ODISHA POWER TRANSMISSION CORPORATION LIMITED

(A GOVERNMENT OF ODISHA UNDERTAKING)
Janpath, Bhoinagar, Bhubaneswar-751022, Odisha.

CORRIGENDUM-5 to

Invitation for Bids No CPC- NIT/OPTCL/OPSEAP/ 32 /2013-14 Dt: 03/03/2014

Bidders are requested to follow the following documents uploaded before quoting:

Bid Identification No.	Following documents are uploaded
ICB Document No: OPTCL/ADB-OPSEAP/2014/Package-II Lot-1:33 kV Sub-Station Work. Lot-2: 11kV and LT Network Work	1. Reply to tech query 2. Reply to commercial query 3. EQC amendment 4. Revised Technical spec for UG cable, GIS Bkr, Isolator, Jointing kit 5. Revised tech spec for 100 KVA energy efficient tfr. 6. Tech spec for AAAC,GTP 7. Technical spec for polymer insulator. 8. 33 Cable GTP 9. Technical spec for HDPE 10. SAS SCADA 11. 33 KV Network Map, SCADA at Autonagar S/S 12. 33 KV DC & SC cable trench 13. 33 KV GIS SS layout 14. Revised Price schedule 1st July2014 for quoting (in excel format).

NOTE: All other terms and condition of the Invitation for Bid shall remain unchanged.

01/07/2014

Chief General Manager (CPC)

TECHNICAL QUERIES PACKAGE-II (LOT 1 & 2)

Sl. No	Reference	Bidders Queries	OPTCL's Clarification
1	HT Cables	Please provide technical specification for following cables. Since the same is not available with bidding documents. a) 11 kV – Single core 400 & 630 Sq.mm Copper cable b) 11 kV 3Cx 300 & 3C X240 Sq.mm Aluminum cable c) 33 kV – Single core 630 Sq.mm& Single core 35 Sq.mm Copper cable	ref revised Spec
2	LT Cables & LT AB cables	Please provide technical specification for following cables. Since the same is not available with bidding documents. a) Supply of Power Cables, LT PVC Three half Core, 95 sq.mm Cable b) Supply of 1.1 kV, Three half core, UG Cable, PVC insulation armoured, 240 sq. mm Aluminum c)Supply of Materials for 1.1 kV, Three Core, Class, three Phase Aerial Bunch Conductor (ABC) 95 sq.mm and 70 Sq.mm	ref revised Spec
3	Transformers	Please provide technical specification for following Transformers. Since the same is not available with bidding documents. a) 500 kVA b) 315 kVA c) 100 kVA	ref revised Spec
4	HT Switchgear	Please provide technical specification for following items. Since the same is not available with bidding documents. a) 750 kVA Compact Sub-stations b) 11 kV RMU c) 11 kV & 33 kV Indoor AIS panels d) 33 kV VCB e) 33kV &11 kV out door Switchgear f) DG Set g) 11 kV LA h) 33 kV & 11 kV instrument transformers	ref revised Spec
5	LT Switchgear	Please provide technical specification for following panels. Since the same is not available with bidding documents. a) LTDB b) ACDB c) DCDB d) Feeder Pillar	Follow standrad design
6	\	Please provide technical specification for following items. Since the same is not available with bidding documents. A) SCADA -DMS, RTU	uploaded revided spec
7	Conductor	Please provide technical specification for following conductors. Since the same is not available with bidding documents. a) AAAC 100 Sq.mm b) AAAC 148 Sq.mm c) AAAC 232 Sq.mm d) Conductor accessories	uploaded

8	Others	Please provide technical specification for following items. Since the same is not available with bidding documents. a) Cable fault locator b) 33 &11 kV Polymer insulators, pin & Disc insulators, LT pin insulators c) Earthing electrodes d) HDPE pipe e) SMART Meter & ETV METER f) HT & LT stay set g) Battery & Battery charger (up to 110 Volts) h) 11 kV termination kits& LT Ab cable termination kits	uploaded
9	SLD	As per SLD, Disconnector switch is indicated in Line side. We would like to offer GIS having 3 position switch (ON-OFF-EARTH) before the breaker & interlocked with the CB (Bus side) Connecting & disconnecting with the bus is achieved by 3 position switch & feeder earthing also takes place with the help of 3 position switch via CB. Please confirm	Accepted
10	Technical spec clause 3.2 Page no 3 of 55	As per the referred clause kindly confirm the rated normal current of the bus bar. We have considered 1250A at 40deg ambient, but as per spec it is required 800A & as per BPS it is 1250 Amps. Please clarify the requirement	1250 A
11	Technical spec clause 3.3 Page no 3 of 55	As per referred clause AFL type is mentioned .We request you to accept AFLR type also . Please confirm.	AFLR is acceptable
12	Technical spec clause 5.0 Page no 21 of 55	Please note that in GIS the VCB is fixed type enclosed in the SF6 gas tank. Hence withdrawable facility is not applicable in GIS & this applicable mainly for AIS type breaker. We will provide standard breaker in conjunction with 3-position switch.	ACCEPED
13	Technical spec clause 5.1 Page no 21 of 55	In GIS, since the CB is enclosed in the SF6 gas tank, hence no facilities is available for monitoring the contract erosion and any change in contact gap, however we have repair opening for any kind of maintenance at site only.	INSPECTION WINDOWS IS ACCEPTABLE
14	Technical spec clause 11 Page no 26 of 55	Mentioned Interlock shall be read with 3 position switch disconnector (ON-OFF-EARTH) in GIS. Service-test-isolated position is not available in GIS	ON-OFF-EARTH IS ACCEPTABLE
15	Technical spec clause 12 Page no 26 of 56	Safety shutters are not applicable for GIS. Please confirm	ACCEPED
16	Technical spec clause 18 Page no 30 of 55	Please confirm the VT burden . Maximum Burden can be provided is 15VA for both the cores.	15 VA ACCEPTED
17	Technical spec clause 13 Page no 26 of 55	Offered GIS is type tested for Internal Arc for AFLR & hence each compartment is separated with each other & it is therefore internal arc will not cause any damage to any other compartment. Hence no additional isolating contacts envisaged.	For better safety additional isolating contacts are required
18	4 & 7	Please note that segmental type conductor formation is applicable for sizes 1000 sq. mm & above. As per point no: 7 it is mentioned as compacted stranded circular. Kindly clarify your requirement.	no relevant,follow revised spec
19	7	Please note that as per the provided details the sq mm works out to 173.29 sq mm only. Please note that Approx no of strands shall be 37 nos. and nominal dia of strands 3.26 mm	as per IS-8130/84
20	4 & 7.f) & g)	Kindly clarify whether water tight conductor is required.	water tight conductor is required and follow revised spec
21	4 , 11 & 13	Kindly confirm whether longitudinal water tight cable is required.	longitudinal water tight cable is requiredfollow revised spec

22	12	As per point no 4 the specification calls for non-magnetic metallic shield and armouring over the core. And against point no: 12 they are specifically calling for copper wire of 2.0 mm dia. kindly clarify whether its screen or armour. If it is armour then it shall be of aluminum material as per IS: 7098/Part2 and the dia of armour shall be 2.5 mm nominal.	follow revised Tech spec
23	14	Kindly clarify your requirement.	
24	Sr.No. of Tech. Particulars-1,33 KV UG XLPE AWA HDPE 1 core	As per referred clause Construction mentioned in BOQ mentions corrugated copper sheath & copper wire screen in TP. Please Confirm the exact construction: 2XC2Y or 2XWa2Y required for 33 kV , 300 Sq.mm1core copper cables	follow revised Tech spec
25	Sr.No. of Tech. Particulars-3 ,Rated Voltage (U0/U)= 18/33 KV	As per referred clause 18/33 kV is mentioned in Speciation, as per the manufacturing practice it should be 19/33 KV. Please confirm	19/33 accepted
26	Sr.No. of Tech. Particulars-- 6 a	As per specification Max short time temperature= 220 deg for 1 sec is mentioned. As per the manufacturing practice it should be 250 deg for 1 sec. Short circuit capacity of 42.9 KA for 1 sec will only be at 250 deg. Please confirm	follow revised Tech spec
27	Sr.No. of Tech. Particulars--10,b	As per specification Nominal /Min thickness of insulation screen to be 1.0/0.85 mm is mentioned. Such high thicknesses are usually for cables of 66 KV and above. 0.5 mm will sufficient for 33 kV cables and cost will also be reduced. Please confirm the requirement.	follow revised Tech spec
28	Sr.No. of Tech. Particulars--12b,c	As per specification Metallic screen of copper wires 64 No's/2 mm is mentioned. Short circuit rating of this works out to be 25.82 KA for an initial temp of 80 and final temp of 200 deg. However coverage works out to be more than 98 %, max No. of wires that can be put is 60 No's to avoid looseness, SC rating of that will be 24.206 KA for 1 sec. Please confirm Confirmation of exact short circuit rating required, this can also be routed through Aluminum armour that will act as screen, 2.5 mm Aluminum wire armour will carry a short circuit of 19.99 KA for 1 sec. Please confirm whether we can use Aluminum armour.	follow revised Tech spec
29	Sr.No. of Tech. Particulars--18	As per specification Min bending radius 1180 mm during installation and 944 mm after laying is mentioned. Min Bending radius should be min 20 D as per the manufacturing practice. Please confirm.	follow revised Tech spec
30	Sr.No. of Tech. Particulars--20	As per specification Current rating of 420 A in ground (30 deg), 360 A in ducts and 620 A in air (40 deg), 1.05 m depth, soil thermal resistivity of 150 for trefoil formation, double point bonding is mentioned. As per calculations & standard manufacturing process for Single core cable, We would like to propose Current rating of 442 A in ground, 645 A in air, and 388 in ducts. The detailed calculations can be submitted to you during detailed engineering. Please confirm.	follow revised Tech spec
31	Sr.No. of Tech. Particulars--23	As per specification Equivalent Star reactance 0.111 is mentioned. As per calculations, We would like to propose equivalent Star reactance will be 0.120 ohm/Km Please confirm.	follow revised Tech spec

32	Sr.No. of Tech. Particulars--29	As per specification Induced Voltage in screen is 5 V/Km when cable is carrying a current of 100 A. As per calculations, We would like to propose Induced Voltage in screen will be 5.44 V/Km when cable is carrying a current of 100 A. Please confirm.	follow revised Tech spec
33	Sr.No. of Tech. Particulars--24	As per specification Max charing current will be 1.64A/kM at nominal voltage is mentioned. As per calculations,we would like to propose charging current 1.289A/kM at nominal voltage. Please comfirm.	follow revised Tech spec
34	Sr.No. of Tech. Particulars--25	As per specification loss in metallic screen is 13.53W/m is mentioned. As per calculations, we would like to propose loss in metallic screen is 10.1W/m @ 645A.Please confirm.	follow revised Tech spec
35	Sr.No. of Tech. Particulars--26	As per specification Max circulating current in screen is 88A is mentioned. As per calculations,we would like to propose Max circulating current in screen is 263A @ 645A. Please confirm.	follow revised Tech spec
36	Sr.No. of Tech. Particulars--30	As per specification Circulating current in screen will be 34 A when cable is carrying a current of 100 A As per calculations, We would like to propose Circulating current in screen will be 40.7 A when cable is carrying a current of 100 A Please confirm.	follow revised Tech spec
37	Sr.No. of Tech. Particulars--31,b	As per specification Rated power frequency withstand voltage will be 63 KV for 5 minutes. As per calculations, Rated power frequency withstand voltage will be 48 KV for 5 minutes. Please confirm.	follow revised Tech spec
38		Please Confirm the exact construction: 2XC2Y or 2XWa2Y required along with short circuit rating of screen/armour and its duration	follow revised Tech spec
39		Please Confirm the exact construction: 2XC2Y or 2XWa2Y required along with short circuit rating of screen/armour and its duration.	follow revised Tech spec
40		Please Confirm the exact construction: 2XC2Y or 2XWa2Y required along with short circuit rating of screen/armour and its duration. Since 35 sq.mm is a very odd size for 33 KV & Most of the Indian manufacturers are not manufacturing the same size. Hence we request you to propose the next size .i.e. 33 KV 1 core 50 sq.mm or 3 core 95 Sq.mm for use. Please confirm	follow revised Tech spec
41		Please Confirm the exact construction: 2XC2Y or 2XWa2Y required along with short circuit rating of screen/armour and its duration.	follow revised Tech spec
42		Please Confirm the exact construction: A2XF2Y or A2XW2Y required along with short circuit rating of screen/armour and its duration. As per manufacturers standard Corrugated Aluminum sheath construction is not used for 3 core cables. Please confirm the requirement	11 KV Cable are not provided with Corrugated AL sheath,ref spec
43		Please Confirm the exact construction: A2XF2Y or A2XW2Y required along with short circuit rating of screen/armour and its duration.	follow revised spec
44	SCADA System & its RTUs, IT Hardwares, OFC Cables etc	As per referred clause we request OPTCL to provide the specification indicating the requirements for the SCADA DMS System and its RTUs with I/O count, IT Hardware's, OFC Cables as a minimum guideline for selection of these systems	uploaded
45	SCADA System interface with existing Systems	As per referred clause we request OPTCL to indicate the interface requirements if any of the new SCADA DMS System with any existing SCADA/ERP/IT Systems. If the interface is required, please clarify the OEM of the existing systems, the extent of data exchange requirement as well as the communication platform/protocol over which the interface is to be established.	uploaded
46	SCADA Central Control Center	Please provide the control center room dimension.	42 ftx30ft
47	FO Cable Routing	Bidder assumes that the Right of Way for OFC Cable routing will be arranged by OPTCL. Please confirm that bidder's assumption is correct.	RoW is in bidders scope

48	Page 88 of 340, S. No. 5.15.1 Schedules of Rates and Prices PACKAGE-2 (LOT-I)	Bidder understands that 160KM of 12 Fiber OFC Cable supply and laying is in bidder's scope of work. Bidder requests Customer to clarify the quantity and specification for OFC Splicing joints if any to be considered in bidder's scope.	bidders scope
49	Page 88 of 340, S. No. 5.15.5 Schedules of Rates and Prices PACKAGE-2 (LOT-I)	Bidder understand that 46 nos. of GSM SIM cards are to be provided. Bidder requests OPTCL to clarify for which RTUs the GSM/GPRS based communication modem using above SIM cards is to be provided.	communication through OFC only
50	Page 88 of 340, S. No. 5.15.5 Schedules of Rates and Prices PACKAGE-2 (LOT-I)	In the item s. no. 5.15.5, under item description 2x25 Nos. is indicated whereas under quantities 46 Nos. GSM SIM cards are indicated. Bidder requests customer to clarify if 50 Nos. GSM SIM Cards are required or 46 Nos.	communication through OFC only
51	Page 88 of 340, S. No. 5.15.5 Schedules of Rates and Prices PACKAGE-2 (LOT-I)	Bidder assumes that for all 3G GSM SIM Cards, the user charges and any initial deposits will be borne by the end user i.e. M/s OPTCL directly as the connections are to be obtained in user's name. Pl. confirm that bidder's understanding is correct.	communication through OFC only
52	Page 89 of 340, S. No. 5.14.1 Schedules of Rates and Prices PACKAGE-2 (LOT-I)	Bidder assumes that the UPS System for the SCADA IT Hardware's at main control Centre is in bidder's scope of work. Pl. confirm and provide the guiding specification for the same indicating the battery backup requirements, battery type and Redundancy requirements for the same.	Tech spech stands
53	Page 84 of 340, S. No. 5.8.1 Schedules of Rates and Prices PACKAGE-2 (LOT-I)	Bidder requests customer to provide the specification indicating the requirements for the SDH equipment as a minimum guideline for selection of the communication system	Tech spech stands
54	Page 88 of 340, S. No. 5.15.5 Schedules of Rates and Prices PACKAGE-2 (LOT-I)	Bidder understands that communication between 4 RTUs, Mini RTUs to central control center via GPRS communication. Pleases confirm bidder understanding is correct	communication through OFC only
55	Page 88 of 340, S. No. 5.13 Schedules of Rates and Prices PACKAGE-2 (LOT-I)	Bidder requests customer to provide the specification for the cat i, cat ii, cat iii cables.	As per IS
56	Page 88 of 340, S. No. 5.15.5 Schedules of Rates and Prices PACKAGE-2 (LOT-I)	Please clarify the purpose of fiber optic cable as the communication between 4 RTUs to central control center via GPS communication, whether the fiber optic is using for connection all the 4 substations.	All communication are in OFC only
57	Page 88 of 340, S. No. 5.15.5 Schedules of Rates and Prices PACKAGE-2 (LOT-I)	Bidder understands normally bandwidth charges, SIM cards are to be taken in the name of end user as per TRAI rule. Hence bandwidth charges, SIM Card charges will be taken care by OPTCL.	correct

58	Cl.No 2.4.2(b) Specific Experience of section3-evaluation & qualification criteria	We request you to note that normally in any particular project the 33kV underground line/feederworks is of very limited quqntity. We request you to kindly restrict this requirement to underground cabling work for HT cables(11kV or more). The process of underground cabling is similar for 11kV & 33kV cable laying and hence we request you to amend the requirement as under: Option1: The Bridder must have successfully executed Underground cable laying work at least of 20km(Route length) of 33kV and higher voltage classes. OR Option2: The Bridder must have successfully executed Underground cable laying work at least of 50km(Route length) of 11kV and higher voltage classes. Apart from above kindly note that 11kV &33kV works will fall under the scope of Distribution Utilities.Therefore we request you to amend the requirement as any Transmission/Distribution Utility.	Bid document stands
59	Cl.No 2.4.2(b) Specific Experience of section3-evaluation & qualification criteria	Please note that 11kV works will fall under the scope of Distribution Utilities.Therefore we request you to amend the requirement as any Transmission/Distribution Utility.	no relevant
60	As per BOQ item no. 1.6 and 1.7(Annexure-1) and item no.2.16 of Annexure-2	Please clarify the configuration of RMU in terms of numbers of circuit breaker,isolator and LBS.	follow BPS
61	As per BOQ item no. 1.1 (Annexure-1)	As per tech. specification of 11kV cable. Clause no. 15.2,Armouring shall be galvanised steel strip-Please clarify.	Tech spech stands
62	As per BOQ item no. 6.1 (Annexure-6)	As per tech. specification of LT cable. Clause no-1.LT cable shall be 1.1kV stranded AI, XLPE, Armoured- Please clarify the same.	ok
63	RMU technical specification clause no.10(protechtion system)	Please clarify the type of relay to be used. Either static or numerical.	numerical
64	Package-II,Lot-2, Annexure-I,Schedule-I,item nos.1.1	As per part-I, section 6,employer's requirements,1. scope clause-E - cable conductor is copper. But as per part-I, section 4, bid form, price schedule, Package-II,Lot-2, Annexure-I,item nos.1.0 cable conductor is Aluminium. Kindly confirm cable conductor is copper or Aluminium.	for 33 kV copper and for 11 kV aluminium
65	Package-II,Lot-2, Annexure-I,Schedule-I, item nos.1.1	Kindly provide Breakup quantity of 300sq. mm and 240 sq.mm XLPE cable.	11kV-300sqmm-50.29kM,240sqmm- 117.34kM
66	Package-II,Lot-2, Annexure-I,Schedule-I,item nos.1.2	Kindly provide Breakup quantity of 300sq.mm and 240 sq.mm straight through joint kit.	Refer revised Price Schedule
67	Package-II,Lot-2, Annexure-I,Schedule-I,item nos.1.3	Kindly provide Breakup quantity of 300sq.mm and 240 sq.mm termination kit.	Refer revised Price Schedule
68	Package-II,Lot-2, Annexure-I,Schedule-I,item nos.1.4	Kindly confirm thickness and class of HDPE pipe. Also provide tech. Spec.	Refer revised Price Schedule
69	Package-II,Lot-2, Annexure-I,Schedule-4,item nos.1.2	Kindly provide no. of location, shortest and longest length of Micro Tunneling.	No micro tunneling ony through HDD

70	Package-II,Lot-2, Annexure-2,Schedule-1,item nos.2.7	Kindly confirm type of earth electrodes.	GI Pipe earthing with GI flat connection (75x6mm)
71	Package-II,Lot-2, Annexure-3,Schedule-1,item nos.3.14	Kindly confirm this is Anti Climbing Devices.	as per Indian standards
72	Package-II,Lot-2, Annexure-6,Schedule-1,item nos.6.6	Kindly provide Breakup quantity of RCC Hume Pipes, Stone ware pipes, PVC pipes.	As per site specific,no PVC pipe should be HDPE only as per IS
73	Clause No.1.1(Second Para) 1 of 36 of SCADA-DMS tech. Spec.	OPTCL is requested to clarify about the exact locations. Bidder would like to get clarification on to whether Narendrapur and Gopalpur are same.Because in some other documents, Gopalpur was mentioned?	Narendrapur and Gopalpur are two different locations
74	Clause No.1.2 Objective (Point 1) 2 of 36 of SCADA-DMS tech. Spec.	a) Bidder would like to know this count of 23 stations are for which city?(Berhampur,Chatrapur,Narendrapur &/or Gopalpur) b) The functional requirements of SCADA system required at Autonagar to be elaborated in terms of features / configuration dia. / server details etc.	bid documents stands
75	Clause No.1.4 Architecture (Point 4) 3 of 36 of SCADA-DMS tech. Spec.	This is contradicting if earlier 23 locations. Bidder would like to get clarification about exact nos. of locations along with detail configuration diagram applicable for SCADA-DMS for this particular Tender.	refer revised Tech. Specification
76	Clause No.1.5.5 Communication subsystem for distribution system SCADA (Point 3) 9 of 36 of SCADA-DMS tech. Spec.	As per bidder's understanding,this shall be Fig.1.	refer revised Tech. Specification
77	11 of 36 of SCADA-DMS tech. Spec.	As per bidder's understanding,this shall be Fig.2.	refer revised Tech. Specification
78	13 of 36 of SCADA-DMS tech. Spec.	As per bidder's understanding,this shall be Fig.3.	ref revised Spec
79	13 of 36 of SCADA-DMS tech. Spec.	The fig. is proposed OFC cable n/w for SCADA. But it is connecting Berhampur,Gopalpur,Chatrapur and Narendrapur Grids. Bidder would like to get clarification?	refer revised Tech. Specification
80	25 of 36 of SCADA-DMS tech. Spec.	As per bidder's understanding,this shall be Fig.4.	refer revised Tech. Specification
81	Clause 2 24 of 36 of SCADA-DMS tech. Spec.	Bidder's request OPTCL to spell about Distribution Management System (DMS) for Gopalpur &/or Narendrapur ?	refer revised Tech. Specification
82	Clause 1.5.5 SCADA-DMS tech. Spec.	Please confirm at 24 S/s(i.e 4 nos. of 132/33kV s/s and 19 nos. of 33/11kV S/s), the bidder shall supply a) STM based OFC n/w and b) 2G/3G based GPRS modems.	refer revised Tech. Specification
83	Clause 2.2.8 SCADA-DMS tech. Spec.	Please let us know how cat i),ii) & iii) mini RTUs are connected to SCADA DMS? Is it through OFC cable n/w as per 2.2.8	refer revised Tech. Specification
84	Clause No.1.3 3 of 36 of SCADA-DMS tech. Spec.	Please Clarify that bidder need not supply any RTUs at 4 nos. of 132/33kV S/s?	refer revised Tech. Specification

85	Clause No.2.1 24 of 36 of SCADA-DMS tech. Spec.	a) Please clarify that SCADA DMS control centers are required at Berhampur and Chatrapur only? b) No connectivity between these two SCADA DMS control centers in terms of physical layer and functional requirements? c) No other place SCADA system is required?	refer revised Tech. Specification
86	Fig.4 24 of 36 of SCADA-DMS tech. Spec.	Bidder understands that LVS indicated in this fig. is to draw better understanding of SCADA/DMS control room and no LVS needs to be supplied in the present tender scope by bidder. Please clarify.	refer revised Tech. Specification
87	Clause No.2.2.8 30 of 36 of SCADA-DMS tech. Spec.	Please clarify why UG cable requirements of 300 & 200 sq.mm are given under this Clause dealing with SCADA/DMS system. Please confirm that no UG cable to be supplied under SCADA/DMS scope.	refer revised Tech. Specification

TENDER NOTICE NO. : CPC- ICB Document No: OPTCL/ADB - OPSEAP /2014/Package-II (Lot- 1 & 2)

Sl. No	Reference	Bidders Queries	OPTCL Compliance
1	Section-III, Evaluation Criteria Clause No. 1.2.6 ,For LOT-1 &2	As per the reference clause it is mentioned that Bidder is required to apply for project license to the Secretary, ELBO, ODISHA by depositing the requisite fee before signing the contract agreement thus, these are to be taken into account by Bidder while submitting bids. wheather above license required for suject tender, if yes , we request you to provide approx. cost for obtaing license in order to icluding in bid price.	Yes, project license from the Secretary, ELBO, ODISHA is required for Transmission Project and HT license avaialble with the Contractor is required for Distribution project of the subject tender. Cost of securing the ELBO license may be obtained from the Office of the EIC-Cum- P&S.
2	Design Services For LOT-1 &2	As per the Schedule-3, design Services of price schedule is not applicable, We presume that all the structurals as well as Civil drawings required for the construction of substation shall be provided by the OPTCL. Kindly provide the same.	Standard structural as well as civil drawings shall be uploaded by OPTCL. However, detailed engineering at the time of execution based on the site condition is within the scope of the contractor.
3	Clause No. 27.10 SCC For LOT-1 &2	As per the reference clause, The critical components covered under the extended defect liability are Transformers, Switch gears, Relays, VCBs, CT & PT, AAA Conductor, XLPE Cables etc. Kindly breakdown these critical components separately for lot 1 and lot 2, in order to know the percent of reduction of the performance bond during the extended defect liability period.	Section-6 (Employer requirment) of the tender document, contains the list of major items to be supplied for Lot-1 & Lot-2. Accordingly, reduction of the performance bond during the extended defect liability period shall be determined depending upon the Price mentioned in the Price Schedule for such items.
4	Sl.No.3	Lot-2:132kV cabling works: a. It is indicated that the bidders having requisite capacity and the capability to execute the contract within the stipulated period of 18 months are advised to participate. b. As per Cl.No.13.2, Section-1-ITB, no alternatives to the Time Schedule are explicitly invited. c. Section-2-BDS, Preparation of Bids, ITB-13.2, Alternatives to the time schedule shall not be permitted. d. Section-3-EQC, Cl.No.1.2.2, i. – Time to complete the plant and services from the effective date specified in Article-3 of the Contract Agreement for determining time for completion of pre-commissioning activities is 18 months, otherwise as Cl.No.1.2.2, iii – Bids mentioning time schedule other than 18 months be considered as non responsive. e. Section-7-GCC, Cl.No.8, The contractor to commence work on the facilities within the period specified in SCC and without prejudice to GCC Sub-cluase 26.2 and proceed with the time schedule specified in Appendix-4-Time Schedule which indicates that 18 months for handing over of Line works and 24 months for contract closing. Request clarification, whether the total execution period is 24 months or 18 months.	The time to complete the plant and services is 15 months for Lot-1 & 18 months for Lot-2 from the effective date of the contract. Additionally, 06 months have been provided for Contract closing. This 06 months period is part of the defect liability period.

5	18 1.2.5 10.3 App-6	Clause calls for the "Single Responsibility" basis for the entire plant and services which includes the acquisition of all permits, approvals and licenses, ROW permissions etc., from various agencies such as NHAI, Railways, Forest Department, State PWD, State R&B, BSNL, Local Municipalities or panchayats, water department, ELBO-Odisha, PTCC, or any other statutory body/governmental agency, etc., for installation of 132kV cabling works. Further under Note of 1.2.5 of Sec-III, the cost or rate put in by the bidder if any, shall not be considered for the purpose of comparative evaluation, however, the same will be considered for total contract value for adopting 10% advance payment. Request clarification. Further, in line with activities outlined in Appendix-4-Time Schedule for the project, as such, this is not a part of the total activity. Request this scope be transferred to the Employer`s scope along with the required payment(s), provision of bank guarantees to the authorities wherever required. Request acceptance.	Notes to Section-3, Clause-1.2.5 stipulates that Cost of additional works, services, facilities etc., if any, other than those categorically specified to be provided by the Employer, shall be taken into account by Bidder while submitting bids. The cost of the same shall be in built into the Unit price of the BOQ of the price schedule. There is no contradiction so far as 10% advance payment is concerned as mentioned by the bidder which shall be guided as per Appendix 1 - Terms and Procedures of Payment. Appendix-4-Time Schedule for the project: The time to complete the plant and services is 15 months for Lot-1 & 18 months for Lot-2 from the effective date of the contract. The said period shall be considered for the purpose of payment(s) and provisions of Bank Guarantee.
6	18.3	The quantities of Mandatory Spares appear to be not included in the main quantities. Request clarification and also clarify, if the same is now indicated, will this be considered for bid evaluation or not.	The quantities of Mandatory Spares shall be separately uploaded as part of BOQ of the price schedule which shall be considered for bid evaluation.
7	18.6	Cl.No.18.6 (a) indicates that a bid submitted with an adjustable price quotation will be treated as non responsive and rejected. Since the tendered 132kV cables which are the major items in more than 150kms, request to accept the standard price variation formula for price adjustment in respect of cable components such as copper and aluminum/lead etc. Attached is the price variation formula of KPTCL for your consideration. Note: The KPTCL price variation formulae for 132kV cables is attached for your reference and for acceptance.	Tender clause shall stand.
8	39.5	Cl. No.39.5 indicates that if the bid, which results in the lowest evaluated bid price, is seriously unbalanced or front loaded in the opinion of the employer ----------, the employer may require that the amount of the performance security be increased at the expense of the bidder. Request to inform the employer`s engineer`s estimated cost of the LOT-2 along with the estimated values of the items in LOT-2.	At this the estiamted cost of Lot-2 can not be given.

9	42.2	Cl. No.42.2 indicates that the employer reserves the right to accept any of the deviations submitted in accordance with ITB 18.2 by the lowest evaluated bidder, at the price shown for the deviation in the bid. Cl. No. ITB 18.2 of Section-2, BDS specifies no deviations are allowed. Request clarification whether the additional price(s) for withdrawal of the deviation(s) is considered for bid evaluation or not along with the clarification whether deviations are allowed or not.	The Employer's right to accept any deviation under Clause no.42.2 of ITB is in accordance with clause no. 18.2 of the ITB. Since, clause 18.2 of ITB is modified in the BDS that no deviations are allowed, for the purpose of clause no. 42.2 the modified clause shall stand. Hence, there shall be no additional price for withdrawal of the deviation.
10	ITB 21.2	It is indicated as not applicable. Our understanding is that the bidder is required to submit Bid Security Only. Bidder is not required to submit Bid Securing Declaration. Request clarification.	The bidder is required to submit Bid Security in form of Bank Draft / Bank Guarantee. Bid security declaration is not acceptable.
11	ITB 34.1	The clause advices the bidders to ascertain on their own the availability of deemed export benefits. Request confirmations that the deemed export benefits are available against this bid and we note the requisite certificate/documents (Project Authority Certificate) will be issued by the employer.	The requisite certificate/documents (Project Authority Certificate) will be issued by the employer during the implementation of the project.
12	1.2.6 i	The clause indicates that the cost of mandatory spares, Operational maintenance equipment & spares and special tools & tackles shall be deemed to be included in the cost of plant. Hence, the same shall not be considered for the purpose of comparative evaluation. While normally the cost of maintenance equipment & spares or recommended spares is not considered for the purpose of comparative bid evaluation, but the cost of mandatory spares as defined by the employer is normally considered for the purpose of comparative evaluation. Since, no mandatory spares are indicated in the BOQ, in order to ensure a fair comparative evaluation, request provision of the quantities under mandatory spares in the BOQ suitably. Request clarification	The quantities of Mandatory Spares shall not be separately uploaded. However, the same shall form part of reivsed BOQ of the price schedule.
13	1.2.6 ii & iii	The clause indicates that the bidder is required to apply for project license to the secretary, ELBO, Odisha by depositing fee before signing the contract agreement, thus, these are to be taken into account by Bidder while submitting bids. Request clarification on our understanding that the successful bidder only is required to file a paper as a proof of applying to the Secretary, ELBO, Odisha by depositing fee for obtaining project license and valid electrical (HT) license before signing the contract agreement.	The successful bidder is required to submt the proof of appliaction with deposit challan applying to the Secretary, ELBO, Odisha for obtaining project license before signing the contract agreement. Valid Electrical (HT) license is required to be submitted at the time of submission of Bid. However, for execution of work the valid project license is required.
14	Annexure-II (i)	We read ICE mentioned as IEC.	"ICE" Typographic mistake, it is "IEC"
15	13.3.3	It indicates that the performance security shall be reduced by 50% on the date of the Operational acceptance. The security shall become zero or shall be reduced on pro-rata to the contract price of a part of the facilities for which a separate time for completion is provided, 18 months after completion of the facilities or 12 months after operational acceptance of the facilities whichever occurs first.	The clause 13.3.3 of SCC shall read as "The performance security shall be valid for 90 days over and above the work completion period".

16	14	It indicates that the taxes and duties treatment shall be discussed and finalized in the pre-bid meeting scheduled at your office on 21.03.2014. We inform that we shall be attending to this proposed pre-bid meeting.	The latest clause 14 on taxes and duties of SCC may please be refered.
17	**Missing Clauses**	**The following clauses are missing in this section of the tender documents.** **15, 16, 17, 18, 18.1, 18.2, 20, 21, 23, 24, 28, 29, 31, 32, 33, 34, 36, 37, 38, 40, 41, 42, 43, 44.** **Request confirmation, that they are deleted and have no relevance to this bid.**	These are not missing clauses. Rather, SCC contains only those clauses of GCC , where there is deviation to the GCC clause. Except for the clauses in the SCC, the clauses in the GCC are applicable to this tender.
18	19	It indicates that the matters relating to ESI, PF and HT Electrical License etc. w.r.t sub-contracting shall be discussed and finalized in the pre-bid meeting scheduled at your office on 21.03.2014. We inform that we shall be attending to this proposed pre-bid meeting.	The latest clause 19.1 on Sub-Contracting of SCC reads as follows "In case of the sub-contracting for the works by the contractor, the same shall be allowed with the prior approval of the employer subject to fulfilling the qualifying requirement for Sub-Contractor/Sub Manufacturer. In addition to the QR, these subcontractors must possess ESI, Provident Fund, and HT Electrical License".
19	Appendix - 8, Section-IX	Functional Guarantees: Request to provide Appendix – 8, since the same is not available in the tender documents.	Clause-1.2.4 of section-3 indicates that "No Functional Guarantees of the facilities are allowed". Hence, Appendix-8 is not applicable.
20		We request please accept If manufacturer already have engineers residing in India and if manufacturer submitting declaration with tender that they will tie up for service centre in India after award	Not acceptable
21		1) As per tender clause OPTCL is asking that **each partner** should have experience of GIS construction for lot 1 and 132 KV cable laying with bay for lot 2 in this case there is no meaning for joint venture as per our view it should be any one partner 2) In some parts of our country, the prevailing voltage levels are 110/115kv in place of 132kv.hence we request your confirmation for **erection experience** that voltage raring of 110kv or higher voltage will be considered because erection and laying system also for 110 KV and 132 KV is exactly same 3] as per tender bidder for underground cables should has experience for extension bay , since scope of bay is considerably very small portion of entire contract . we request you to delete bay experience in cable laying portion	SL. No.1:Tende clasue 2.4.1 General Experience is amended as: Joint Venture: All Partners Combined: must meet requirement, Each Partner: Not Applicable and One Partner: Not Applicable Sl. No.2: 132kV or higher voltage is replaced as 110kV or higher Voltage class. Sl. No.3: Clause: 2.4.1 General Experience is amended as: 110 kV underground Cabling work
22		1)As per tender bidder for underground cables should have experience for extension bay , since scope of bay is considerably very small portion of entire contract . we request you to delete bay experience in cable laying portion 2) Please accept experience for 110 KV UG cable laying any size because erection and laying system also for 110 KV and 132 KV is exactly same	Sl. No.1 & 2: Clause 2.4.1 General Experience is amended as: 110 kV underground Cabling work. The period of execution of works is modified as follows; -For General experience: 07 Fianancial Years preceding to the year of NIT. -For XLPE cable supply experience: 10 Financial years preceding to the year of NIT

23	Taxes & Duties	We understand form the bidding documents that Excise Duty is exempted for ADB funded project. I.e. for LOT-1 & LOT-2. Please clarify. If yes Please confirm the following. a) The required documents will be issued by OPTCL for claiming E.D benefits. b) Required PAC (Project authority certificate will be given by OPTCL to us. c) C- form will be provided by OPTCL for the transactions effected by us including sale in transit. d) Entry permit will be provided by OPTCL for supply of Goods. e) Entry tax will be reimbursed by OPTCL for which supplies are effected.	Yes. a. Duty exemption certificate obtained from the State Govt. of Odisha shall be circulated. b. Yes c. Yes d. Yes e. Yes, if the supply is from within the state the entry tax amount will be reimbursed. If Entry permit is provided by OPTCL for supply from outside the State, Entry Tax is to the account of OPTCL, Hence Entry tax amount shall not be reimbursed.
24	Taxes & Duties	Please confirm the following. 1) CST& VAT to be included in BPS separately and will not be considered for evaluation, but will be reimbursed to the bidders as per actuals. Please confirm. 2) Service tax to be included in BPS separately and will not be considered for evaluation, but will be reimbursed to the bidders as per actuals. Please confirm.	1) Yes, CST & VAT will be reimbursed to the contractor as per actual against documentary evidence (Tax Invoice). 2) Yes, Service will be reimbursed to the contractor as per actual against documentary evidence (Tax Invoice).

25	Taxes & Duties	As per SCC "The Taxes and Duties Treatment shall be discussed and finalized in the Pre-bid Meeting.Please Clarify the following: We understand that Employer shall bear and promptly pay all customs and import duties as well as other local taxes like VAT, CST, Goods and Service Tax(if implemented) on the plant and equipment specified in Schedule No.1 and Schedule No.2 & Schedule 4 for both Bought out as well as Direct Transactions also. Please confirm.	Please refer to clause-14 of SCC for taxes and duties, which reads as follows: 14.1 Concessional CST and Entry Tax: Concessional Sales Tax declaration forms, as admissible, would be issued to the contractor, on their request, by EMPLOYER for all items (as identified in the price schedule of the bid) to be supplied directly by the contractor and also in case of sourcing from Vendor through transit sales as may be permissible. In the event the EMPLOYER is required to issue Way bill, the EMPLOYER will be required to pay Entry Tax on materials entering in to the State. If the Contractor has quoted nil against the Entry Tax in their bid, in such a case the Entry Tax amount paid by the EMPLOYER shall be deducted from the Bill of Contractor. If the Contractor has quoted the Entry Tax in their bid, in such a case the Entry Tax amount shall not be released by the EMPLOYER. 14.2 The Service Tax at the applicable rate shall be released by the Employer to the Contractor on submission of TAx Invoice. The reverse charge mechanism as applicable for released of service tax to the contractor shall be effected. 14.3 Any changes in the rates of taxes & duties during the contractual period shall be to the account of the EMPLOYER.
26	Taxes & Duties	We understand that all taxes and duties will be paid by employer (for both direct and bought out transactions).Please confirm.	Please refer to clause-14 of SCC for payamnt of taxes and duties.
27	Taxes & Duties	We understand that No taxes and duties will be considered for evaluation (for both direct and bought out transactions).Please confirm.	Yes
28	Price variation	Supply of Huge quantity of 33 kV /11 kV & LT cables is under present scope. As you are aware, raw materials of cables like copper, Aluminum, XLPE etc. are very volatile commodities. Any variation either upward or downward the price impact is high to project.Providing Price variation will be beneficial for the Project as it will avoid Manufacturers in loading higher price considering the future increase in raw material rates and it enables bidder to quote at actuals thus making bid more competitive. Also any decrease in price same will be transferred to OPTCL. So we request OPTCL to provide Price Variation to main equipment's like Cables, CB, CT, CVT, Structures ,Transformers etc.	No price variation is allowed, since the project period is less than 18 months.

