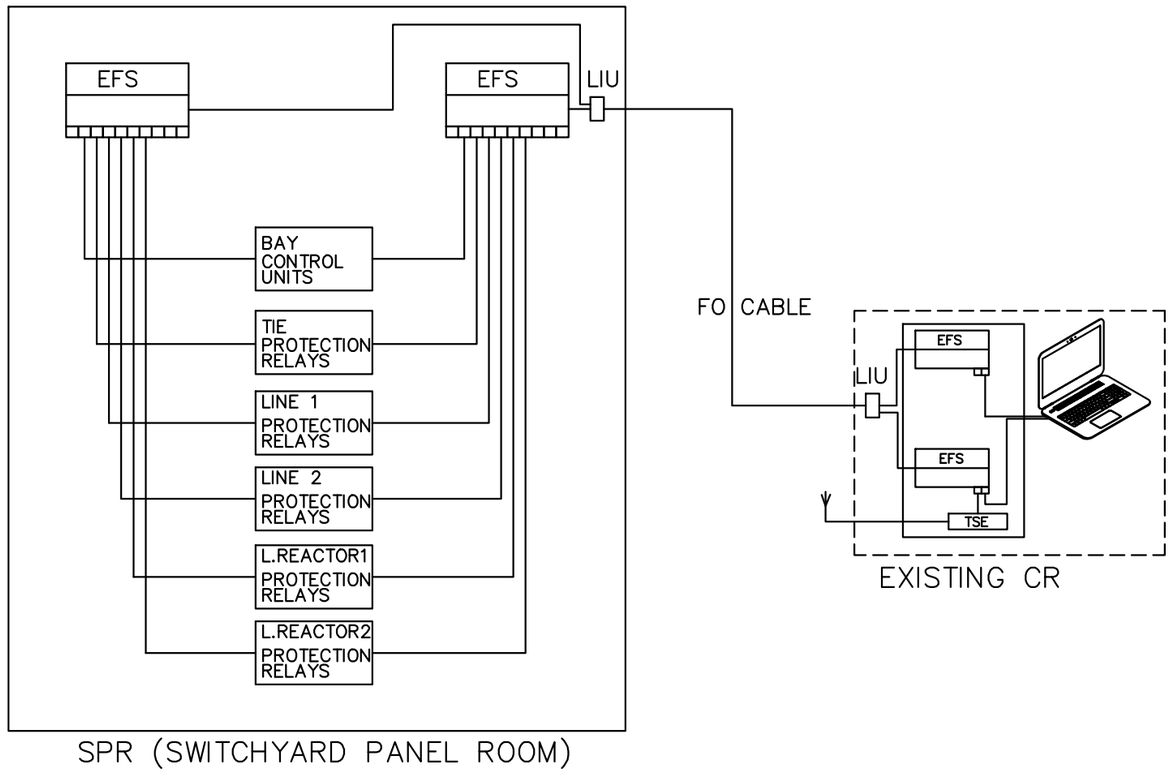
DRAWING No. TB-3-420-510-001-D

COMPUTER DRG. PATH NAME :

REF. DRG. No.

SIGN. & DATE

INVENTORY No.



				REMARKS
23	COMPLETE SUB-STATION AUTOMATION SYSTEM FOR 400 KV BAY EXTENSION INCLUDING HARDWARE AND SOFTWARE FOR THE SUB-STATION AND REMOTE CONTROL SYSTEM ALONGWITH ASSOCIATED EQUIPMENT AND ACCESSORIES AS PER TECHNICAL SPECIFICATION & RELAY PROTECTION PANEL, EVENT LOGGER PANEL ,BUS BAR PROTN PAN & RELAY TOOL KITS AS PER TECH SPEC. The SAS & Bus Bar Protection scheme shall be integrated with the existing system. Allmaterials & equipment as required for successful completion shall be considered.			
23.1	SUB-STATION AUTOMATION SYSTEM FOR PROPOSED 400 kv bay extension	SET	1	Ethernet switch, FO Cable, LAN Cables, LIUs, Time Synchronising Equipment (TSE)
23.2	BCU FOR CONTROLLING AND MONITORING OF THE PROPOSED (400 KV)	SET	5	1 No BCU shall be provided for each CB. i.e. Total 3 Nos are additional.
23.3	400 KV FEEDER PROTECTION RELAY PANEL(MAIN-I WITH AUTO RECLOSURE & MAIN-II WITH AUTO RECLOSURE AND BACK-UP PROTECTION) AND TIE PROTECTION PANEL with Bus Bar Protection.	SET	2	—
23.4	400 KV LINE REACTOR AND 132 KV NGR PROTECTION RELAY PANEL	SET	2	—
23.5	400kV CB Panel for Switched reactor protection	SET	2	—
23.6	400kV Tie Protection Panel	Nos	1	—
23.7	Integration with existing Busbar protection & SAS system	SET	1	1 No. Laptop with IED configuration software, ICD Files for SAS Integration.