29	Payment terms	Please confirm the following. 1) 10% Advance : We request you to pay 10% advance on total contract price instead of total EXW amount. 2) 15% on Progressive payment : We understand that 15% progressive amount will be paid after issue of completion certificate. Please confirm that bidders can obtain completion certificates monthly, for commissioning of each Sub-station, Feeder/ cable estimates or each activity mentioned in BOQ.	Tender clause shall stand.
30	Payment terms	In continuation to the above please confirm that bidders are eligible for payments for completed works & delayed in commissioning for which reasons are not attributable to the bidder.	Tender clause shall stand.
31	Defect liability	As per the bidding documents we understand that the critical components covered under the extended defect liability are Transformers, Switch gears, Relays, VCBs, CT & PT, AAA Conductor, XLPE Cables etc. , and the period shall be a time span of five hundred and forty (540) days from the date of Completion of the Facilities (or any part thereof). The defect liability for other component of plant and services shall be one year from the date of Operational Acceptance of the Facilities.	Yes
32	Defect liability	In continuation to the above we understand that date of completion of facilities means- The day immediately after the initial commissioning of facilities and operational acceptance means- The day immediately after the initial commissioning and the load taken thereof. Please confirm.	Clause-1of GCC (Defination) shall apply to completion, intial commisioning and operation acceptance.
33	Annexure-I, Sl. No.(k)	Commercial Questionires- Acceptance of Important conditions , Sl. No.(k) The Contractor agrees to supply spare parts for a period of years: 20 years	Annexure-I, Sl. No.(k) shall stand deleted
34	Annexure-II, Sl. No.(k)	Technical Questionires- Acceptance of Important conditions , Sl. No.(k) The Contractor agrees to supply spare parts for a period of years: 20 years	Annexure-II, Sl. No.(k) shall stand deleted

Revised Section-3(Package-II)

Evaluation & Qualification Criteria

Amended Qualifying Experience Crtiteria for Package-II

2.4 Experience

Criteria	Compliance Requirements				Documents
Requirement	Single Entity	Joint Venture			Submission Requirements
		All Partners Combined	Each Partner	One Partner	
2.4.1 General Experience					
(i) **For Lot- 1 :** Experience under contracts in the role of contractor or subcontractor, for at least last Ten (10) years prior to the bid submission deadline covering following activities: Construction of 33/11 kV Sub-Stations with 33kV Network. **(ii) For Lot- 2 :** Experience under contracts in the role of contractor or subcontractor, for at least last Ten (10) years prior to the bid submission deadline covering following activities: Construction of 11/0.43kV Distribution S/s. **Note:** The above facility (Both for Lot-1 & Lot-2) should be in satisfactory operation for at least 01 (one) year from the date of commissioning. To substantiate this requirement the performance certificate from user is required to be furnished.	must meet requirement	must meet requirement	must meet requirement	not applicable	Form EXP - 1

2.4.2 Specific Experience

Criteria	Compliance Requirements				Documents
Requirement	Single Entity	Joint Venture			Submission Requirements
		All Partners Combined	Each Partner	One Partner	
Contracts of Similar or higher Size and Nature					
(i) For Lot-1 A) The bidder must have successfully erected, tested and commissioned at least 01 nos. of 33/11 kV or higher voltage class of GIS Sub-Stations (having Transformer Capacity of 5 MVA or above) & SCADA equipment on EPC Contract / Turnkey Contract basis for any Transmission Utility during Last Ten (10) Financial Years preceding to the year of IFB. B) The bidder must have successfully executed XLPE underground Cable laying work at least of 50KM (Cable Length) of 33 kV or higher voltage class for any Transmission Utility during Last ten (10) Financial Years preceding to the year of IFB. Note: The above facility should be in satisfactory operation for at least 01 (one) year from the date of commissioning. To substantiate this requirement the performance certificate from user is required to be furnished.	must meet requirement	must meet requirement	Not applicable	Must meet Requirement	Form EXP - 2(a)
(ii) For Lot-2 : The bidder must have successfully executed XLPE underground Cable laying work at least of 50KM (Cable Length) of 11 kV or higher voltage class for any Transmission Utility during Last Ten (10) Financial Years preceding to the year of IFB. **Note:** The above facility should be in satisfactory operation for at least 01 (one) year from the date of commissioning. To substantiate this requirement the performance certificate from user is required to be furnished.	Must meet Requirement	Must meet Requirement	Not applicable	Must meet Requirement	Form EXP - 2(a)

Revised Section 6 – Employer's Requirements

Under Clause 1:
Note:
The Bidder shall provide details of proposed items of own manufactured equipment using the relevant Form in Section 4 (Bidding Forms). In the Equipment is not manufactured by the bidder, Manufacturers Authorization Certificate using the relevant Form in Section 4 (Bidding Forms)shall be furnished.

New Clause-7: Qualification of Subcontractors /Manufacturers:

Subcontractors/Manufacturers for the items described for following supply or services must meet the following minimum criteria, herein listed for that item. Failure to comply with this requirement will result in rejection of the Subcontractor/ Manufacturer.

Item No.	**Description of Item**	**Minimum Criteria to be met**
1	Supply of all items as per BOQ.	At least 50% of the total BOQ quantity of the major items (identified) should have been supplied during last five (05) financial years preceding to the year of IFB.
	Lot – 1:	
	33/11 kV GIS Sub-Stations with 33kV Network & SCADA	
	1) 33/11 kV Gas Insulated Switchgears Module	
	2)Bus PTs in 33 KV side	
	3)Bus PTs in 11 KV side	
	4)Gas insulated Bus bar	
	5)33 kV,UG Cable, XLPE insulated 300 Sqmm single core Copper.	
	6)AAAC 232 sqmm & 148 sqmm. Conductor	
	7)NBLS tower/ H-Type Pole	
	8)33kV Ring Main Units	
	9) 5MVA Power Transformer	
	10) 33/0.4 kV, 500kVA ,AIS Substation	
	11)SCADA-DMS equipment	
	Lot - 2	
	11kV & LT network and DT's:	
	1) 11/0.4 kV, 750kVA Compact S/s	
	2)11/0.4 kV, 315 kVA Distribution Transformer	
	3) 11kV Ring Main Units	
	4)AAAC 100 sqmm Conductor	
	5) H-Type Pole	
	6)11 kV, UG Cable, XLPE insulated 300 Sqmm & 240sqmm Three core Aluminium.	
	7)1.1kV, Three half Core, UG Cable, PVC insulation armoured, 240 sqmm Aluminum	
	8)1.1 kV, Three Core, ABC 95 sqmm and 70 Sqmm	
	9)LT Distribution feeder pillar box	
	10)R.S Joists 200X100 mm 9 Mtrs Poles	
2	Construction of XLPE Cable laying work	Execution of 33KV or above XLPE Cable laying work for at least five (05)

		Km (Cable Length) without HDD methodology and for at least one (01) Km (Cable Length) through HDD methodology.

Note: The bidder shall furnish the documentary evidence to meet the above criteria. Besides, Subcontractor/ Manufacturer should have valid relevant license as applicable to the contractor. In case the bidder does not have HDD experience, bidder shall provide Authorisation from HDD Subcontractor using the form provided in Section 4.

In the case of a Bidders, who do not who do not manufacture or otherwise produce major items of supply under the contract, the Bidder shall provide the manufacturer's authorization, using the form provided in Section 4 (Bidding Forms), showing that the Bidder has been duly authorized by the manufacturer or producer of the related plant and equipment or component to supply and install that item under this contract. The Bidder is responsible for ensuring that the manufacturer or producer complies with the requirements of ITB 4 and 5 and meets the minimum criteria listed for respective items. In the event of non-compliance, bid shall be rejected.

ODISHA POWER TRANSMISSION CORPORATION LIMITED

ODISHA POWER SECTOR EMERGENCY ASSISTANCE PROJECT

(PACKAGE – II)

TECHNICAL SPECIFICATION
FOR
33 KV NETWORK

INDEX FOR TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATIONS OF 33 kV, Single Core, Copper XLPE UG CABLE

TECHNICAL SPECIFICATION FOR 33 kV CROSS LINKED ETHYLENE INSULATED PVC SHEATHED SINGLE CORE, 300sqmm COPPER POWER CABLE.

1. SCOPE

This specification covers the design, manufacture, testing, inspection at manufacturer's work, supply & delivery F.O.R. destination of 300mm2 Single Core XLPE insulated PVC sheathed Cable and single core XLPE cable suitable for solidly grounded system size as per clause(5) mentioned below.

2. PARTICULARS OF THE SYSTEM

The cable should be suitable for use on 50 Cycles, 3 Phases solidly earth neutral system & working voltage of 33kV.

3. STANDARDS

The cable covered under this Specification shall conform in all respects with the latest editions of IS-7098 (Part-2) 1985 & IS-8130-1984 & IEC:60502 of the latest version thereof.

4. TECHNICAL PARTICULARS

33kV, Single Core under ground XLPE insulated PVC sheathed cable suitable for working potential of 33kV on earthed system manufactured in accordance with IS-7098 (Part-2) 1985 with latest amendments or latest editions thereof. The electrolytic grade copper conductor with formation of compacted circular type as per IS 8130/84, tapped with semi conducting conductor shall comply with requirements specified in IS:8130-1984. The insulation shall be chemically cross-linked polyethylene confirming to the physical, electrical and ageing property as required in latest edition of IS-7098 (Part-2) 1985. Cable shall be provided with both conductor screening and insulation screening. The conductor screening shall be non-metallic and shall be consisting of either semi-conducting tape or a layer of semi-conducting compound or combination of two. The insulation screening shall consist of extruded semi conducting compound layer in combination with non- magnetic metallic shield. followed by conducting swellable tape.

Corrugated aluminium sheathwith adeqate thickness shall be extruded over the finished corewith sufficient capacity to allowing fault current.The bidder shall have to calculate and furnish short circuit calculation

PVC outer sheath. The composition of PVC compound shall be type ST-2 of iS-5831-1984. The colour of outer sheath shall be black or grey.

5. SIZE

The size of the cable shall be: -

33kV, Single Core 300mm2, Copper, XLPE Cable

6. TESTS

6.1 Type Tests

The equipment offered should be type tested. Type test report should not be more than five years old, reckoned from the date of bid opening, in respect of the following tests, carried out in accordance with ISS-7098/IEC-871/IEC-60502, from Govt./Govt. approved test house, shall be submitted along with bid:

i) Physical tests for insulation and outer sheath.
ii) Bending test.
iii) Di-electrical power factor test.
iv) Heating cycle test followed by di-electrical power factor as a function of voltage and partial discharge test.
v) Impulse withstand test.

The remaining type test report as per clause 3 of ISS-7098/IEC-871/IEC-60502 shall be submitted by the successful bidder within three months from the date of placement of order. These type test reports shall be from Govt./Govt. approved test house and shall not be more than five years old, reckoned from the date of placement of order. The failure to do so will be considered as a breach of contract.

6.2 ROUTINE TESTS AND ACCEPTANCE TESTS

All routine and acceptance tests shall be carried as per relevant ISS in the presence of Nigam's representative.

7. INSPECTION

The material shall be inspected and tested before dispatch by an authorized representative of OPTCL in respect of quality.

8. TEST CERTIFICATES

The supplier shall supply test certificates from a Govt. agency in respect of quality as per IS:7098(part-II) 1985 with latest amendments thereof for approval of the purchaser.

9. PACKING

The cable shall be supplied in returnable steel drum as per IS:10418:1982 or any other relevant standard so constructed, as to enable the cable to be transported on each drum. The cable wound on such drum shall be one continuous length. The ends of cables shall be sealed by means of non-hygroscopic sealing material.The cable ends to be sealed efficient ly to prevent moisture ingression during storege and handling.

10. MARKING

The marking on the drum shall have the following information: -

a) Reference to Indian Standard & cable code.
b) Name of the manufacturer & trade name.
c) Nominal cross section area of conductor for the cables.
d) Number of core.
e) Sequential No. at each meter.
f) Type of the cable & voltage for which it is suitable.
g) Length of cable on the drum.
h) Approximate gross weight.
i) Net weight of the cable.
j) Drum identification number.
k) P.O. No. and date.
l) Consignee's name with designation.
m) Year of manufacture.
n) Direction of rotation

Note: Cable should be marked with ISI Certification mark.

11. DRAWINGS & INSTRUCTION MANUAL

The tenderer shall supply the following drawings with the tender: -

i) Detailed drawing of the cable showing conductor, screening insulation, Armouring, outer sheath etc.
ii) Detailed drawing showing jointing of cable and sealing of end boxes.

Copies of instruction manuals for testing, installation jointing operation and maintenance of cables, shall also be submitted with the offer for reference of the purchaser.

STANDARD TECHNICAL PARTICULARS FOR 1-CORE 33 KV CU XLPE CABLE

1.	Type of cable	33kV(E)UGXLPE/Al Seath/HDPE 1 Core
2.	Standard according to which cable has been manufactured and tested	Is7098(P-2),IEC60502&IEC60840
3.	Rated Voltage (Uo/U}	:19/33kV
4.	Highest System Voltage which the cable can withstand	36 kV (Um)
5.	Maximum Conductor temperature for continuous operation	90^0ac
6.	(a) Maximum short time conductor temperature with duration	:250°C
	(b) Maximum allowable conductor temp.during overload	:130^0C
7.	Conductor Details	
	(a) Normal Cross-Sectional Area	:300 mm^2
	(b) Material and Grade	.COPPER/ Compacted stranded circular ·as per IS 7098PA T2,IS8130/84
	(c) Shape of Conductor	: Circular
	(d) Diameter of Conductor	: 19.54 mm (Approx.)
	(e) No. of Strands and Diameter of each Strand	: As per above standard
	(f) Water swellable powder/yarn provided	: Yes
	(g) Conducting water swellable tape with 50% overlap over compacted conductor provided	Yes

8. Extruded Conductor Screen

(a)	Material	• Extruded Semi-Conductive XLPE
(b)	Nominal Thickness	:0.30 mm (Approx.)
(c)	Diameter over Conductor Screen	: 26.5 mm (Approx.)
(d)	Designed maximum stress at Conductor Screen	: 3.05 kV/mm

9. Insulation

(a)	Material	: XLPE
(b)	Nominal Thickness	: 8.80 mm
(c)	Minimum Thickness at any point	7.1 mm
(d)	Diameter over insulation	37.5 mm (Approx.)
(e)	Designed maximum stress	1.90 kV/mm
(f)	Detail of vulcanization process	
	(i) Extrusion Method	:Triple Extrusion Process
	(ii) Curing Method	: Dry Cure
	(iii) Cooling Method	:Inert Gas
	(iv) CO/ or VOl Line	: ccv line

10. Extruded Insulation Screen

(a)	Material	Semi-Conductive XLPE
(b)	Thickness (Nominal/Minimum)	1.0 mm/ 0.85 mm
(c)	Diameter over Insulation Screen	38.3 mm (Approx.)
(d)	Strippable/ Bonded	Bonded

11. Conducting Longitudinal Water Sealing.

(a)	Material	Water Swellable Tape applied with 50% overlap.
(b)	Thickness	0.3 mm (Approx.)

12.	Metallic Sheath	
	(a) Material	corrugated Al with adequate thickness to allow short circuit current.MFG to furnish supporting dimensions with fault current
	(b) Diameter of Cable after sheath application	Manufacturer to Specify
	(c)Radial Moisture Barrier	Poly Aluminum sheath
13.	Non-conducting Longitudinal Water Sealing.	
	(a) Material	Water Swellable Tape applied with 50% overlap.
	(b) Thickness	0.3 mm (Approx.)
14.	HDPE Outer Sheath	
	(a) Type	ST7
	(b) Colour	Black
	(c) Thickness (Nom/min)	2.6 mm (Nominal)/2.11 mm (Min. Spot)
	(d) Conductive Coating Provided	Graphite Coating/semiconductor layer
15.	Nominal OVerall Diameter of Cable	Manufacturer to Specify
16.	Nominal OVerall Weight of Cable per Metre	Manufacturer to Specify
17.	Standard Drum Length with Tolerance	500 m ±5%
18.	Minimum Bending Radius allowable during installation	20 times diameter Over finished cable

19.	Short Circuit Current Rating of Conductor with maximum conductor temperature (90°C) at the commencement of fault	
	(i) 1Sec. Duration	42.90 kA
20.	Maximum Continuous Current Rating of a Circuit comprising of 3 nos. Single Core Cable laid in trefoil formation at a depth of 1.05 M.	
	(i) Soil Temperature	30^0 C
	(ii) Ambient Temperature	40°C
	(iii) Soil Thermal Resistivity	150°C Cm/W
	(iv) System of Bonding	Solidly earthed at both ends
	(a) Laid in Ground(at a depth of l.OSM)	420A
	(b) Laid in Ducts	360A
	(c) Installed in Air	620A
21.	Short Time Overload capacity with Duration of cable installed as per conditions mentioned in Item no.22 (2 hours)	
	(a) Laid in Ground(at a depth of 1.05M)	490 A
	(b) Laid in Ducts	473 A
	(c) Installed in Air	N/A
22.	Maximum AC Resistance at 90°C	0.078 ohm/km
23.	Equivalent Star Reactance of a Circuit comprising of 3 Nos. of Single Core cable laid in Trefoil Formation	To follow IS value
24.	Maximum Charging Current per Conductor at Nominal Voltage	1.64 *AI* km

25.	Loss in Metallic Screen of a Circuit comprising of 3 nos. of Single Core Cable installed in Trefoil Formation as per item no. 22	13.53 W/m
26.	Maximum Current in Metallic Screen when the cable is installed as per item no. 22 (Circulating Current	As per specification calculation furnished by manufacturer
27.	Derating factor of Cable installed per Item No.22 under following conditions Ambient Temperature	
	(a) 35°C	:0.96(ground & Duct)1.04(Air)
	(b) 45°C	0.87(ground & Duct)0.95(Air)
	Group derating factor of Cable Circuits installed as per Item no. under following conditions	
	(a) Laid 100 mm. apart	: 0.81(for no trefoil in group is 2)
	(b) Laid 250 mm. apart	: 0.85(for no trefoil in group is 2)
29.	Induced voltage in metallic screen : V/km when conductor is carrying lOOAmps(V/Km)	5
30.	Circulating current in metallic screen when conductor is carrying lOOAmps.	34 A
31.	Test Voltages	
	(a) Impulse Withstand Voltage at 90°C	170 kVp
	(b) Rated Power Frequency Withstand Voltage	63 kV for 5 minutes Yes
	(c) Water penetration test as per IEC 60502-2	(24-hours Water penetration test without heating cycles)
	(d) Abrasion Test on HOPE Outer sheath as per IEC 60229	Yes (Physical Abrasion test as per IEC 60229 clause 4.1.2.1)
	(e) Recommended Test Voltage after installation	Comply with Clause 20 as per IEC 60502-2

32.	Details of Drum	
	(a) Material and Weight of Drum	:Steel drum ,weight to be furnished by manufacturer
	(b) Weight of Drum with Cable	:3570 kg (Gross Weight) (Approx.)
	(c) Flange Diameter of Drum	:2150 mm (Approx.)
	(d) Barrel Width of Drum	:1100 mm (Approx.)
	(e) Spindle hole Diameter	:120 mm (Approx.)
33.	Safe Pulling force	5kg/mm^2 of CU area. *II* 3kg/mm^2
34.	Sealing of Cable	Both the ends to be sealed putty and heat shrinkable cap with mastic inside to prevent moisture ingression during laying /handling.

1.0 INSTALLATIOIN OF 33 kV U.G. CABLES:

1.1 System particulars:

Nominal system voltage	33 kV
Highest system voltage	36.3 kV
Maximum permissible one phase System voltage (both cores insulated)	42 kV
Maximum permissible one phase System voltage (one core earthed)	21 kV
Number of phases	3
Frequency	50 Hz
Method of grounding	Solidly Earthed
Total relay and breaker operation time	15 to 20 cycles
Basic impulse level	170 KVp

1.2 METHOD OF LAYING:

1.2.1 This involves digging a trench in the ground in all types of soils including laterite and rock and laying cable(s) on virgin bedding at the bottom of the trench, and covering with riddled soil of minimum 150-mm over the cable and protecting it by means of tiles, or slabs. The desired minimum depth of laying from ground surface to the top of the cable shall not be less than 1.05-m. At railway crossings the same shall be measured from bottom of sleepers to the top of pipe.

1.2.2 The desired minimum clearances are as follows:

Power cable to power cable: Clearance not necessary; however, larger the clearance, better would be current carrying capacity.

Power cable to control cables:	0.2-m
Power cable to communication cable:	0.3-m
Power cable to gas/water main:	0.3-m

1.2.3 HDPE (IS4984)1995 pipes depending on the crossing and load should be used where cables cross roads and railway tracks depending on the requirement, and at each particular location pipes shall be used as directed by the Owner's representative. Spare ducts/pipes for future extension should be provided as per the directions of OPTCL. Such spare ducts/pipes shall be sealed off. The inner diameter of the ducts/pipes shall not be less than 225 mm. The ducts/pipes shall be mechanically strong to withstand forces due to heavy traffic when they are laid across the roads/railway tracks.

1.2.4 The power cable should not be laid above the telecommunication cable, to avoid danger to the life of the person, digging to attend to the fault in telecommunication cable. For identification of power cables, the cable protective cover, such as RCC slabs shall be marked as "OPTCL". The likely interference to the existing telecommunication cables should be avoided by referring to and coordinating with the appropriate telecommunication authorities.

1.3 ROUTE PLANS:

Tentative cable route plans will be furnished to the contractors, indicating the roads, position of substations and road crossings. The exact route survey and alignment will be decided on evaluating the findings by excavating trial holes by the contractor / subcontractor. The work should be taken upon only after OPTCL's Engineers approve the final route. The OPTCL reserves the right to change, alter deviate the route on technical reasons. It is the responsibility of the contractor to conduct necessary detailed route survey and submit of proposals to the owner for approval.

1.4 TRIAL HOLES:

The Bidder shall excavate trial holes, for alignment purpose at appropriate distance apart as warranted by the local conditions, keep a record of the findings and close the trial holes properly to avoid hindrance / accidents to pedestrian traffic. The final route / alignment of the cable shall be decided based on the finding of the trial holes.

1.4.1 It is the responsibility of the bidder to maintain as far as possible the required statutory clearances from other utility services.

1.4.2 Any damage caused, inadvertently to any utility services shall be set right & it is the sole responsibility of the contractor to do the same to the satisfaction of the concerned utility.

1.5 LAYING OF CABLES:

1.5.1 The contractor shall excavate the cable trench using manual and mechanical modes. An air compressor driven pneumatic drill or equivalent mechanical excavating tool will be essential if the crossing is to be made with minimum delay. Where paved footpaths are to be dug to excavate the cable trench, care must be taken to carefully remove the pavement slabs and store them properly and relay them properly after the work is completed.

1.5.2 The contractor shall take all precautions while excavating the trench to protect the public / private property and to avoid any accidental damage. Any accidental damage should immediately be reported to the concerned utility.

1.5.3 The contractor is liable to pay for all damages caused by his workmen. The sides of the excavated trench shall, wherever necessary be well shored up with timber and sheeting and use of danger boards wherever required. The depth of the cable trench shall be 1. 05 m.

1.5.4 The width shall be sufficient for easy handling of the cables during the laying operations depending upon the method of laying employed. For road crossings and railway crossings the same shall be 1.0 m. At other places the width varies from 0.85m to 1.0 m depending on number of cables to be laid in the trench.

1.5.5 The excavated material shall be properly stored to avoid obstruction. The bottom of the excavated trench should be carefully leveled and freed from pebbles / stones. Any gradient encountered shall be gradual.

1.5.6 There is a likelihood of a situation demanding that more than one cable is required to be run in the same trench. The contractors shall agree to increase the width of the trench to accommodate more than one cable.

1.5.7 The arrangement of cable trench duly indicating the position of cable, sand cushion, back fill and concrete finishing shall be as per sketch enclosed. It should be noted that the excavation required for laying the cable shall be finished accordingly by providing the sand cushion, back fill etc

2.0 PAVING OUT OF THE CABLE:

15.1 The pulling shall be done by hand and in such a manner as to provide good bedding for the protective cable covers like tiles or bricks. The maximum permissible pulling force on XLPE armored cables shall not exceed $P= 9 D^2$ Newton where P is the pulling force in Newton and D is the outer diameter of the cables in mm. However the normal values of pulling force shall be around 15 to 20 percent of this force when laid in trenches, 20 to 40 percent with one or two 90 degree bends in trenches, 50 to 60 percent when the bends are 3 or more. The cables shall have a minimum of 0.3-m clearance from the communication cables or water supply mains whenever they are encountered.

The excavated cable trench shall be drained of all water and bed surface shall be smooth, uniform and fairly hard before laying out the cable. The cable shall be pulled in the trench only on cable rollers spaced out at uniform intervals to prevent damage to cable.

The laying out process shall be smooth and steady, without subjecting the cable to abnormal tension. The cable laid out shall be smoothly and evenly transferred to the ground after providing sand cushion and shall never be dropped. All snake bends in the cable shall be straightened out.

3.0 FLAKING:

3.1 Wherever it is not possible to lay off the entire cable drum length, the cable should be cut and properly sealed and if it is necessary to remove the cable from the drum, it should be properly flaked, in the form of figure 8. Such cable lengths should be properly stored at site.

4.0 Vergin-Soil CUSHION:

4.1 When the cable has been properly straightened
cable shall be covered with cleaned riddled soil free from hard objects upto 150 mm from the bed

5.0 CABLE COVERING TILES:

5.1. The size of RCC covers should be 750mm long x 300mm wide. The thickness at the outer edge should be 50mm. The average breaking load shall be not less than 135Kg. The tiles should be laid side-by-side without any gap in between.

6.0 PREVENTION OF DAMAGE DUE TO SHARP EDGES:

6.1 After the cable has been laid in the trench and until the cable is covered with its protective covering, no sharp metal tool shall be used in the trench or placed in such a position that may fall into the trench.

6.2 Rollers used during laying of the cables shall have no sharp projecting parts liable to damage the cables.

6.3 While pulling cable through Hume pipes/HDPE pipes, the cable shall be protected to avoid damage due to sharp edges.

6.4 Warning tape:

A pre warning, Red color plastic / PVC tape, 250 mm wide 150 microns thick, two runs shall be laid at approximate 500mm above the cable specified depth, throughout the Trenched cable route. The tape shall carry the legend printed in black continuously as under

CAUTION / OPTCL / 33 KV CABLES ARE BELOW. With a '**SKULL AND BONE'** Signs

6.5 The cables shall never be bent, beyond the specified bending radius

7.0 CABLES OVER BRIDGES:

7.1 Wherever the cable route crosses bridges the cable shall be laid in the ducts, if provided, by removing and replacing the R.C.C. covers and filled with sand cushion.

7.2 In the absence of the cable ducts over bridges, the cable shall be laid in suitable size RCC/steel/G.I. pipes or as directed by the engineer In-charge and the pipe covered by cement concrete if necessary to protect from direct sunrays and Masonry/RCC supports at suitable intervals, wherever required as decided by the Engineer in charge and/or stipulations of concerned Highway/Railway/local authorities.

8.0 CABLE CROSSING OPEN DRAINS WITH LONG SPAN:

8.1 Wherever the cable has to cross open drains, with a long span, the cable shall be laid in suitable size RCC closed duct/GI pipe/ hume pipe/ HDPE pipe properly jointed with suitable collars. The GI pipe/hume pipe shall be firmly supported on pillars, columns, or suitable support of R.C.C. foundation & walls in CC 1:1½ : 3 to the required

required depth & width as required at site and directions & drawings as per technical specifications & procedures of PWD.

8.2 Wherever the U.G. cable has to cross the sewerage or water supply line the U.G. cable has to be taken below them maintaining adequate clearance. Further wherever the U.G. cable runs parallel to the telephone cable a separation distance of at east 300-mm shall be maintained. The cable should be taken inside HDPE Pipes wherever required.

8.3 The cables shall be laid in HDPE pipes wherever the cable and trench crosses private roads, gates, etc. In order to avoid inconvenience the stoneware pipe should be laid first after excavation and excavated trench shall be back filled, compacted and surface properly redone to restore that original condition.

9.0 ROAD CROSSINGS:

9.1 The road cutting whether cement concrete, asphalt or macadam road shall be taken after obtaining approval from civic authorities, Police, Telecom authorities and work should be planned to be completed in the shortest possible time. Where necessary the work shall be planned for night time or light traffic time. . In the excavated trench across the road the HDPE pipe of appropriate size shall be laid, excavation back filled compacted and surface shall be redone in shortest time to allow the traffic on the road.

10.0 FOOTPATH CUTTING:

10.1 The pavement slabs shall be removed, neatly stacked on side before starting excavation.

11.0 REINSTATMENT:

11.1.1 After the cables and /or pipes have been laid and before the trench is filled in all joints and cable positions should be carefully plotted and preserved till such time the cable is energized and taken over by the engineer in charge. The requisite protective covering will then be provided, the excavated soil replaced after removing large stones and well rammed in successive layers of not more than 20cm in depth, where necessary the trench being watered to improve consolidation. It is advisable to leave a crown of earth not less than 50 mm and not more than 100 mm in the center and tapering towards the sides of the trench.

11.1.2 The temporary reinstatement of roadways should be inspected at regular intervals, more frequently during the wet weather and immediately after overnight rain. If trench is to be closed overnight and settlement should be made good by further filling to the extent required, such temporary reinstatement should then be left for a time so that soil thoroughly settles down.

11.1.3 After the subsistence has ceased the trench may be permanently reinstated and the surface restored to the best possible condition.

12. CIVIL AND STRUCTURAL WORKS:

12.1 The scope of civil works include:

(a) Earth excavation and cable laying, removal of excavated earth, design, supply and provide plain and / or reinforced cement concrete for the cable trenches, back filling, de-watering of trenches. The surplus earth should be disposed off suitably at all leads/lifts. Excavation should be done in all types of soils laterite or rock either manually or using machines as per site requirements & instructions.

(b) The design of cable duct/pipe ducts for crossing drains, roads, Railways, Highways, canals etc., shall be suitably done and rates quoted shall include complete supplies and erection as per relevant schedules. The Masonry work / concrete work should be done as per standard PWD practices and specifications & instructions of engineer-in-charge.

(c) Design, fabrication, supply & erection of galvanized steel structures for cable end terminations.

(d) Supply of all consumables and sundry materials not included in the specifications in detail but are necessary to meet the intent of the project.

12.2 Codes and standards: Unless otherwise stated, latest editions of the following standards are applicable.

1) IS: 1255: Installation and maintenance of power Cable.
2) IS : 5820: Specification for pre-cast concrete cable cover.
3) IS : 209 : Quality of zinc for galvanizing.
4) IS : 2062 : Structural steel.
5) IS : 456 : Plain and reinforced cement concrete.
6) IS : 800 : Use of structural steel in general building construction.
7) IS : 2016 : Plain washers
8) IS : 2633: Zinc coating on galvanized steel.
9) IS : 3063 : Spring washers.
10) IS : 5358: Hot Dip Galvanized coating on fasteners.
11) IS : 6639 : Hexagonal bolts for steel structures.
12) Any other equivalent International/ National standard

12.3 Excavation and measurement in hard rock: Blasting in hard rock shall be done as per IS: 4081 (latest edition). The hard rock excavated shall be stacked, measured and reduced by 40% for voids. Pre-measurement of rock is to be recorded when measured on section. The quantity whichever is less shall be paid.

12.4 Back, filling materials: The back filling of excavated trenches around foundation, shall consists of one of the following materials as the Engineer-in-charge may direct in each location.

i. Selected sieved earth from excavated soil.
ii. Selected sieved earth brought from borrow area
iii. Sand filling (sieved).

NOTE: Sieved sand shall be strictly used for all the works.
Filling shall be done after the work of laying cables and providing sand cushion is completed. The contractor shall commence concrete finish only after the proper reinstatement and approved by the Engineer-in-charge.

12.5 Back filling for cable trench: Back filling shall be done in horizontal layers of thickness not exceeding 300-mm thickness, free from pockets with careful watering where necessary for compaction. The backfill earth shall be riddled free from materials likely to cause damage to the cables. The thermal backfill surrounding the cable shall be as per the design approved by the owner. Surplus available/ New earth after refilling should be disposed off to a place away from site at all leads & lifts.

12.6 **Cable route markers/joint markers:**

Permanent and durable type, cable route markers/joint indicating blocks should be provided as per the design supplied by the purchaser. The cement concrete shall consist of one part cement, two parts sand, four parts aggregate of size 20 mm and down. The finishing should be given a smooth cover surface of cement mortar and shall have the appropriate legends, 5 mm deep engraved on them as "OPTCL 33 KV CABLE", or "OPTCL 33 KV CABLE JOINT" as the case may be. Markers shall be of size 700x240x75mm thick RCC and fixed in cement concrete at top of cable trench at 250mts distances.

12.7 Pipes: HDPE pipes and accessories conforming to the relevant Indian standard specifications shall be used wherever required. All sundry materials like coupling, collars, caps to cover the pipe ends before cable is pulled in shall be provided. HDPE pipes, Hume pipes, stoneware pipes, can also be used where the cable passes through the passage or driveways of public and private buildings as per the directions of the Owner's representative for each particular location. The size of the pipe shall be at least 225 MM. The pipe joint shall be done by using proper sleeves so as to get tight fitting. Suitable steel rope will be drawn in pipe to pull the cable. Before drawing the cable, wire brush to be drawn through pipe to clean the burrs and steel ball (sphere) shall be pushed through pipe to know whether pipe is smooth for drawing the cable. HDPE pipes of suitable size shall be used wherever required as per site requirement.

12.8 **SAND:** The sand used for filling should be sieved, free from pebbles and approved quality. Only river sand should be used. The depth & width of sand filling should correspond to the details shown in the drawing.

12.9 **RCC Work**: RCC work required for supports to Pipes & others shall be of required size and depth constructed as per PWD specifications. The foundations should be of RCC as per design and drawing (to be furnished by the bidder) and got approved. Care to be taken to divert/bailout water wherever necessary during constructions. All RCC work should be of 1:1½ :3 proportion. The surface of supporting wall should be neatly plastered and finished suitable clamps should be provided for holding the pipes in position.

12.10 **CONCRETE:** All plain concrete/RCC provided should correspond to relevant IS codes. Concrete mixing should be done with machines. Curing should be as per codal requirements. All plain concrete should of 1:2:4 proportions. Before laying concrete at top of cable trenches, the back fill earth should be thoroughly compacted with water. The Concrete should be compacted and nearly finished to correspond to the road level.

12.11 Precast RCC slabs/ or interlocking stones for cable protection at top shall be provided as per drawing and design with wedge shaped notches on one side and protruding wedges on the other to facility interlocking and placing RCC shall be of M20 grade and shall be provided in stretches of concrete roads and such others reaches specified and decided during execution. Interlocking stones of approved quality should be provided wherever instructed.

13. CABLE AND JOINT MARKERS:

13.1 Permanent means of indicating the positions of joints on site should be provided. During the course of permanent reinstatement cable and joint markers, should be laid directly above the route of the cable and the position of the joint respectively.

13.2 Wherever it is not possible to place the marker directly over the cable route or the joint, the marker should be suitably placed near the cable route or joint on which the distance of the cable route or joint at right angles to and parallel to the marker should be clearly indicated.

13.3 The position of fixing the markers will be at the discretion of the Engineer In-charge.

14. JOINTING OF CABLES:

14.1 **GENERAL**: It shall be noted that the U.G. cables are of XLPE insulation and needs special care in jointing. The cable jointer and his assistant shall have experience in making joints/terminations. Jointing work should commence as soon as two or three lengths of cables have been laid. All care should be taken to protect the factory-plumbed cap/seal by laying the end solid in bitumen until such time as the jointing is commenced.

14.2 Jointing of cables in carriage ways, drives, under costly paving, under concrete or asphalt surfaces and in proximity to telephone cables and water mains, should be avoided whenever possible.

14.3 **JOINT PITS:** The joint pits should be of sufficient dimensions as to allow jointers to work with as much freedom of movement and comfort as possible. The depth of the pit should be at least 0.3-m below the cables proposed to be jointed. The sides of the pit should be draped with tarpaulin sheet to prevent loose earth from falling on the joint during the course of making. The pit should be well shored with timber, if necessary. An overlap of about 1.0-m of the cables to be jointed may be kept, for allowance to adjust the position of the joint. When two or more cables are laid together the joints shall be arranged to be staggered by 2 to 2.5 m.

14.4 **SUMP PITS:** When jointing cables in water logged ground or under monsoon conditions, a sump pit should be excavated at one end of the joint pit in such a position so that the accumulating water can be pumped or baled out by buckets without causing interference to the jointing operation.

14.5 **TENTS:** A tent should be used in all circumstances wherever jointing work is carried out in the open irrespective of the weather conditions. The tent should be so covered as to have only one entrance and the back facing the direction of the wind. The tent cover should be properly weighted or tied down on the sides.

14.6 **PRECAUTIONS BEFORE MAKING A JOINT OR CUTTING A CABLE**: The cable end seals should not be opened until all necessary precautions have been taken to prevent circumstances arising out of rainy/inclement weather conditions, which might become uncontrollable. The cable seals should be examined to ascertain if they are intact and also that the cable ends are not damaged. If the seals are found **broken or the lead** sheath punctured, the cable ends should not be jointed until after due examination and testing by the engineer in charge of the work.

14.7 **MEASUREMENT OF INSULATION RESISTANCE**: Before jointing is commenced the insulation resistance of both sections of the cable to be jointed should be checked by insulation resistance testing instrument. An insulation resistance-testing instrument of 2.5/5 kV shall be used. The insulation resistance values, between phases and phase to earth shall be recorded. The actual jointing operation shall start only after the approval of the engineer in charge of works.

14.8 **PRECAUTIONS TO BE TAKEN ON LIVE CABLES IN SERVICE:** Sometimes it becomes necessary that a H.V. cable, which is in service, be cut for making a straight joint with a new cable. In such cases work on joint should start only after the in service cable is properly identified, isolated, discharged, tested and effectively earthed. Search coils, interrupters or cable-identifying instruments should be used for this purpose.

14.9 **IDENTIFICATION NUMBERS / COLORS AND PHASING**: The cables should be laid and jointed number to number or color to color shown on the core identifying marks and prevent cross jointing. In all cases, the cables should be tested and phased out, and more particularly so when the cable terminates at Ring Main Unit/Sub-Station.

14.10 **MAKING A JOINT**: The Heat shrinkable joints used shall conform to the specification vide Annex 2. The contractor should furnish all the technical particulars of these joints and obtain approval only in case they are found superior to the heat shrinkable joints. Epoxy based joints are not permitted. Comprehensive jointing instructions obtained from the manufacturer of joint kits shall be meticulously followed. The connection of the earth wires should be done using flexible bonds connected to cable sheath using clips or soldering. Aluminum conductor strands shall be joined by mechanical compression method, using suitable die and sleeve with a good quality tool. The joints shall conform to specification as per IS 13573.

14.11 **TRANSITION JOINTS**: Wherever straight through joints will have to be made with existing cables under the following conditions the contractor shall arrange such type of joints and execute them with skilled jointers:

(1) Between cables having two different types of insulation viz., paper and XLPE.
(2) Between cables having two different types of conductor material, viz., copper and aluminum.
(3) Or a combination of the above.

The transition joints shall conform to IS: 13705 - Transition joints for cables for working voltages from 11 kV up to and including 33 KV _ performance requirements and type tests.

14.12 **CABLE TERMINATIONS**: Cable terminations required are both indoor and outdoor type and invariably be of heat shrinkable type conforming to the specifications vide Annex 2. All the technical particulars to establish the superiority in the performance of these joints shall be furnished while seeking approval. The terminations shall conform to specifications as per IS: 13573. The instructions furnished by the manufacturer of termination boxes/kits should strictly be followed.3

14.13 Wherever a cable rises from the trench to end in a termination, to be finally connected to an overhead line or a transformer, the following instructions should be complied with:

i) One coil to be made and left in the ground for future needs.
ii) The rise of cable, immediately from the ground level should be enclosed in suitable diameter GI pipe to a height of 2 m.
iii) The balance portion of the cable should be neatly curved, in 'S' shape.
iv)The cable and pipe should be properly fastened by using appropriate clamps/support. The hardware of clamps shall be painted with red oxide and enamel paint or galvanized.
v) The lugs on the termination shall be compressed with a suitable compression tool.

15. **EARTHING AND BONDING**:

15.1 The metal sheath and Armor should be efficiently bonded and earthed at all terminals to earth electrodes provided. The cross sectional area of the bond shall be such that the resistance of each bond connection shall not exceed the combined resistance of an equal length of the metal sheath and Armor of the cable.

16. TESTING BEFORE AND AFTER LAYING AND JOINTING:

16.1 All new cables should be tested for insulation resistance before jointing with a 5 kV megger. After satisfactory results are obtained cable jointing and termination work should commence. Records of this shall be maintained.

16.2 All cables after laying and jointing works are completed should be tested systematically and insulation and pressure tests should be made on all underground cables.

16.3 All test results should be recorded in tabular form in logbooks kept for the purpose.

16.4 The cable cores should be tested for: -

i) Continuity;
ii) Absence of cross phasing;
iii) Insulation resistance to earth; Insulation resistance between conductors.
iv) Conductor Resistance (dc) measured with a suitable bridge.
v) Capacitance. Using Capacitance Bridge.

17. H.V. TESTS:

17.1 After the laying and jointing work is completed, a high voltage test should be applied to the cable to ensure that the cable has not been damaged during or after the laying operations and there is no defect in the jointing.

17.2 The high voltage tests should be as per IS 1255 or as per international standards. The H.V. testing instruments shall be brought by the bidder. The dc test voltage to be applied after installation and before commissioning between any conductor and metallic sheath/screen/armor shall be 60 kV.

18. TESTING AND RECORD OF CABLE CONSTANTS:

18.1 When the cable is ready, just before commissioning, the cable constants, viz., the resistance, capacitance and inductance of each conductor should be determined and recorded, along with frequency at which the values of capacitance and inductance are determined.

19. GUARANTEE:

19.1 All cable joints/termination done by the contractor shall be guaranteed for 24 months from the date of energization of the complete cable. In the event of failure during the guarantee period, the restoration work shall be done free of cost by the contractor within 24 hours of giving notice or else the expenditure incurred by OPTCL to re-do the joint/termination will be recovered from the performance guarantee amount with the OPTCL. (See Performance guarantee clause in special Conditions of contract.)

20. CABLE RECORDS:

20.1 Accurate neat plans/sketches, drawn to suitable scale (1 cm = 10M) should be prepared and furnished by the contractor after the completion of each work.

20.2 All relevant information should be collected at site, during the progress of work and preserved for preparation of drawings.

20.3 The following essential data should be incorporated on all drawings.

a) Size, type of cable or cables.
b) Location of the cable in relation to prominent land mark property. Kerb-line, etc., with depths.
c) The cross section showing where cables are laid in pipes or ducts, giving their sizes, type and depths.
d) Position and type of all joints.
e) Location of other cables which run along side or across the cable route.
f) Position and depths of all pipes, ducts, etc., which are met as obstruction to the cable route.
g) Accurate lengths from joint to joint and
h) Manufacturers name and drum number of the cable, between sections/joint to joint.
i) Year and month of laying

33 kV CABLE JOINTING KITS

SPECIFICATION OF CABLE KITS

The distribution system in which the cables along with the Straight through and end termination kits joints are expected to perform reliably over a period of 30-35 years, is a five phase, 3-wire System operating at 33 KV with solidly earthed neutral at the source neutral terminal with maximum possible continuous voltages being 36KV, and cable conductor temperatures up to 90°C on a continuous basis and This specification defines the requirements for 33KV Straight through and end termination kits jointing Cable Joints kits for underground 33 kV XLPE insulated power cables. The requirements cover the material properties of the components used in the Cable Joints as well as the performance of these products after installation on cables. Heat shrinkable components are based on polymeric materials and are to be supplied in an expanded state. Heating of these components to a temperature generally above 120°C would activate their elastic memory and cause these components to recover or shrink down on a substrate within a specific application range.

Service Conditions

under short circuit conditions up to 250°C.

The Service conditions include ambient temperatures range from -5°C to 50°C, height of installation up to 700 m above sea level, dusty, industrially polluted as environments, humidity levels up to 95% and heavy average rainfall of 600 mm (annually).

GENERAL REQUIREMENTS

All materials used and products provided under this specification must be in accordance with the standards listed below of this specification

REFERENCES:

1. Standard Number ESI-09-13- Performance Specification for high voltage, heat shrinkable components for use with high voltage solid cables up to an including 33,000 volts.
2. IS 13573 Type Test and Performance Requirements for cable Terminations and Joints on XLPE Cables of 33 KV ratings.
3. IEC 61238-1 : Compression and Mechanical Connectors for Power Cables with copper or aluminum conductors - Tests Materials and Requirements.

All materials components and products offered shall be of the latest designs, incorporating any improvements in materials and installation procedures knowledge of which has been gained through the manufacturers' research or experience.

The jointing materials and components shall be offered in the form of kits. The kits shall be supplied complete with all necessary tubings components (mechanical connectors/ earthing/ cable preparation etc) to form a ready to energize joint / termination.

2 Quality, Environmental Management **System and Laboratory Accreditation**

2.1 The kits shall be offered from the factory having a valid IS0 9001:2000 Quality Management System(QMS) certificate for the goods offered. The goods shall include the shrinkable and moulded components, as well as connectors.

3.0 Units **of measurement**

In all correspondence, in all technical schedules and drawings metric units of measurement shall be used.

4.0 Packing and Marking

The joint/termination kit shall be properly packed with all the shrinkable tubings, moulding components and connectors, lugs, other accessories as required to form a self contained kit. The packing shall be of such design as to prevent moisture and dust ingress and shall also protect the contents against mechanical damage.

External packing shall carry a label with the following information clearly marked:

- Name of Manufacturer
- Manufacturers reference
- Year of Manufacture/ Purchase order No.
- Expiry date whenever applicable

The kits shall also include the following:

a) Installation Instruction sheet manuals containing complete step by step instructions in the English language.

b) A check list stating the quantities and description of components contained in the kit shall be supplied in each kit.

Each component of the kit shall be separately packed in polyethylene and component name/part number shall be marked on the polyethylene packing.

All materials and components comprising the kit shall be clearly and permanently marked in a prominent position with the supplier's/manufacturer's name, product identification, batch number and year of manufacture. The batch number shall allow for full traceability of manufacture including the new materials which make up the polymeric compounds used in extrusion and moulding processes. Extruded components (tubing and wrap-arounds) shall additionally be marked with their expanded and fully recovered internal diameter. They may alternatively be marked with the upper and lower diameters of their range of application.

Markings on extruded components shall be repeated along the length with gaps not exceeding 200mm. Components which cannot be marked shall have the above information provided on immediate packaging.

Packed kits shall be packed in carton boxes which shall be placed in wooden pallets in order to facilitate fork-lift handling.

5.0 Storage

Components and kits shall be capable of being stored without deterioration in an ambient air temperature 5°C to 50°C when protected from direct sunlight.

6.7 Inspection and testing

All materials covered by this Specification shall be subject to inspection and test by the Authority during manufacture and before final despatch from manufacturer's works. The approval of the Authority of any such inspection or test will not, however, prejudice the right of the Authority to reject the materials or any part thereof, if it does not comply with the specification when erected or does not give complete satisfaction in service. The contractor shall make available to the Authority for the inspection and testing all required personnel and offer facilities (equipment, testing instruments etc.) at no cost to the Authority. The Authority may, however, use his own instruments and apparatus as a check.

Before any part of the jointing materials is packed or despatched from the manufacturers works, all tests called for are to have been successfully and satisfactorily carried out in the presence of the Inspector and a certificate issued to that effect by the Inspector in writing.

Adequate notice is to be given when any part of the jointing materials is ready for inspection or test and every facility is to be provided by the Contractor and his sub-contractors to enable the Inspector to carry out the necessary inspection and witness the tests. Duplicate copies of all principal Test Records and Test Certificates are to be supplied to the Inspector for all tests carried out in accordance with the provisions of this specification.

The jointing materials and all component parts thereof are to be fully tested in accordance with the provisions of the latest relevant standards as stated in paragraph 2.0 of this Specification or as may be agreed in writing with the Inspector. Test Certificates are to be forwarded to the Purchaser together with the invoices.

Guarantee.

The Straight through and end termination kits jointing kits shall be guaranteed for

five years form the date of supply.

6.10 Samples

BIDers are required to submit with their BIDs two No's samples of the kits offered as to be delivered in case of order. The kits shall include the installation instructions.

BIDs without samples shall not be considered. The samples shall be returned to the BIDers, after the award, at their own expenses.

6.11 Training

Bidders are required to provide training for OPTCL staff and also to the available outsourced cable jointers for at least 10 man days in phase wise over the period of the contract, at dates that will be decided at a later stage. All expenses i.e trainers wages, living expenses. Training materials i.e cables and jointing materials shall be provided by shall be covered by the Bidder.

7.0 TECHNICAL REQUIREMENTS

The technical requirements described below refer to heat shrinkable, elastic and moulded products (separable connectors).

7.1 Design **and** Technology

Product design shall be based on the use of heat-shrinkable or elastic tubings and moulded parts to provide for the functions of high voltage insulation, electrical stress control, electrical screening, sealing and environmental protection as necessary. The use of tapes to provide primary insulation, screening or primary stress control is not acceptable.

BIDers shall submit evidence with their BIDs that designs are based on sound engineering principles, accumulated know-how and satisfactory service experience.

Design shall aim at minimizing the number of component parts and the time and skill required for satisfactory installation.

For joints single anti tracking tube design is required, which shall provide both anti tracking and stress control grading.

Anti-track and weather-resistant tubing shall be used in outdoor Straight through and end termination kits kits in all positions where the material surface is subject to electrical stress. Mastics or adhesives used as sealants for these tubings must be similarly anti-track and weather-resistant.

All necessary sealants shall be provided pre-coated on the internal surfaces of tubings and moulded parts. Sealant surfaces shall be protected by release paper as necessary.

Screening of conductor connectors shall be achieved with *single* co-extruded dual wall tubing/Tripple wall tubing comprising an inner insulating layer and an outer conducting layer. Separate or additional insulating and conducting tubings are not acceptable. The insulating layer shall provide an insulation thickness at least 30% more than the cable insulation.

7.2 Lugs **and connectors**

7.2.1. Mechanical **shear bolt type**

Mechanical shear bolt type connectors shall be used as follows:

They shall have the following characteristics/features:

(i) They shall be in accordance with EN 61238-1.

(v) Connectors shall be of the water block type, and the shear bolt heads to be hexagonal.

(vi) Lugs on aluminium cores shall be provided with oxidation inhibiting compound, or any other approved means for inhibiting oxidation.

(vii) Bolts of the shear bolt type shall be suitable for M12 bolt

7.3. Installation Instructions

Detailed installation instructions with drawings for all joints and terminations offered, including all parts, shall be provided with the BID documents in English language.

The successful BIDer shall provide installation instructions in English language.

7.4 Component types

For heat shrinkable materials:

(i) The tubing components (such as internal insulating tubing, stress control tubing, anti-track tubing, external protective tubing) shall conform to the requirements given of EA TS 09

The moulded components shall conform to the requirements given in List 2 of EA TS 09-13.

(ii) The sealants shall conform to the requirements given in List 3 of EA TS 09-13 and EA TS 09-11.

7.4.1 Specific requirements for components

Electric stress control for the cable insulation screen ends and over the connectors shall be achieved by tubings.

The stress control material shall have defined impedance characteristic, volume resistivity, and permittivity (dielectric constant). The AC impedance shall remain constant despite of thermal ageing, which will take place due to heating effect within the conductor and the temperature of the environment.

7.4.1.2 Non tracking erosion and weather resistant, insulating tubing and moulded parts

BIDers must provide proof of weather and track resistance of the polymeric material offered, through actual field studies or through accelerated laboratory studies, to confirm a minimum of 30 years expectancy.

This should include:

(i) Thermal Endurance - An Arrhenius plot to confirm the life expectancy on continuous exposure at 90° C.

(ii) Tracking and Erosion Resistance Test to prove the withstand ability against effects of surface electrical leakage currents.

(iii) Weathering Data properties.

7.4.1.3 Track Resistant Sealant is (Insulating and Weather Resistant)

Sealing of the interfaces between components subject to electrical stress shall be achieved by using a track resistant sealant or a hot melt adhesive. This sealant/adhesive shall be pre-coated inside the shrinkable components. BIDers must provide the following information:

(a) The adhesive peel strength the sealant provides between Non tracking tubing and non tracking moulded part.

(b) The dielectric strength, tracking and erosion resistance of the sealant as per ASTM D2303.

7.4.1.4 Tripple wall co, extruded Tubing

(a) The Tripple wall tubings are manufactured by means of co extrusion.

Further the BIDer shall have

- Proof of accelerated laboratory and long term field usage to confirm the retention of key properties within permissible limits due to thermal ageing. Minimum key properties before and after ageing to be stated.
- Confirmation of the minimum thickness of insulation provided over the connector for the maximum size of conductor for which the tubing is supplied.

The insulation layer shall provide an insulation thickness at least 30% more than the cable insulation.

7.4.1,5 Void Filling, Stress Relieving Mastic

BIDers must submit:

(a) Data of the stress relieving mastic, which should include information on the volume resistivity, and permittivity.

The mastic shall provide a void free interface between the stress control layer and the cable insulation as well as the connector and Proof of long term usage in the field to confirm satisfactory performance.

7.5. Specific **Requirements for Joints.**

7.5.1 General requirements for joints.

7.5.1.1 External leakage insulation between the live conductor and earth potential using anti-track and weather resistant material.

7.5.1.2 Electrical stress control using electrical stress control material over the cores.

7.5.1.3 Hermetic sealing of the interfaces between the cable accessory and cable surfaces, bushings or cable lugs by use of track resistant adhesive/sealant.

7.5.1.4. Detail technical characteristics wrap around sleeve if offered must be provided.

7.5.2.4 Outdoor termination kits shall provide means for protecting the exposed insulation of the conductors from UV radiation.

8.0 TESTS

8.1 Type **Tests on Components**

1. The BIDer shall submit with the BID documents test certificates tested not more than 5 years to prove that shrinkable or elastic or moulded components connectors used for cable joints and termination kits comply with the performance specification as indicated IS 13573 1992 with latest amendments and EATS 09-13. Test certificates shall be submitted with the BID documents.

8.2 Routine Tests on Components

BIDers must submit with their BIDs routine tests certificates as per the requirements of EA TS 09-11 and EA TS 09-13.

In addition, during the acceptance testing of the first and any other subsequent consignment, components will be randomly selected by the Inspector from jointing kits and will be subjected to the following routine and type tests, at CPRI.

The cost of testing shall be inclusive of all tests specified at CPRI in the bid cost. Visual examination

a) Dimension
b) Flame Retardance
c) Packing and markings.

8.3 Type Tests on 33 kV Straight through and end termination kits kit

The BIDers are required to submit with their BIDs the type test certificates

mentioned in the following paragraphs, for Straight through and end termination kits kit

9.0. **BIDers must submit**

2. Test certificates certified by CPRI or any international recognized testing laboratory as per IS 13573 1992 with latest amendments not more than 5 years..

3. Test certificates certified by CPRI or any international recognized testing laboratory as per EATS 09-13 not more than 5 years.

4. Test certificate as per IEC 61238-1 from CPRI or any international recognized Mechanical Connectors testing laboratory not more than 5 years.

5. Documentary evidence including graphs showing the effects of temperature and thermal ageing on the impedance of the stress control material offered.

4 A technical explanation as to how the correct electrical properties of the material Vs volume resistivity, permittivity and AC impedance, have been derived

5 The recommended lengths of the stress control material.

6 Proof of accelerated laboratory and long term field usage to confirm the retention of the properties within permissible limits under variations of temperature and thermal ageing

7 Full set of dimensioned drawings including installation instructions

8 Transport, storage and installation requirements

9 Acceptance letter of two samples to be submitted

GUARANTEED TECHNICAL PARTICULARS FOR 33 KV UG CALES						
NORMAL STRAIGHT THROUGH JOINT TRIPPLE EXTRUSION WITH MECHANICHAL CONNECTOR						
Bidders Name						
CLASS OF POWER CALES						
Sl.No.	**PARTICULARS**					
1	Name of the manufacturer					
2	Country of Manufacture					
3	Type (Design) of joint					
4	No. of years the design is in commercial use					
5	Rated voltage	KV				
6	Rated Current	Amps				
7	Suitable for conductor	Sq.mm				
8	Connector, type, material					
9	Partical discharge test 72 KV	PC				
10	A.C. withstand voltage	KV				
11	Impulse withstand voltage +ve and -ve 10 times	KV				
12	Load cycling 90 deg. C +50 deg. C (No. of cycles)					
13	Load cycling as above under 1 M water (No. of cycles)					
14	D.C. withstand (maximum voltage)	Hrs.				
15	D.C. withstand voltage 15 Min.					
16	Conductor thermal short circuit 250 deg. C, 1 sec.					
17	Shield thermal short cuircuit 250 deg. C 1 Sec					
18	Type tested to standard (s)					
19	Additional Information					
20	Comply with IS					
21	Comply with EATS/ESI					
22	Comply with IS					

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR ACCESSORIES					
Out door type Cable end Termination (Sealing End) With unicon tube					
Bidder's Name					
Class of Power Cables					
1	Manufacturer's Name				
2	Country of Manufacture				
3	Class and Type				
4	No. of years the design is in commercial use				
5	Rated Voltage kV				
6	Total Creepage distance (mm)				
7	Maximum conductor size, Al (sq.mm)				
8	Details of terminal connectors				
9	Power frequency voltage 1 min. (kV rms) dry withstand test				
10	Power frequency voltage wet with stand voltage KV & duration				
11	Power frequency voltage 6 H Dry withstand voltage Kv. Rms.				
12	Radio interference voltage (R.I.V) Test (Micro Volts)				
13	Practical discharge (corona) extinction test :				
	a) Extinction voltage Kv rms				
	b) Minimum detector sensitivity PC				
14	Impulse voltage Lightning voltage Dry with stand kV (Crest)				
15	Direct voltage 15 Min. Dry with stand KV				
16	Description of materials used in the terminations with electrical & mechanical particulars				
17	Mounting Structure Details for termination				
18	Electrical & Mechanical Particulars of				
	a) Heat Shrinkable Tubing				

	b) Heat Shrinkable Moulded parts				
	c) Heat Shrinkable adhesives / sealents				
19	Type tested to (standard(s))				
20	Other details				
	Please enclose complete Technical literature				
20	Comply with IS				
21	Comply with EATS/ESI				
22	Comply with IS				

TECHNICAL SPECIFICATIONS FOR EXTENSIBLE 33 kV, RMU

1.0 GENERAL:

1.1 All equipment and material shall be designed manufactured and tested in accordance with the latest applicable Indian Standard, IEC standard.

1.2 Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case copies of English version of the standard adopted shall be submitted.

1.3 The electrical installation shall meet the requirement of Indian Electricity Rules, 1956 as amended up to date, relevant IS code of practice and Indian Electricity Act, 1910. The Electricity Act, 2003 shall also apply. In addition other rules and regulations applicable to the work shall be followed. In case any discrepancy the most stringent and restrictive one shall be binding.

1.4 The high-tension switchgear offered shall in general comply with the latest issues including amendments of the following standards but not restricted to them.

IEC IS Description

60694: 12729 Common clauses for high-voltage switchgear and control standards (for voltages exceeding 1000 V).

60298: A.C. Metal-enclosed switchgear and control gear

60129: Alternating current disconnectors (isolators) and earthing switches

60529: 13947 Classification of degrees of protection provided by enclosures

-IP 67 for tank with high voltage components

-IP 2X for the front covers of the mechanism

-IP 3X for the cable connection covers

-IP 54 for the outdoor enclosure (kiosk)

60265: High voltages switches Part 1

60056: 13118 High Voltage AC Circuit Breakers, General Requirement.

6005:Colour for ready mixed paints and enamels,Code of practice for phosphating of iron and steel,

60185: 2705 Current Transformers

60186: 3156 Voltage Transformers

60255: Electrical Relays

60 9135 High Voltage testing techniques.

427 13516 Method of Synthetic Testing of H.V.A.C Circuit Breakers.

IEC 62271-200 MV metal-enclosed switchgear,

(IEC 62271-102) AC disconnections and earthing switches,

2.0 Design Criteria

Service conditions

The 33 kV RMU shall be suitable for operations at a height up to 1000 meters above sea level.The 33 kV RMU shall be used in coastal region. The RMU shall be capable of operating normally within the following temperature range:

- Maximum ambient temperature : + 45 ° C
- Minimum ambient temperature : - 10 ° C

Manufacturer shall declare whether RMU is able to operate in air temperature higher than + 40 °C and if current de-rating is necessary. The RMU shall be capable of being electrically commanded The RMU shall be capable of being exposed to high relative humidity and polluted environments. The RMU shall be suitable for outdoor use.

4. System Parameters

Network	Three phases - Three wires
Rated Voltage	36 kV
Service Voltage	33 kV
System Frequency	50 Hz
Lightning Impulse withstand Voltage Phase to phase, phase to earth Across the isolating distance	 170 kV 195 kV
Power Frequency withstand voltage	70 kV rms - 1 mn
Rated Normal Current Line switches	 630 Amps
Rated Short time current withstand (1 sec)	21 kA
Internal Arc 1 sec	16KA
Rated Short circuit making capacity of line switches and earthing switches	62.5KA
Number of operations at rated short circuit current on line switch and earthing switch	5 making operations
Rated load interrupting current Line switch	 630 Amps
Cable charging breaking current Earth fault breaking current	40 A 50 A
Cable charging breaking current und. earth fault	25 A
Number of mechanical operations	1000 O/C
Number of electrical operations at full rated current	100 O/C

All of the switchgear shall be capable of withstanding these parameters without any damage being caused, in accordance with the standards mentioned in this specification

5. Configuration requirements

Line switch - Breaker – Line Switch

6. General stipulations regarding the design and development of switchgear

6.1 Introduction

The RMU shall meet the criteria for compact, metal-enclosed outdoor switchgear in accordance with IEC 62271-200,IEC 60694:

- Switchgear classification: PM class
- Loss of service continuity class: LSC2A

It shall include, within the same metal enclosure, the number of MV functional units required for connection, power supply, i.e.:switch disconnectors, earthing switches.

6.2 Switchboards

The switchgear and busbar shall all be contained in a stainless steel enclosure filled with SF6 at 0.3 bar relative pressure to ensure the insulation and breaking functions. Sealed for life, the enclosure shall meet the "sealed pressure system" criterion in accordance with the IEC 62271-1 standard (§ 3.6.6.4 and 5.15.3) : "a volume for which no further gas processing is required during its entire expected life. In addition, manufacturer shall confirm that maximum leakage rate is lower than 0,1 % / year. It shall provide full insulation, making the switchgear insensitive to the environment (temporary flooding, high humidity...), IPX7 degrees of protection in accordance with recommendation IEC 60529 § 14.2.7. It shall provide full insulation, making the switchgear insensitive to the environment conditions such as pollution, humidity, dust, etc…

The active parts of the switchgear shall be maintenance-free and the switchboard shall be low-maintenance. The switchgear shall provide IP3X degree protection with the exception of the MV cable entrance and earthing plug where entrance is admissible. The tank shall be made of 2.5 mm ANSI 304 unpainted stainless steel. The colour shall be RAL 9002 for the enclosure and RAL 9005 for the mimic panel. The switchboards shall be suitable for mounting on a trench, utilities space or base. Each switchboard shall be identified by an appropriately sized label which clearly indicates the functional units and their electrical characteristics. The switchgear shall be designed

so that the positions of the different devices are visible in its front panel; in addition the cubicle must have voltage indicators that allow check if any income or outcome is energized.
In accordance with the standards in effect, the switchboards shall be designed so as to prevent access to all live parts during operation without the use of tools.

6.3 Dielectric medium

SF6 gas is the preferred dielectric medium for MV RMUs. Oil filled switchgear will not be considered. SF6 gas used for the filling of the RMU shall be in accordance with IEC 60376.

6.4 Earthing of metallic parts

There shall be continuity between the metallic parts of the switchboard and cables so that there is no electric field pattern in the surrounding air, thereby ensuring the safety of people. The substation frames shall be connected to the main earth busbar without dismantling any busbars.

6.5 Earthing of the main circuit

The cables shall be earthed by an earthing switch with short-circuit making capacity; the earthing switch can only be operated when the switch is open. in compliance with IEC standard 62271-102. The earthing switch shall be fitted with its own operating mechanism. The speed of the manual closing, driven by a fast-acting mechanism, is independent of the operator.
Mechanical interlocking systems shall prevent access to the operating shaft to avoid all operator errors such as closing the earthing switch when the switch is closed.

6.6 "Network" disconnectors:

They shall be maintenance-free, with breaking in low pressure SF6 gas.
The position indicator shall **provide positive contact indication** and reliability of indication in accordance with IEC 62271-102 standard. The switches shall be of the type E3 "increased operating frequency" in accordance with IEC 60265-1 § 3.104 standard. They shall have 3 positions, open-disconnected, closed and earthed, and will be constructed in such a way that natural interlocking prevents unauthorized operations. The switches shall be fully mounted and

inspected in the manufacturer's factory. Manual opening and closing will be driven by a fast-acting mechanism, independent of operator action.

Each switch can be fitted with an electrical operating mechanism in future in a specially reserved location, without any modification of the operating mechanism and without de-energizing the switchboard.The switch and earthing switch operating mechanism shall have a mechanical endurance of at least 1000 mechanical operations.

They shall have 3 positions, open-disconnected, closed and earthed, and will be constructed in such a way that natural interlocking prevents unauthorized operations.

The switches shall be fully mounted and inspected in the factory.

An operating mechanism can be used to manually close the switch and charge the mechanism.

It shall be fitted with a local system for manual tripping by an integrated push button.

Circuit Breaker:

The CB shall be consist of Vacuum circuit breaker or SF6 circuit breaker confirming to latest IEC standards. The CB shall be maintenance free. The CB shall be three position indepandant operation

1. Service position
2. Disconnected position
3. Earthed

he disconnecter operation is only possible when circuit breaker is open. The CB shall be suitable for up gradation for electrical operation. The CB shall be equipped with a protection relay for over current and earth fault

6.7. RMU bushings and Cable terminations

6.7.1 Bushing

The bushing should be conveniently located for working with 2 runs of 3 core 400 Sq mm 33 kV cables specified and allow for the termination of these cables in accordance with the instructions supplied for the 630A M16 bolted connectors on line switches.

The profiles of the cable connection bushings shall be in compliance with EN-50181 standards.

6.7.2 Cable clamps

A non ferro-magnetic cable clamp arrangement must be provided for all network cables terminated on the RMU

6.7.3 Cable sealants

The cable sealants shall have sealing collar which is designed for double collar suitable for 2 runs of 400 sq.mm XLPE cable and can be assembled into packages by means

- frames around the collar to be imbedded flush into the RMU of the formwork.
- The frame is provided with nail holes for fixing with stud nails.
- The cable sealants shall be provided with protective foils and sealing caps.
- The interior of the sealing collar shall be clean during installation.
- The entry sealing for 33 kV double run cable shall be press water tight

6.7.4 The RMU's shall be suitable for termination of 33 kV Single core 300 sq.mm UG cable and the. elbow connectors if requires is in the scope of supply.

6.7.5. Padlocking facilities

Live switches and earthing switches can be locked in the open or closed position by means of padlocks introduced in holes of 8 mm diameter.

6.6. Voltage indicator lamps and phase comparators

Each function shall be equipped with a voltage indicator box on the front of the device to indicate whether or not there is voltage in the cables. The capacitive dividers will supply low voltage power to the lamps.

Three inlets can be used to check the synchronization of phases.

This device shall be in compliance with IEC 61 958 standard.

6.7 Fault locators (communicable type)

6.9.1 Each ring main unit incoming line and outgoing lines switch shall be provided with fault passage indicator .These shall facilitate quick detection of faulty section of line. The fault indication may be on the basis of monitoring fault current flow through the device. The unit should be self contained requiring no auxiliary power supply. The unit preferably be encapsulated in resin/plastic housing to provide a robust weather proof assembly for

installation around the 33 kV cable at RMU. The principle of operation of detector shall be indicated by supplier. The response value of Earth fault circuit current the No. of auxiliary contacts provided and its operation shall be specified. Suitable inspection windows in the cable connection compartment should be provided to observe the status of fault indicator.

6.8 Communicable FPI

The communication shall be suitable for SCADA application using protocol such as IEC 870-5-1001/104.The communicable FTU shall be powered by self powered with backup which is to be integrated with the RMU panel.

6.9 The software required for communicating the FPI's complete is in the scope of supply.

6.10. Safety of people

Any accidental overpressure inside the sealed tank will be limited by the opening of a pressure limiting device in the lower part of the enclosure. Gas will be released to the bottom and rear of the switchboard away from the operator.

Manufacturer shall provide type test report to prove compliance with internal fault, according the relevant standards.

6.11. Front plate

The front plate shall have an IP 3X degree of protection. The front shall include a clear mimic diagram which indicates the different functions.

The position indicators shall give a true reflection of the position of the main contacts. They shall be clearly visible to the operator.

The lever operating direction shall be clearly indicated in the mimic diagram.

The manufacturer's plate shall include the switchboard's main electrical characteristics.

6.12. Cable insulation testing

It must be possible to test the core or the sheath insulation of the network cables while the RMU remains energized at rated voltage. It shall be preferable to carry out the phase by phase testing. The maximum test voltage shall be less than 72 kV DC for 15 minutes.

6.13. Dimensions

The overall dimensions shall not be greater than the followings :

Width (mm)	Height (mm)	Depth (mm)
1250/1300	2200	1000

6.14 Finishing

The device shall be fully designed for use in a hot, humid atmosphere and shall be low-maintenance. At least two lifting rings shall be installed on the top of the switchboards for handling.

7. Type and routine tests

According to this specification and IEC recommendations, the following type test certificates shall be supplied :

- Impulse withstand test,
- Temperature-rise test,
- Short-time withstand current test,
- Mechanical operation test,
- Checking of degree of protection,
- Switch, , earthing switch making capacity.
- Switch, breaking capacity.
- Internal arc withstand
- Checking of partial discharge on complete unit

In addition, for switches, test reports on rated breaking and making capacity shall be supplied.
For earthing switches, test reports on making capacity, short-time withstand current and peak short-circuit current shall be supplied.

The routine tests carried out by the manufacturer shall be backed by test reports signed by the factory's quality control department. They shall include the following:

- Conformity with drawings and diagrams,
- Measurement of closing and opening speeds,
- Measurement of operating torque,
- Checking of filling pressure,
- Checking of gas-tightness,
- Checking of partial discharges on individual components,
- Dielectric testing.
- Main circuit resistance measurement.
- Fuse combination mechanical checking.

8. Quality

When requested by the customer, the supplier shall provide proof that he applies a quality procedure in compliance with the standard, namely:

- Use of a quality manual approved and signed by a top management representative,
- Periodic updating of the manual so that it reflects the quality control procedures in effect,
- ISO 9001and ISO 14001 certification.

9.0. TESTS

Type test certificates from Accredited NABL Testing Laboratories for 33 kV RMU's shall be submitted along with Bid. The Type Tests should have been conducted not later than 5 years as on the date of BID opening

Each type of H.V. Switchgear shall be completely assembled, wired, adjusted and tested at the factory as per the relevant standards and during manufacture and on completion.

10.0. Routine Test

The tests shall be carried out in accordance with relevant standards but not necessarily limited to the following:

(a) Withstand voltage at Power Frequency for all current carrying parts including wiring

(b) Measurement of resistance of the main circuit Non-Extensible RMU

(c) Leakage test

(d) Withstand power frequency voltage on auxiliary circuits

(e) Operation of functional locks, interlocks, signaling devices and auxiliary devices

(f) Suitability and correct operation of protections, control instruments and electrical connections of the circuit breaker operating mechanism (primary & secondary injection)

(g) Verification of wiring

(h) Visual Inspection Routine test shall be carried out on all equipment such as circuit breakers, current transformers, relays, meter etc. as per relevant standards.

11.0. Acceptance Tests

The acceptance tests shall include all the routine tests mentioned above and also demonstration of tripping through the relay by secondary injection tests.

12. Type Test

The Type Test reports, for following tests conducted in an accredited lab shall be submitted. The type tests shall be in accordance with relevant IS 9920/IEC 265/IEC 420.

The type Tests shall include but not limited to the following-

(a) Impulse test

(b) Temperature rise test

(c) Short Circuit test

(d) Dielectric Tests

(e) Operation and mechanical endurance

13. Guarantee The material shall be guaranteed for five years from the date of commissioning.

TECHNICAL SPECIFICATION OF RMU INSTALLATION

1. RMU shall be installed out door locations. The support structure shall be supplied and

installed with the RMU.

2. RMU units shall be installed on platform at 50 Cm above ground level.

3. Earthing of RMU shall be made by utilising existing earth pit and risers to the extent possible. A total of 2 earth pits would be needed 2 for the RMU and other equipment bodies. Earthing to be done as per general technical requirement.

ANNEXURE – I

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR 33KV RING MAIN UNIT (SF6)

Sl.No.	Description
(A)	
1.	Maker's Name and Address
2.	Normal current
3.	Breaking capacity
4.	Making capacity
5.	Short time current capacity
6.	No. of poles
7.	Maximum temp. rise of contacts at normal rating and frequency
8.	Method of closing
(B)	
9.	Type & Designation
10.	Standards
11	Rated service voltage
12	Frequency
13.	Installation
14.	Minimum clearances in SF6
	i) Between Poles

ii) Between live parts & earth

iii) Between fixed and moving contacts in the open position

15. No. of tanks
16. Type of insulation
17. Quantity of SF6 Gas in the complete switch.
18. Total length of break per pole
19. Type of arcing contacts and arc control device
20. Steady hydraulic test pressure tank can withstand for one minute without distortion.
21. Weight of switch complete with operating mechanism.

---

22. BUS BAR

1 Material

2 Continuous current

a) Standard

b) At site conditions and within cubicle.

3 Short time current for 1 sec (kArms)

4 Minimum clearance from bare bus bar connection

a) Phase to Phase (mm)

23. SF_6 Gas Pressure

SPECIFICATION OF 33 kV GAS INSULATED SWITCHGEAR (GIS)

TECHNICAL SPECIFICATION FOR 33kV GAS INSULATED SWITCHGEAR

1.0 SCOPE:

This specification covers the technical requirements of design, manufacture, testing at manufacturer's works, packing, forwarding of 33kV Gas Insulated Indoor switchgear complete with all accessories for trouble free and efficient performance including supply, design, manufacture, and factory production, testing, supervision of installation and commissioning of SF6 gas-insulated vacuum circuit breaker switchgear and associated equipment.

2.0 STANDARDS:

Switchgear	**IEC 62271-200 / EN 62271-200**
Switchgear	**IEC 60694 / EN 60694**
Behaviour in the	
event of internal faults	**IEC 62271-200 / EN 62271-200**
Three-position disconnector	
and disconnector	**IEC 62271-102 / EN 62271-102**
Busbar earthing switch	**IEC 62271-102 / EN 62271-102**
Circuit-breaker	**IEC62271-100/EN 62271-100**
Current transformer	**IEC 60044-1 / EN 60044-1**
Voltage transformer	**IEC 60044-2 / EN 60044-2**
Voltage detection systems	**IEC 61243-5**
Protection against accidental contact, foreign	
Objects and water	**IEC 60529 / EN 60529**
Installation	**HD 637 S1**

3.0 DESIGN CRITERIA:

3.1 OPERATING CONDITIONS:

Operating Conditions according to	**IEC 60694 / EN 60694**
Temperature of ambient air:	

Maximum value	**50 °C**

3.2 RATED NORMAL CURRENT:

The rated normal currents of components are stated in the Technical data and shall be valid for design ambient temperature of 50° C.

3.3 INTERNAL ARC FAULT:

Classifications to IEC 62271-200

Partition class- PM

Internal arc classification - AFL (Authorized person access permitted from front & lateral side) for the panels with no rear access required.

3.4 INSULATING GAS:

Insulating gas Type Sulphur hexafluoride (SF6)

Design pressure at 20 °C For 36 kV Class - 0.05 MPa

4.0 TECHNICAL DATA

4.1 BUS RATING:

33 kV GIS, 25 kA 3s, Single Bus Bar 800 A @ max. 50 °C to 35°C average 24h

4.2 REQUIRED TECHNICAL PARAMETER:

Busbar System	**Single busbar**
Electrical Data	
Rated voltage	**36 kV**
Rated operating voltage	**33 kV**
Rated frequency [Hz]	**50**
Rated power-frequency withstand voltage	**70 kV**
Rated lightning impulse withstand voltage	**170 kV**

Rated short-time withstand current	**25 kA**
Rated short-circuit duration	**3 s**
Rated peak current	**62.5kA**
Rated operating current busbar	**800 A**
Degree of Protection:	
Main circuits	**IP 65**
Drives	**IP 3X**
Cable connection compartment	**IP 3X**
Low voltage cabinet	**IP 4X**
Auxiliary Voltage:	
Control	**48 V DC**
Motor	**48 V DC**
Protection system	**48 V DC**
Remote control	**48 V DC**
Socket/lighting/heating	**230 V AC**
IAC Classification acc. to IEC 62271-200	
Classification IAC	**AFL**
Internal arc	**25 kA 1 s**
Dimensions:	
Cubicle width max.	**800mm**
Cubicle depth maximum	**2000 mm**
Cubicle height max.	**2500 mm**
Properties:	
Pressure relief duct	**Not Required**
SF6 pressure control	**IDIS**
Voltage Indication System	**IVIS**
Control panel	

mechanical

Mech. Operation	**Closed door Operation**

5.0DESIGN FEATURES OF SF6 GAS INSULATED SWITCHGEAR:

5.1 GENERAL DESCRIPTION:

The SF6 insulated switchgear shall be type-tested and of pre-fabricated metal construction.

The offered Indoor GIS shall have VCB, Three Position Disconnecting Switch and Bus Bars shall be enclosed in SF6 Gas

Single panels, each built up from a modular range of separate functional units, can be combined to produce the specified switchgear configuration. The modular units comprise:

A) Standard basic module:

Incorporating the vacuum circuit-breaker

B) Floor-pan module, flange-mounted to the lower part of the basic module, with:

- **A wide range of cable connection options, appliance couplers for outer cone-type cable connection systems**
- **Current transformers (toroidal type)**

C) Cable compartment.

A metal-enclosed, air insulated clad compartment, with:

- **Cable support for single and multiple cable installation**
- **Sufficient space for installation of current**

Circuit-breaker and three-position switch drives are to be designed with mechanical interrogation interlocks and shall include all necessary auxiliary devices (auxiliary switches, releases etc.)

The three-position disconnector (ON-OFF-EARTH) is to be designed with separate manual and/or

motorized drives for the disconnector and earth switch functions.

All switching device drives shall be located outside of the gas compartments, for easy access. Under normal operating conditions for indoor switchgear units in accordance with IEC 50594 and when complying with the specified number of operations, no maintenance is required.

5.2 FUNCTIONAL COMPARTMENT:

- **Circuit-breaker compartment – Gas insulated**
- **Busbar compartment – Gas insulated**
- **Cable connection / transformer clad compartment are to be equipped with individual pressure relief devices - Air Insulated**

5.3 SWITCHGEAR OPERATOR INTERFACES REQUIREMENTS:

- **A standard mechanical user interface, ergonomically Positioned at a convenient height. It must be visible directly without opening of doors etc.**
- **The user interface comprises all the mechanical, panel- related interfaces and continuous interrogating interlocks.**
- **All the basic mechanical ON/OFF of CB, Isolator & earth switch operation, manual spring charge of CB must be possible without opening the door to ensure the operator safety.**
- **Mechanical mimic directly linked to mechanism should be provided at the panel front door.**
- **The basic switchgear unit is to be designed for suitable free-standing installation within a switch room.**
- **The Interlocking shall be as per IEC.**

5.4 FUNCTIONAL INTUITIVE OPERATOR INTERFACE DESIGN

The SF6 Gas insulated switchgear shall be characterized especially by the following operating features:

- **Ergonomic operability**
- **Logical operation**
- **Logical function states**

- **Good visual communication of the overall function and operating states**
- **Optimum operator guidance**
- **All operations can be performed optionally via a motor-operated mechanism**

The mechanical control panel is located at an optimum height for operation and arranged in a recessed position on the switchgear front. Thus, the operating area is clearly visible while no control elements protrude from the switchgear front. The position of the individual elements has been selected according to their function, i.e. according to their allocation to the corresponding device functions. The elements which form part of a switching device, such as position indicators, crank ports or mechanical push buttons, are visually linked by a specific pattern and integrated in a mimic diagram. Mechanical operation is performed the same way as with the habitual operation with stationary switching devices. Separate control elements and mechanical switch position indicators are available for the following functions:

- **Circuit-breaker ON - OFF**
- **Disconnector ON – OFF-EARTH**

5.5. BUSBAR / PANEL CONNECTIONS:

The gas-insulated busbar sections of the single panels shall be connected via single-pole solid-insulated connection elements which allows for easy exchange of a cubicle without SF6 works. Busbar connection to be designed in such a way that no adjacent panels must be moved or opened for exchange of a panel.

Busbar couplings between adjacent panels should be designed with a minimized quantity of electrical sealing joints.

5.6 GAS COMPARTMENT TECHNOLOGY:

A Temperature Compensated Gas Monitoring Device shall be provided on the offered GIS to constantly monitor the Gas Pressure inside the Gas Tank.

By design there should be no need for gas works during the whole time on site, not even for exchanging a centre panel or extending the switchgear at later stage, e.g. no gas handling shall be necessary during the anticipated service life of the switchgear, under normal operating conditions. (The gas-filled clad compartments are to be designed to be maintenance-free and hermetically sealed pressure systems in accordance with IEC 62271-200).

The switchgear panels shall be filled with gas and checked for leakage in the factory. For a proper recycling / emergency replacement, a gas valve in gas compartment has to be provided. In addition, the

standard tools for filling the SF6 Gas also have to be provided.

All the live parts including the VCB, Three position Disconnector, and main busbar shall be encapsulated in stainless steel enclosure filled with SF6 gas.

5.7 INSTALLATION FACILITY:

The panels are to be delivered to site as factory assembled and routine tested units. After linking the panels (or panel assemblies) by the busbar connection system and connection of the power and control cables the system should be ready for operation. No gas filling is required at site during bus bar connection & installation.

6.0 CIRCUIT BREAKERS:

The three-pole vacuum circuit breaker with its maintenance-free vacuum interrupters is installed horizontally in the gas compartment.

The CB shall be spring operated, motor charged, and manually released spring closing mechanism with three pole simultaneous operations. The speed of closing operation shall be independent of the hand-operating lever. The indicating device shall be mechanical type directly linked to the mechanism & shall show the OPEN and CLOSE position of breaker visible from front of the cubicle. The spring charging time of the motor shall not exceed 20sec in case of Vacuum Circuit Breaker. The "TRIP" and "CLOSE" coils shall be of reliable design and low consumption.