NOTES

1. Numerical relays & BCU will be based on IEC 61850 protocol & are PRP Compliant
2. ICD files will be made available for SAS Integration.
3. Hardwired Protection Integration shall be carried with existing Busbar Protection
4. SAS is offered for 400kV Bay Extn. Exclusions include Gateway Panel and other accessories, printers. (To be procured by OPTCL through Main SAS vendor)

CHECKED
D.G.M. (Elect)
ENGG. & QUALITY
OPTCL, BHUBANESWAR

APPROVED
G.M. (Elect)
ENGG. & QUALITY
OPTCL, BHUBANESWAR

REV.	DATE	
		ALTERED
		CHECKED
		APPROVED
ZONE		

REV.	DATE	
		ALTERED
		CHECKED
		APPROVED
ZONE		

REV.	DATE	
01	23.12.23	ALTERED
		CHECKED
		APPROVED
ZONE	Revised as per OPTCL Comments dated 5.10.2023	

ADDITIONAL INFORMATION W.O.No.	ग्राहक/परियोजना का नाम NAME OF CUSTOMER/PROJECT: 400/220kVGIS SUBSTION AT ERASAMA, ODISHA & 400kV AIS FEEDER BAY EXTENSION AT DUBURI, ODISHA — ODISHA POWER TRANSMIISSIION CORPORATION LIMITED
STATUS OF DRAWING	CONSULTANT: NA
DISTRIBUTION OF PRINTS	भारत हेवी इलेक्ट्रिकल्स लिमिटेड पारेषण व्यापार समूह BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION BUSINESS GROUP

	नाम /NAME	हस्ता./SIGN.	दि./DATE
बनाया DRAWN	NS		30.08.23
जाँचा CHECKED			30.08.23
स्वीकृत APPROVED			30.08.23