The Breakers shall be capable of Making & Breaking the short time current in accordance with the requirement of IEC 62271-100 and latest amendment thereof. The continuous current rating of breaker shall not be less than 630 A for outgoing feeders and incomer feeders. Ratings are IN-Panel at 50 Deg C design ambient.

Comprehensive interlocking system to prevent any dangerous or inadvertent operation shall be provided. Two stage gas density alarm and lockout system with local and remote indication shall be provided.

Emergency mechanical trip push button on each CB shall be provided on panel front & shall be accessible.

Spring charge indication to be provided.

The vacuum circuit-breakers are to be equipped with

- **Spring-stored-energy operating mechanism with motor, auto-reclosing**
- **Mechanical OPEN and CLOSE buttons**

- **1 closing solenoid**
- **1 shunt release**
- **Operating cycle counter**
- **Auxiliary switch with at least 6NO + 6NC available**
- **Auxiliary switch for "spring charged" signal**

The circuit-breaker has to control at least 10,000 Make-Break cycles (One operating cycle of making & Breaking) operations at rated current or 100 breaking operations at rated short-circuit breaking current without maintenance. The mechanical life of the vacuum interrupter has to comprise at least 20,000 operating cycles.

The operating mechanism must be maintenance-free without time limit up to 10,000 operating cycles.

7.0 ISOLATORS AND EARTHING SWITCHES:

Isolators or isolators combined with earthing switches (3 position switches) shall be motor operated. In cases of emergency, manual operation must be possible.

The earthing position for all 3 phases must be visible via a mechanical position indicator (MIMIC) directly connected to the drive shaft on panel front Fascia.

The mechanical operation of isolator / 3 position disconnector switch must be possible with door closed for operator safety.

8.0 INSTRUMENT TRANSFORMERS:

Only Conventional inductive voltage and current transformers according to IEC 60044-1 and IEC 60044-2 or electronic current and voltage transformers to IEC 60044-7 and IEC60044-8 or a combination of both are acceptable. Current & voltage Sensors are not acceptable.

8.1 CURRENT TRANSFORMERS:

The current transformers shall be toroidal-current transformers. The Current Transformers shall be located outside the Gas Compartment.

The transformer ratio, the accuracy class and the performance load to be selected to suit the application requirements.

Outgoing Feeder Variant

Toroidal type Current Transformer

CT Primary Current: 400-200 A

CT Secondary Current: 1-1A

Core 1: Cl-0.2 / 15 VA,

Core 2: Cl-5P20 / 15 VA.

Core3: Cl-5P20 / 15 VA

Incomer Feeder Variant

Toroidal type Current Transformer

CT Primary Current: 400-200 A

CT secondary Current: 1-1-1A

Core 1: Cl-0.2 / 15 VA

Core 2: Cl-5P20 / 15 VA

Core 3: Cl-5P20 / 15 VA

(CT burden shall be provided as per relay and metering requirement and bidder to substantiate this with suitable calculations during detail engineering with CT/ VT Burden calculation)

9.0 MECHANICAL SAFETY

INTERLOCKING FEATURES:

Internal mechanical interlocks of the panel

•With the circuit-breaker closed, the interrogation slide is locked for the disconnector and the earthing switch. (Restriction to the insertion of Hand Crank for Disconnector-Earth Switch when CB is ON)

•The interrogation slide always releases one insertion opening only (disconnector or earthing switch), or both of them are locked. (To ensure that either Disconnector- or Earth Switch operating at a time)

•The crank for the disconnector and earthing switches can only be removed in its appropriate end position.

•When the crank on the disconnector or earthing switch is still in place, or when the interrogation slide is open, the following components are locked:

- ON push button of circuit breaker

- ON pulse is interrupted

10.0 PROTECTION & CONTROL SYSTEM:

Following functions shall be available in the Protection Relay

Incomer & Outgoing Feeders

Current protection (Directional & Non-directional feeder Protection)

*** Over current instantaneous (50)**

*** Over current IDMT (51)**

*** Earth fault instantaneous (50N)**

*** Earth fault IDMT (51N)**

*** Directional Earth fault IDMT (67)**

*** Directional over Current IDMT (67)**

*** Auto Reclosure – 4 Shots**

11.0 BUS PT (IVT)

33kV Bus PT (IVT) shall be housed in a separate Panel and it shall be air insulated.

Voltage protection (Bus VTs shall be Part of Feeder Protection relay)

*** Overvoltage (59)**

*** Under voltage (27)**

*** Frequency Relay (81 O/U)**

Outgoing Feeder (Separate Relays to be provided for Trafo Differential & Over Current & Earth fault)

Differential protection (For Transformer Feeders) in addition to the above

*** Differential protection for transformer (87T)**

*** Restricted earth-fault for transformer (87N)**

Other protections and related functions (Part of Numerical Relay)

*** Lock-out (86)**

*** Trip circuit supervision (95)**

11.1 COMMUNICATION PROTOCOL:

The protection relay shall have communication protocol on IEC 61850 Protocol.

12.0 TESTS:

All tests shall be carried out according to relevant IEC standards.

12.1 TYPE TESTS

The metal-enclosed switchgear is to be type tested at a recognized and internationally well-reputed test laboratory. Type test certificates shall be available for verification as evidence of successful completion of type tests.

The switchgear furnished under this specification shall be fully tested and documented by certified production test reports in accordance with IEC 62271-200.

12.2 ROUTINE TESTS

Tests shall be carried out according to IEC requirements. The following minimum tests apply:

- **Wiring and function tests**
- **Equipment verification tests**
- **Low voltage circuit insulation test**
- **High voltage power frequency test**

12.3 FACTORY INSPECTION TESTS

Notification for factory tests along with list of proposed tests shall be submitted as required.

12.4 SITE TESTS

The site tests shall include the following:

- **Power frequency withstand test (at 80% of the rated power frequency withstand voltage)**
- **Insulation resistance**
- **Functional test of the fully installed and wired equipment delivered.**

BASIC Technical REQUIREMENTS OF 33KV CUBICLE GIS.

Sl. No.	Particulars	33 kV GIS (Cubicle type)
1.		
a)	Type (Model No.)	To be specified by the bidder.
b)	Standard Applicable	IEC-62271-100 / IEC-62271-200
2.	Service Indoor	
3.a	Enclosure - Tank	Stainless steel

3.b	**Enclosure - Panel**	**CRCA**
4.	**Nominal System Voltage**	**33 kV**
5.	**Highest System Voltage**	**36 kV**
6.	**No. of phases and frequency**	**3ph. 50 Hz**
7.	**Busbar material**	**Copper**
8.	**Bus Color code**	**RYB**
9.	**System Earthing**	**Solidly earthed**
10.	**Circuit Breaker Rating**	
10.1	**Continuous Current Rating at 50 Deg C**	**630A**
10.2	**Short Circuit Rating**	**25 kA**
10.3	**Short Circuit duration**	**3 sec**
10.4	**Internal Arc Rating**	**25kA**
10.5	**Internal Arc Duration**	**1 sec**
11.	**Rated making Current**	**As per IEC-62271**
12	**Operating duty**	**O-0.3sec-CO-3 minutes -CO**
13	**Leakage rate per year in gas compartment**	**Less than 0.2%**
12.	**Busbar rating**	**800A**
13.	**Outgoing feeder rating**	**630A**
13.	**Power Frequency Withstand voltage**	**70 kV for 1 minute**
14.	**Impulse withstand voltage (1.2/50 micro sec)**	**170 kV**
15.	**Control Voltage**	**48 V DC**
16	**Spring charge motor voltage**	**48 V DC**
17.	**CT Ratio**	**Secondary Current 1A (Ratio during detail engineering)**
18.	**PT ratio -STAR/ STAR/ Open delta**	**(33//3) / (.11//3) / (. 11/3)**
19.	**Aux. Contacts**	**6 NO + 6 NC**
20.	**Termination**	
20.1	**Incomers**	**XLPE Cables as specified**

20.2 Outgoings XLPE Cables as specified

21. Degree of protection (HV equipment) IP – 65 for Gas Compartment

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS OF 33KV GIS FOR BREAKERS / PANELS

01. Manufacturer's Name and Country of origin

Manufacturing Facilities for GIS in INDIA

Manufacturing Location

02. Manufacturer's Design / type Ref

03. Frequency

04. Rated Voltage

05. Highest system voltage

06. Rated current

07. Short Circuit current rating with duration

08. Certificate or report of short circuit type test

09. Rated operating duty cycle

10. Short Circuit Breaking Current :

(a) Symmetrical

(b) Symmetrical at rated voltage

(c) Asymmetrical at rated voltage

(i) Per Phase

(ii) Average

(iii) D.C.Component

11 Arcing time (at rated breaking current) in ms.

12 Opening time

13 Total break time in milli sec.

(a) At 10% rated interrupting capacity

(b) At rated interrupting capacity

14. Make time in ms.

15. Dry 1 minute power frequency withstand test voltage

(a) Between line terminal and Earth KV rms

(b) Between terminals with breaker contacts open

16. 1.2/50 full wave impulse withstand test voltage

(a) Between line terminal and Earth KVrms

(b) Between terminals with breaker contacts open KVp

17 Control Circuit Voltage DC

18 Power required for Closing Coil at 48 V

19 Power required for Tripping Coil at 48V

20 Whether Trip free or not

21 Whether all the interlocks provided

22 Overall dimensions

23 Total weight of one complete Breaker

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR 33KV CURRENT TRANSFORMERS

01. Manufacturer's Name and country of origin

02. Manufacturer's design Ref / Model

03. Applicable Standards

04. Type

05. Rated Primary current

06. Rated secondary current

07. Rated frequency

08. Transformation ratios

09 Number of cores

10 Rated output (Core wise)

11 Class of insulation

12 Class of accuracy

(a) For metering

(b) For Protection

(c) PS Class

13 Short circuit current rating and its duration

14 One minute power frequency dry withstand voltage

15 1.2/50 micro sec. impulse withstand test voltage

16 One minute power frequency withstand test voltage on secondary

17 Instrument safety factor

18 Type of primary winding

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR 33KV POTENTIAL TRANSFORMERS

01. Manufacturer's Name and country of origin

02. Manufacturer's design reference

03. Applicable Standards

04. Type

05. Ratio

06. Rated Primary voltage

07. Rated secondary voltage

08. Rated frequency

09. Class of accuracy

10. No. of phase and method of connection

11. Burden

12. One min. power frequency dry flash over voltage

13. 1.2/50 micro sec. impulse withstand test voltage

14. Class of insulation

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR NUMERICAL RELAYS

01. Manufacturer's Name and country of origin

02. Manufacturer's design Ref / Type

03. Applicable Standards

04 Current setting range for

(a)Over current relay IDMTL Instantaneous

(b) Earth-fault relay IDMTL Instantaneous

(c) Contact Rating

05. Details on IDMTL characteristics

06 Whether High Set is Transient free

07 Whether separate Time setting for IDMTL / Instantaneous Elements available

08 Whether Relay senses True RMS Current

09. Accuracy for different settings and limits of errors

10 Whether settings site selectable and HMI provided

11 Whether Alpha Numeric LED display

12. Whether Compatible for 48 V DC

13 Whether Compatible for 1 A CT Secondary

14 Whether Self diagnostic features available

15 Whether Communication Port RS 485 Compatible for IEC 61850

16 Whether Blocking characteristics available for blocking the unscrupulous tripping of Upstream Breakers

17. a) Whether relay test block is provided

b) Type of test block with literature

18. Whether draw out type unit or not

19. Types of case

20. Reset time

21. Burden of relay

22. Maximum and Minimum operating ambient air temperature

PART –A.1

33 KV Indoor Switch gear panel for GIS

Technical Specification for 33 KV Indoor Switch gear panel for GIS

1.0 SCOPE:

This specification covers design, engineering, manufacture, testing, and inspection of 33 KV indoor Switchgear panel (provided with Vacuum circuit Breaker, CT, IVT, Disconnector etc) for use in the 33/11KV primary substations under the distribution networks. 33 KV Switchgear (Vacuum breakers,CT,IVT & Disconnector) must be type tested & the Dimension of Type Tested equipment are only be accepted.

1.1 Description of the switchgear panels for GIS.

Indoor switchgears for GIS should be provided in a cubicle, which shall be erected inside a building. Separate switchgear panels for 33 KV GIS and 11 KV AIS system to be considered. Care should be taken during manufacturing of the same as the equipment like VCB, Disconnector switches, CT & IVT are to be installed in the panel individually. Vibration is inevitable as mechanical operation for closing the VCB & disconnectors may cause problem and its performance will be affected. In 33 KV GIS panel SF6 gas will be filled as insulation at 0.3 bar relative pressure to ensure insulation and breaking operation. Sealed for life,the enclosure shall meet the "sealed pressure system" criterion in accordance with the IEC 62271-1. The manufacturer shall confirm that the maximum leakage rate is lower than 0.1% per year.

2.0 STANDARDS:

Expect where modified by this specification, the circuit breakers and the accessories shall be designed, manufactured and tested in accordance with latest editions of the following standards.

IEC/ISO/BS	IS	Subject
IEC:56		
IEC:62271-100 & 200		High voltage alternating current circuit breakers general

Requirement.

IEC:694 IS : 12729 Common clauses of high voltage switch-gear and control gear standards (for voltage exceeding 1000 V).

IEC:60 IS : 9135 High Voltage testing techniques.

I EC:427 IS:13516 Method of synthetic testing of HV .A.0 circuit breakers.

IEC: 1233 HV. AC. Circuit breakers- inductive load switching.

IEC: 17A/CD:474 HV. AC. Circuit breakers- capacitive switching.

IEC:529 IS: 13947 Degree of protection provided by enclosure.

IEC:137 IS: 2099 Insulating bushing for A.C. voltages above 1000V

IEC:233 IS : 5621 Hollow insulators for use in electrical equipment & testing.

IEC:273 IS: 5350 Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V.

IEC:815 IS: 13134 Guide for selection of insulators in respect of polluted conditions.

IEC: 34 IS : 996 A.0 motors

ISO:1460 BS:729 IS:2629 Hot dip galvanizing

IS:2633 Method of testing uniformity of zinc coated articles.

IS: 5 Colour for ready missed paints and enamels

IS: 6005 Code of practice for phosphating or iron and steel.

IEC: 227 IS:1554 P.V.0 Insulated cables for voltages up to and including 1100 Volt.

IEC:269 IS:13703 Low voltage fuses for voltages not exceeding 1000volt.

ISO:800 IS:1300 Phenolic moulding materials.

IS:13118 Guide for uniform marking and identification of conductors and apparatus terminals.

IEC: 185 IS: 2705 Current transformers.

IEC: 296 IS: 335 Specification for unused insulating oil for transformer and switchgear.

IEC:186 IS: 3156 Potential transformers.

CBIP Technical Report No. 88 revised July, 1996 read with amendment issued (April, 99, September, 99

and also any other amendment thereafter) Specification for AC Static Electrical Energy Meter.

CBIP Technical Report No. 88 revised July, 1996 read with amendment issued (April, 99, September, 99 and also any other amendment thereafter): Specification for AC Static Electrical Energy Meter.

This list is not to be considered exhaustive and reference to a particular standard or recommendation in this specification does not relieve the Supplier of the necessity of providing the goods and services complying with other relevant standards or recommendations.

3.0 TYPE OF SWITCHGEAR PANEL

The switchgear boards shall be indoor metal clad, single front, single tier, fully compartmentalized construction comprising of a row of free standing, floor mounted panels. Each circuit shall have a separate vertical panel with distinct compartments for circuit breaker, main bus bars, current transformers cum cable compartment and low voltage compartment. Each compartment of individual cubicle shall be segregated by earth metallic sheet. Cubicle should be type tested for internal arc in all three compartments for 25KA for 1sec as per IEC 62271-200.

4.0 TYPE OF SHEET STEEL & CUBICLE.

The cubicle shall be of bolted construction with minimum thickness of 3.0mm for load bearing & cable entry gland plate portion and for other non-load bearing members such as inter compartment partition etc can be of 2.0 mm. Sheet steel used for fabrication shall be cold rolled carbon annealed only and fabrication shall be done through CNC turret punch press and CNC bending machine. Sheet steel shall be of aluzinc material without painting. Width of cubicle shall be max 1000 mm . All covers & doors shall be of folded design type with viewing window at rear cover (box type) of polycarbonate.

5.0 CIRCUIT BREAKER (VCB): 33 KV

The circuit breaker (VCB) shall be mounted on a withdrawable truck which shall roll out horizontally from service position to isolated position with ease and it shall also be possible to take out the breaker truck from cubicle smoothly on to the floor. It is preferred to provide with guides for withdrawal and insertion of truck into the cubicle with ball bearing arrangement on the top of the truck. Circuit breaker shall be of vacuum only and the truck shall have distinct 'SERVICE' and 'TEST' position. Special multi point hinged locking arrangement shall be provided to prevent opening of door in the event of internal arc in breaker compartment. Isolation shall be horizontal.

All the three interrupters of individual phases shall be fully encapsulated Circuit breaker shall be

vacuum type only. No separate fiberglass sheet barrier to be used.

It shall be operated through a common motor wound spring charged mechanism with electrical release coil for closing and shunt trip coil for tripping. Operating mechanism must have manual charging, closing and tripping facility with the provision locking facility in push to close & push to trip mechanical push button.

The mechanism shall be such that motor will automatically recharge the mechanism springs after a closing operation enabling breaker to perform OCO operation. The charging time of motor shall be less than 15 secs, making it suitable for rapid auto reclosing duty. Mechanical push to trip button shall be provided for manual tripping with front door closed. All the 'MS' components of circuit breaker mechanism shall be treated properly with passivation for longer life even in adverse climatic condition. Yellow passivation shall not be acceptable. All mechanism springs shall be powder coated. Plating on mechanism spring is not acceptable .The normal current rating of circuit breaker shall be 630 Ampere, SCC 25 KA for 3 Sec with duty cycle of 0-0.3 Sec- CO-3 min-CO & the same shall also be indicated in panel name plate. The mechanism and the connected interrupters shall satisfy the mechanical endurance requirements of IEC:62271 - 100 & 200and all additional requirements specified herein.

5.1 Interrupting media Vacuum:

In vacuum circuit breakers, facilities shall be provided for monitoring the contract erosion and any change in contact gap. The vacuum bottles shall be easily replaceable on site and the mechanism shall be conveniently adjustable to permit resetting the contact gap. The current rating of the vacuum interrupters shall be 630Amp.

The vacuum circuit breaker poles shall be sealed to prevent contamination of the spaces surrounding the interrupters. The bidder shall demonstrate how this is achieved by supplying technical details with the bid.

The circuit breakers shall be fitted with spring mechanism type. The inherent design of the circuit breakers shall be such that they shall satisfactorily perform all test duties and interrupt out-of-phase current and produce very low over voltage (<2.5 p.u) on all switching circuits, capacitive and inductive to IEC:62271 - 100 & 200 and other associated standards mentioned in the clause of this specification.

5.2 Basic Technical Requirements of 33 KV VCB

SI. No	Particulars	Requirements
1	Service type	Indoor

2 **No. of Poles 3**

3 **Nominal system voltage 33KV**

4 **Highest system voltage 36KV**

5 **Rated normal current at 50°C**

i) **For Bus-bar of Circuit Breaker 800A**

ii) **For Interrupter 630A**

iii) **For Outgoing Feeders/ For Incomer & Bus Sections 630A**

6 **Rated short circuit breaking current (rms) 25KA**

7 **Rated short circuit making current (peak) 63KA**

8 **Rated short time current withstand capability for 3 sec. 25KA(Panel)/25KA (Interrupter)**

9. **Rated insulation level:**

i) **One minute power frequency withstand voltage to earth (wet and dry) rms 70KV**

ii) **Impulse withstand voltage to earth with 1.2/50psec, wave of +ve and —ve polarity (Peak) 170KV**

10 **First — pole — to clear factor 1.5**

11 **Rated operating sequence (for auto reclosing) 0-0.3 Sec- CO-3 min-CO**

12 **Maximum break time 3 cycles**

13 **Rated out of phase breaking current 25% of the symmetrical short circuit breaking current**

14 **Maximum pole scatter 10 mili seconds**

15 **Rated Auxiliary supply for spring charge motor, lamp & heater circuit. 230V A.C**

16 **Rated supply voltage for trip/close coil 48V D.C**

17 **No load line/cable breaking current capacity 25A**

18 **No load transformer breaking current capacity 25A**

19 **Minimum creepage distance (mm) 900 mm**

20 **Minimum protected creepage distance (mm) As Per IS**

6.0 OPERATING MECHANISM

General

6.1 The operating mechanism of the circuit breaker shall be motor wound spring charged type. It shall be electrically and mechanically trip free with anti-pumping device (as per IEC:694 definition). All working parts in the mechanism shall be of corrosion resistant material. Self-lubricating, wearing resistant bearings shall be provided in the mechanism.

6.2 The mechanism shall fully close the circuit breaker and sustain it in the closed position against the forces of the rated making current and shall fully open the circuit breaker without undue contact bounce at a speed commensurate with that shown by tests to be necessary to achieve the rated breaking capacity in accordance with IEC:56 or IS:13118. The mechanism shall be capable of being locked in either the open or closed position. The mechanism shall be capable of fully closing and opening again after the auto-reclose time interval specified as 0.3 second in this specification.

6.3 Spring mechanism (In case of Spring Charged VCB)

6.3.1 The spring operating mechanism shall be with spring charging motor, openingand closing springs with limit switches and all accessories necessary for automatic charging. In normal operation, recharging of the operating springs shall commence immediately and automatically upon completion of the closing operation so that a complete sequence of closing and opening operation should be possible.

6.3.2 It shall be possible to hand charge the operating spring with the circuit breaker in either the open or closed position conveniently from the ground level. Closure whilst a spring charging operation is in progress shall be prevented and release of the springs shall not be possible until they are fully charged.

6.3.3 The state of charge of the operating springs shall be indicated by a mechanical device showing 'SPRING CHARGED' when closing spring is fully charged and operation is permissible and 'SPRING FREE' when closing spring is not fully charged and the operation is not possible. Provision shall be made for remote electrical indication of 'Spring Charged' and 'Spring Free' conditions.

6.3.4 The operating mechanism shall be such that the failure of any auxiliary spring shall not cause

tripping or closing the circuit breaker but shall not prevent tripping against trip command.

6.3.5 Closing action of the circuit breaker shall charge the opening spring ready for tripping. From the close position with spring charged, one open-close-open operation shall be possible without recharging the spring.

7.0 Operation and controls

The breaker shall normally be operated by electrical control with electrical tripping by 2 Nos.shunt trip coil. Provision shall be made for local electrical operation and mechanical operation.

The following facilities shall be provided in the circuit breaker local control cabinet:

- **ON/NEUTRAL/ OFF control switch or ON and OFF push buttons. The push buttons shall be momentary contract type with rear terminal connections. The close push button shall be of green colour and the open push button red colour.**

- **MECHANICAL EMERGENCY TRIP DEVICE: suitable for manual operation in the event of failure of electrical supplies. The device shall be accessible without opening any access doors and distinctly labeled. It shall be shrouded and protected against inadvertent operation.**

- **Means shall be provided for manual operation of these circuit breakers during failure of auxiliary power in addition to electrical operation.**

Means shall be provided to prevent the mechanism from responding to a close signal when the trip coil is energized or to reclosing from a sustained close signal either opening due to a trip signal or failure to hold in the closed position.

The circuit breaker shall be able to perform 10,000 operating cycles at no load in accordance with IEC:17A/474/CD for circuit breakers for auto reclosing duties.

8.0 Motor

The motor for spring charging shall be single phase 230 Volt A. C motor. Continuous motor rating shall be at least ten percent above the maximum load demand of the driven equipment. It shall remain within its rated capacity at all operating points that will arise in service. It shall be protected by MCB. The motor shall comply with IEC: 34 or IS:996.

9.0 THERMAL RATING OF SWITCHGEAR

All current carrying parts including breaker Relay shall be governed by IEC 62271-1. All isolating

contacts shall be silver plated.

10.0 AUXILIARY POWER SUPPLY:

The operating mechanism shall be suitable to operate with the following auxiliary Power supplies.

a) 230V,50Hz Single phase A.C For spring charging motor

b)DC supply 48 Volts- For close and open coils.

The DC supply shall be from Battery Bank.

The mechanism shall be designed to operate satisfactorily despite fluctuations of Auxiliary power supplies as under:

AC supply: Voltage From 115% to 85% of normal voltage

Frequency: ±3% of normal frequency

DC supply: Voltage From 120% to 70% of normal voltage

11.0 INTERLOCKS

Circuit breaker can be inserted only in open position. Likewise circuit breaker in closed position cannot be withdrawn. Attempt to draw out closed breaker shall not trip the breaker.

The circuit breaker shall operate only in one of the three defined positions i.e. service, test and isolated. The breaker shall not close in any of the intermediate positions.

The circuit breaker cannot be inserted into service position till auxiliary contacts are made. Similarly interlock shall prevent auxiliary contacts from being disconnected, if circuit breaker is in service position.

12.0 SAFETY SHUTTERS

Safety shutters shall be metallic and shall be provided to cover up the fixed High voltage contacts on bus bar and cable sides when the truck is moved to Test / isolated position. The shutters shall move automatically, through a Linkage with the movement of the truck and shall be of gravity fall type only. It shall be possible to padlock shutters individually.

13.0 FIXED ISOLATING CONTACTS

Switch gear cubicle shall have seal off bushing arrangement between the circuit breaker compartment and bus bar / C.T. cum cable compartment, i.e. the fixed isolating contacts shall be embedded in epoxy cast bushing so the these act as seal off bushing to prevent transfer of arc from one compartment to the other in the event of internal arc within the cubicle & must be tested for internal arc 25 kA for 1 sec in

all three HV compartments as per new IEC 62271- 200.

14.0 AUXILIARY SWITCH AND AUXILIARY PLUG &SOCKET

There shall be minimum 6NO and 6NC contacts in breaker auxiliary switch (10 amps DC rating) shall be provided in each circuit breaker.

15.0 ELECTRICAL & MECHANICAL POSITION INDICATION.

In addition to mechanical position indication in breaker for test and service position, electrical indication shall also be provided through limit switch. There shall be minimum 2NO +2 NC contacts available in each position for electrical indication and for any other interlocking purpose.

16.0 CURRENT TRANSFORMER

Current transformers, three per circuit breaker, shall be of indoor, single phase,

resin cast and shall comply with IEC:185 and IS:2705, suitable for operation in hot and humid atmospheric conditions described in service condition. They shall be mounted inside the panel.

16.1 Core

16.1.1 High grad non- ageing cold rolled grain oriented (CRGO M4 or better grade) silicon steel of low hysteresis loss and permeability shall be used for the core so as to ensure specified accuracy at both normal and over currents. The flux density shall be limited to ensure that there is no saturation during normal service.

16.1.2 The instrument security factor of the core shall be low enough so as not to cause

damage to the instruments in the event of maximum short circuit current.

16 . 2 Windings

16.2.1 The secondary windings shall be made of electrolytic copper with suitable insulation. The conductor shall be of adequate cross- section so as to limit the temperature rise even during short circuit conditions. The insulation of windings and connections shall be free from composition liable to soften, coze, shrink or collapse during service.

16.2.2 Polarity shall be indelibly marked on each current transformer and at the lead and termination at associated terminal blocks. CTs with multi ratio winding shall be clearly tabulated to show the connections required for different ratios. Similar numbers shall be marked on terminal block arrangement and wiring diagram. Apart from the above marking and those to be provided as per IEC 185 or IS 2705, other markings shall be provided in consultation with owner.

16.2.3 The continuous current rating of the primary winding shall be one hundred and twenty percent of the normal rated current.

16.2.4 Secondary windings of current transformers shall be used for metering,instrumentation and protection and shall be rated for continuous current of one hundred and twenty percent of normal rated current of primary winding.

Current transformers shall be three core window/bar primary for higher rating or wound primary for lower rating. Maximum VA burden shall be of 15 VA and shall be rated for full short circuit current 25 KA for 1 second. Out of three cores one Core having 0.2 class (Metering) & other two cores having 5P20 (Protection) class accuracy.

Current Ratio: 400-200/1-1-1 Amp

No. of Cores: 03

Burden: 15 VA for each core

Technical Requirements

SI. No	Particulars	Requirements
1	Function	To control 33 KV Feeder & HV side of 33/11KV power transformers of ratings between 3.15MVA to 12.5MVA
2	Requirement	The CTs in the 33 KV Indoor VCB switchgear panel should have three cores as follows.
3	Transformation Ratio	Category- A (For TFR) 400-200/1-1-1-A Category- B (For Feeder) 400-200/1-1-1 A
4	Rated Burden (VA)	Core:1: 15 VA , Core:2: 15 VA, Core:3:15 VA Core:1: 15 VA , Core:2: 15 VA, Core:3:15 VA
5	Class of Accuracy	Core:1: 0.2 , Core:2: 5P20, Core:3: 5P20 Core:1: 0.2 ,

Core:2: 5P20,

Core:3: 5P20

6 Instrument Security Factor Core- 1:- <5

Core- 1:- <5

7 Purpose Core:1: Metering ,

Core:2: Differential,

Core:3:O/C& E/F & REFCore:1: Metering ,

Core:2: Spare

Core:3:O/C& E/F & REF

8 Rated/Highest system Voltage 33/36 KV

9 Short Time Rating 25KA rms for 3 seconds

10 Power frequency 1 min voltage withstands level/ Insulation Level:

-Impulse Voltage1.2/50ps wave withstand level - 70 KV/170KV

17.0 Tests

The CTs shall be tested in accordance with the requirements of the type tests and routine tests as per the latest issues IEC:185 or IS:2705.The tests to be conducted shall include:

17.1 Type Tests:

- **Lightning impulse voltage:**
- **Power frequency wet withstand voltage;**
- **Temperature rise;**
- **Short time current;**
- **Composite error;**
- **Accuracy test (for measuring core);**
- **Instrument security current (for measuring core);**

17.2 Routine tests

- **Verification of terminal marking and polarity;**

- **Power frequency dry withstand test on primary windings;**
- **Power frequency dry withstand test on secondary windings;**
- **Power frequency dry withstand test between sections;**
- **Over voltage inter-turn test;**
- **Composite error;**
- **Turn ratio;**
- **Accuracy test (for measuring core);**
- **Current error and phase displacement (for protection core);**
- **Knee point voltage and magnetizing current test (for PS class);Secondary winding resistance (for PS class).**

18.0 IVT:

The 33 KV Indoor voltage transformers are required to meet the following basic technical requirements (Reference standards: IEC:186, IS:3156 and associated standards listed in the specification):

SI. No	**Particulars**	**Requirements**
1	**Type**	**Single phase**
2	**Nominal system voltage, phase to phase**	**33 KV**
3	**Application**	**Instrumentation, Metering and Protection**
4	**Number of secondary windings**	**2**
5	**Rated normal burden*-(Core-I/II)**	**50VA/15VA**
6	**Rated primary voltage**	**33000V/√3**
7	**Rated secondary voltage**	**110V/√3-110V/√3**
8	**Class of accuracy-(Core-I/II)**	**0.2/3P**
9	**Rated insulation level: (Primary winding) (Phase to earth)**	

i) One minute power frequency withstand voltage to earth (wet and dry) rms 70KV

ii) Impulse withstand voltage to earth with 1.2/50 ilsec wave of +ve and —ve polarity (peak) 170KV

10 One minute power frequency withstand voltage of secondary winding (rms)

i) Between phase to earth 3KV

ii) Between sections 3KV

11 Rated voltage factor

i) Continuous 1.2

ii) For 30 seconds 1.5

*** The burden indicated is the minimum acceptable to the Employer. The Contractor shall ensure that the rated outputs of the voltage transformers are adequate to meet at least 120 percent of the connected load (burden).**

18.1 GENERAL

The voltage transformers to be supplied under this specification shall be of Indoor, single phase Polycrate complying with IEC:185 and IS:3156 suitable for operation in hot and humid atmospheric conditions described in this document.

18.2 Duty requirement

33 KV Voltage transformer for all the indicating instruments and measuring meters in the primary substation on 33 KV side. It shall be of indoor, 1-Phase or 3- phase Poly- crate type.

18.3 Core

High grade non-ageing cold rolled grain oriented (CRGO-M4 or better) silicone steel of low hysteresis loss and permeability shall be used for core so as to ensure accuracy at both normal and or over Voltages. The flux density shall be limited to 1.6 Tesla at normal voltage and frequency. There shall be no saturation at any stage during operation.

The instrument security factor of the core shall be low enough so as not to cause damage to the instruments in the event of maximum short circuit current or over voltages.

18.4 Windings

The primary and secondary windings shall be electrolytic copper of high purity and conductivity and

covered with double paper insulation. The conductor shall be of adequate cross-section so as to limit the temperature rise even during maximum over voltages.

The insulation of windings and connections shall be free from composition liable to soften, ooze, shrink or collapse during service.

18.5 The secondary windings of the voltage transformers shall also be suitable for continuous over voltage corresponding to the maximum system voltage at the primary winding. The winding supports shall be suitably reinforced to withstand normal handling and the thermal and dynamic stresses during operation without damage.

18.6 The voltage transformer secondary circuits will be taken out to form the star point and earthed at one point outside the voltage transformers.

18.7 Both primary and secondary winding terminals shall be clearly and indelibly marked to show polarity in accordance with IEC:186. The connections required for different secondary windings in case of multi-winding voltage transformers shall be clearly indicated in terminal blocks and the wiring diagrams.

18.8 Fuse protection

The Primary winding shall be protected by HRC Fuses in suitable holder designed by the manufacturers. The secondary windings shall be protected by HRC cartridge fuses in fuse holder consisting of carriers and bases. The carriers and bases shall be of high grade flame retarding and non-hygroscopic moulded insulating materials with hard glass surface. Each fuse shall be identified with engraved plastic label. Potential transformer shall be 3nos single phase & there shall be two cores. One core having 0.2 Class (Metering) & other having 3P Class (Protection). Bus P.T. shall be mounted in a separate draw out carriage.

19.0 TEST AND INSPECTIONS

19.1 The voltage transformers shall be tested in accordance with the requirements of the type tests and routine tests as provided in the latest issues of IEC:186 or IS:3516.

The tests to be conducted shall include;

19.2 Type tests:

- **Lightning impulse voltage test;**
- **High voltage power frequency wet withstand voltage;**

- **Temperature rise test;**
- **Short circuit withstand capability test;**
- **Determination of limits of voltage error and phase displacement**

19.3 Routine tests:

- **Verification of terminal marking and polarity;**
- **Power frequency withstand tests on primary winding;**
- **Power frequency dry withstand tests on secondary winding;**
- **Power frequency withstand tests between sections;**
- **Determination of limits of voltage errors and phase displacement;**
- **Insulating Resistance measurement.**
- **Partial discharge measurement.**

Voltage Ratio: 33000/√3 / 110/√3-110/√3.

No. of Cores: 02

Burden: 50 VA for Metering & 15 VA for protection

20.0 PRESSURE DISCHARGE FLAPS

Pressure discharge flaps shall be provided at the top in all high voltage compartments for the exit of hot gases in the event of internal arc in any of the compartments.

21.0 BUSBARS

Bus bar material shall be of high conductivity electrolytic copper only and accessibility of the same shall be from top only. All bus bars shall be tubular /rectangular design insulated with heat shrinkable BPTM compound sleeves and joints shall have sufficient clearances in order to meet the BIL (70kV RMS and 170 kVp) withstand. Phase identification shall be made at the end by coloured tape.

22.0 EARTH BUS

There shall be a continuous copper bus at the bottom of the panel. Earth bus shall be robust and shall be capable of carrying full short circuit current 25 KA for 1 second. Doors, covers and all non-current carrying metallic parts shall be earthed through flexible copper breading of adequate size. This also includes instrument casing and cable armour which are also connected to the earth bus. Earth bus

must be tested for 25 KA for 1 sec.

23.0 BUS & CABLE EARTHING

Each feeder shall be provided with fault make type Earth switch duly interlocked with circuit breaker. Unless the breaker is tripped & brought to test position, the earthing switch cannot be operated. Earth Switch should be fully type tested for STC withstand of 25kA for 1 seconds.

24.0 CABLE COMPARTMENT

It shall be at the rear side with rear bolted box type back covers. There shall be an inspection window at the rear back cover enabling operator to have visual inspection without opening back cover in live condition .Viewing window at the rear side shall be of poly carbonate only and shall be tested for internal arc. The gland plate of cable chamber shall be of minimum 3mm thickness MS sheet in two halves section.

Sufficient headroom of 750 mm shall be provided for cable termination.

25.0 LOW VOLTAGE COMPARTMENT

Low voltage compartment shall be mounted at the front on the top of breaker compartment and shall also have hinged type of door. All wiring shall be routed through PVC ducts and shall be terminated on to stud type terminal with plastic cover. For current transformer terminal shall be disconnecting link type only. The wire shall be of 1.1KV grade and suitable for 2KVrms for 1 minute power frequency high voltage.

26.0 CONTROL AND POWER CABLE ENTRY

Control cable entry shall be from front and there should be a possibility of terminating to LV chamber from both right hand and left hand side. Power cable entry shall be from rear bottom. Provision shall be available for entry of power cable from rear bottom.

The CR Panel (Instrument Chamber) should be mounted on top of the VCBPanel.

Control panel (inbuilt) with protective relay and meter shall be provided by the supplier suitable for above breakers. The equipment shall have protection scheme with the following relays:

27.0 PROTECTION RELAYS FOR FEEDER:

The offered relays shall be multifunction numerical type only. The aux relays for lockout, transfer fault indication etc can be electro-mechanical type. All Numerical relays shall have minimum following features

- **Relay shall be IEC 61850 compliant Numerical & suitable for 1A secondary CT current & 110 V**

IVT secondary supply.

27.1 Over current & Earth fault relay:

- **Relay shall have 3 phase directional and non-direction (site selectable feature) over current and earth fault protection. It shall have three stages with first stage programmable as IDMT or DT. The second and third stages shall be programmable as DT or instantaneous.**

- **Relay shall have thermal overload protection.**
- **Relay shall have negative sequence over current protection.**
- **Relay shall have adoptive & creative logics for meeting the requirement**
- **Relay shall have 4 shots auto reclose function built-in**
- **Relay shall be with under and over voltage protection elements provided**
- **Relay shall have under frequency protection facility at least two stages.**

Details are given below separately:

28.0 PROTECTION RELAYS FOR TRANSFORMER:

The offered relays shall be multifunction numerical type only. The aux relays for lockout, transfer fault indication etc can be electro-mechanical type. All Numerical relays shall have minimum following features

- **Relay shall be IEC 61850 compliant Numerical & suitable for 1A secondary CT current & 110 V IVT secondary supply.**

28.1 Over current & Earth fault relay:

- **Relay shall have 3 phase directional and non-direction (site selectable feature) over current and earth fault protection. It shall have three stages with first stage programmable as IDMT or DT. The second and third stages shall be programmable as DT or instantaneous.**

- **Relay shall have thermal overload protection.**
- **Relay shall have negative sequence over current protection.**
- **Relay shall have adoptive & creative logics for meeting the requirement**
- **Relay shall have 4 shots auto reclose function built-in**
- **Relay shall be with under and over voltage protection elements provided**

- **Relay shall have under frequency protection facility atleast two stages.**

Details are given below separately:

28.2 Transformer Differential Relay:

The Transformer Differential protection relay shall consist of two winding protection, two REF protections, V/f protection etc.

Details are given below separately:

28.3 Specification for Numerical Directional & Non-Directional Over Current and Earth Fault Protection.

28.3.1. General

A comprehensive communicable numerical protection should be offered by the relay. High level of security should be built-in the relay to avoid any mal operation causing over protection of the system or any non-operation of the relay causing under protection. Should have flexibility to customize the relay for intended applications as may be desired at site, in other words the relay should not have very limited features rendering it equipment specific. The relay should have high immunity to electrical and electromagnetic interference and also continuous supervision of hardware and software should be done to ensure enhanced system reliability and availability, the relay should have auto diagnostic fault indication to facilitate fault location and repair after detection of internal relay fault. The compulsory features required by the relay to be fulfilled are listed as below

28.3.2. Application

The relay will be required for applications where time graded Directional & Non-Directional (site selectable feature) o/c and e/f protection is required. The Directional & Non-Directional (site selectable feature) earth fault protection should provide suitable sensitivity for most systems where the earth fault current is limited. Typically the relay should be applied for all incoming transformers, capacitors and plant feeders for any application. The relay should be designed in such a way that it operates for a wide range of AC and DC auxiliary power supplies.

28.3.3 General requirements

The relay in addition to protection and control should display and store all parameters necessary for

post fault analysis. The relay shall have a back light LCD display. It shall be possible to view the measurement values. The relay shall record all the events affecting the relay performance. All the time stamped data should be available via a RS232 serial communication port for access locally and/or remotely via a computer. All the events, faults and disturbance records shall be extracted via a RS485 /RS232/USB/RJ45(Ethernet)serial port.

28.3.4 Operating Principle

The sampling frequency of the digital/analogue converter should be synchronised to power frequency by suitable frequency tracking methods to improve both accuracy of measurement and harmonic rejection. The relay should necessarily have software filtering to prevent induced ac signals in the external wiring causing operation of logic inputs.

28.3.5. Functional Description

a) Directional O/C protection:

The relay should have 4 independent time delayed Directional O/C stages which can be selectable either as directional or non-directional. MTA shall be adjustable anywhere within -180 degrees to + 179 degrees. The first and second stages shall be programmable to have either a DMT characteristics or IDMT characteristics (as per IEEE/IEC Standards) described as follows,

1. The low set phase current should start when the current of any phase exceeds the set value.

The first and the second current stage shall have a current setting range of 0.10 - 4.00 In and time setting range of 0.06 sec to 300 sec.

2. The Third, fourth stage of protection shall be with instantaneous operation or DT having a current setting range as 0.1 to 20 In and a time delay of 0.06 sec to 300 sec for stage III and IV. These stages may have the flexibility to be configured for a busbar protection scheme using blocking logic at a later date. Facility available in the relays for this flexibility may be highlighted.

b) Directional Earth fault protection:

The relay should have at least 2 independent time delayed Directional/Non –Directional E/F stages suitable for networks with different earthing types(solidly earthed, resistive earthed, Petersen coil earthed systems).The relay shall also be suitable where ever a selective and sensitive earth fault protection is needed. It shall also be possible to detect intermittent earth faults. MTA shall be adjustable anywhere within -180 degrees to + 179 degrees. The first and second stage shall be programmable to have either a DT characteristics or IDMT characteristics described as follows:

The low set phase current should start when the current of any phase exceeds the set value.

Both the stages Shall have a current setting range of 0.01 to 8 IoN and time setting range of 0.1 sec to 300 sec. The lower setting is critical to take care of systems which have low earth fault currents. Additionally there shall be four non-directional earth fault stages where the first stage can be programmed either to IDMT or DT and the rest 3 stages shall be of definite time type.

c) Sensitive Earth Fault/Restricted Earth Fault.

The relay shall have five CT input to take care of transformers applications where Restricted Earth fault and standby earth fault is required. It shall be possible to either measure the value of neutral current through available C.T I/Ps or derive it internally within the relay and use the same for applications as described above. The Relay shall be able to accept input from Core balance current transformer to detect earth faults of very low amplitude. The setting range shall be settable to a minimum of 0.005 Amps. The relay shall have restricted earth fault protection feature of high Impedance type.

d) Over Voltage & Under Voltage

If the system goes for very high under and over voltages in case of Supply or Load unbalance it shall be possible to grade the system for Voltage protections. Relay shall have 3 under voltage stages and 3 over voltage stages respectively.

e) Residual voltage protection:

The relay shall have at least 2 residual voltage stages in order to give an unselective backup for existing earth fault protection. The stages shall have a setting range of 1 – 60 %U0N with a time delay settable from 0.3 – 300.0s (in steps of 0.1 s).

f) Under frequency/Over Frequency /ROCOF:

The relay shall have four frequency stages out of which it shall be possible to program at least 2 of them to under or over frequency to be suitable for various load sharing applications. The under frequency stages shall be settable any where within a frequency range of 40.0 - 60.0 Hz. With the flexibility to block any mal operation on event on under voltage. All stages shall be of definite time type with a setting range of 0.10) – 300.0 s (in steps of 0.02 s).

The relay shall also have the facility to detect a rate of change of frequency for load shedding applications , to speed up operation time in over- and under-frequency situations and to detect loss of grid. Pick up setting shall be settable from 0.2 – 10.0 Hz/s (step 0.1 Hz/s).

g) The relay in addition to the above basic function should also provide the following functions,

1. The relay should have the protection feature which allows the relay to trip the upstream circuit breaker when a local breaker failure condition is detected and should be energised both from operation of the relay or by an external trip.

2. The relay shall also have the feature of auto reclosure with independently programmable dead time and reclaim time for each shot. The function shall be programmable for at least 4 shots of auto reclosure.

3. The relay should measure the following standard quantities,

i.) It shall be possible to view the current voltage phasors as well in the graphical mimic display.

ii.) Phase current(Positive, negative and zero sequence currents)

iii.) Phase Voltage(Positive, negative and zero sequence voltages)

iv.) Neutral current

v.) Frequency

vi.) Active and Reactive Power

vii.) Power factor

viii.) Harmonics of current and voltages which shall be possible to view as a diagram on the display.

ix.) Relay should be able to measure the true RMS value up to 15th harmonics

4. The relay shall have atleast two independent setting groups. The relay shall automatically switch from one setting group to another depending on system conditions (such as failure of incomer supply, which causes fault level to decrease etc.)

5. The relay shall have a facility to have communication on IEC61850 protocol through redundant rear port for SAS connectivity without use of any external converter. Further, the test levels of EMI as indicated in IEC 61850 shall be applicable to these. The relay shall support peer to peer communication.

The relays shall generate GOOSE messages as per IEC 61850 standards for interlocking/tripping and also to ensure interoperability with third party relays.

a) 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.

b) Goose signals shall be freely configurable for any kind of signals using graphic tool/user friendly software.

Bidder shall also ensure adequate hardware.

7. The Relay shall have facility for Time synchronization on IRIG B port.

h. Relay hardware:

The relay should be modular type. It will be installed on the top of the switchgear panel. Standard terminal blocks should be located at the rear of the relay providing connections for all input and output circuits.

i. Output relays:

The relay should have up to 2-CT inputs. They should provide atleast 6 optically isolated inputs and atleast 7 programmable outputs. They should be arranged in response to any or all of the available functions by suitably setting the output relays. The protection and control function to which these relays respond should be selectable via the menu system of the relay. One output relay shall be permanently assigned for self-supervision.

H. The Relay shall also have the following functionality/Features..

*** Thermal overload protection.**

Negative sequence over current.

Permanent Self-Test.

x.) Circuit breaker maintenance information.

xi.) Broken conductor detection by measuring I2/I1 .

xii.) Cold load pickup function to change the settings when the protected object is connected to a network i.e., at starting allowing the set value being lower than the connected inrush current.

xiii.) The relay shall also have the feature of Inrush blocking through 2nd harmonic detection.

xiv.) Disturbance recorder & Event recorder facilities.8 fault records shall be possible in each protection stage.

xv.) Front RS232/USB port for communication to LAPTOP .

xvi.) The relay shall have a facility for C.T. Supervision, P.T. Supervision and Trip Circuit Supervision.

Relay shall support customer-defined programmable logic for Boolean signals. It shall be possible to form equations using AND, OR, NOT gates.

29.0 Detail on Differential Protection:

a) Transformer differential protection scheme shall be of numerical relay (low impedance type) suitable for two winding Transformer.

b) Shall be triple pole type with faulty phase identification/indication.

c) Shall have an operating time not greater than 30ms at 5 times the rated current.

d) Shall have three instantaneous high set over current units.

e) Shall have an adjustable bias setting range of 10 – 50%.

f) Suitable for rated 1 amp current.

g) Shall have 2nd harmonics or other inrush restraint features and also should be stable under normal over fluxing conditions. Magnetizing inrush inrush features shall not be achieved any intentional time delay.

h) Shall have an operating current setting of 15% or less.

I) Shall have an internal feature of the relays to take care of the angle and ratio correction.

j) Shall have provision of self monitoring and diagnostic feature.

k) Shall have provision of recording features to record graphic from of instantaneous values during faults and disturbances for the pre and post fault period and during running conditions.

l) Current in all the windings in separate analog channels and voltage in one channel.

The disturbance recorder shall have the facility to record the following external digital channel signals apart from the digital signals pertaining to differential relay.

*** REF protection operated.**

*** HV breaker status**

***LV breaker status.**

*** Buchholz /OLTC Buchholz /PRV alarm/trip.**

*** WTI/OTI alarm/trip**

*** MOG alarm**

Necessary hardware and software for automatic up-loading the data captured by disturbance recorder to the personal computer.

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.

Shall have feature of two nos. of independent REF protection for two winding power transformers.

This function should be provided to maximize the sensitivity of the protection of earth faults. The REF function should be a Low impedance element. 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.

Shall have feature of v/f protection of different stage setting.

1. over fluxing protection to suit the transformer.

2. Wide range of setting to suit the worst condition of the highest system voltage and worst system frequency).

3. Alarm and trip setting separately.

4. Thermal slope setting.

Shall be numerical type and shall have continuous self-monitoring and diagnostic feature.

29.1 Additional Protection Function

1, Differential Unit protection (87) which includes

***Three phase differential protection**

***Digital correction of vector group and Ratio**

***Homopolar component filter, which is used to remove the Homopolar component from the phase currents.**

***Instantaneous Differential Trip.**

***2nd, 4th and 5th harmonic restraint features.**

2, Restricted Earth Fault Protection (87G)

3, Current Unbalance (46), which protects against current unbalances resulting from anomalies in the power system or unbalanced loads.

4, Thermal image (49), which protects the transformer against damage resulting from heating up during overloads.

5, Breaker Failure Protection(50BF),Which verifies the breaker correct actuation for clearing a fault,otherwise, the trip of the necessary breakers to clear that fault

6, Phase over current protection (3*50/51) with time delayed and two instantaneous levels, as a backup protection for Transformer external faults, if external faults are not cleared by primary protections

7, Over Excitation protection (V/Hz) (24) with two independent levels, which prevents transformers from at a greater flow density than that for which they were designed. And also avoiding heating and consequent damage in the transformer due to over excitation.

8, Over Excitation protection (5th harmonic)

9, Neutral Earth fault with time delayed and Instantaneous for each winding as for backup protection

10, Frequency protection (81O/U)

11, Over Voltage protection (59)

12, Ground Over current Protection (50G/51N), which act as an over current function by using the current measured at the grounding of the power transformer, being its function to detect faults to earth.

29.2 Automatisms

1, The user can configure up to 15 logic signals that can be assigned to output relays, Led's or input for protection functions blocking features.

2, A lockout relay (86) function is needed. Relay programme with this function will act when differential unit acts (At instantaneous) so that they can be used as a locking device for breaker close circuits.

29.3 Monitoring Functions

1, Breaker monitoring needed

2, Trip and close circuit supervision needed for detecting any anomalies in the circuit with the open or close.

3,The unit temperature measurement supervision needed(Optional).

4,The Battery voltage supervision needed.

29.4 Data Acquisition Functions

I. The following Measurements should be available

***Current in each winding (A)**

***Average current in each winding (A)**

***Differential current (A)**

***Voltage (KV)**

***Frequency (Hz)**

29.5 Oscillograph data recorder

I. All the units should needed an Oscillograph data recorder with the next characteristics,

***Each Record comprises the samples from analog signals and the status of 32 selectable digital signals**

***16 or more samples per cycle.**

***Configurable pickup.**

***Records in nonvolatile memory.**

***The disturbances are collected and exported in COMTRADE format.**

II. Event Recording:

The relay should store minimum 8 numbers or more last events in a nonvolatile memory, which can retrieved from a PC with the following data,

***Date and time of the Event.**

***Descriptive text of Event.**

***Values of Electrical parameters.**

III. A queue of minimum 8 disturbance records is stored in the nonvolatile memory.

IV. Fault Recorder

Minimum 5 or more faults are stored in the nonvolatile memory, with the following data

***Date and time of the fault pickup, beginning and end.**

***Prefault and fault values of electrical parameters.**

***Duration and Type of Fault.**

***Level of Electrical parameters at the faults occurrence time.**

V. Time synchronization

Via communication* Via demodulated IRIG-B input

VI. Setting Group

Independent setting groups should be available.

VII. Communication Ports

As indicated above .

29.6 Other technical characteristics

***Have self-diagnostic feature and watchdog output.**

***Have front RS232 port/usb port and rear Redundant port remote communications. The communication shall be on IEC61850**

***Closed terminal needed for 12 current inputs and three voltage input.**

*** Have programmable minimum of 5 digital Inputs, minimum of 8 digital outputs, minimum of 13 numbers programmable led .**

*** Necessary latest version /communication software should be supplied for configuration, setting modification, event analysis, and scada communication.**

***Programmable system frequency should be 50 Hz and operating range should be fn = +/-5HZ.**

***The contact of the relay shall have the following Minimum rating.**

Make and carry continuously : 5A

Make and carry for minimum 1Sec. : 30A

*** Current balancing transformers, shall form a part of the relay. The successful Bidder shall furnish sufficient data to prove stability of the equipment up to 10 times full load through fault current. Interposing C.Ts if necessary for current balancing shall be within the scope of supply. I.C.Ts shall be of universal type of setting different ratios.**

30.0 OVER FLUXING RELAY:(V/f)

(a)Suitable relay with v/f characteristics shall be provided to defeat the over fluxing condition of the transformer.

(b)The relay shall be a separate electromechanical relay to be connected in parallel to the over fluxing relay, if, available in any of the numerical relay i.e. if the same software is available in the numerical differential protection relay.

(c) Shall have inverse time characteristics, matching with transformer over fluxing withstand capability curve.

(d) shall provide an independent 'alarm' with the time delay continuously adjustable between 0.1 to 6.0 seconds at values of v/f between 100% to 130 % of rated values.

(e)Tripping time shall be governed by v/f Vs time characteristic of the relay.

(f) have a set of characteristics for various time multiplier settings. The maximum operating time of the relay shall not exceed 3 seconds and 1.5 seconds at v/f values of 1.4 and 4.5 times, the rated values, respectively.

(g)Have an accuracy of operating time, better than +/-10 %.

31.0 TESTS

Following tests as indicated should have been conducted for the above relays:

31.1 Soak test:

All solid state equipment/system 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. The temperature of the interior shall not exceed 65C.

31.2 Type tests:

1. 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)

2. 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 analyzer or PTL as applicable.

31.3 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.

32.0 MULTIFUNCTION METER

GENERAL: Multifunction Meter will be installed on the top of the switchgear panel.

1. Each bay should be provided with a multifunction meter having following features:-

2. Features: By level monitoring of all electrical parameters of V,I,Φ,cosΦ,Hz,KVA,KVAR,KW & KWH.True RMS measurement

3. Accuracy: 0.2.

4. User selectable display ranges. (CT/PT).

5. Auto scrolling/Manual display

6. RS 485 communication port with MODBUS RTU protocol. Compatible for data logging & SCADA application.

7. Inbuilt Real time clock with calendar.

8. 3phase,4 wire,3 element or as per requirement.(to be decided during detail Engineering).

9. Quadrant of operation: 04 Quadrant.

10. Display: Bright red 7-segment LED display.

11. HMI: Through Front panel tactile keys.

12. Indication: Phase voltage, Phase current ,Line voltage, Frequency, Power factor, KVA,KVAR,KW,KVAH,KVARH,KWH.

13. Voltage input: 63.5/110V

14. Current Input: 1 A

15. Auxiliary supply: 85-250 V AC or 48 V DC

16. VA burden: 15VA

17. Frequency Range: 45 to 55 Hz

18. Power factor range: 0.1 lag -1 -0.1 lead

19. Over voltage: 130% continuously & 200% for 30 sec

20. Over current: 2 times continuous, 20 times for 1 sec.

21. Response time: 200 ms

22. Class of accuracy: 0.2s as per IEC 60687, IS 14697

23. Complies to EMI: IEC 61000-4-5,3,4

24. Display resolution: upto 1 decimal

25.Output: Two communication port with optical isolation. RS 485 communication port with MODBUS RTU protocol.

26.CT shorting provision should be there.

27.Mounting: Flush panel mounting.

28. Dimensions:144X144 mm

29.Ambient condition: working: 0-55 deg cent,5- 95% RH.

32.1

(a) A flag operated master trip relay should be provided (48 V DC with N/C contact in series with the relay coil): Electromechanical relay having sufficient output contact (N/O & N/C) should be available for interlock, indication & other SCADA purpose.

(b) Other electromechanical auxiliary relays as required as per the scheme to be provided.

(for contact multiplication, Transformer trouble shooting like Oil temp al & trip, Winding temp Al & Trip, Bucholtz Alarm & Trip, MOG alarm, PRV Trip etc)

(c) A 12 Window static annunciator with Test, Accept & Reset arrangement and with Buzzer & Bell.

32.2 Test terminal Blocks- Test terminal Block need be provided for testing meters in test position.

32.3 Indication Lamp¬(24DC LED type)Red- Breaker 'ON'

Green Breaker 'OFF'

Amber- Breaker 'AUTO TRIP'

Blue- Spring charge indication.

White-Healthy Trip illuminated push bottom switch

33.0 Panel wiring and accessories.

Wiring: Each panel shall be supplied with all internal wiring complete.

33.1 Panel wiring shall be suitably bunched and clamp for neat appearance. The conductors used for wiring purpose shall be PVC insulated 1100 volt grade semi- flexible heat resistant, flame retardant and vermin proof electrolytic copper cable conforming to IEC:227, 502 or IS:1554. The wiring shall be securely supported and taken though PVC through PVC troughs. Each wire shall be continuous from end to end without any joint in between. All panel wiring shall be capable of withstanding a voltage of 2KV AC 50Hz for one minute.

33.2 Cable and wire for connections within the switchgear and between the switchgear and terminal blocks shall have a minimum temperature rating of 90 degree Celsius. The size of the conductors for panel wiring shall be not less than 2.5mm2. For CT secondary wiring, two such wires shall be used in parallel.

33.3 Panel wiring protection

The panels shall be equipped with links and HRC cartridge fuses conforming to IEC:269 or IS:13703 in 1100 Volt grade phenolic moulded fuse holder consisting of fuse carrier and base or

miniature circuit breakers conforming to IEC:947-2 or IS:13947-2 at appropriate locations. The carriers and bases shall be made of high grade flame retardant and non-hygroscopic phenolic moulded material with hard glass surface. Each fuse or MCB shall be identified with engraved plastic label.

33.4 In general, fuses and MCBs shall be limited to the minimum required for safety.

The protection scheme shall include fuses for VT secondary circuits and DC supply to each panel and fuses for MCB for spring charging motor and incoming AC supply.

34.0 Terminal blocks

Terminal blocks of brass studs rated for 10 amps continuous current,1100volt. DC grade covered by moulded insulating materials with adequate electrical clearances shall be provided for terminating the panel wiring and outgoing connections. The termination shall be made by crimping lugs or bare conductor with insulating sleeves at ends. The arrangement can be horizontal or vertical as per standard practice adopted by the manufacturer. All terminals must be numbered and wire termination provided with numbered ferrules for identification. All numbering and marking including those in wiring diagram shall follow the guidelines provided in IS:11353. All circuit breaker auxiliary contracts including spare contacts shall be wired to the terminal blocks. Ten percent spare terminals shall be provided.

35.0 Colour and numbering

The wiring used for 230V AC supply for illumination lamp, panel heater and other devices shall be coloured. The colour of wires connecting directly to Earth shall be green. CT & PT connection wires shall be of R, Y & B colour. Engraved core identification plastic ferrules marked to correspond with the panel wiring diagram shall be fixed at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the fire is disconnected from the terminal block. Number 6 and 9, if used shall be under scored to enable differentiation.

36.0 Circuit diagram

A durable copy of the circuit wiring diagram shall be affixed to the inner side of the door of the switchgear compartment. Labels shall be provided inside the compartment to describe the functions of the various items of equipment.

The scope of the supply shall include the panel mounting foundation bolts, nuts and washers necessary for making the supporting.

37.0 DISCONNECTORS (In GIS Panel):

Disconnector shall be provided in the GIS Switchgear panel. There shall be interlock with the VCB.

Rating: 650 Ampere.

SCC: 25 KA for 3 sec.

Internal Arc 25 kA 1 sec

Material: Electrolyte copper.

38.0 AUXILIARY SUPPLY

Control supply for closing and tripping shall be 48 Volts D.C. through external battery source. 230 Volts single phase A.C. supply shall also be available for the operation of spring charging motor and cubicle space heater.

39.0 OVERALL DIMENSION

Width of the switch gear cubicle shall be maximum 1000mm with height of 2450 max and Max Depth with Line PT shall not exceed 3300mm.

40.0 TYPE TEST OF THE 33 KV SWITCH GEAR (VCB) PANEL.

Following type test reports shall be submitted during the detailed Engineering and approval of drawings.

All short circuit duties including single phase and double line to ground as per IEC62271-100

- **Short time rating for 3 seconds as per IEC 62271-100,62271-200**
- **Temperature rise test as per IEC 62271-200**
- **Capacitor bank switching for 400A minimum & cable charging 25 A test as per IEC 62271-100**

For test duties 1 to 4

- **Degree of protection test as per IEC 62271-200**
- **Lightning impulse voltage test as per IEC 62271-100 , 62271-200**
- **Internal arc test of 25 kA 1sec or 31.5 kA 0.1 sec in all the three high voltage compartments as per IEC 62271-200**

41.0 QUALIFYING REQUIREMENT.

The equipment offered shall be procured from short listed vendor at E-23 and shall have been successfully Type Tested during last five years on the date of bid opening. The Type Test reports shall be submitted along with the bid.

SPECIFICATION OF 33kV ISOLATOR

Specification of 33 kV Isolators

A) For 33 KV 1250A Isolators (centre rotating type):

B) 1. Operating down pipe : 6.1 Mts, 32 NB Class-B GI Pipe

C) 2. Connectors (Jumper plate) : LM –6 Alloy terminal connectors (75X12mm) suitable for panther conductor.

D) 3. Fixed Contact : 25X4 mm Copper Flat (HDE)

E) 4. Moving Contact : 38 OD and 30 ID Copper Pipe (HDE) F) 5. Base Channel : 100X50 mm GI Channel of length 1065 mm G) 6.

Provision for pad lacking in ON-OFF position shall be provided.

H) 7. Three numbers Guides of GI Angle 50X50X6 mm for supporting the down pipe, slotted holes are to be mate to the angles for fixing the same to the pole.

S.No.	**Details**	33KV 1250A
1.	Whether single break or double break	Double Block
2	No. of poles	3 Poles
3.	Frequency	50 Hz
4.	Voltage rating	36 KV
5.	Current rating in Amps	
	i) Normal	1250Amps
	ii) Maximum with duration	1250 Amps
6.	Temperature rise of the following at full rated current in Degree over ambient temperature	Within limits as specified in IS.
	i) Copper contract with coating	Within limits as specified in IS.
	ii) Terminals of switches intended to be bolted to the external conductor	Within limits as specified in IS.
	iii) Metallic parts acting as springs	Within limits as specified in IS.
7	Whether contacts are silver coated or tin coated	Silver plated
8.	Volt drop across terminals of poles	Note more than 20 mv at 100A DC.
9.	Short time current and duration	25 KA
10.	Material of fixed contract & size	Copper flat

12.	Material of moving blade & size	Electrolytic Copper tube
13.	Material of terminal connector	LM-6 Alloy
14.	Type diameter and length of operating pipe	6.1 mtr. 40mm N.B. class 'B' G.I.Pipe
15.	Material of arcing horns	G.I. Rod 10mm dia
16.	Size & Length of base mounting channel (Hot dip Galvanized)	100X50mm channel 1065 mm long
17.	Whether dimensional drawing is enclosed with the tender	Yes
18.	Whether the air break switch is complete with all accessories	Yes
19.	Minimum clearance between phases (The center distance between the insulators of adjacent phases in the assembled position of switch)	1524 mm
20.	Center to center distance between insulators of the consecutive poles of the same phase in the assembled position of switch (in mm)	457.5mm
21.	Whether mechanical interlock has been provided for arcing switches	Yes
22.	Types of bearing used in	
	i) Rotating insulators stack	Ball bearing
	ii) Operating shaft	NM
23.	Impulse withstand voltage (peak) with 1/50 MS wave positive and negative polarity	
	i) Across isolating distance	195 KV Peak
	ii) To earth between poles	170 KV Peak
24.	One minute power frequency withstand voltage (RMS) across isolating distance to earth and between poles	
	i) Across isolating distance	80 KV (RMS)
	ii) To earth between poles	70 KV (RMS)

Specification of Passive Electronic Marker

Specification of Passive Electronic Marker

The Passive Electronic marker shall be buried for every 100 meters of UG cable for marking of significant points in underground systems.

The markers shall able to trace up to a depth of 2.3 m

The markers shall be housed in a robust and rugged plastic enclosure with a life expectancy of at least 50 years.

Technical Data:

Search frequency:	
Power Networks	169,8 kHz
Diameter of the location area	2.5 m
Maximum depth	2.3 m
Pressure resistance min.	40 kPa
Temperature range	-30° to +50°C
Life expectancy min.	50 years
Dimensions	(Ø x height) 25 x 30 mm

TECHNICALSPECIFICATION OF CABLE IDENTIFICATION EQUIPMENT

TECHNICAL SPECIFICATION OF CABLE IDENTIFICATION EQUIPMENT:-

The system should Large, high-contrast LCD to read all parameters.

The systems should Displays up to 8 types of frequency marker buried on the underground cables.

The system should Semi-automatic amplification adjustment for easy operation.

The system should work any other noise in the field like other utilities like pipes line of water ,sewerage and gas etc , system should have improved noise suppression for fast and precise locating.

The system should locates markers frequency up to 2.40 m depth of under ground cable.

The system measure the Digital depth of markers.

The system should have audio audio indication respective frequency strength (frequency modulation)

The system should have numeric field strength display and bar graph of marker frequency.

The system operation should ergonomic design for easy, non-fatiguing operation.

The system should display wrong-Marker-Alert . If identified any wrong“ markers are displayed and an audio warning sounds.

The system should have facility to do the online-Scan-Mode“ for cable route tracing.

The system should operate with battery continuously 12 hours.

TECHNICAL DATA:

Cable marker Locator:-

Parameter	Shall comply to	Deviation	Remarks
Frequency	169.8KHZ to 77KHz		
Maximum cable depth location	2.40 meters		
Operating voltage	12V DC with rechargeable batteries		
Operating time	Minimum 12 hours		
Weight	Not more that 2.5 Kgs		
Operating temp	➢ 50 degrees		
Standard protection	IP 54		
Frequency	169.8 KHz		
Maximum depth of marker	2.3 meters		
Pressure resistance	Min.40kPa		
Life of marker	Min. 50 years		
Dimensions of markers	25 X 30mm		

Specification of Copper control cables

SPECIFICATION OF COPPER CONTROL CABLES

1.0 For all control/protection/instrumentation purposes PVC insulated armoured control cables of minimum 2.5 sq.mm. size with stranded Copper conductors shall be used.

1.1 Cables shall be laid conforming to IS: 1255.

1.2 While preparing cable schedules for control/protection purpose following shall be ensured:

- Separate cables shall be used for AC & DC.
- For different cores of CT & CVT separate cable shall be used.
- At least one (1) core shall be kept as spare in each copper control cable of 4C, size whereas minimum no. of spare cores shall be two (2) for control cables of 10 core or higher size.

1.3 For control cabling, including CT/VT circuits, 2.5 sq.mm. size copper cables shall be used per connection. However, if required from voltage drop/VA burden consideration additional cores shall be used. Further for potential circuits of energy meters separate connections by 2 cores of 2.5sq.mm. size shall be provided.

2.0 **TECHNICAL REQUIREMENTS**

1.1kV PVC Power and Control Cable

2. 1 **General**

2.2 The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground-buried installation with uncontrolled back fill and chances of flooding by water.

2.3 The PVC insulated cables shall be capable of withstanding a conductor temperature of 160°C during a short circuit.

2.4 The Copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be uniformly good quality, fre**e** from defects.

2.5 The fillers and inner sheath shall be of non-hygroscopic, fire retardant material, shall be softer than insulation and outer sheath shall be suitable for the operating temperature of the cable.

2.6 Progressive sequential marking of the length of cable in meters at every one metre shall be provided on the outer sheath of all cables.

2.8 The 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.

2.9 All the cables shall pass fire resistance test as per IS: 1554 (Part-I)

2.10 The normal current rating of all PVC insulated cables shall be as per IS: 3961.

Repaired cables shall not be accepted.

2.11 Allowable tolerance on the overall diameter of the cables shall be plus or minus 2 mm.

3.0 PVC CONTROL CABLES

The 1100 grade control cables shall be of FR type C1 category conforming 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 armored or not. The over sheath shall be extruded PVC to type ST-1of IS: 5831 and shall be gray in colour except where specifically advised by the Employer to be black.

3.1 Cores shall be identified as per IS: 1554 (Part-1) for the cables upto five (5) cores and for cables with more than five (5) cores the identification of cores shall be done by printing legible Hindu Arabic Numerals on all cores as per clause 10.3 of IS 1554 (Part-1).

CABLE DRUMS

4.1 Cables shall be supplied non-returnable wooden or steel drums of heavy construction. Wooden drum shall be properly seasoned sound and free from defects. Wood preservative shall be applied to the entire drum.

4.2 Standard lengths for each size of 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. In case, the total requirement is less than 500 meters, non-standard drum length shall also be acceptable.

4.3 A layer of waterproof paper shall be applied to the surface of the drums and over the outer most cable layer.

4.4 A clear space of at least 40 mm shall be left between the cables and the lagging.

4.5 Each drum shall carry the manufacturer's name, the purchaser's name, address and contract number and type, size and length of the cable, net and gross weight stencilled on both sides of drum. A tag containing the same information shall be attached

to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

4.6 Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation and erection.

5.0 TESTS

5.1 All cables shall conform to all type, routine and acceptance tests listed in the relevant IS.

6.0 GAURANTEE

The material shall be guaranteed for five years from the date of commissioning

CT MARSHALLING BOXES

Specification of junction Box:

The specification covers Junction Box to be provided for current transformer connections.

- The Junction Box shall be of 1.1kV grade and the enclosure shall be fabrication out of FRP/SMC/Industrial thermoplastic sheet with adequate steel reinforcement member.
- The door shall be provided with spring loaded latch operated by common key for all boxes.
- Hinges shall be provided at a distance of 150mm from top and bottom.
- Door shall be of non-removable type.
- The design shall be such that the boxes are whether proof, dust and vermin proof.
- Two earthing terminals one on each side of the box shall be legibly identified and connected to earth with No.8 GI wire.

Application Standards:

IS-1079 : Hot rolled carbon steel

IS-1730 Steel sheet and strip steel

IS-13497 : Circuit Breakers part I & II

IS-6639 : Hexagonal Bolts

Earthing shall be with 25x6 mm GI Flat with 2 Nos. for box and 2 Nos. for neutral earthing for each Junction Box and connected to 40 mm dia GI Earth Pipe.

The frame work and surface of steel panels shall be treated with seven tank process and power coated with RAL 6032.

An embossed caution board * MARSHALLING BOX* in English and Telugu languages shall be provided on the front door of the Junction Box and treated with red colour radium paint for better visibility at night.

The name plate incorporating *OPTCL* *Circuit/Feeder details* and *Agreement reference No * shall be provided on stainless steel plate with engraved & black painted letters.

GUARANTEE : The materials supplied by the contractor under this contract shall be guaranteed for a period of 5 years from the date of commissioning for satisfactory performance.

HORIZONTAL DIRECTIONAL DRILLING (HDD)

SPECIFICATION FOR HORIZONTAL DIRECTIONAL DRILLING (HDD):-

The contractor shall have shall have ISO 9001-2008/18001-2007. The contractor shall bring his own machinery for this purpose. The contractor who is executing the HDD shall have preferably ownership of five no's of HDD and two machines of Rock drilling.The machinery shall be used in such a way that there is minimum obstruction to traffic and pedestrians. The Horizontal drilling shall be for a distance of not less than 90 mts at each stretch and subsequently thereafter. The reinstatement of road dug up for drilling shall be incorporated in the price for Horizontal Directional Drilling. Hence the reinstatement of roads to its original condition in the dugup portion where drilling is commenced shall be inclusive and not charged extra by the Successful Tenderer. Disposal of extra excavated material such as mud, slurry, stones etc shall be also included in the rate per meter of Horizontal drilling and shall not be charged extra.

The trenchless technology shall be used with HDPE casing for the portion of the cable route such as road, railway, nullah crossing and without HDPE casing for major portion of the cable route. The outer diameter of the HDPE pipe shall be suitable for insertion in an 8" diameter horizontally drilled bore. The HDPE pipe shall be of PE 80 grade with pressure rating PN4 conforming to IS 4984/1995 and shall have wall thickness of 6.20 to 7.10 mm. The HDPE pipes shall be joined by using Butt welding and a 7/20 G.I wire shall be provided along the entire length of each pipe duct.

The Depth of horizontal drilling shall be between 2 to 3 meters and shall be site specific. The Successful Tenderer shall carry out radar survey of the route using Ground penetrating Radar and determine route profile of any other utility cables, pipes etc along the route. The route survey and drilling profile shall be got approved and finalized by the Engineer-in-Charge prior to commencement of the drilling, HDPE pipe insertion and cable insertion.

The drilling shall be with a Directional drilling unit equipped with automated pipe handling system and all necessary accessories. The unit shall utilize bentonite mud circulation pilot boring, grinding, reaming and pulling the pipe carefully without damaging other service installations in the vicinity.

The XLPE Cable laying shall include insertion into the HDPE pipe manually with proper safety of the cable.

- The rate shall include cost of butt welding, cost of HDPE pipe and other required accessories, cost of entry and exit pits, restoration of entry and exit pits at original level.

- The charges towards all machinery involved including accessories and power requirement thereof for carrying out the Horizontal Drilling shall be included in the rate for HDD by the contractor.

GUIDELINES FOR HDD

The method described herein is not exhaustive or exclusive. If the Tenderer has any other

technique meeting the requirements of laying of 33kV, Single core, 300 sq.mm. XLPE cable, the details may be submitted. However, the general requirements of HDD technique described herein shall remain as a guideline for submission of the Tender.

General :

The directional drilling equipment shall consist of a directional drilling rig of sufficient capacity to perform the bore and pull back the pipe/cable, a drilling fluid mixing, delivery, and recovery system of sufficient capacity to successfully complete the installation, a drilling fluid recycling system to remove solids from the drilling fluid so that the fluid can be reused (if required), a magnetic guidance system or walk over system to accurately guide boring operations, a vacuum truck of sufficient capacity to handle the drilling fluid volume, and trained and competent personnel to operate the system. All equipment shall be in good, safe condition with sufficient supplies, materials and spare parts on hand to maintain the system in good working order for the duration of this project.

Drilling Rig: The directional drilling machine shall consist of a hydraulically powered system to rotate and push hollow drilling pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. The machine shall be anchored to the ground to withstand the bulling, pushing and rotating pressure required to complete the installation. The hydraulic power system shall be self-contained with sufficient pressure and volume to power drilling operations. Hydraulic system shall be free of leaks. Rig shall have a system to monitor and record maximum pullback pressure during pullback operations.

There shall be a system to detect electrical current from the drill string and an audible alarm which automatically sounds when an electrical current is detected.

Head : The drill head shall be steerable by changing it's rotation and shall provide necessary cutting surfaces and drilling fluid jets.

Motors (if required) : Mud motors shall be of adequate power to turn the required drilling tools.

Drill Pipe: Shall be constructed of high quality 4130 seamless tubing, grade D or better, with threaded box and pins. Tool joints should be hardened to 32-36 RC.

SPECIFICATION OF EARTHING

Earthing

1.Scope of supply : The scope of supply includes providing the copper bonding steel earth electrodes and backfilling with zerolyte compound and excavation and running of Earth mats of size 75 X 8 mm GI flat in the excavated trench of 0.6 m depth with bentonite underneath the GI flat duly jointing the earth mat (T, straight, +) as per IS 3043 including the cost of bentonite powder, welding, Jointing, and painting the exposed earth flat with Black paint and joints with Bituminous paint, transformer neutral earthing with flexible copper jumper (current Capacity of 25 KA for 1 sec bracing complete etc).

2.Requirements of the finalized design: The finalized design shall provide the following:

a) The Grid Resistance and Overall Earth Return Impedance values.

b) The earth potential rise (Equipment Potential Rise), for a maximum value of ground current.

c) Specify whether the substation is hot or "cold".

d) Show the limits of the hot zone - if applicable.

e) Confirm that at all points, the internal maximum touch and step potentials are below the safe acceptable value.

f) Confirm that at the fence, the maximum touch potentials are below the safe acceptable value.

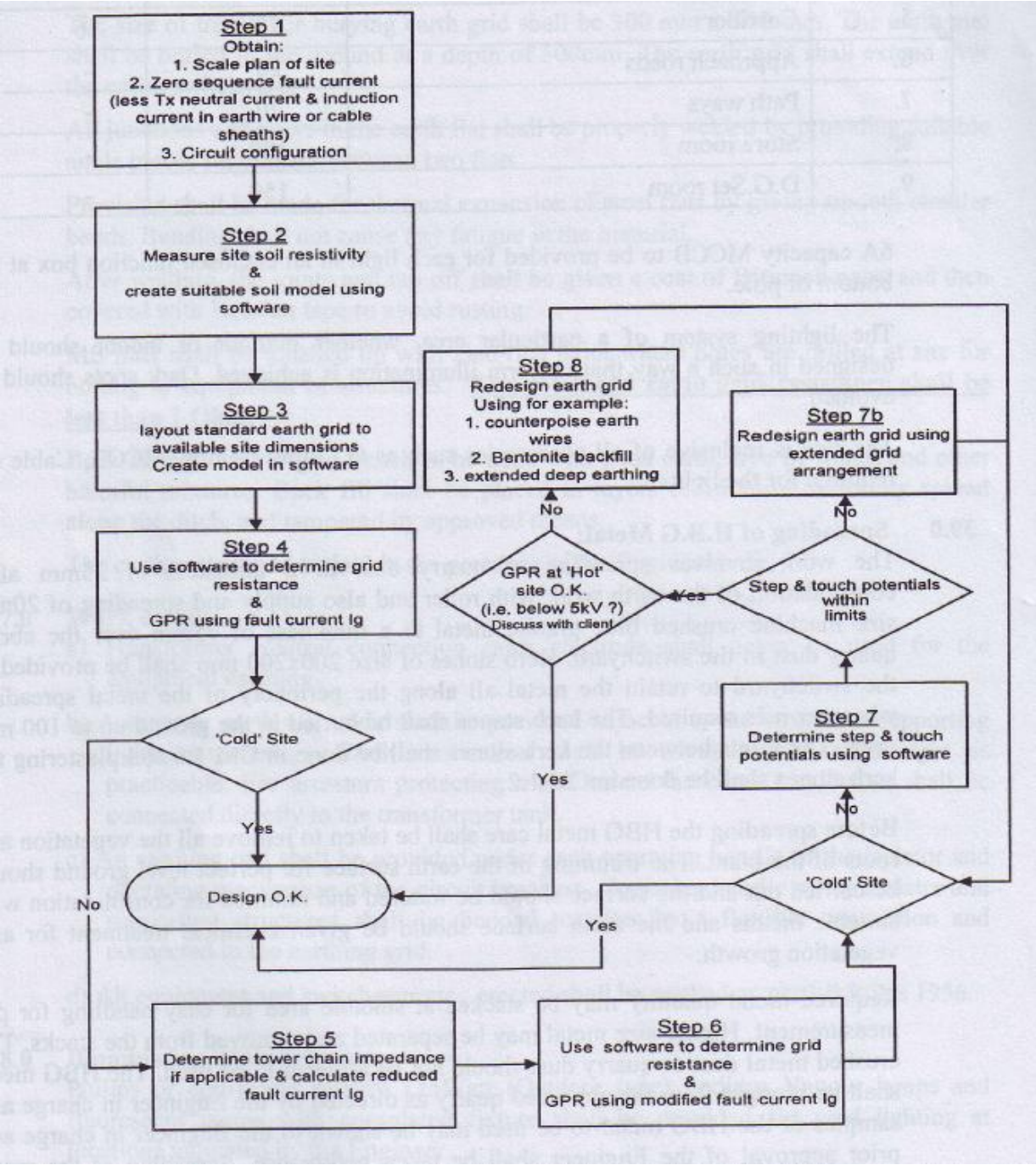
g) Confirm that the maximum external step potentials are below the safe acceptable value.

h) Where the design makes significant use of vertical rods, the fault current distribution within the grid is required to ensure that the rods can carry their proportion of current without damage.

Ensure that there is earth electrode reasonably close to each item of plant which requires connection to it.

3.Earth-grid Design:

These guidance notes are intended to guide you through the process of designing an effective earth system for a 33/11kV substation installation in accordance with European industry standards. The process is set out below in the form of a flow chart. Accompanying notes in the sections that follow supports the steps of the flow chart.



(i) In cases where it is clear that the substation will require an extended earthing system, the grid boundary conductor should be shown installed 1 metre deep using standard GI Flat electrode, and normally situated 1 metre outside any metallic fencing.

(ii) Convert the outer ring to a mesh by plotting standard tape across the site, in two directions at 90° to each other, each flat being parallel to the outer conductor where practicable. The cross-members should form squares or oblongs, should be spaced a nominal 10 metres apart and laid to a depth of 0.6 metres. They will be bonded to the outer ring and at each crossing point.

(iii) Some of the cross members should be laid in rows alongside plant to facilitate the connection of exposed metalwork to the grid. Great care must be taken when planning the grid layout to ensure that critical components such as transformer neutral connection points, switchgear earth bars etc., are provided with **direct and duplicated routes** to the electrode.

(iv) At or near to the connection point of each cross member to the perimeter ring electrode, install one 3m x 5/8'' copper bonded steel rod and shall be backfilled with Zerolyte. Each pipe is to be backfilled with Zerolyte and loamy soil (black top soil) with added Gypsum, to a diameter of 300mm if neccessary.