विभाग DEPT. TBEM		अनुपात / SCALE	कार्ड कोड CARD CODE
कोड CODE 410			-

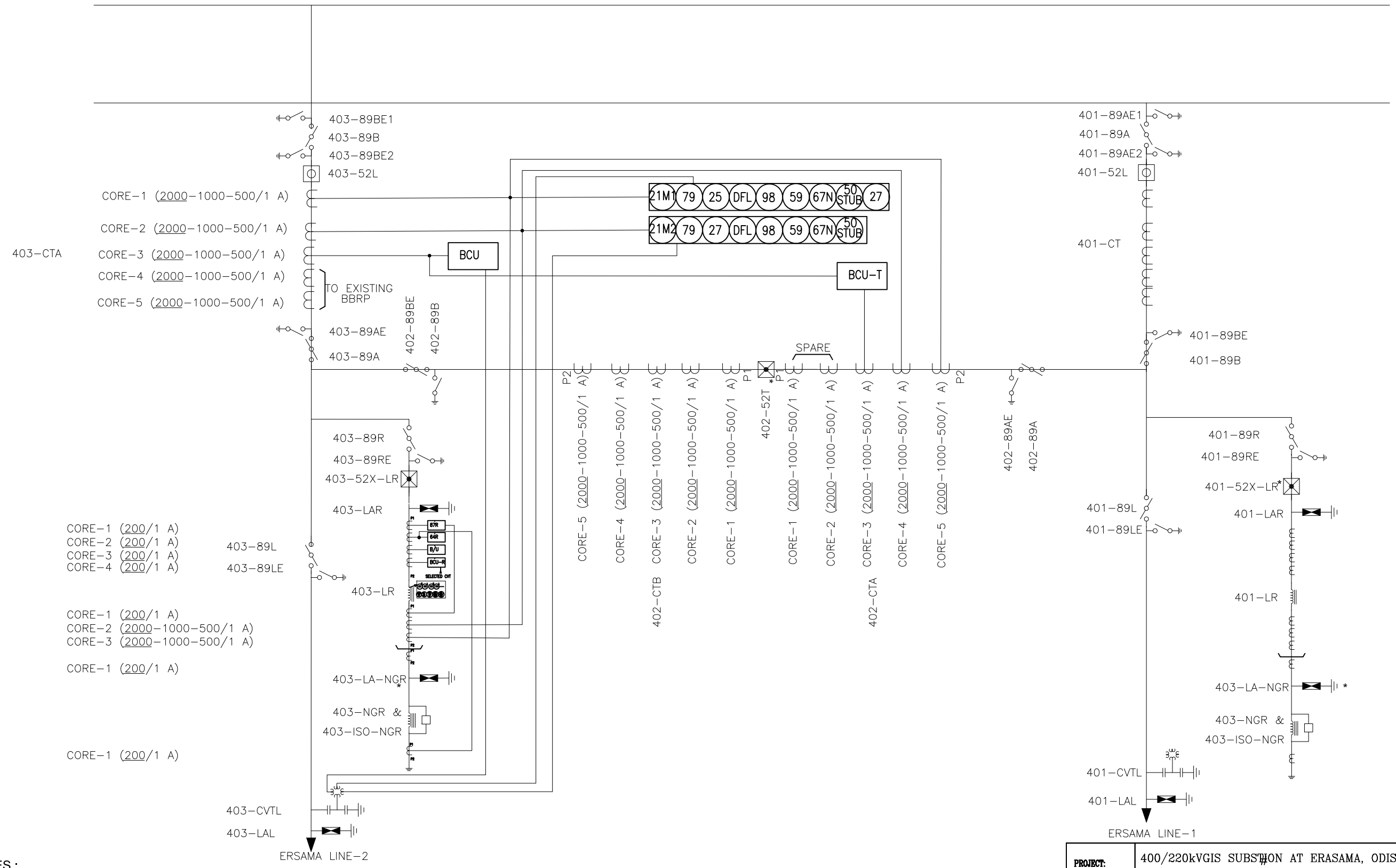
शीर्षक/TITLE	ड्राईंग क्र./DRAWING NO. / पुनः/REV.
PRELIMINARY SAS ARCHITECTURE – OPTCL NEW DUBURI	TB-3-420-510-001-D / 01
	पृष्ठ क्र./SHEET No. 01 / अगला पृष्ठ /NEXT SHEET — —

A3 SIZE

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG. NO. TB-3-420-510-001-D



NOTES :

1. SIMILAR PROTECTION PHILOSPHY FOR BAY-401

REV.	DATE	ALTERED	REV.	DATE	ALTERED	REV.	DATE	ALTERED	REV.	DATE	ALTERED
		CHD/APPD			CHD/APPD			CHD/APPD			CHD/APPD
ZONE			ZONE			ZONE			ZONE		

PROJECT:	400/220kVGIS SUBSTION AT ERASAMA, ODISHA & 400kV AIS FEEDER BAY EXTENSION AT DUBURI, ODISHA				
OWNER:	ODISHA POWER TRANSMIISSIION CORPORATION LIMITED				
BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION BUSINESS GROUP NOIDA		NAME	SIGN.	DATE	NO.OF VAR.
	DRN.	NS	-sd-	13-01-23	N.A.
	CHD.	SKS	-sd-	13-01-23	
	APPD.	SKS	-sd-	13-01-23	
DEPT. TBG / CODE	UNTOL. DIMS. GR. C/M/F	SCALE N.T.S	WEIGHT (KG) N.A.	REF. TO ASSY. DRG. N.A.	ITEM NO. N.A. / NO.OF ITEMS N.A.
TITLE: SINGLE LINE DIAGRAM OF 400kV AIS SUB STATION EXTN. AT DUBURI	CARD CODE NA	DRG.NO. TB-3-420-510-001-D			REV. 00
		SHT. No 01	NO. OF SHT. 03		

SIZE-A3

ANNEXURE-A: Compliance Certificate of Technical Specification

The bidder shall confirm compliance to the following by signing and 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 schedule of deviations.

3. Only those technical submittals which are specifically asked for in Notice Inviting Tender (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 technical 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