(v) COPPER BONDED EARTH RODS

(vi) The Earth Rods shall have a nominal (actual) dia of 5/8" (14.2 mm) and length of 10' (3 M). The Rods shall have a steel core with molecular bonding of 250 micron of copper as per international standards.

(vii) The Core used shall be 1035 steel cold drawn to ASTM A 1080 and AISI C 1017 standards with tensile strength min. 90000 psi.

(viii) A nickel layer is applied to steel core (and subsequently copper) by an electrolytic process forming a metallurgical bond between the three. The copper used shall be type DHP alloy No. 122 CDA and rated at 99.95% copper. The thickness of copper layer shall be uniform 0.010" (250 micron).

(ix) The Earth Rod shall be UL (Under writers' Laboratory) listed and should have the UL mark.

(x) The Rods should be manufactured by a company of high repute to ensure quality of Copper Bonding.

Coke and salt are not to be used as backfill as they are corrosive.

Metal fencing should be connected to the grid at each corner and at points long its length not exceeding 50 meters

S.No	Item	Material to be used
1	Grounding Electrodes	5/8''mm Copper Bonded steel rod backfilled with zerolyte or ground enhancement material with a resistivity of 0.12 ohm-m
2	Earth Grid	75 X 8 mm MS flat
3	Connection between Earth Electrodes and earth Grid	75 X 8 mm MS flat
4	Connection between Earth Grid and Equipment including the cable terminations	50 X 6 mm MS flat
5	Backfilling material	a) Zerolyte ground enhancement material with a resistivity of 0.12 ohm-meter b) Backfill with soft loamy or black cotton soil if necessary.
6	Connections	Welded Joints for the earth mat and earth electrodes and with hot dip galvanized bolts
7	Power Transformer	Double earthing for Neutral with flexible copper capable of carrying 20 KA for 1 sec.

The size of trench for burying earth grid shall be 300 mm x 600 mm. The earth mat shall be buried in the ground at a depth of 600mm. The earth grid shall extend over the entire switchyard.

All junctions and risers in the earth flat shall be properly welded by providing suitable angle pieces for contact between two flats.

Provision shall be made for thermal expansion of steel flats by giving smooth circular bends. Bending shall not cause any fatigue in the material.

After welding, the joints and tap off shall be given a coat of Bitumen paint and then covered with Hessian tape to avoid rusting.

MS flats shall be touched up with zinc-rich paint where holes are drilled at site for bolting to equipment or structures.

The combined earth grid resistance shall be less than 0.5 Ohms

The contractor shall give warranty for 5 years for the material supplied for the earthing system.

Back filling of earth grid trench shall be done with a layer of bentonite powder before laying of earth grid and then back fill with good earth, free of stones and other harmful mixtures. Back fill shall be placed in layers of 150mm, uniformly spread along the ditch, and tampered by approved means.

The earth mat should be laid in the presence of the Engineer only.

a) Transformer Neutral connection earth electrode shall never be used for the equipment earthing.
b) A separate earth electrode shall be provided adjacent to the structures supporting lightning arrestors. Earth connection shall be as short and as straight as practicable. For arrestors protecting transformers the earth conductors shall be connected directly to the transformer tank.
c) An earthing pad shall be provided under each operating handle of the isolator and operating mechanism of the circuit breakers. Operating handle of the isolator and

supporting structures shall be bonded together by a flexible connection with No.8 SWG and connected to the earthing grid.

All equipment and switchgear etc., erected shall be earthed as per I.E Rules 1956,IEEE 80, IEEE100, IEEE148, IS 3043.

4. CONNECTION OF ABOVE GROUND PLANT AND USE OF METALLIC STRUCTURES.

- Items of plant shall be connected to the earth grid with MS flat to the existing copper earth flat of indoor and outdoor switchgear.
- Facility to provide the hollow duct with concrete or channel with suitable clamps shall be provided wherever possible for support of cables and earth flat.
- Care shall be taken for perfect joints between the earth grid and equipment and within the earth grid and bituminous paint shall be done for all joints and care shall be taken that there shall be no high resistances at steel jointing surfaces.

A calculation is required to ensure that the steel has sufficient cross-section area and that the final temperature will not exceed 250°C for a bolted/welded joint.

4.1. Low Voltage Cables:

(i) ables used exclusively for "in house" supplies.The sheaths of these cables must be bonded to the substation grid.

(ii) Cables used for supplying external loads.L.V. cables for which the neutral/earth connection is within the substation, are not suitable for supplying customers outside if there is any possibility of the Equipment Potential Rise exceeding 430V/650V (as appropriate).

For similar reasons, house supplies to a substation should not be provided direct from an adjacent L.V. network.

5.COMMUNICATION FACILITIES

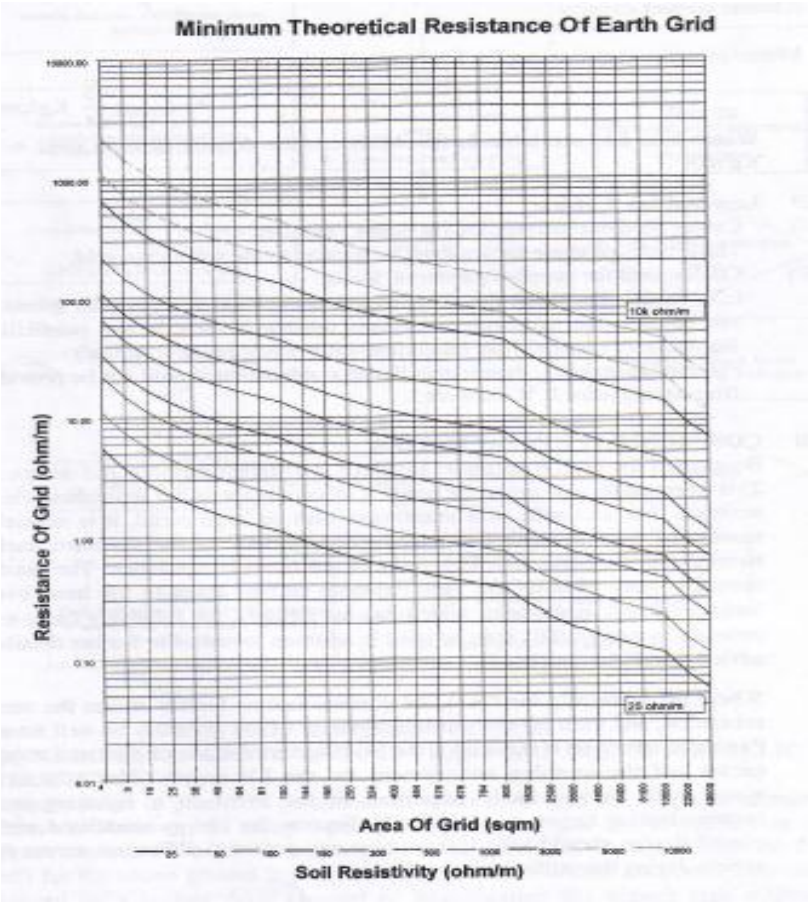
Because of the high frequencies involved, a different earthing grid design is required. This attempts to maximize the amount of conductor in the immediate vicinity of the structure. For example, at a microwave dish or large aerial, it is normal to have a number of parallel earth down leads near the base of the structure, each of which terminate in an earth rod. This reduces the overall impedance.

The mast itself will normally carry most of the fault/lightning current down to the base, even if down leads are fitted. Electrodes, which run out radially, are relatively close together and arranged symmetrically may be used in addition to rods. For further details, specialist advice should be sought.

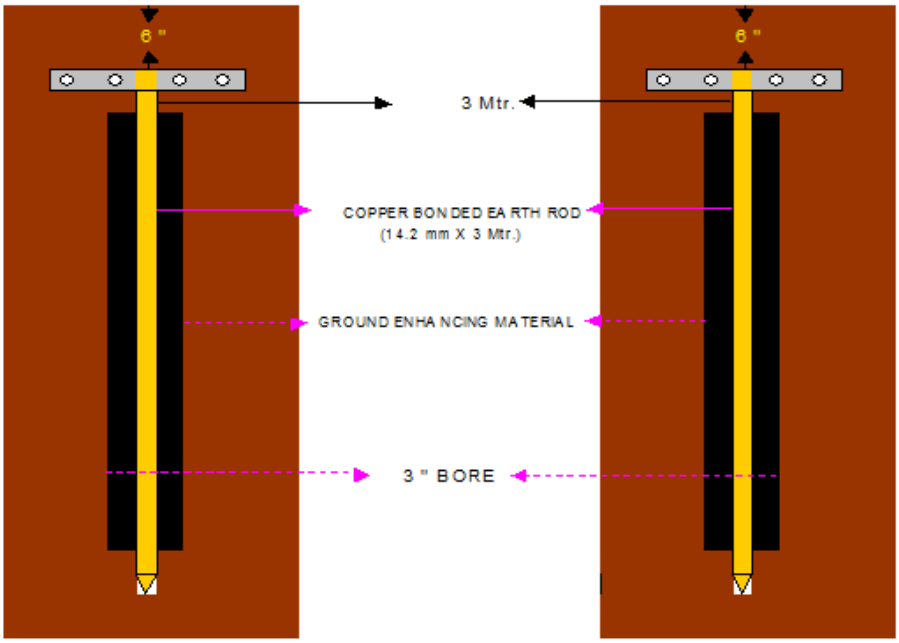
Where (as is usually the case), the communication facility shares the same site as a substation, and then the two earthing systems would normally be well interconnected. Particular attention is required to the bonding/termination of pilot and communication cables and the earthing arrangement for the LV supply. The substation earthing system will be especially important in the event of a lightning strike to the communication tower, as it will help disperse the energy associated with this. The overall design should seek to minimize any potential difference across the earthing system during the strike.

6.EARTH GRID RESISTANCE GRAPH

The graph below shows the minimum theoretical resistance of a mesh grid for different soil resistivity's and grid area. This can be used as a quick guide as to determine the value of Equipment Potential Rise of the grid. Having established an equivalent soil resistivity from the site measurements the grid resistance can be read off the y-axis for the grid area under consideration along the x-axis. The resistance can then be multiplied by the fault current to give the Equipment Potential rise


Minimum Theoretical Resistance Of Earth Grid
Resistance Of Grid (ohm/m)
Area Of Grid (sqm)
Soil Resistivity (ohm/m)

VERTICAL INSTALLATION ERICO'S EARTHING SYSTEM

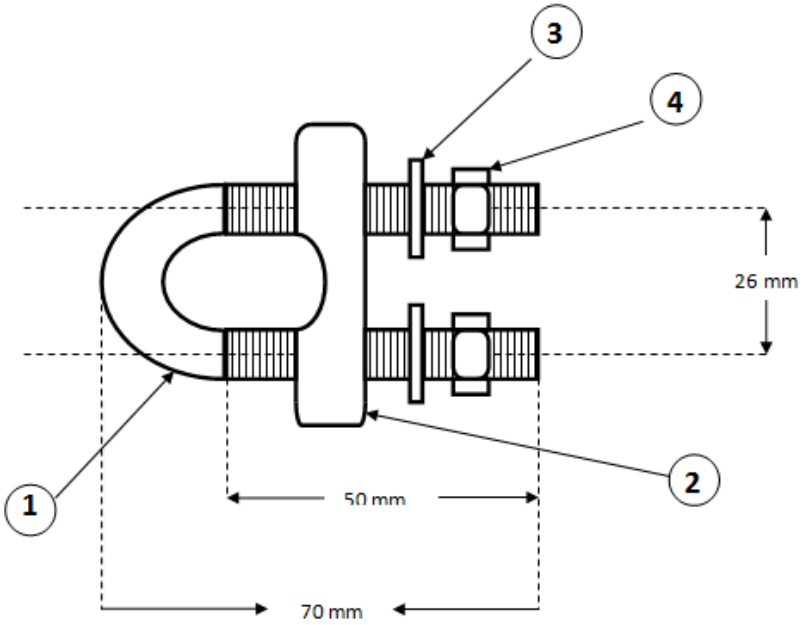


INSTALLATION PROCEDORE:-

Auger a 3 inch hole to a depth equal to 6 inches less than the rod length .

Drop the rod down the hole with the lower end centered and driven in 6 inches .

Fill the hole using premixed (Slurry) GEM material. or ground enhancing meterial of resistivivity of 0.12 ohm–meter



1. U- Bolt, M10 (S/Steel)
2. Keeper Casting (S/Steel)
3. Washer, Spring, M10 (S/Steel)
4. Nut, M10 (S/Steel)

Ground Rod Clamp 35-120 mm^2

21 ERECTION OF BAYS:

21. Foundations

The Cement Concrete used for the foundations shall be M-150. The sand used shall be composed of hard silicon material and well sieved. It shall be clear of a sharp angular grill type and free of earthly organic matter and salts. The aggregate shall be clean broken hard granite. It shall be as far as possible cube like, preferably angular, but not flanky, preferably clean and free from earth organics. 38mm aggregate shall be of size.

21.1.1 Water used for mixing concrete shall be fresh, clean and free from oils, acids, alkali water shall not be used.

21.1.2 Proper moulds adequately braced to retain proper shape while concreting shall be used. The mould shall be made water tight so that cement cream will not come out leaving only sand and jelly, consequently forming honey-combing in the concrete.

21.1.3 After concreting, top surface shall be finished smooth. Plastering of outer surfaces shall be done with 12mm thick with 1:3 cement mortar. White washing with white cement shall be done neatly.

21.2 Fabrication

21.2.1 All pieces shall be straight, straightening shall not damage the material. Hammering shall not be permitted for straightening and/or flattening of members. Sharp bends are not permitted. Cutting may be effected by shearing, cropping, flame cutting or sawing. The surfaces so cut shall be clean, smooth reasonably square and free from distortion.

Holes in the members shall either be drilled or punched and shall not be formed by flame cutting process. All blurs left by punching or drilling shall be completely removed.

It shall be ensured that fasteners provide positive attachment at all times and under conditions when the structure is subject to vibrating loads. Bolts used for erection shall preferably be of 12,16,20mm diameter and in no case bolt diameter shall be less than 12mm. The length of the bolt shall be such that the threaded portion does not lie in the plane of contact of members.

It shall be ensured that the threaded portion of the bolt protrudes not less than 3mm and not more than 8mm over the nut after it is fully tightened. Holes shall be cylindrical and perpendicular to the structural members. Oval or lobed forms of holes shall not be permitted. The diameter of holes shall be equal to the diameter of the bolt plus 1.5mm. The accuracy of the location of the holes such that for any group of members where assembled, the holes shall admit the bolt at right.

Spacing of Bolts and Edge distances:				
Bolt dia (mm)	Hole dia (mm)	Bolt spacing (mm)	Edge hole center to rolled (mm)	Distance min. hole centre to sheared or flame cut edge (mm)
12	13.5	32	16	20
16	17.5	40	20	23
18	21.5	48	25	28

Spring washers of positive lock type of the following thickness shall be provided for insertion under all nuts.	
Bolt dia (mm)	Thickness of spring washer (mm)
12	2.5
16	3.5
18	4

21.2.2 Bolts and nuts: Nominal nut size Proof stress

(N/sq.mm)

M16 490

M20 500

21.2.2 The bolts and nuts shall be hot dip galvanized as per IS-1367

Spring washers shall be of type B and shall confirm IS-3063. The spring washers shall be made from high quality spring steel conforming to IS-4072. The spring washers shall be electro galvanized with a coating thickness of 25 microns.

21.2.3 The structures shall be erected piece-meal method on foundations after allowing the required curing time for the foundations. After erection of structures, the bolts shall be checked to ascertain that all nuts are fully tight shall ensure that none of the bolts are left out. The structure shall be truly vertical after erection and no stringing is permitted to bring them to vertical position. The tolerance allowed for verticality is one in 360 structure height.

Stringing of Bus bar: 33KV and 11KV bus in 33/11KV Sub-Station shall be formed with panther/Zebra conductor (200 Sq.mm AAAC) to a tension of 250Kg comprising of three phases. The bimetallic clamps and other connectors required for connections between bus and equipment and between equipments are to be procured by contractor. The stringing of bus conductors covers hosting of tension insulator strings, suspension insulator strings, post type insulator stacks and other accessions along with tensioning of conductor and clamping. The jumpering to the equipment shall be arranged properly.

The insulator strings shall be assembled on the ground. These shall be cleaned and examined before hosting. All the parts including current carrying parts shall be clean and smooth without greese, paint, and dirt. Insulators with cracks or chips or those having glazing defects exceeding 0.5 Sq.mm shall not be used.

The sag of bus conductor shall not be more than 1%. Damaged conductor shall not be used. No joints are to be made. The conductor surface shall be clean and smooth without projections, sharp points, cuts, or abrasions etc. and the conductor shall be continuous in line span.

22. FINAL CHECKING, TESTING AND COMMISSIONING

FINAL CHECKING : After completing the works, the contractor shall ensure that following points are not missed :

i) Backfilling is completely done and compacted along with leveling.

ii) Coping / Muffing / Plinth surfaces are done to proper shape.

iii) Bolts of the structures are properly tightened.

iv) Cables are properly dressed.

v) Equipment such as breakers, isolators are properly operation.

23 COMMISSIONING : All the tests shall be completed by the contractor successfully before commissioning of Equipment.

24. RECTIFICATION OF DEFECTS DURING THE DEFECTS LIABILITY PERIOD:

The defects liability period of the Sub-Station is 12 months from the day of commissioning and acceptance by the OPTCL. Defects if any, noticed during the above period shall be rectified by the contractor free of cost of the Board on hearing from the OPTCL.

Note: The Contractor has to follow REC standard for the work where ever it is not specifically mentioned above.

CIVIL WORKS

SPECIFICATION OF FOUNDATION / RCC CONSTRUCTION

General

1. Work covered under this Clause of the Specification comprises the design and construction of foundations and other RCC constructions for switchyard structures, equipment supports, trenches, control cubicles, bus supports, and systems, or for any other equipment or service and any other foundation required to complete the work. This clause is as well applicable to the other ECC constructions.

2. Concrete shall conform to the requirements mentioned in IS: 456 and all the tests shall be conducted as per relevant Indian Standard Codes as mentioned in Standard field quality plan appended with the specification. A minimum grade of M20 concrete (1:1.5:3 mix) shall be used for all structural/load bearing members as per latest IS 456.

3. If the site is sloppy, the foundation height will be adjusted to maintain the exact level of the top of structures to compensate such slopes.

4. The switchyard foundation's plinths and building plinths shall be minimum 300 mm and 500 mm above finished ground level respectively.

5. Minimum 75 mm thick lean concrete (1:4:8) shall be provided below all underground structures, foundations, trenches, etc., to provide a base for construction.

6. Concrete made with Portland slag cement shall be carefully cured and special importance shall be given during the placing of concrete and removal of shuttering.

7. The design and detailing of foundations shall be done based on the approved soil data and sub-soil conditions as well as for all possible critical loads and the combinations thereof.

The Spread footings foundation or pile foundation as may be required based on soil/sub-soil conditions and superimposed loads shall be provided.

8. If pile foundations are adopted, the same shall be case-in-situ driven/bored or precast or underreamed type as per relevant parts of IS Code 2911.

Only RCC piles shall be provided. Suitability of the adopted pile foundations shall be justified by way of full design calculations. Detailed design calculations shall be submitted by the bidder showing complete.

Details of piles/pile groups proposed to be used. Necessary initial load test shall also be

carried out by the bidder at their cost to establish the piles design capacity. Only after the design capacity of piles has been established, the Contractor shall take up the job of piling. Routine tests from the piles shall also be conducted. All the work (design & testing) shall be planned in such a way that these shall not cause any delay in project completion.

D**esign**

1. All foundation shall be of reinforced cement concrete. The design and construction of RCC structures shall be carried out as per IS: 456 and minimum grade of concrete shall be M-20. Higher grade of concrete than specified above may be used at the discretion of Contractor without any additional financial implication to the Owner.

2. Limit state method of design shall be adopted unless specified otherwise in the specification.

3. For detailing of reinforcement IS: 2502 and SP: 34 shall be followed. Cold twisted deformed bars (Fe=415 N/mm2) conforming to IS: 1786 shall be used as reinforcement. However, in specific areas, mild steel (Grade-I) conforming to IS: 432 can also be used. Two layers of reinforcement (on inner and outer face) shall be provided for wall and slab sections having thickness of 150 mm and above. Clear cover to reinforcement towards the earth face shall be minimum 40 mm.

4. The procedure used for the design of the foundations shall be the most critical loading combination of the steel structure and or equipment and or superstructure and other conditions, which produces the maximum stresses in the foundation or the foundation component and as per the relevant IS Codes of foundation design. Detailed design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used.

5. Design shall consider any sub-soil water pressure that may be encountered following relevant standard strictly.

6. Necessary protection to the foundation work, if required shall be provided to take care of any special requirements for aggressive alkaline soil, black cotton soil or any other type of soil which is detrimental/harmful to the concrete foundations.

7. RCC columns shall be provided with rigid connection at the base.

8. All sub-structures shall be checked for sliding and overturning stability during both construction and operating conditions for various combinations of loads. Factors of safety

for these cases shall be taken as mentioned in relevant IS Codes or as stipulated elsewhere in the Specifications. For checking against overturning, weight of soil vertically above footing shall be taken and inverted frustum of pyramid of earth on the foundation should not be considered.

9. Earth pressure for all underground structures shall be calculated using coefficient of earth pressure at rest, co-efficient of active or passive earth pressure (whichever is applicable). However, for the design of substructures of any underground enclosures, earth pressure at rest shall be considered.

10. In addition to earth pressure and ground water pressure etc., a surcharge load of 2T/Sq.m shall also be considered for the design of all underground structures including channels, sumps, tanks, trenches, sub-structure of any underground hollow enclosure, etc., for the vehicular traffic in the vicinity of the structure.

11. Following conditions shall be considered for the design of water tank in pumps house, channels, sumps, trenches and other underground structures:

a) Full water pressure from inside and no earth pressure and ground water pressure and surcharge pressure from outside (application only to structures, which are liable to be filled up with water or any other liquid).

b) Full earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

c) Design shall also be checked against buoyancy due to the ground water during construction and maintenance stages. Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the superimposed loadings.

12. The foundations shall be proportioned so that the estimated total and differential movements of the foundations are not greater than the movements that the structure or equipment is designed to accommodate.

13. The foundations of circuit breaker shall be of block type foundation. Minimum reinforcement shall be governed by IS: 2974 and IS: 456.

14. The tower and equipment foundations shall be checked for a factor of safety of 2.2 for normal condition and 1.65 for short circuit condition against sliding, overturning and pullout. The same factors shall be used as partial safety factor overloads in limit state design also.

Admixtures & Additives

1. Only approved admixtures shall be used in the concrete for the Works. When more than one admixture is to be used, each admixture shall be batched in its own batch and added to the mixing water separately before discharging into the mixer. Admixtures shall be delivered in suitably labeled containers to enable identification.

2. Admixtures in concrete shall conform to IS: 9103. The water proofing cement additives shall conform to IS: 2645. Owner shall approve concrete

3. The Contractor may propose and the Owner may approve the use of a water-reducing set-retarding admixture in some of the concrete. The use of such an admixture will not be approved to overcome problems associated with inadequate concrete plant capacity or improperly planned placing operations and shall only be approved as an aid to overcoming unusual circumstances and placing conditions.

4. The water reducing set-retarding admixture shall be an approved brand of Ligno-sulphonate type admixture.

5. The water proofing cement additives shall be used as required/advised by the owner.

Lattice & Pipe Structure

STATUTORY CLEARANCES:

1.0 Statutory Clearances:

The installation of cables and equipment shall be as per established code of practice and fulfill the requirements of statutes.

1.1 The bidder shall maintain all statutory clearances from other utility services, like telephones, water supply, power supply etc. The bidder shall obtain all necessary approvals from local authorities on behalf of OPTCL .

1.2 **Any other items not specifically mentioned in the specification but which are required for turnkey installation, testing, commissioning and satisfactory operation of the underground distribution system as per Indian standards/IE Rules/IE Act and local authority regulations are deemed to be included in the scope of the specification and no deviation in this regard shall be accepted**.

1.3 The successful bidder shall also be responsible for the overall coordination with internal/external agencies, project management, training of Employer's manpower, loading, unloading, handling, moving to final destination for successful erection, testing and commissioning of the 33 kV,11kV and LT underground cable works

1.4 The scope includes construction power and water. The contractor shall arrange construction water and power during construction stage at his own cost.

1.5 The road cutting for cable trench, whether cement concrete, asphalt or macadam road surface shall be undertaken after obtaining approval for cutting from the road owning authorities, traffic police, telephone authorities and work should be planned to be completed in the shortest possible time. Where necessary the work shall be planned during night or light traffic periods. The railway track crossing design shall be got approved from the railway authorities and the contractor shall do work in coordination with them **However the charges paid to Municipal Corporation, R & B or any Government bodies or road owning authorities for the restoration of roads/foot path shall be paid by OPTCL**

Safety measures

The Contractor shall maintain safety tools and materials as per the work to be carried out. OPTCL is not liable for any accident or untoward incident during the execution of work.

Warnings Signs

Different types of warning signs such as "Men working", "Line under permit to work", "Danger", etc and other indications for earthing, live parts, shock hazard possibility etc are to be displayed at strategic points by the contractor.

The contractor shall utilize the safety material as detailed during the execution of work.

Rubber Gloves

These are specially processed gloves, high dielectric strength, hardened as required and with flexibility for normal bend of fingers and thumbs for operating equipment handles.

Work Gloves

These are gloves made of silicon grain leather, flexible and with large protective cuff. These gloves are used while working on equipment for pre-commissioning tests or for repairs.

Polyethylene helmets

Safety hats for industrial and construction use, with tough outer shell, brims to allow water to drain and with adjustable side ventilation, in standard sizes.

Insulated boots

These are boots made of special leather with elastomeric canvas support, flexible with anti-slip sole.

Safety Unit

Safety clothing, include safety suit with no metal parts, resistant to wear and tear, flexible comfortable with Velcro straps.

Hooded Rain Coat

PVC rain garment with matching nylon trousers for the use of the workmen during rains

Reinforced Safety Belt

These are waist belts for use in the overhead line work, with polyamide or leather elements, cast

steel buckles suspension rings, straps, fibre ropes etc. Anti-fall safety-snaps will also be part of the safety belt.

Portable lamps '

In the safety tools of workmen, head lamps, pocket torch, hand lamps etc are also included.

Life saving Kits

These shall contain, voltage detectors, cable cutter with insulated handles, insulated platform on ladder and rescue sticks.

Fire Extinguisher -

Normally CO_2 cylinder 4.5'*g, 6.5 kg, 9 kg, 22 kg are used in sub-stations and generating stations. 22 kq^{s} cylinders are generally trolley mounted type.

The work area shall be separated from all possible sources of supply of power, by ensuring relevant circuit breakers, isolating switches etc.

i) The equipment like breakers and isolators shall be locked in the open condition.
ii) Warning boards shall be exhibited even during the simple temporary maintenance operation,
iii) The area of work shall be properly demarcated with identifying ribbons or ropes.
iv) Each conductor or apparatus shall be checked to ensure absence of voltage.
v) Proper short circuit and earthing shall be made before commencing any work on the line or equipment.

All safety rules given above and other associated guide lines are for enhancing safety when a person is in contact with or in close proximity to an electrical network. Using proper ladders, safety belts, helmets, insulating gloves etc form part of the safety rules, as observation of the same are essential for preventing accidents other than the electrical shock hazard.

Safety Checks

The safety checks include the following

i) Whether the worker is properly trained for the work and aware of safety rules?
ii) Whether appropriate tools, and gadget available for the work? ***AN%***
iii) Whether the' person is properly insulated by using insulated platform, gloves, mats etc.?
iv) Whether the active or live conductors are away at a safe distance?
v) Whether safety equipment like helmets, safety belts, fire fighting equipment, earth rods etc. available?
vi) Whether all accidental reconnection of supply or induced voltage possibilities are

guarded against?
vii) Whether life saving kits and first aid equipment available?

Safety Measures during erection of lines and installation of Equipment 3.5.1

Excavation For Foundations.

• The excavation for pad or pile type foundations in excess of 1.5 meters depth located on unstable earth shall be either sloped to the angle of repose or shored if entry is required., Ladders shall be used for access to pad or pile type footing excavations in excess of 1.2 meters.

Workmen shall not enter excavated pit in un-stable earth unless shoring is used to protect them.

- Workmen shall not remain in the excavated pit where concreting is done using machinery.
- Mobile machines for concreting shall be located only on leveled earth to ensure stability.

5		**SPECIFIC TECHNICAL REQUIREMENTS OF 100kVA TRF,33/0.433kV**		
1		Rated KVA (ONAN rating)		100 KVA, 33/0.433 KV
2		No. of phases		3
3		Type of installation		Outdoor
4		Frequency		50 Hz (± 5%)
5		Cooling medium		Insulating Oil (ONAN)
6		Type of mounting		Channels
7		Rated voltage		
	a)	High voltage winding		33 KV
	b)	Low voltage winding		0.433 KV
8		Highest continuous system voltage		
	a)	Maximum system voltage ratio (HV / LV)		36 KV / 0.476 KV
	b)	Rated voltage ratio (HV / LV)		33 KV / 0.433 KV
9		No. of windings		Two winding Transformers
10		Type of cooling		ONAN (Oil natural / Air natural)
11		KVA Rating corresponding to ONAN cooling system		100%
12		Method of connection:		
		HV:		Delta
		LV:		Star
13		Connection symbol		Dyn 11
14		System earthing		Neutral of LV side to be solidly earthed.
15		Percentage impedance voltage on normal tap and KVA base at 75^0 C corresponding to HV/ LV rating and applicable tolerances :		**<u>% Impedance</u> + <u>Tolerance %</u>** 4.5 + 10% **(No negative tolerance will be allowed)**
16		Intended regular cyclic overloading of windings		As per IEC –76-1, Clause 4.2
17	a)	Anticipated unbalanced loading		Around 10%
	b)	Anticipated continuous loading of windings (HV / LV)		110 % of rated current
18	a)	Type of tap changer		Off-load tap changer
	b)	Range of taping		+ 2.5% to – 7.5% in 5 equal steps of 2.5% each on HV winding
19		Neutral terminal to be brought out		On LV side only
20		Over Voltage operating capability and duration		112.5 % of rated voltage (continuous)

21		Maximum Flux Density in any part of the core and yoke at rated KVA, rated voltage i.e. 11 KV / 0.433 KV and system frequency of 50 HZ		**1.5 Tesla**	
22		Insulation levels for windings :-			
	a)	1.2 / 50 microsecond wave shape Impulse withstand (KVP)		HV: 170	LV: N.A.
	b)	Power frequency voltage withstand (KV-rms)		HV: 70	LV: 03
23		Type of winding insulation			
	a)	HV winding		Uniform	
	b)	LV winding		Uniform	
24		Withstand time for three phase short circuit		2 Seconds	
25		Noise level at rated voltage and frequency		As per NEMA Publication No. TR-1.	
26		Permissible Temperature Rise over ambient temperature of 50^0C			
	a)	Of top oil measured by thermometer.		**35^0C**	
	b)	Of winding measured by resistance.		**40^0 C**	
27		Minimum HV clearances in air (mm):-			
	a)	Phase to Phase		350	
	b)	Phase to ground		320	
28		Terminals			
	a)	HV winding line end		36 KV oil filled porcelain communicating type of bushings (Antifog type)	
	b)	LV winding		0.4 KV porcelain type of bushing (Antifog type)	
29		Insulation level of bushing		HV	LV
	a)	Lightning Impulse withstand (KVP)		170	Not applicable
	b)	1 Minute Power Frequency withstand voltage (KV –rms)		70	3
	c)	Creepage distance (mm) (minimum)		25 mm/ KV	
30		Material of HV & LV Conductor		Electrolytic Copper	
31		Maximum current density for HV and LV winding for rated current		**2.4 A/ mm^2**	
32		Polarisation index i.e ratio of megger values at 600 sec. to 60 sec for HV to earth, L.V to earth and HV to LV.		Shall be greater than or equal to 1.5, but less than or equal to '5'.	
33		Core Assembly		Boltless type	
34		Maximum permissible total losses (No load & Load loss) (Watts) at 75^0 C.		**At 50% loading**	**At 100% loading**
				560 Watts	**1820 Watts**

N.B. The above losses mentioned at SL.34 are maximum allowable and there should not be any positive tolerance. Offers quoting losses higher than our prescribed losses as above shall be rejected. Loss Capitalization shall not be factored for evaluation of Bids.

CORE MATERIAL:- The core shall be constructed from non-ageing, Cold Rolled Grain Oriented silicon steel laminations of grade **M–3 with lamination thickness ≤ 0.23 mm or better** only. No other

core materials shall be entertained. Bidders are requested to note that only **PRIME CORE** materials are to be used. In no case, second grade core material is to be used. The purchaser at his discretion, may select samples from the core laminations and get the same tested in CPRI/ Approved National Govt. Laboratory to prove the quality of the core material.

12. FITTINGS AND ACCESSORIES:- The following standard fittings and accessories shall be provided :

- rating, diagram and terminal marking plate.
- two earthing terminals .
- lifting lugs/ platform lugs.
- pressure relief device in form of explosion vent.
- silica gel breather.
- filter and drain / sampling valve with proper locking arrangement.
- a magnetic or prismatic oil level gauge for all transformers indicating three position (3) of oil - minimum. 5^{0} C, 30^{0} C and 98^{0} C.
- A thermometer pocket with thermometer with screwed top to prevent ingress of water or leakage oil.
- Top filter valve (25 mm with adopter for 16 mm hole) with plug.
- Arcing horns for HT bushing.
- Set of Radiators.
- Conservator Tank

Bi-metallic terminals on the bushings for connection with over head ACSR/ AAAC conductor. The Specification and brief details of the salient features of these terminals should be stated

14. STEPS FOR INSPECTION:-

A) STAGE INSPECTION:- The Purchaser shall have free entry at all times, while work on the contract is being performed, to all parts of the manufacturer's works which concern the processing of the equipment ordered. The manufacturer shall afford the Purchaser without charge, all reasonable facilities to assure that the equipment being furnished is in accordance with this specification. After approval of Drawings by the Purchaser, the manufacture shall manufacture a Prototype Model as per the Approved Drawing and offer the same for inspection. The Supplier shall offer the core, windings and tanks of each transformer for inspection by the Purchaser's representative(s). During stage inspection of the Prototype Model, all the measurements like diameter, window, height, leg centre, stack width, stack thickness, thickness of laminations etc for core assembly, conductor size, insulation thickness, I.D., O.D., Winding height, major and minor insulations for both HV and LV windings, length, breadth, height and thickness of plates of transformer tanks, the quality of fittings and accessories will be taken/ determined.

The Inspection Report for the Tests conducted by our Authorized Inspectors in presence of the manufacturer's representative, for the Prototype Model offered for inspection with suggested modifications, if any shall be submitted to the undersigned for approval.

After Inspection, the Prototype Model shall be kept sealed, in the premises of the manufacturer till the completion of delivery of final consignment, for future reference during subsequent Inspections.

The Supplier can offer for final inspection of the transformers subject to clearance of the stage inspection report by the Purchaser.

B) ROUTINE TESTS:- Routine tests shall be carried out on all transformers and the tests shall be conducted in accordance with relevant National/ International Standards. No sampling is allowed. In addition, tank tests in accordance with IS:1180 shall be carried out.

The following routine measurements and tests shall be carried out in presence of Purchaser's authorized representative(s):-

a) measurement of winding resistance. (at normal tap and both extreme tap positions)
b) voltage ratio measurement and check of polarity and vector group. Bushing positions shall have permanent markings at this stage of production;
c) measurement of impedance voltages/ short circuit impedance at rated current and frequency (at normal, highest and lowest tap positions)
d) measurement of load loss at full load and 75^0C; (at normal, highest and lowest tap positions)
e) measurement of neutral unbalance current (which should be within 2% of full load current);
f) temperature rise test on one transformer of each rating and measurement of hot resistance.
g) measurement of no-load loss and no-load currents at full, 50%, 75%, 90%, 110%, 112.5% and 121% of rated voltages;
h) induced over voltage withstand test at 66KV for 60 sec on the HV windings;
i) power frequency voltage withstand tests on HV and LV windings;
j) magnetic balance test
k) Polarization Index test P.I. value shall be not less than 1.5. P.I. = IR at 600 sec / IR at 60 sec.
l) oil leakage test : The criterion of leakage shall be discoloration by oil of whitewash applied externally to suspected parts at an oil temperature of 90^0C or other method, as approved by the Purchaser;
m) pressure test on transformer tank on one unit for each rating.

Bushings and oil shall be subject to the following routine tests.

n) bushing routine test: in accordance with IEC 137/IS 3347;
o) oil dielectric and moisture content test: conforming to IEC 156 or IS 335.

15. PACKING AND SHIPPING:-

The equipment and any supporting structures are to be transported adequately sealed against water ingress. All accessories and spares shall be packed and securely clamped against movement in robust, wooden, non returnable packing cases to ensure safe transit in rough terrain, cross country road conditions and in heavy rains from the manufacturer's works to the work sites/ earmarked destinations.

All accessories shall be carefully packed so that they are fully protected during transport and handling operations and in storage. Internal surfaces of loose accessories shall be sealed by means of gaskets and blanking off plates. All parts liable to rust shall receive an anti-rusting coat and shall be suitably protected. It shall be the responsibility of the Supplier to make good any damage caused through insufficient packing.

Each packing case shall be indelibly marked, on two adjacent sides and on the top, with the following:

- Individual serial number;
- Purchaser's name;
- Contract number;
- Destination;
- A colour coded marking to indicate destination;
- Supplier's name;
- Name and address of supplier's agent in Orissa;
- Description and numbers of contents;
- Manufacturer's name;
- Country of origin;
- Case measurements;
- Gross and net weight in kilograms: and
- All necessary slinging and stacking instructions.

16. Guarantee:

The supplier shall guarantee for satisfactory performance of the equipments/materials for a minimum period of 36 months from the date of Commissioning or 42 months from the date of receipt of last consignment whichever is earlier. In the event of any defect in the equipment/ materials arising out of faulty design, inferior quality of raw material used or bad workmanship within the guarantee period, the Seller shall guarantee to replace/ repair to the satisfaction of the Purchaser the defective equipments free of cost. Should however, the manufacturer fails to do so within a reasonable time, the Purchaser reserves the right to recover the amount from the seller either from the bills pending or may recover from the Performance Guarantee submitted by the firm. Seller shall give a Performance Bank Guarantee in favour of the Purchaser for 10% of the order value valid for 90 days over and above the guarantee obligation. Accordingly the supplier must submit a Guarantee Certificate & Inspection / Test Reports for the supplied materials to the undersigned for approval, before submitting his bills for payment.

GUARANTEED TECHNICAL PARTICULARS FOR 100 KVA, 33/0.433KV (CU.) WOUND, THREE PHASE TRANSFORMER

Sl. NO.	DESCRIPTION	UNIT	SPECIFIED	
1	**GENERAL**			
a)	Name and address of manufacturer			
b)	International or national standards with which the transformer and accessories comply		IEC – 76, IS – 2026 & IS – 1180 (part-2)	
c)	Nominal frequency	HZ	50	
d)	Nominal power rating	KVA	100	
e)	Maximum continuous power rating	KVA	100	
f)	Nominal primary voltage	KV	33	
g)	Nominal secondary voltage	V	433	
h)	Type of cooling		ONAN	
i)	Vector Group		Dyn 11	
j)	Winding polarity			
2	**IMPEDANCE VOLTAGE**			
a)	Impedance at rated current and frequency	%	4.5 + 10% (no negative tolerance)	
b)	Resistance component of impedance	%		
c)	Reactance component of impedance	%		
3	**SHORT CIRCUIT PERFORMANCE**			
a)	Short circuit current withstand capability	KA		
b)	Duration	Sec	2 sec	
c)	X/R ratio			
4	**INSULATION LEVELS**			
a)	Separate source power frequency withstand voltage			
	HV winding	kV rms	70	
	LV winding	kV rms	3	
b)	Induced over voltage withstand level			
	HV winding	kV rms	66	
	LV winding	kV rms	0.866	
c)	Full wave 1.2/50 μ sec. lightning impulse withstand level of HV winding	kV peak	170	
5	**OVERLOAD / TEMPERATURE RISE**			
a)	Duration of overload: 25%	Min	As Per IS-6600	
b)	Duration of overload: 50%	Min	As Per IS-6600	
c)	Design maximum ambient temperature	ºC	50	
d)	Design average ambient temperature	ºC	32	

Sl. NO.	DESCRIPTION	UNIT	SPECIFIED		
e)	Maximum winding temperature rise by resistance method	ºC	**40**		
f)	Maximum top oil temperature rise by Thermometer	ºC	**35**		
g)	Maximum hot spot temperature of ambient temperature of 50 ° C	ºC	98		
h)	Maximum temperature gradient	ºC/ mm	13		
6	**CURRENT AND FLUX DENSITY**				
a)	Maximum current density at full load current.				
	HV winding	A/mm^2	**2.4 (Cu)**		
	LV winding	A/mm^2	**2.4 (Cu)**		
b)	Maximum Flux density at rated voltage and rated frequency.	Tesla	**1.5**		
c)	Maximum flux density at 33 kV and 48.5 Hz	Tesla			
7	**GUARANTEED LOSSES**				
a)	Core losses at rated voltage and rated frequency (Note: No-load loss calculation with handling factor of 25% supported by characteristics curve shall be submitted along with the offer.)	**W**			
b)	Winding losses at 100% and 50% rated current at 75^0C at normal tap (Note: Calculation of load loss along with computation of stray loss shall be submitted along with the offer. Stray loss equivalent to KVA rating shall be added to I^2R loss.)	**W**			
c)	Total losses (Core & Winding losses) at rated voltage, rated frequency, 75^0C and normal tap	W	**At 50% loading**	**At 100% loading**	
			560 (Max.)	**1820 (Max.)**	
d)	No load current (as percentage of full load current (LV)) & core losses at normal frequency and 50%, 75%, 90%, 100 %, 110%, 115%, 120% and 121.5% of rated voltage.	%			
e)	Regulation at 75^0C: full load PF=1	%			
f)	Regulation at 75^0C: full load PF=0.85	%			
8	**CORE AND WINDINGS**				
a)	CRGO Silicon steel of core:				
	(i) Manufacturer/supplier				
	(ii) Type/ Grade	**CRGO-M3 or higher**	**CRGO-M-3, Prime Core or Better**		
	iii) Maximum Thickness of laminations (mm)	**0.23**	**0.23 to 0.27**		
b)	Insulation materials provided for				
	i) Core				
	ii) Conductors of HV & LV windings	Copper			
	→ Manufacturer/ Supplier				

NO.	DESCRIPTION	UNIT	SPECIFIED	
	→ type/ grade	EC grade		
c)	Size of HV winding Conductors (dia) (bare):	mm		
d)	Size of LV winding Conductors (Width x Thickness) (bare):	mm		
e)	Cross section area of HV winding conductor	mm^2		
f)	Cross section area of LV winding conductor	mm^2		
g)	H.V. Resistance at 75^0 C/Phase	Ohms.		
h)	L.V. Resistance at 75^0 C/ Phase	Ohms		
i)	Core diameter	(mm)		
j)	Core Window Height	(mm)		
k)	Core leg centre	(mm)		
l)	Gross core cross-sectional area	mm^2		
m)	Stacking factor of core laminations			
n)	LV winding No. of turns/phase	No		
o)	LV winding I.D/O.D	Mm / mm		
p)	LV winding length	mm		
q)	HV winding No. of turns/phase	No		
r)	HV winding I.D/O.D	Mm / mm		
s)	HV winding length including packing.	mm		
t)	Details of core step width & stack thickness and Specific Core Loss Curve (To be enclosed with the offer)			
9	**CLEARANCES**			
a)	Minimum HV Phase to Phase clearance in air:	mm	350	
b)	Minimum HV clearance Phase to earth in air	mm	320	
c)	Core & LV	mm		
d)	LV & HV	mm		
e)	Any point of winding to tank	mm		
10	**BUSHINGS AND TERMINALS**			
a)	HV bushings:			
	(i) Manufacturer/supplier			
	(ii) type/grade			
b)	LV bushings:			
	(i) Manufacturer/supplier			
	(ii) type/grade			
c)	Type of HV terminal			
	(i) Metal used for terminal studs		Non ferrous Bolt and Nut	
	(ii) Tightening bolt diameter	mm		

Sl. NO.	DESCRIPTION	UNIT	SPECIFIED	
	(iii) Type of atmospheric protection			
	(iv) Minimum phase to phase clearance	mm	350	
	(v) Minimum phase to earth clearance	mm	320	
d)	Type of LV terminal			
	(i) Metal used for terminal studs		Non ferrous Bolt and Nut	
	(ii) Tightening bolt diameter	mm		
	(iii) Type of atmospheric protection			
	(iv) Minimum phase to phase clearance	mm	75	
	(v) Minimum phase to earth clearance	mm	55	
e)	Type of earth terminal material		Non ferrous Bolt and Nut	
f)	Are spring and lock washers included?	Yes/No		
11	**TRANSFORMER OIL**		IEC:296/ IS:335	
a)	Oil: Manufacturer/ supplier.			
b)	Type/ Grade		CLASS-1 mineral oil	
c)	Quantity of oil for first filling up to normal level of conservator.	Litres		
d)	Total Quantity of Oil to be supplied	Litres		
e)	Breakdown Voltage at the time of filling (min)	kV(rms)	60	
f)	Moisture content at the time of filling (max)	ppm	< 25	
12	**TRANSFORMER TANK**			
a)	Non-Sealed Type	Yes/No		
b)	Type of steel		Mild steel	
c)	Grade of steel		High Grade	
d)	Minimum thickness of:			
	(i) Tank steel	mm	3.15	
	(ii) Top cover	mm	5	
	(iii) Bottom cover	mm	5	
	(iv) Cooling surfaces (radiators)	mm	1.2	
e)	Top oil temperature corresponding to 100 kN/m^2 pressure.	ºC	105	
f)	Steady load to give top oil temp (50^0C amb.)	kVA	100	
g)	Steady load to give top oil temp (50^0C ambient and solar radiation of 1,200 W/m^2)	kVA	100	
h)	Corrosion protection		Paint	
	type/grade			
	supplier			
i)	Minimum thickness of coating	microns	200	
13	**DIMENSIONS AND WEIGHTS**			
a)	Overall width/Tank width	mm/mm		
b)	Overall height/ Tank height	mm/mm		

Sl. NO.	DESCRIPTION	UNIT	SPECIFIED	
c)	Overall length/ Tank length	mm/mm		
d)	Weight of core	kg		
e)	Weight of tank	kg		
f)	Weight of windings	kg		
g)	Weight of oil at 20^0C	kg		
h)	Total weight of transformer, ready for service	Kg		
i)	Oil required for first filling upto normal level of conservator.	Ltrs.		
j)	Total Quantity of Oil to be supplied	Litres		
k)	Shipping weight of transformer	Kg		
14	**EFFICIENCY**			
a)	Efficiencies at 75^0C and unity power factor			
	i) at 125% load	%		
	ii) at 100% load	%		
	iii) at 75% load	%		
	iv) at 50% load	%		
	v) at 25% load	%		
	vi) Load at which maximum efficiency occurs	kVA		
	vii) Maximum efficiency	%		
b)	Efficiencies at 75^0C and 0.8 power factor (lag)			
	i) at 125% load	%		
	ii) at 100% load	%		
	iii) at 75% load	%		
	iv) at 50% load	%		
	v) at 25% load	%		
	vi) Load at which maximum efficiency occurs	kVA		
	vii) Maximum efficiency	%		
15	**INSULATION RESISTANCE AND PI**			
	(PI = IR at 10 min to 1 min at 30^0C)			
	HV to Earth	Mega ohms		
	LV to Earth	Mega ohms		
	HV to LV	Mega ohms		

TECHNICAL SPECIFICATION

FOR

ALL ALUMINIUM ALLOY CONDUCTOR (AAAC)

TABLE OF CONTENTS

OF

ALL ALUMINIUM ALLOY CONDUCTOR

TECHNICAL SPECIFICATION FOR ALL ALUMINIUM ALLOY CONDUCTOR

1.0 SCOPE

This specification covers design, Engineering, Manufacture, Testing, Inspection before despath, forwarding, packing, transportation to sites, Insurance (both during transit & storage), storage, erection, supervision testing & commissioning of all sizes of All Aluminum Alloy Conductors of the Aluminum–Magnesium-Silicon type for use in the distribution overhead power lines.

The conductor offered shall be procured from short listed vendor at **E-23** and shall have been successfully Type Tested during last five years on the date of bid opening. Tthe Type Test reports shall be submitted along with the bid.

The AAA Conductor shall conform in all respects to highest standards of engineering, design, workmanship complying this specification and the latest revisions of relevant standards at the time of offer and the Purchaser shall have the power to reject any work or materials, which, in his judgement, is not in full accordance therewith.

2.0 STANDARDS

Except where modified by the specification, the Aluminum Alloy Conductor shall be designed, manufactured and tested in accordance with latest editions of the following standards:

Sl.No	International Standard	IS	Description
1	IEC :1089		Round wire concentric lay overhead electrical standard Conductor
2		IS 398	Aluminum Alloy Stranded Conductors
3		IS 9997	Aluminum Alloy redraw rods for electrical purposes
4	IEC 502 : 1994		Extruded solid dielectric insulated power cables for rated voltages 1.0 kV up to 30 kV
5	IEC 104		Aluminum Magnesium Silicon alloy wire for overhead line conductors
6		IS 1778	Reels and drums of bare conductor.
7	BS : 6485-1971		PVC covered conductors for overhead power lines.

3.0 GENERAL

The wires shall be of heat treated aluminium, magnesium silicon alloy containing approximately silcon-0.5 to 0.9 %, magnesium-0.6 % to 0.9%, Fe-0.5% (maximum) , Copper- 0.1% (max), Mn- 0.03%, Cr-0.03%, Zn-0.1%, B-0.06%, and having the mechanical and electrical properties specified in the table and be smooth and free from all imperfections, such as, spills, splits and scratches.

Neutral grease shall be applied between the layers of wires. The drop point temperature of the grease shall not be less than 120^0C.

3.1 Mechanical and Electrical Characteristics of Aluminium Alloy Wires used in the Construction of Stranded Aluminium Alloy Conductors

Nominal Diameter	Minimum Diameter	Max. Diameter	Cross Sectional Area	Mass	Minimum Breaking Load		Maximum Resistance at 20^0 C
					Before stranding	After stranding	
1	2	3	4	5	6	7	8
mm	mm	mm	mm^2	Kg/km	KN	KN	ohms/km
3.15 *	3.12	3.18	7.793	21.04	2.41	2.29	4.290
4.26 *	4.22	4.30	14.25	38.48	4.40	4.18	2.345

Maximum resistance values given in column 8 have been calculated from the maximum values of the resistively as specified and the cross sectional area based on the minimum diameter.

The minimum breaking load is calculated on nominal diameter at ultimate tensile strength of 0.3 09 KN / mm^2 for wire before stranding and 95% of the ultimate tensile strength after stranding.

4.0 PHYSICAL CONSTANTS FOR ALUMINIUM ALLOY WIRES

4.1 Resistively:

For the purpose of this specification, the standard value of resistively of aluminum alloy wire which shall be used for calculation is to be taken as 0.0325 ohm-mm^2/m at 20^0 C. the maximum value of resistively of any single wire shall not, however, exceed 0.0328 ohm-mm^2/m at 20^0 C

4.2 Density:

At a temperature of 20^0 C, the density of aluminum alloy wire is to be taken as 2700 kg/m^3.

4.3 Temperature Coefficient of Linear Expansion:

The temperature coefficient of linear expansion of aluminium alloy wire is to be taken as 23 x 10^{-6} /^{0}C

4.4 Constant – Mass Temperature Coefficient

At a Temperature of 20^0 C, the constant – mass temperature coefficient of resistance of aluminium alloy wires, measured between two potential points rigidly fixed to the wire, is taken as 0.00360/^{0} C

5.0 STANDARD SIZES

5.1 Nominal Sizes of Wires

The aluminium alloy wires for standard constructions covered by this specification shall have the diameters as specified in the table and a tolerance of ±1% shall be permitted on the nominal diameter.

5.2 Standard Conductors

The sizes, resistance and masses (excluding the mass of grease) of stranded aluminium alloy conductors shall be as given in table. The preferred sizes are highlighted in the table.

5.3 Mechanical and Electrical Characteristics of Aluminium Alloy Stranded Conductors

Sl. No.	Actual Area	Stranding and Wire Dia	Approx. Overall Dia	Approx. Mass	Calculated Maximum Resistance at 20^0 C	Approx Calculated Breaking
1	2	3	4	5	6	7
	Mm^2	mm	mm	kg/km	ohms/km	KN
2	100	7/4.26	12.78	272.86	0.3390	29.26
3	148	19/3.15	15.75	406.91	0.2290	43.50

5.3.1 Increase in Length due to Stranding

When straightened out, each wire in any particular layer of a stranded conductor, except the central wire, is longer than the stranded conductor by an amount depending on the lay ratio of that layer.

5.3.2 Resistance and Mass of Conductor

The resistance of any length of stranded conductor is the resistance of the same length of any one wire multiplied by a constant as set out in the table below.

The mass of each wire in any particular layer of the stranded conductor, except the central wire, will be greater than that of an equal length of straight wire by an amount depending on the lay ratio of that

layer. The total mass of any length of an aluminium stranded conductor is, therefore, obtained by multiplying the mass of an equal length of straight wire by an appropriate constant as mentioned below. In calculating the stranding constants as mentioned in the table below, the mean lay ratio, that is the arithmetic mean of the relevant minimum and maximum values in table for lay ratio has been assumed for each layer.

5.3.3 Calculated Breaking Load of Conductor

For a conductor containing **not more than** 37 wires, 95% of the sum of strength of the individual wires calculated from the values of the minimum breaking load given in this specification.

For a conductor containing **more than** 37 wires, 90% of the sum of the strengths of the individual wire calculated from the values of the minimum breaking load given in this specification.

5.3.4 Calculated Area and Maximum Resistance of Conductor

The actual area of a stranded conductor has been taken as the sum of the cross-sectional areas of the individual wires of nominal diameter.

Maximum resistance values of stranded conductor have been calculated on the basis of maximum resistively and the cross-sectional area based on the minimum diameter of wires.

5.4 Stranding Constants

Number of Wires in Conductor	**Stranding Constants**	
	Mass	Electrical Resistance
(1)	(2)	(3)
7	7.091	0.1447
19	19.34	0.05357

6.0 JOINTS IN WIRES

6.1 Conductor containing seven wires

There shall be no joint in any wire of a stranded conductor containing seven wires, except those made in the base rod or wire before final drawing.

6.2 Conductors containing more than seven wires

In stranded conductors containing more than seven wires, joints in individual wires are permitted in any layer except the outermost layer (in addition to those made in the base rod or wire before final drawing) but no two such joints shall be less than 15 m apart in the complete stranded conductor. Such joints shall be made by cold pressure butt welding. They are not required to fulfill the mechanical requirements for un-jointed wires.

7.0 STRANDING

The wire used in the construction of a stranded conductor shall, before and after stranding, satisfy all the relevant requirements of this standard.

The lay ratio of the different layers shall be within the limits given in the table for lay ratio.

In all constructions, the successive layers shall have opposite directions of lay, the outermost layer being righ-handed. The wires in each layer shall be evenly and closely stranded.

In aluminium alloy stranded conductors having multiple layers of wires, the lay ratio of any layer shall not be greater than the lay ratio of the layer immediately beneath it.

7.1 Lay Ratios for Aluminium Alloy Stranded Conductors

Number of Wires in Conductor	LAY RATIOS							
	3/6 Wire Layer		12 Wire Layer		18 Wire Layer		24 Wire Layer	
	Min	Max	Min	Max	Min	Max	Min	Max
7	10	14	---	---	---	---	---	---
19	10	16	10	14	---	---	---	---

NOTE: For the purpose of calculation the mean lay ratio shall be taken as the arithmetic mean of the relevant minimum and maximum values given in this table

8.0 LENGTHS AND VARIATIONS IN LENGTHS:

Unless otherwise agreed between the Owner and the Contractor, stranded aluminium alloy conductors shall be supplied in the manufacturer's usual production lengths to be indicated in the bid Schedule. The Owner reserves the right to specify particular lengths of conductor such that certain drum lengths will be shorter than others. There will in both cases be a permitted variation of –0 + 5% in the length of any one conductor length.

9.0 TESTS

9.1 Type Tests

The following tests should have been carried out as per relevant ISS

9.1.1 Ultimate Tensile Strength Test

This test is intended to confirm not only the breaking strength of the finished conductor but also that the conductor has been uniformly stranded.

A conductor sample of minimum 5mtr. length fitted with compression dead end clamps at either end shall be mounted in a suitable tensile test machine. Circles perpendicular to the axis of the conductor shall be marked at two places on its surface. Tension on the conductor sample shall be increased at a steady rate upto 50% of the minimum UTS specified and held for one minute. The circles drawn shall not be distorted due to relative movement of the individual strands. Thereafter the load shall be increased at a steady rate to the specified minimum UTS and held at that load for one minute. The conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

9.1.2 D.C Resistance Test

On a conductor sample of minimum 5mtr. length two contact clamps shall be fitted with a predetermined bolt torque. The resistance between the clamps shall be measured using a Kelvin double bridge by initially placing the clamps at zero separation and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20^0 C, which shall conform to the requirements of this specification.

9.2 Routine Tests

9.2.1 Measurement of Physical Dimensions:

The samples should meet the desired dimensional requirements before conducting following Routine Tests as per relevant ISS.

9.2.2 Selection of Test Samples

Samples for the tests specified in this specification shall be taken by the manufacturer before stranding, from not less than 10% of the individual lengths of aluminium alloy wire included in any one final heat-treatment batch and which will be included in any one consignment of the stranded conductors to be supplied.

Samples shall then be obtained by cutting 1.2 meters from the outer end of the finished conductor from not more than 10% of the finished reels or drums.

Tests for electrical and mechanical properties of aluminium alloy wire shall ordinarily be made before stranding since wires unlaid from conductors may

have different physical properties from those of the wire prior to stranding because of the deformation brought about by stranding and by straightening for test.

Spools offered for inspection shall be divided into equal lots, the number of lots being equal to the number of samples to be selected, a fraction of a lot being counted as s complete lot. One sample spool shall be selected at random from each lot.

The following test shall be carried out once on samples of completed line conductor during each production run of up to 500 kms of the conductor from each manufacturing facility .

9.3 Breaking Load Test

The breaking load of one specimen, cut from each of the samples taken shall be determined by means of a suitable tensile testing machine. The load shall be applied gradually and the rate of separation of the jaws of the testing machine shall be not less than 25 mm / min and not greater than 100mm /min.

9.4 Elongation Test

The elongation of one specimen cut from each of the samples taken shall be determined as follows :

The specimen shall be straightened by hand and an original gauge length of 200 mm shall be marked on the wire. A tensile load shall be applied as described above and the elongation shall be measured after the fractured ends have been fitted together. If the fracture occurs outside the gauge marks, or within 25 mm of either mark, and the required elongation is not obtained, the test shall be disregarded and another test should be made.

When tested before and after stranding, the elongation shall not be less than 4% on a gauge length of 200 mm

9.5 D.C Resistance Test

The electrical resistance test of one specimen cut from each of the samples taken shall be measured at ambient temperature. The measured resistance shall be corrected to the value at 20^0 C by means of the formula

$$R_{20} = R_T [1/(1+\alpha(T-20)]$$

Where R_{20} = Resistance corrected at 20^oC

R_T = Resistance measured at T^0C

A = Constant – Mass temperature coefficient of resistance, 0.0036, and

T = ambient temperature during measurement

The resistance corrected at 20^0 C shall not be more than the maximum values specified .

9.6 Chemical Analysis of Aluminium Alloy

Samples taken from the alloy coils / strands shall be chemically / spectrographically analysed. The results shall conform to the requirements stated in this specification. The Contractor shall make available material analyses, control documents and certificates from each batch as and when required by the **<OPTCL>**.

Test should be conducted at the independent test house by the purchaser in the case of absence of facility at manufacturer. However the cost of such testing shall be borne by the manufacturer/Contractor.

9.7 Dimensional and Lay Length Check

The individual strands of the conductors shall be dimensionally checked and the lay lengths checked to ensure that they conform to the requirements of this specification.

Ten percent drums from each lot shall be rewound in the presence of the purchaser or his representative to allow visual checking of the conductor for joints, scratches or other surface imperfections and to ensure that the conductor generally conforms to the requirements this specification. The length of conductor would on the drum shall be re-measured by means of an approved counter / meter during the rewinding process.

9.8 Visual and dimensional Checks on the Conductor Drums.

9.8.1 The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this specification and of IS 1778: Specification for reels and drums of bare conductors. For wooden drums, a suitable barrel batten strength test procedure is required . The Bidder shall state in his bid the tests to be carried out on the drums and shall include those tests in the Quality Assurance Programme.

9.8.2 Acceptance Tests :

The following acceptance tests as per IS-398 (PartIV)/1994 with latest amendments if any, shall be carried out on all samples

i. Measurement of lay ratio
ii. Measuerement of diameters of individual wire
iii. Meae of resistance of individual wire
iv. Breaking load test of individual wire
v. Elongation test of individual wire
vi. Torsional test of individual wire

10.0 REJECTION AND RETESTS

10.1 **Type Tests**

Should the conductor fail any of the type tests specified above, the purchaser will not accept any conductor manufactured from the material, nor conductor made by the manufacturing methods used for the conductor which failed the test.

The manufacturer shall propose suitable modifications to his materials and techniques in order that he can produce conductor which will satisfactorily pass the type test requirements.

10.2 **Routine Tests**

Should any one of the test pieces first selected fail the requirements of the tests, two further samples from the same batch shall be selected for testing, one of which shall be from the length from which the original test sample was taken unless that length has been withdrawn by the manufacturer.

Should the test pieces from both these additional samples satisfy the requirements of the tests, the batch represented by these samples shall be deemed to comply with the standard. Should the test pieces from either of the two additional samples fail, the batch represented shall be deemed not to comply with the standard.

If checked on individual strand diameters, conductor lay lengths and conductor surface condition indicate non-compliance with the requirements of the specification, the particular drum will be rejected. Inspection will then be carried out on two further drums within the same batch. If the conductor on either of the drums is non-complaint, the complete batch will be rejected.

.

GUARANTEED TECHNICAL PARTICULARS FOR 100 / 148 mm2 AAAC

Sl. No.	Particulars	100mm^2 AAAC AAAC	Bidder's offer	148mm^2 AAAC	Bidder's offer
1	Nominal Aluminium Alloy area of conductor in mm^2	100		148	
2	No. of strands	7		19	
3	Wire dia in mm.:				
	Nominal	4.26		3.15	
	Minimum	4.22		3.12	
	Maximum	4.3		3.18	
4	Approximate overall dia of the conductor in mm.	12.78		15.75	
5	Cross-sectional area of:				
	Individual wire in mm^2	14.25		7.793	
	Stranded conductor in mm^2	99.81		148	
6	Approximate mass of :				
	Individual wire in Kg/Km	38.48		21.04	
	Stranded Conductor in Kg/Km	272.86		406.91	
7	Minimum breaking load in KN				
	Individual wire	4.18		2.289	
	Conductor (U.T.S.)	29.26		43.5	
8	Calculated maximum DC resistance at 20 ^{0}C in Ohm/ Km				
	Individual wire	2.345		4.351	
	Conductor	0.339		0.229	
9	Lay ratio for 7 wire conductor	Min : 10, Maxm : 14		Min : 10, Maxm : 16	
10	Direction of Lay	Right handed		Right handed	
11	Modulus of Elasticity (Kg/ cm^2)	0.63 24 x 10^6		0.63 24 x 10^6	
12	Co-efficient of linear expansion per ^{0} C	23.0 x 10 -6		23.0 x 10 -6	
13	Standard length (Mtr.)	2000 ± 5%		2000 ± 5%	
14	Size of drum in mm.	To be offered by the bidder		To be offered by the bidder	
15	No. of lengths in one drum	To be offered by the bidder		To be offered by the bidder	
16	No. of cold pressure butt welding	8 (Eight)		8 (Eight)	

ODISHA POWER SECTOR EMERGENCY ASSISTANCE PROJECT

SPECIFICATION

FOR

11 KV & 33 KV

COMPOSITE INSULATORS

TECHNICAL SPECIFICATION FOR 11 KV/33 KV COMPOSITE INSULATORS

INDEX

TECHNICAL SPECIFICATION 11 KV/33 KV COMPOSITE INSULATORS

1.0 SCOPE :

This specification covers the design, manufacture, testing and supply of 11KV / 33 KV Composite Insulators. The composite insulators shall be of the following type:

i) Long rod insulators for conductors in tension application at angle / cut points the insulators shall be of tongue & clevis type.
ii) Line post insulators or pin insulators for straight line locations

2.0 SERVICE CONDITIONS :

The insulators to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions.

2.1.1	Maximum ambient temperature (Degree C)	…	50
2.1.2	Minimum ambient temperature (Degree C)	…	3.5
2.1.3	Relative Humidity (%)	…	10 to 100
2.1.4	Maximum Annual Rainfall (mm)	…	1450
2.1.5.	Maximum Wind pressure (kg/m.sq.)	…	150
2.1.6	Maximum wind velocity (km/hour)	…	45
2.1.7	Maximum altitude above mean sea level (meter)	…	1000
2.1.8	Isoceraunic level (days/year)	…	50
2.1.9	Seismic level (Horizontal acceleration)	…	0.3 g
2.1.10	Moderately hot and humid tropical climate Conductive to rust and fungus growth		

3.0 SYSTEM PARTICULARS:

a) Nominal System Voltage	11 kV	33 kV
b) Corresponding highest system Voltage	12 kV	36 kV
c) Frequency	50 Hz with 3% tolerance	
d) Number of phase	3	3
e) Neutral earthing	effectively grounded.	

4.0 STANDARDS :

Unless otherwise specified elsewhere in the specifications insulators shall confirm to the latest revisions of all relevant standards available at the time of placement of the order. The standards are listed in Annexure ‘A’.

5.0 GENERAL REQUIREMENTS

5.1 The composite insulators shall generally conform to latest Standards as listed in Annexure 'A'

5.2 The Composite Insulators will be used on lines on which the conductors will be A.A.A. Conductor of size up to 200 sq. mm. and ACSR of any size up to Panther (0.2 sq. inch copper equivalent). The insulators should withstand the conductor tension, the reversible wind load as well as the high frequency vibrations due to wind.

5.3 Bidder must be an indigenous manufacturer and supplier of composite insulators of rating 33 kV or above OR must have developed proven in house technology and manufacturing process for composite insulators of above rating OR possess technical collaboration /association with a manufacturer of composite insulators of rating 33kV or above. The Bidder shall furnish necessary evidence in support of the above along with the bid, which can be in the form of certification from the utilities concerned, or any other documents to the satisfaction of the owner.

5.4 Insulator shall be suitable for both the suspension and strain type of load & shall be of tongue & clevis type. The diameter of Composite Insulator shall be less than 200 mm. The center-to-center distance between tongue & clevis shall be max. 300 mm for 11 kV, & 550 mm for 33 kV composite Insulator.

5.5 Insulators shall have sheds with good self-cleaning properties. Insulator shed profile, spacing, projection etc. and selection in respect of polluted conditions shall be generally in accordance with the recommendation of IEC-60815/IS: 13134.

5.6 The size of Composite insulator, minimum creepage distance and mechanical strength along with hardware fittings shall be as follows:

Sr. No.	Type of composite insulators	Nominal System voltage kV (rms)	Highest System voltage kV(rms)	Visible discharge test voltage kV(rms)	Wet Power Frequency Withstand voltage kV(rms)	Impulse Withstand voltage kV(rms)	Minimum Creepage Distance (mm) (Heavily polluted 25mm/kV)	Center to center distance between Tongue & Clevis (mm)	Min. failing load kN	Shed Diameter (mm) (min)
i.	Long rod insulator	11	12	9	35	75	320	300	45	100
		33	36	27	75	170	900	550	70	100
ii.	Post/Pin Insulator	11	12	9	35	75	320		5	
		33	36	27	75	170	900		10	

5.7 Dimensional Tolerance of Composite Insulators

The tolerances on all dimensions e.g. diameter, length and creepage distance shall be allowed as follows in line with-IEC 61109:

± (0.04d+1.5) mm when d≤300mm.
± (0.025d+6) mm when d>300 mm.
Where, d being the dimensions in millimeters for diameter, length or creepage distance as the case may be. However no negative tolerance shall be applicable to creepage distance.

5.8 Interchangeability:

The composite insulator together with the tongue & clevis fittings shall be of standard design suitable for use with the hardware of any other indigenous make conforming to relevant standards referred above.

5.9 Corona and RI Performance

All surfaces shall be clean, smooth, without cuts, abrasions or projections. No part shall be subjected to excessive localized pressure. The insulator and metal parts shall be so designed and manufactured that it shall avoid local corona formation and not generate any radio interference beyond specified limit under the operating conditions.

6.0 TECHNICAL DESCRIPTION OF COMPOSITE INSULATORS

Polymeric Insulators shall be designed to meet the high quality, safety and reliability and are capable of withstanding a wide range of environmental conditions.
Polymeric Insulators shall consist of THREE parts, at least two of which are insulating parts:- (a) Core- the internal insulating part (b) Housing- the external insulating part (c) Metal end fittings.

6.1 CORE

It shall be a glass-fiber reinforced epoxy resin rod of high strength (FRP rod). Glass fibers and resin shall be optimized in the FRP rod. Glass fibers shall be Boron free electrically corrosion resistant (ECR) glass fiber or Boron free E-Glass and shall exhibit both high electrical integrity and high resistance to acid corrosion. The matrix of the FRP rod shall be Hydrolysis resistant. The FRP rod shall be manufactured through Pultrusion process. The FRP rod shall be void free.

6.2 HOUSING:

The FRP rod shall be covered by a seamless sheath of a silicone elastometric compound or silicone alloy compound of a thickness of 3mm minimum. It shall be one-piece housing using Injection Molding Principle to cover the core. The elastomer housing shall be designed to provide the necessary creepage distance and protection against environmental influences. Housing shall conform to the requirements of IEC 61109/92-93 with latest amendments

6.3 WEATHERSHEDS

The composite polymer weather sheds made of a silicone elastometric compound or silicone alloy compound shall be firmly bonded to the sheath, vulcanized to the sheath or molded as part of the sheath and shall be free from imperfections It should protect

the FRP rod against environmental influences, external pollution and humidity. The weather sheds should have silicon content of minimum 30% by weight. The strength of the weather shed to sheath interface shall be greater than the tearing strength of the polymer. The interface, if any, between sheds and sheath (housing) shall be free from voids.

6.4 METAL END FITTINGS:

End fitting transmit the mechanical load to the core. They shall be made of spheroidal graphite cast iron, malleable cast iron or forged steel or aluminum alloy. They shall be connected to the rod by means of a controlled compression technique. Metal end fittings shall be suitable for tongue & clevis hard wares of respective specified mechanical load and shall be hot dip galvanized after, all fittings have been completed. The material used in fittings shall be corrosion resistant. As the main duty of the end fittings is the transfer of mechanical loads to the core the fittings should be properly attached to the core by a coaxial or hexagonal compression process & should not damage the individual fibers or crack the core. The gap between fitting and sheath shall be sealed by a flexible silicone elastomeric compound or silicone alloy compound sealant. System of attachment of end fitting to the rod shall provide superior sealing performance between housing, i.e. seamless sheath and metal connection. The sealing must be moisture proof. The dimensions of end fittings of insulators shall be in accordance with the standard dimensions stated in IEC: 60120/ IS: 2486 - Part-II /1989.

7.0 WORKMANSHIP

7.1 All the materials shall be of latest design and conform to the best engineering practices adopted in the high voltage field. Bidders shall offer only such insulators as are guaranteed by them to be satisfactory and suitable for continued good service in power transmission lines.

7.2 The design, manufacturing process and material control at various stages shall be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish and elimination of sharp edges and corners.

7.3 The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.

7.4 The core shall be sound and free of cracks and voids that may adversely affect the insulators.

7.5 Weather sheds shall be uniform in quality. They shall be clean, sound, smooth and shall be free from defects and excessive flashing at parting lines.

7.6 End fittings shall be free from cracks, seams, shrinks, air holes and rough edges. End fittings should be effectively sealed to prevent moisture ingress; effectiveness of sealing system must be supported by test documents. All surfaces of the metal parts shall be perfectly smooth with out projecting points or irregularities, which may cause corona.

All load bearing surfaces shall be sooth and uniform so as to distribute the loading stresses uniformly.

7.7 All ferrous parts shall be hot dip galvanized to give a minimum average coating of zinc equivalent to 610 gm/sq.m. or 87 microm thickness and shall be in accordance with the requirement of IS:4759. the zinc used for galvanizing shall be of purity 99.5% as per IS:4699. The zinc coating shall be uniform, adherent, smooth, reasonably bright continuous and free from imperfections such as flux, ash rust stains, bulky white deposits and blisters. The galvanized metal parts shall be guaranteed to withstand at least four successive dips each lasting for one (1) minute duration under the standard preece test. The galvanizing shall be carried out only after any machining.

8.0 TESTS AND STANDARDS

Insulators offered shall be manufactured with the same configuration & raw materials as used in the insulators for which design & type test reports are submitted. The manufacturer shall submit a certificate for the same. The design & type test reports submitted shall not be more than five years old.

8.1 DESIGN TESTS :

For polymeric insulators it is essential to carry out design test as per clause 4.1 of IEC 61109 / 92-93 with latest amendments. The design tests are intended to verify the suitability of the design, materials and method of manufacture (technology). When a composite insulator is submitted to the design tests, the result shall be considered valid for the whole class of insulators, which are represented by the one tested and having the following characteristics:

- Same materials for the core, and sheds and same manufacturing method;
- Same material of the fittings, the same design, the same method of attachment;
- Same or greater layer thickness of the shed material over the core (including a sheath where used);
- Same or smaller ratio of the highest system voltage to insulation length;
- Same or smaller ratio of all mechanical loads to the smallest core diameter between fittings
- Same or greater diameter of the core.

The tested composite insulators shall be identified by a drawing giving all the dimensions with the manufacturing tolerances.
Manufacturer should submit test reports for Design Tests as per IEC – 61109 (clause – 5) along with the bid. Additionally following tests shall be carried out or reports for the tests shall be submitted after award of contract:
UV test: the test shall be carried out in line with clause 7.2 of ANSI C29.13.

8.2 TYPE TESTS :

The type tests are intended to verify the main characteristics of a composite insulator. The type tests shall be applied to composite insulators, the class of which has passed the design tests.

8.2.1 Following Type test shall be conducted on a suitable number of individual insulator units, components, materials or complete strings:

SI. No	Description of type test	Test procedure / standard
1	Dry lightning impulse withstand voltage test	As per IEC 61109(Clause 6.1)
2	Wet power frequency test	As per IEC 61109(Clause 6.2)
3	Mechanical load-time test	As per IEC 61109(Clause 6.4)
4	Radio interference test	As per IEC 61109(Clause 6.5) revised
5	Recovery of Hydrophobicity test	Annexure – B This test may be repeated every 3yrs by the manufacturer
6	Chemical composition test for silicon content	Annexure – B Or any other test method acceptable to the owner
7	Brittle fracture resistance test	Annexure – B

.

The bidder shall submit type test reports as per IEC 61109 along with the bid valid for last 5 years. Additional type tests required if any shall be carried out by the manufacturer, after award of contract for which no additional charges shall be payable. In case, the tests have already been carried out, the manufacturer shall submit reports for the same.

8.3 ACCEPTANCE TESTS :

The test samples after having withstood the routine test shall be subject to the following acceptance tests in order indicated below:

(a)	Verification of dimensions	: Clause 7.2 IEC: 61109,
(b)	Verification of the locking system (if applicable)	: Clause 7.3 IEC: 61109,
(c)	Verification of tightness of the interface Between end fittings & Insulator housing	: Clause 7.4 IEC: 61109 amendment 1of 1995
(d)	Verification of the specified mechanical load	: Clause 7.4 IEC: 61109, amendment 1of 1995
(e)	Galvanizing test	: IS:2633/IS:6745

8.4 ROUTINE TESTS:

Sr.No.	Description	Standard
1	Identification of marking	As per IEC: 61109 Clause 8.1
2	Visual Inspection	As per IEC: 61109 Clause 8.2
3	Mechanical routine test	As per IEC: 61109 Clause 8.3

Every polymeric insulator shall withstand mechanical routine test at ambient temperature tensile load at RTL corresponding to at least 50 % of the SML for at least 10 sec.

8.5 TESTS DURING MANUFACTURE:

Following tests shall also be carried out on all components as applicable

(a)	Chemical analysis of zinc used for galvanizing
(b)	Chemical analysis, mechanical, metallographic test and magnetic particle inspection for malleable castings.
(c)	Chemical analysis, hardness tests and magnetic particle inspection for forgings.

8.6 SAMPLE BATCH FOR TYPE TESTING :

8.6. The sample for type testing will be manufactured strictly in accordance with the Quality Assurance Plan approved by the OPTC.

9.0 QUALITY ASSURANCE PLAN :

9.1 The successful bidder shall submit following information along with the bid:

9.1.1 Test certificates of the raw materials and bought out accessories.

9.1.2 Statement giving list of important raw material, their grades along with names of sub-suppliers for raw materials, list of standards according to which the raw materials are tested. List of tests normally carried out on raw materials in presence of bidder's representative.

9.1.3 List of manufacturing facilities available.

9.1.4 Level of automation achieved and lists of areas where manual processing exists.

9.1.5 List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.

9.1.6 List of testing equipments available with the bidder for final testing of equipment along with valid calibration reports.

9.1.7 The manufacturer shall submit Manufacturing Quality Assurance Plan (QAP) for approval
& the same shall be followed during manufacture and testing.

9.2 The successful bidder shall submit the routine test certificates of bought out raw materials/accessories and central excise passes for raw material at the time of inspection.

9.3 The Owner's representative shall at all times be entitled to have access to the works and all places of manufacture, where insulator, and its component parts shall be manufactured and the representatives shall have full facilities for unrestricted inspection of the Supplier's and sub-Supplier's works, raw materials, manufacture of the material and for conducting necessary test as detailed herein.

9.4 The material for final inspection shall be offered by the Supplier only under packed condition. The owner shall select samples at random from the packed lot for carrying out acceptance tests. The lot offered for inspection shall be homogeneous and shall contain insulators manufactured in 3-4 consecutive weeks.

9.5 The Supplier shall keep the Owner informed in advance of the time of starting and the progress of manufacture of material in their various stages so that arrangements could be made for inspection.

9.6 No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested unless the owner in writing waives off the inspection. In the later case also the material shall be dispatched only after satisfactory testing specified herein has been completed.

9.7 The acceptance of any quantity of material shall in no way relieve the Supplier of his responsibility for meeting all the requirements of the specification and shall not prevent subsequent rejection, if such material are later found to be defective

10.0 TEST CERTIFICATE:

The tenderer shall furnish detailed type test reports of the offered composite Insulators as per clause 8.2 of the Technical Specifications at the NABL approved laboratories to prove that the composite Insulators offered meet the requirements of the specification. These Type Tests should have been carried out within five years prior to the date of opening of this tender.

i) The offered composite Insulators are already fully type tested at approved Laboratory within five years prior to the date of opening of this tender.

ii) There is no change in the design of type-tested composite Insulators and those offers against this tender.

11.0 TESTING FACILITIES :

The tenderer must clearly indicate what testing facilities are available in the works of the manufacturer and whether facilities are adequate to carry out all Routine & acceptance Tests. These facilities should be available to OPTCL's Engineers if deputed or carry out or witness the tests in the manufacturer works. If any test cannot be carried out at the manufacturer's work, the reasons should be clearly stated in the tender. The insulators shall be tested in accordance with the procedure detailed in IEC 61109 / 92-93 with latest amendments.

12.0. DRAWINGS :

12.1 The Bidder shall furnish full description and illustration of the material offered.

12.2 The Bidder shall furnish along with the bid the outline drawing (3 copies) of each insulator unit including a cross sectional view of the long rod insulator unit. The drawing shall include but not be limited to the following information:

(a) Long rod diameter with manufacturing tolerances
(b) Minimum Creepage distance with positive tolerance
(c) Protected creepage distance
(d) Eccentricity of the long rod unit
    (i) Axial run out
    (ii) Radial run out
(e) Unit mechanical and electrical characteristics
(f) Size and weight of ball and socket/tongue & clevis

(g) Weight of composite long rod units
(h) Materials
(i) Identification mark
(j) Manufacturer's catalogue number

13.0 RETEST AND REJECTION:

13.1 Sample Procedure for testing of insulators shall be as per clause 7.1 to 7.6 of IEC 61109 for Acceptance & Routine Tests.

For the sampling tests, two samples are used, E1and E2. The sizes of these samples are indicated in the table below.

Lot Size (N)	Sample Size	
	E1	E2
N < 300	Subject to agreement	
300 < N < 2000	4	3
2000 < N < 5000	8	4
5000 < N < 10000	12	6

If more than 10000 insulators are concerned, they shall be divided into an optimum number of lots comprising between 2000 and 10000 insulators. The results of the tests shall be evaluated separately for each lot.

The insulators shall be selected by the purchaser's representative from the lot at random.

The samples shall be subjected to the applicable sampling tests.

The sampling tests are:

Verification of dimensions	-	(E1 + E2)
Verification of the locking system	-	(E2)
Verification of tightness of the interface between end fittings & Insulator housing	-	(E2)
Verification of the specified mechanical load SML	-	(E1)
Galvanizing test	-	(E2)

In the event of a failure of the sample to satisfy a test, the retesting procedure shall be as follows :

If only one insulator or metal part fails to comply with the sampling tests, a new sample equal to twice the quantity originally submitted to the tests shall be subjected to retesting. The retesting shall comprise the test in which failure occurs. If two or more insulator or metal parts fail to comply with any of the sampling tests or if any failure occurs during the retesting, the complete lot is considered as not complying with this standard and shall be withdrawn by the manufacturer.

Provided the cause of the failure can be clearly identified, the manufacturer may sort the lot to eliminate all the insulators with these defects. The sorted lot then be resubmitted for testing. The number then selected shall be three times the first chosen quantity for tests. If any insulators fail during this retesting, the complete lot is considered as not complying with this standard and shall be withdrawn by the manufacturer.

13.2 Verification of dimensions (E1 + E2)

The dimensions given in the drawings shall be verified. The tolerances given in the drawing are valid. If no tolerances are given in the drawings the values mentioned in this specification shall hold good.

13.3 Verification of the locking system (E2)

This test applies only to the insulators equipped with socket coupling as specified by IEC 120 and is performed according to IEC 383.

13.4 Verification of tightness of the interface between end fittings & Insulator housing (E2)

One insulator selected randomly from the sample E2, shall be subjected to crack indication by dye penetration, in accordance with ISO 3452,on the housing in the zone embracing the complete length of the interface between the housing and metal fitting and including an additional area, sufficiently extended beyond the end of the metal part.

The indication shall be performed in the following way.

- the surface shall be properly pre-cleaned with the cleaner ;
- the penetrant, which shall act during 20 minutes, shall be applied on the cleaned surface;
- with in 5 minutes after the application of the penetrant, the insulator shall be subjected, at the ambient temperature, to a tensile load of 70 % of the SML, applied between the metal fittings; the tensile load shall be increased rapidly but smoothly from zero up to 70 % of the SML, and then maintained at this value for 1 minute;
- the surface shall be cleaned with the excess penetrant removed, and dried;
- the developer shall be applied if necessary;
- the surface shall be inspected.

Some housing materials may be penetrated by the penetrant. In such cases evidence shall be provided to validate the interpretation of the results.

After the 1 min. test at 70 % of the SML, if any cracks occur, the housing and, if necessary, the metal fittings and the core shall be cut, perpendicularly to the crack in the middle of the widest of the indicated cracks, into two halves. The surface of the two halves shall then be investigated for the depth of the cracks.

13.5 Verification of the specified mechanical load SML

The insulators of the sample E1 shall be subjected at ambient temperature to a t ensile load, applied between the couplings. The tensile load shall be increased rapidly but smoothly from zero to approximately 75 % of the SML, and then be gradually increased to the SML in a time between 30 sec. to 90 sec.

If 100 % of the SML is reached in less than 90 s, the load (100 % of the SML) shall be maintained for the remainder of the 90 s. (This test is considered to be equivalent to a 1min withstand test at the SML.)
The insulators have passed the test at 13.4 & 13.5 above if:

- No failure (breakage or complete pull out of the core, or fracture of the metal fitting) occurs either during the 1 min. 70 % withstand test (a) or during the 1 min.100 % withstand test (b).
- No cracks are indicated after the dye penetration method described in 13.4 above.
- The investigation of the halves described in 13.4 above shows clearly that the cracks do not reach the core.

13.6 Galvanizing test
This test shall be performed according to IS: 2633/IS: 6745 on galvanized parts.

14.0 MARKINGS :

14.1 Each insulator shall be legibly and indelibly marked with the following details as per IEC- 61109:

a) Name or trademark of the manufacturer.
b) Voltage & Type
c) Month and year of manufacturing.
d) Min. failing load/guaranteed mechanical strength in kilo Newton followed by the word 'KN' to facilitate easy identification.
e) 'OPTCL'. Marking

14.2 One 10 mm thick ring or 20 mm thick spot of suitable quality of paint shall be marked on the end fitting of each composite long rod of particular strength for easy identification. The paint shall not have any deteriorating effect on the insulator performance.

Following codes shall be used as identification mark:

For 45 KN long rod units : Blue
For 70 KN long rod units : Red

15.0 PACKING :

15.1 All insulators shall be packed in strong corrugated box of min. 7 ply duly paletted or wooden crates. The gross weight of the crates along with the material shall not normally exceed 100 Kg to avoid hackling problem. The crates shall be suitable for outdoor storage under wet climate during rainy season.

15.2 The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.

15.3 Suitable cushioning, protective padding, or Dunn age or spacers shall be provided to prevent damage or deformation during transit and handling.

15.4 All packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings. Each wooden case /crate /corrugated box shall have all the markings stenciled on it in indelible ink.

15.5 The bidder shall provide instructions regarding handling and storage precautions to be taken at site.

16.0 GUARANTEE

The Supplier of insulators shall guarantee overall satisfactory performance of the insulators. The tenderer shall furnish in the form attached (Schedule 'A') all the guaranteed technical particulars.

SCHEDULE – A1

GUARANTEED TECHNICAL PARTICULARS.

COMPOSITE INSULATOR UNIT

11KV(45KN) / 11KV(70KN),
(to be filled separately for each type mentioned above)

Sr.No	Parameter Name	Parameter type
1.	Type of insulator	Text
2.	Standard according to which the insulators manufactured and tested	Text
3.	Name of material used in manufacture of the insulator with class/grade	
3.1	Material of core (FRP rod) i) E-glass or ECR-glass ii) Boron content	Text
3.2	Material of housing & weather sheds (Silicon content by weight)	Text
3.3	Material of end fittings	Text
3.4	Sealing compound for end fitting	Text
4.0	Colour	Text
5.	**Electrical characteristics**	
5.1.	Nominal system voltage KV (rms)	Numeric
5.2	Highest system voltage KV (rms)	Numeric
5.3	Dry Power frequency withstand voltage KV (rms)	Numeric
5.4	Wet Power frequency withstand voltage KV (rms)	Numeric
5.5	Dry flashover voltage KV (rms)	Numeric
5.6	Wet flash over voltage KV (rms)	Numeric
5.7	Dry lighting impulse withstand voltage a) Positive KV (peak) b) Negative KV (peak)	Numeric
5.8	Dry lighting impulse flashover voltage c) Positive KV (peak) d) Negative KV (peak)	Numeric
5.9	RIV at 1 MHz when energized at 10 kV/ 30 kV (rms) under dry condition Micro volts	Numeric
6.0	Creepage distance (Min.) (320mm) (mm)	Numeric
6.1	Center to center distance between tongue & clevis) (300mm) (mm)	Numeric
6.2	Shed diameter (100mm) (mm)	Numeric

Sr.No	Parameter Name	Parameter type
7.0	Mechanical characteristics: KN Minimum failing load	Numeric
8.0	**Dimensions of insulator**	
8.1	Weight Kg	Numeric
8.2	Dia. of FRP rod: mm	Numeric
8.3	Length of FRP rod mm	Numeric
8.4	Dia. of weather sheds (100mm) mm	Numeric
8.5	Thickness of housing mm	Numeric
8.6	Dry arc distance mm	Numeric
8.7	Dimensioned drawings of insulator (including weight with tolerances in weight) enclosed.	Boolean
9.0.	Method of fixing of sheds to housing (Specify): Single mould or Modular construction (Injection molding / compression molding)	Text
10.0	No of weather sheds	Text
11.0	**Type of sheds**	
11.1	Aerodynamic	Text
11.2	With underribs	Text
12.	**Packing details**	
12.1	Type of packing	Text
12.2	No. of insulators in each pack	Text
12.3	Gross weight of package	Text
13.0	Design Test Report, Type Test Report of insulator enclosed.	Boolean
14.0	Any other particulars which the bidder may like to give	File

SCHEDULE – A2

GUARANTEED TECHNICAL PARTICULARS.

COMPOSITE INSULATOR UNIT

33KV (70KN)

Sr.No	Parameter Name	Parameter type
1.	Type of insulator	Text
2.	Standard according to which the insulators manufactured and tested	Text
3.	Name of material used in manufacture of the insulator with class/grade	
3.1	Material of core (FRP rod) v) E-glass or ECR-glass vi) Boron content	Text
3.2	Material of housing & weather sheds (silicon content by weight)	Text
3.3	Material of end fittings	Text
3.4	Sealing compound for end fitting	Text
4.0	Colour	Text
5.	**Electrical characteristics**	
5.1.	Nominal system voltage KV (rms)	Numeric
5.2	Highest system voltage KV (rms)	Numeric
5.3	Dry Power frequency withstand voltage KV (rms)	Numeric
5.4	Wet Power frequency withstand voltage KV (rms)	Numeric
5.5	Dry flashover voltage KV (rms)	Numeric
5.6	Wet flash over voltage KV (rms)	Numeric
5.7	Dry lighting impulse withstand voltage i) Positive KV (peak) j) Negative KV (peak)	Numeric
5.8	Dry lighting impulse flashover voltage k) Positive KV (peak) l) Negative KV (peak)	Numeric
5.9	RIV at 1 MHz when energized at 10 kV/ 30 kV (rms) under dry condition Micro volts	Numeric
6.0	Creepage distance (Min.) mm	Numeric
6.1	Center to center distance between tongue & clevis (mm)	Numeric
6.2	Shed diameter (mm)	Numeric

Sr.No	Parameter Name	Parameter type
7.0	Mechanical characteristics: Minimum failing load KN	Numeric
8.0	**Dimensions of insulator**	
8.1	Weight Kg	Numeric
8.2	Dia. of FRP rod: mm	Numeric
8.3	Length of FRP rod mm	Numeric
8.4	Dia. of weather sheds mm	Numeric
8.5	Thickness of housing mm	Numeric
8.6	Dry arc distance mm	Numeric
8.7	Dimensioned drawings of insulator (including weight with tolerances in weight) enclosed.	Boolean
9.0.	Method of fixing of sheds to housing (Specify): Single mould or Modular construction (Injection molding / compression molding)	Text
10.0	No of weather sheds	Text
11.0	**Type of sheds**	
11.1	Aerodynamic	Text
11.2	With underribs	Text
12.	**Packing details**	
12.1	Type of packing	Text
12.2	No. of insulators in each pack	Text
12.3	Gross weight of package	Text
13.0	Design Test Report, Type Test Report of insulator enclosed.	Boolean
14.0	Any other particulars which the bidder may like to give	File

ANNEXURE 'A'

STANDARDS TO BE ADOPTED FOR COMPOSITE INSULATORS

Sr. No.	Indian Standard	Title	International Standard
1	-	Definition, test methods and acceptance criteria for composite insulators for A.C. overhead lines above 1000V	IEC: 61109
2	IS: 731	Porcelain insulators for overhead power lines with a nominal voltage greater than 1000V	IEC: 60383
3	IS: 2071	Methods of High Voltage Testing	IEC: 60060-1
4	IS: 2486	Specification for Insulator fittings for Overhead power Lines with a nominal voltage greater than 1000V General Requirements and Tests Dimensional Requirements Locking Devices	IEC: 60120 IEC: 60372
5.	-	Thermal Mechanical Performance test and mechanical performance test on string insulator units	IEC: 60575
6.	IS: 13134	Guide for the selection of insulators in respect of polluted condition	IEC: 60815
7.	-	Characteristics of string insulator units of the long rod type	IEC: 60433
8.	-	Hydrophobicity Classification Guide	STRI guide 1.92/1
9.	-	Radio interference characteristics of overhead power lines and high-voltage equipment.	CISPR: 18-2 Part 2
10.	IS: 8263	Methods of RI Test of HV insulators	IEC: 60437
11.		Standard for Insulators- Composite-Distribution Dead-end Type	ANSI C29.13-2000
12.	IS: 4759	Hot dip zinc coatings on structural steel & other allied products	ISO: 1459 ISO: 1461
13.	IS: 2629	Recommended Practice for Hot, Dip Galvanization for iron and steel	ISO: 1461 (E)
14.	IS: 6745	Determination of Weight of Zinc Coating on Zinc coated iron and steel articles	ISO: 1460
15.	IS: 3203	Methods of testing of local thickness of electroplated coatings	ISO: 2173
16.	IS: 2633	Testing of Uniformity of Coating of zinc coated articles	
17.	-	Standard specification for glass fiber strands	ASTM D 578-05
18.	-	Standard test method for compositional analysis by Thermogravimetry	ASTM E 1131-03
19.	IS:4699	Specification for refined secondary Zinc	

Annexure-B

Tests on Insulator units

1 RIV Test (Dry)

The insulator string along with complete hardware fittings shall have a radio interference voltage level below 100 micro volts at one MHz when subjected to 50 Hz AC voltage of 10kV & 30 kV for 11 kV & 33 kV class insulators respectively under dry condition.The test procedure shall be in accordance with IS:8263 /IEC:437/CISPR 18-2.

2 Brittle Fracture Resistance Test

Brittle fracture test shall be carried out on naked rod along with end fitting by applying "1n HNO3 acid" (63 g conc. HNO3 added to 937 g water) to the rod. The rod should be held 80% of SML for the duration of the test. The rod should not fail within the 96-hour test duration. Test arrangement should ensure continuous wetting of the rod with Nitric acid.

3 Recovery of Hydrophobicity & Corona test

The test shall be carried out on 4mm thick samples of 5cm X 7cm.

(i) The surface of selected samples shall be cleaned with isopropyl alcohol. Allow the surface to dry and spray with water. Record the Hydrophobicity classification in line with STRI guide for Hydrophobicity classification. Dry the sample surface.

(ii) The sample shall be subjected to mechanical stress by bending the sample over a ground electrode. Corona is continuously generated by applying 12 kV to a needle like electrode placed 1mm above the sample surface. The test shall be done for 100 hrs.

(iii) Immediately after the corona treatment, spray the surface with water and record the HC classification. Dry the surface and repeat the corona treatment as at clause 2 above. Note HC classification. Repeat the cycle for 1000 hrs. or until an HC of 6 or 7 is obtained. Dry the sample surface.

(iv) Allow the sample to recover and repeat hydrophobicity measurement at several time intervals. Silicone rubber should recover to HC 1 – HC 2 within 24 to 48 hours, depending on the material and the intensity of the corona treatment.

4 Chemical composition test for Silicon content

The content of silicon in the composite polymer shall be evaluated by EDX (Energy Dispersion X- ray) Analysis or Thermo-gravimetric analysis. The test may be carried out at CPRI or any other NABL accredited laboratory.

STANDARD TECHNICAL PARTICULARS FOR 1-CORE 33 KV CU XLPE CABLE

1.	Type of cable	33kV(E)UGXLPE/Al Seath/HDPE 1 Core
2.	Standard according to which cable has been manufactured and tested	Is7098(P-2),IEC60502&IEC60840
3.	Rated Voltage (Uo/U}	:19/33kV
4.	Highest System Voltage which the cable can withstand	36 kV (Um)
5.	Maximum Conductor temperature for continuous operation	90^{0}ac
6.	(a) Maximum short time conductor temperature with duration	:250°C
	(b) Maximum allowable conductor temp.during overload	:130^{0}C
7.	Conductor Details	
	(a) Normal Cross-Sectional Area	: 300 mm^2
	(b) Material and Grade	.COPPER/ Compacted stranded circular ·as per IS 7098PA T2,IS8130/84
	(c) Shape of Conductor	: Circular
	(d) Diameter of Conductor	: 19.54 mm (Approx.)
	(e) No. of Strands and Diameter of each Strand	: As per above standard
	(f) Water swellable powder/yarn provided	: Yes
	(g) Conducting water swellable tape with 50% overlap over compacted conductor provided	Yes

8. Extruded Conductor Screen

(a)	Material	• Extruded Semi-Conductive XLPE
(b)	Nominal Thickness	:0.30 mm (Approx.)
(c)	Diameter over Conductor Screen	: 26.5 mm (Approx.)
(d)	Designed maximum stress at Conductor Screen	: 3.05 kV/mm

9. Insulation

(a)	Material	: XLPE
(b)	Nominal Thickness	: 8.80 mm
(c)	Minimum Thickness at any point	7.1 mm
(d)	Diameter over insulation	37.5 mm (Approx.)
(e)	Designed maximum stress	1.90 kV/mm
(f)	Detail of vulcanization process	
	(i) Extrusion Method	:Triple Extrusion Process
	(ii) Curing Method	: Dry Cure
	(iii) Cooling Method	:Inert Gas
	(iv) CO/ or VOl Line	: ccv line

10. Extruded Insulation Screen

(a)	Material	Semi-Conductive XLPE
(b)	Thickness (Nominal/Minimum)	1.0 mm/ 0.85 mm
(c)	Diameter over Insulation Screen	38.3 mm (Approx.)
(d)	Strippable/ Bonded	Bonded

11. Conducting Longitudinal Water Sealing.

(a)	Material	Water Swellable Tape applied with 50% overlap.
(b)	Thickness	0.3 mm (Approx.)

12.	Metallic Sheath	
	(a) Material	corrugated Al with adequate thickness to allow short circuit current.MFG to furnish supporting dimensions with fault current
	(b) Diameter of Cable after sheath application	Manufacturer to Specify
	(c)Radial Moisture Barrier	Poly Aluminum sheath
13.	Non-conducting Longitudinal Water Sealing.	
	(a) Material	Water Swellable Tape applied with 50% overlap.
	(b) Thickness	0.3 mm (Approx.)
14.	HDPE Outer Sheath	
	(a) Type	ST7
	(b) Colour	Black
	(c) Thickness (Nom/min)	2.6 mm (Nominal)/2.11 mm (Min. Spot)
	(d) Conductive Coating Provided	Graphite Coating/semiconductor layer
15.	Nominal OVerall Diameter of Cable	Manufacturer to Specify
16.	Nominal OVerall Weight of Cable per Metre	Manufacturer to Specify
17.	Standard Drum Length with Tolerance	500 m ±5%
18.	Minimum Bending Radius allowable during installation	20 times diameter Over finished cable

19.	Short Circuit Current Rating of Conductor with maximum conductor temperature (90°C) at the commencement of fault	
	(i) 1Sec. Duration	42.90 kA
20.	Maximum Continuous Current Rating of a Circuit comprising of 3 nos. Single Core Cable laid in trefoil formation at a depth of 1.05 M.	
	(i) Soil Temperature	30^0 C
	(ii) Ambient Temperature	40°C
	(iii) Soil Thermal Resistivity	150°C Cm/W
	(iv) System of Bonding	Solidly earthed at both ends
	(a) Laid in Ground(at a depth of l.OSM)	420A
	(b) Laid in Ducts	360A
	(c) Installed in Air	620A
21.	Short Time Overload capacity with Duration of cable installed as per conditions mentioned in Item no.22 (2 hours)	
	(a) Laid in Ground(at a depth of 1.05M)	490 A
	(b) Laid in Ducts	473 A
	(c) Installed in Air	N/A
22.	Maximum AC Resistance at 90°C	0.078 ohm/km
23.	Equivalent Star Reactance of a Circuit comprising of 3 Nos. of Single Core cable laid in Trefoil Formation	To follow IS value
24.	Maximum Charging Current per Conductor at Nominal Voltage	1.64 *AI* km

25.	Loss in Metallic Screen of a Circuit comprising of 3 nos. of Single Core Cable installed in Trefoil Formation as per item no. 22	13.53 W/m
26.	Maximum Current in Metallic Screen when the cable is installed as per item no. 22 (Circulating Current	As per specification calculation furnished by manufacturer
27.	Derating factor of Cable installed per Item No.22 under following conditions Ambient Temperature	
	(a) 35°C	:0.96(ground & Duct)1.04(Air)
	(b) 45°C	0.87(ground & Duct)0.95(Air)
	Group derating factor of Cable Circuits installed as per Item no. under following conditions	
	(a) Laid 100 mm. apart	: 0.81(for no trefoil in group is 2)
	(b) Laid 250 mm. apart	: 0.85(for no trefoil in group is 2)
29.	Induced voltage in metallic screen V/km when conductor is carrying lOOAmps(V/Km)	: 5
30.	Circulating current in metallic screen when conductor is carrying lOOAmps.	34 A
31.	Test Voltages	
	(a) Impulse Withstand Voltage at 90°C	170 kVp
	(b) Rated Power Frequency Withstand Voltage	63 kV for 5 minutes Yes
	(c) Water penetration test as per IEC 60502-2	(24-hours Water penetration test without heating cycles)
	(d) Abrasion Test on HOPE Outer sheath as per IEC 60229	Yes (Physical Abrasion test as per IEC 60229 clause 4.1.2.1)
	(e) Recommended Test Voltage after installation	Comply with Clause 20 as per IEC 60502-2

32.	Details of Drum	
	(a) Material and Weight of Drum	:Steel drum ,weight to be furnished by manufacturer
	(b) Weight of Drum with Cable	:3570 kg (Gross Weight) (Approx.)
	(c) Flange Diameter of Drum	:2150 mm (Approx.)
	(d) Barrel Width of Drum	:1100 mm (Approx.)
	(e) Spindle hole Diameter	:120 mm (Approx.)
33.	Safe Pulling force	5kg/mm^2 of CU area. *//* 3kg/mm^2
34.Sealing of Cable		Both the ends to be sealed putty and heat shrinkable cap with mastic inside to prevent moisture ingression during laying /handling.

Technical specification of HDPE pipes

HDPE Pipes should conform to IS : 4984 – 1995. The following are the specifications:

PIPE	For LT/HT	FOR EHT
Outer Diameter	160 mm	315 mm
Mat. Grade	PE 63	PE 80
Pressure Rating	PN 6	PN 6
Wall Thickness	11.2mm to 12.5mm	17.9mm to 20mm

Technical Specifications of

SCADA / DMS system for Orissa Cyclone Resilience System

Contents

1. Scope of work

The scope of work can be divided into three parts

1. Substation Automation of 19 nos of 33/11 kV Substations. The list of 33 kV substations along with 33 kV and 11 kV circuit breaker details for which Substation Automation need to be implemented is as follows:

Table 1 : List of 33 kV substations along with circuit breaker number

S. No	**Substation**	**33 kV incoming feeder and Transformer Circuit breaker Nos**	**11 kV Transformer , bus coupler and outgoing feeder Circuit breaker Nos**
1	Ambagada	4	8
2	Lochapada	3	6
3	Medical (GIS)	5	11
4	Narendrapur	3	9
5	Rangeilunda	4	8
6	Gopalapur (GIS)	4	7
7	Chhatrapur	6	9
8	Ambapua	3	8
9	Bidyutpur Colony (GIS)	4	7
10	MES	4	6
11	Kanisi	3	5
12	Lathi	1	5
13	Goods Shed	3	6
14	NilaKantha Nagar	4	8
15	Lingarajpur (GIS)	4	7
16	Municipality Kalyan Mandap (GIS)	4	7
17	Corporation road(GIS)	4	7
18	Ankuli(GIS)	4	7
19	Water works*	1	-
	Total	**67**	**131**

*water works is a 33/0.415 kV substation

2. Implementation of a state of the art Supervisory Control and Data Acquisition System (SCADA) for the electrical distribution system comprising of 19 nos. 33 kV substations (listed in Table 1), 5 nos. 33 kV RMUs and 11 kV feeders of selected substations with control centre located at Auto Nagar Grid substation. 33 kV network

connectivity is given in Annexure The list of selected substations for which SCADA of 11 kV feeders need to be implemented is as follows:

a. Medical
b. Lochapada
c. Goods Shed
d. NilaKantha Nagar
e. Rangeilunda
f. Ambagada
g. Ambapua
h. Corporation Road
i. Municipality Kalyan Mandap
j. Ankuli
k. Goplapur
l. Chhatrapur

Also, Interface to remote SCADA system (Orissa State Load Dispatch Center - SLDC), need to be provided

3. Implementation of DMS for 11 kV feeders of selected substations. The DMS control centre will be located at Auto Nagar Grid Substation along with SCADA control centre. The list of selected substations for DMS implementation is below
    a. Medical
    b. Lochapada
    c. Goods Shed
    d. NilaKantha Nagar
    e. Rangeilunda
    f. Ambagada
    g. Ambapua
    h. Corporation Road
    i. Municipality Kalyan Mandap
    j. Ankuli
    k. Goplapur
    l. Chhatrapur

2. Specifications of Substation Automation System

A substation automation scheme is required to possess the following features:

- Control of all substation electrical equipment from a central point (Autonagar grid substation).
- Monitoring of all substation electrical equipment from a central point.
- System database management
- Condition monitoring of substation electrical equipment (switchgear, transformers, relays, IED's). Condition monitoring of transformers should also include winding temperature, oil temperature and Bochholz relay.

2.1. Proposed Architecture for Substation Automation at each of the 33 kV Substations

In the proposed architecture, each bay of the substation is controlled by a Bay Module, which houses the control and interlocking software, interfaces to the various IED's required as part of the control and protection for the bay, and an interface to the local SCADA and gateway computers. It should be possible to use an HMI computer to take local control of an individual bay for commissioning/testing and fault finding purposes. Proposed configuration is as shown in Figure 1.

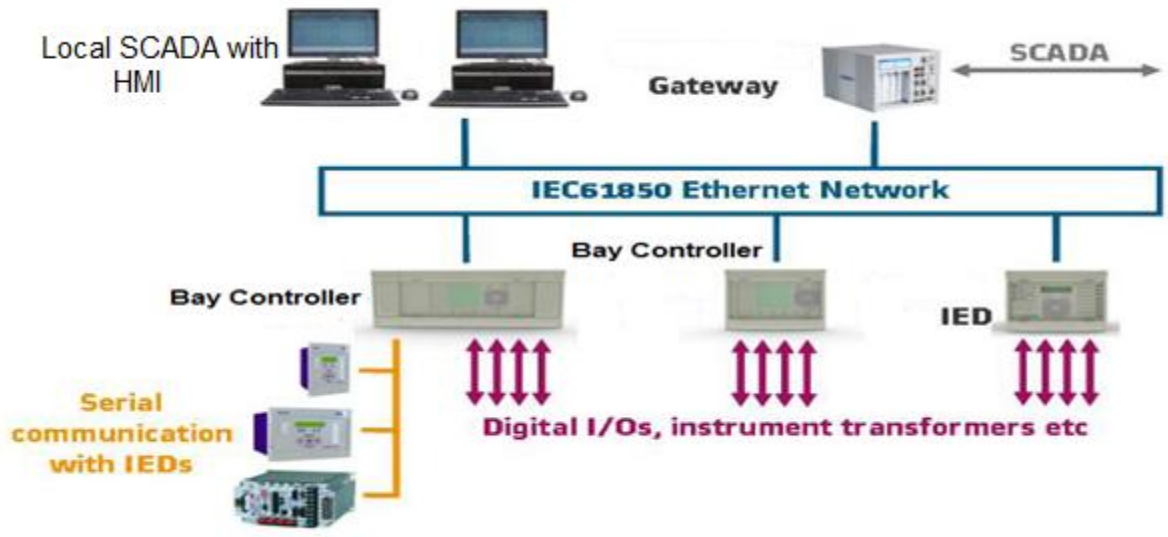


Figure 1: Proposed configuration

Two local scada systems are proposed at each of the 33 kV substations in redundant mode.

The connectivity between Bay IEDS, local SCADA and gateway shall be based on PRP protocol as per IEC 61850 standard. Bidders shall submit the detailed architecture diagram reflecting this requirement.

2.2. Substations Communication standards and protocols

The communication of the protection IED's in the substation should comply with ***IEC 61850*** standard and the multifunction meters shall be with modbus RS 485.

The communication between Substations / RMU's and control centre shall be based on ***IEC-60870-5-104***

2.3. Selection of IED'S and Bay Controller's

The IED's and Bay controllers should be IEC 61850 complaint. The number of IED's and Bay controllers should be selected so as to handle following functions:

i. Control , monitor of all 33 kV and 11 kV circuit breakers of the 19 substations listed above
ii. Control , monitor all 33 kV and 11 kV Isolators of the 19 substations listed above
iii. Monitor Real time metered data like current, voltage, power factor, power and energy from the respective meters at all the 19 substations
iv. Condition monitoring of transformers such as winding temperature, oil temperature and Bochholz relay.

The bidder has to give the details of the number of IED's and Bay Controllers in the bid document.

3. General System Requirements of SCADA / DMS

The SCADA / DMS system shall be made of integrated, well-documented, and field proven standard software applications. The system shall provide the minimal following characteristics:

- The SCADA system shall be seamlessly integrated with the real time DMS. SCADA and DMS applications shall originate from the same supplier for consistent evolution and maintenance.
- The system should address the full lifecycle to Monitor Analyze, Control, Optimize and Simulate the SCADA environment.
- Scalable architecture, where all the functions of the SCADA system are integrated in a modular way. Operator workstations shall run on the current Microsoft Windows operating systems release including Windows server 2008 and Windows 8 as a minimum. Substation Automation application software shall run on Windows server 2008.
- The system shall be built on a client-server architecture that is designed to eliminate a single point of failure.
- Reliability: The system shall include redundant SCADA/DMS servers, redundant HIS, redundant FEPs, redundant networks. Redundancy of critical SCADA components shall be provided to achieve a high level availability (typically, more than 99.95%). Redundancy of critical functions shall be ensured in a secure way, so that it shall be impossible to have two redundant functions active simultaneously.
- The product must be scalable, configurable, robust and conform to international standards. The manufacturer of the product shall have field-proven reliability references in various electricity utilities around the world.
- Service-Oriented Architecture (SOA) adoption which will facilitate flawless integration of third-party software components. The de-coupled nature of the architecture will facilitate replacement or addition of new components to minimize upgrade and replacement effort and cost.
- The SCADA System developed, built and installed to meet Cyber Security Compliant. Patch management and other security services enable the SCADA System more secure and resilient to cyber-attacks. The security standards and services including key areas of communications network segmentation, perimeter protection, system and communication protection, user security, centralized audit and monitoring, change management and system integrity, shared storage plus virtualization etc. The security architecture relies on security policy that is based on standards, such as NERC-CIP, NIST. The cyber security and network architectures must meet the availability, integrity and confidentiality objective. The bidder shall describe the ciber security features included.
- Integration with a number of enterprise and external systems based on industry standard data and exchange formats.
- Support for IEC60870-TASE 2 Inter Control Centre Protocols (ICCP).
- Data Historian supports bi-directional, buffered interfaces providing native collection/retrieval either from vendor own or third party data historian's software.

4. SCADA

4.1. SCADA Function Description

All data acquired from the electrical power system, all calculated data and historical data, and all control commands or parameters to be output to the power system shall be stored in one database. The database shall be the central interface among all elements of the SCADA including the SCADA functions, automatic meter reading function, feeder SCADA functions, HIS information and operator interfaces.

As the common interface, the system database shall include all information necessary for the proper operation of all application programs, including tele-metered data, data which is program calculated or operator entered, as well as all program constants, historical information and reporting (HIS) data, and SCADA communication statistics. The database shall comprise a real- life portion optimized for fast access, and a historical portion, which meets the requirements of "HIS Database". The database may be distributed between various processors and storage devices, but it shall be of a consistent design, and data residency shall be transparent to the accessing function.

4.1.1. Data Acquisition

The Communication between field RTU's and Control centre will be through IEC 60870-5-104.

The type of data to be acquired through RTU/SAS, FRTUs shall include analog values, digital status data (Double point and single point indications) and SOE data from the substation, RMUs etc. Analog values like P, Q, F, each phase V, each phase I, each phase pf, and energy values (Export/Import KWh and KVARh) shall be collected by the RTU/SAS, FRTUs from the MFTs. Analog values such as station battery voltage, oil temperature, winding temperature, tap changer, weather transducer data etc. shall also be acquired through RTU/SAS, FRTU's using analog input modules & suitable transducer, if defined in the RTU BOQ.

Integrity Scanning

It shall be possible to report the values of all scanned points (regardless of whether they changed) in the following cases:

- On start-up of the system
- After loss of communication with the RTUs
- On operator's request

4.1.2. Data Conversion

The SCADA system shall provide a data conversion function taking tele-metered data received from the RTUs/SAS and converting it to a standard internal form for further processing. The different types of data conversion shall be as a minimum related to:

Raw Tele-metered Data

The data exchanged with the RTUs/SAS are raw data that shall be converted. The conversion process is to be defined during the data configuration phase of the project.

These data shall be returned from the front end computer: digital status points, analog values and pulse accumulator values.

The raw tele-metered status input bits shall be stored by the conversion function before performing a versatile input conversion on the raw value. Raw tele-metered Analog input value shall be converted to engineering units using linear translation or non linear translation. Each pulse accumulator value shall be stored as floating point value in the database. In their conversion, pulse accumulator values shall differ somewhat from analogs because they involve some history, not just the current reading.

4.1.3. Data Processing

Data processing involves a value which has been converted to internal form and analyzed for violations of limits. The data processing shall set various data attributes depending on the results of the checks and shall trigger any additional processing or calculation. There shall be several normal sources of SCADA data.

- Telemetry
- Calculation
- Manual entry
- Host process external to SCADA

Different data quality flags shall be provided about data quality, status points, analogs, special calculations and accumulators, with a minimum of fifteen basic flags.

It shall be possible to manually replace SCADA values. This status shall also be propagated to all calculated values using the replaced value as an input argument.

A summary display shall show all the currently replaced values. At any time, it shall be possible to put a replaced value back in service.

Status Data Processing

A status point shall be defined as being either legal or illegal, and normal or abnormal:

- **Illegal state:** The first check on a new input to a digital status point is the legality check. If the new state is illegal, then the old value shall be left in the database and marked old.
- **Abnormal state:** If the new state is legal, it shall be checked to see if it is among the normal states defined for the point. If not, the status point shall be marked as abnormal. While abnormal, it shall appear in the summary display of abnormal conditions.

Newly acquired status data shall be compared against the current status data in the data base to determine if changes have taken place. If so, and if no control action is pending on the status point, then an alarm action shall be triggered. Un-commanded changes of state shall be processed as alarms and commanded changes of state as events. Points for which a normal state is defined in the database shall be included in Abnormal Summaries while they are not in their normal state. All status changes shall result in an immediate update of all displays on which the points are currently shown. The scan processing shall be designed to ensure that no change of status is lost. For each status point, it shall be possible to define the relationship between the position of the contact input to the RTU and state of the device. So, for instance, an open contact may represent “Closed” or “Open”.

Analog Processing

An analog value shall have one or more limits assigned to it to be checked each time its value changes. For each analog value, there shall be two basic types of limits: on the analog value itself and on the rate of change of that analog:

- **Value limits:** They shall be used to check the current value of the analog against limit values. Up to four limit values can be set. Limit values shall always come in pair, a high limit and a low limit.

- **Reasonability limits:** There shall be on each analog a pair of reasonability limits beyond which no value is even believable. If a value violates these limits, then the checked value shall be kept and marked old.
- **Forbidden range limit:** A forbidden range is a limit pair which is considered to be violated when the value of the analog falls within the pair. A forbidden range would be used if there were a particular area where operation must be prevented.
- **Limit dead-band:** To minimize cycling between the violated and un-violated states, a dead-band shall be specified on the return of a limit to the un-violated state. Dead-bands shall be individually specifiable for each limit pair either as an engineering units value or as a percentage of the range between the high and low limits.
- **Rate of change limits:** They are those which check the rate at which an analog value changes. There shall be a positive limit and a negative limit to catch excessive rises in the analog value.

Data Quality Codes

Quality codes indicate the presence of one or more factors that affect the validity of a data value. Data quality codes shall be maintained in the database, real-time and historical, for points that are tele-metered or calculated based on tele-metered data. For calculated points the data quality shall be set to that of the lowest quality data involved in the calculation. It shall be possible to display all quality codes on graphical & tabular displays. Following are some examples of some quality tags that may be included.

- Old => This indicates the measurement is not being updated from any of its defined sources. Typically, this indicates telemetry failure.
- Bad => This indicates that an analog has exceeded its reasonability limits, or that a multi- state digital status point is in an illegal state (e.g. both “I” and “O” contacts are closed).
- Not In Service => This indicates the measurement has been placed out of scan by the operator, so that the value will no longer be updated
- Manually Replaced => This indicates that a user has replaced the value.
- Test Mode => This indicates the measurement is under calibration.
- Inhibited => This indicates that alarms will be suppressed for a measurement, but the value will continue to update.

- Limit Violation 1 through 3 => This applies to analog measurements only, and indicates a limit violation.
- Abnormal => This applies to digital status measurements, and indicates the measurement is not in a normal position.

4.1.4. Calculated Analog Points

A calculated analog point is a data point whose value is a function of the value of one or more other tele-metered data, or calculated data points (component points). Analog data point calculations shall be performed at predefined frequency. Alternatively, the calculations can occur whenever a significant change is detected in any analog point's component. It shall be possible to use tele-metered data, manually entered data, constants and other calculated data points as the component points in the definition of calculated point. Up to sixteen (16) component points shall be definable as part of a calculated point's definition. Newly calculated values shall immediately be limit checked, and subject to the same processing as tele-metered points. As a minimum, the following operators shall be available for the calculations:

- The four arithmetic operators (+ - * /)
- Trigonometric functions
- Square root
- Maximum, minimum, and average of a set of data
- Sum of the values in a set of data
- Absolute value
- Running average.

The following computational capabilities are also required:

- Definition of constants to be used in the calculations
- Reset counters and maximum r minimum values
- Structured conditional statements such as IF, THEN ELSE with Boolean operators (AND, OR, NOT, XOR) and comparison operators (>,> =, <, <=) to define conditions.
- Simple programming steps, including the following
- Conditional branch

- Unconditional branch
- Call another calculation Return from calculation

In order to prepare data for the historical database, the following calculation shall be performed for every tele-metered analog point during the processing of data acquired from the RTUs:

- Average Values- The average value shall be calculated for every 15 minute period, synchronized with the hour.
- Maximum/ Minimum Values -The daily instantaneous maximum and minimum values shall be saved and the time of their occurrence shall be recorded.

Data quality codes shall be assigned to calculated values accordingly to the rules specified for calculated points as mentioned previously.

4.1.5. Sequence of Events Recording

The Sequence-of-events (SOE) data is listing of status change events with time stamp. SOE data shall be collected by the SCADA system from RTUs/SAS. The description of each event shall include the database description name, device state, the date and the time (to the nearest millisecond) of each event.

4.1.6. Supervisory Control

The operator shall be able to request digital status control, set-point control and raise/lower control on selected points and analogs. Operators shall be able to control power system devices via RTU/SAS. Select-before-operate (SBO) practices are required for both the operator procedure and the communications with the RTU/SAS. RTU/SAS shall be instructed to execute a command only after the master station verifies that the correct selection of point has been done.

A supervisory control request shall be sent to an RTU/SAS only after the controlled point is checked for proper conditions. The request shall be rejected if:

- The device is not subject to supervisory control of the type being attempted
- The requested control operation is inhibited by a tag placed on the device
- There is no match between the area-of-responsibility of the device and of the console initiating the control request

- The operator's console is in a mode which does not permit supervisory control
- A control request for the same device from another console is still pending (it has not yet been EXECUTED)
- A previous control command for the same device is incomplete

Control of the Two State Devices

Select-Before-Operate (SBO) control shall be provided for various types of two-state devices, including:

- All 33 kV circuit breakers of 5 RMU's
- All 33 kV and 11 kV circuit breakers and Isolators of the 19 substations listed in Table 1.
- All 11 kV breakers in 102 Compact substations
- All 11 kV breakers of 79 RMU's
- All 11 kV breakers of 272 mini RMU's
- 11 kV and 33 kV Switches (open/close)
- Re-closer (auto/off)
- Fault indication reset
- Motor-operated switches
- Miscellaneous devices (auto/manual, start/stop, open/close, etc.).

Selection of a point for control shall be canceled after the Execute command is initiated. The point shall also be automatically de-selected if the operator does not choose a specific control operation within a control time-out period after the point was selected, or does not issue an Execute command within the same control time-out period after the operation was chosen.

Incremental Device Control

Incremental, open loop, select-before-operate device control capabilities shall be provided to transmit incremental RAISE or LOWER commands to devices. Once an Operator has selected such a device for control and has chosen a RAISE or Lower operation, it shall be possible to execute the command any number of times without having to reselect the device or the operation. The operator shall also be able to alternate between RAISE and LOWER operations without device reselection. The device selection shall automatically be canceled if neither an execution command nor a new operation selection was issued by the operator within a pre specified control time-out period. The control time-out period for incremental device control shall be a system-wide parameter, independent of the control time-out specified in previous section, but adjustable in the same way.

Set-point Controls

A set-point involves a numerical value being sent to an RTU, resulting of either a digital or analog value out of the RTU to external equipment. Several conditions shall be checked before a requested set-point action is actually allowed to be sent as for example: « the set-point is in service ».

Control Completion Check

Control completion checks are required when devices are controlled via an RTU. After the successful conclusion of the exchange of control messages with an RTU, the master station shall schedule itself to check for control completion by monitoring the status of the controlled device. If the expected change of status is not detected within a pre-set time period, a control-failed-to- complete alarm shall be generated. Each controlled power system device may have a different pre-set time period for control completion. The change of state shall be reported to the operator as soon as it is detected, instead of waiting until the end of the control-completion check period. A control-failed-to complete condition shall not cause any automatic control retry.

4.1.7. Alarm and Event Processing

System's conditions change or operator's actions are events that shall be recorded by the SCADA system. System conditions that require user notification shall launch an alarm when detected. The alarm function shall provide the following facilities:

- Methods for notifying operators of unsolicited changes in the system's state. Notification shall include audible and visual indicators of the presence of unacknowledged state changes.
- The visual indicators shall include a dedicated display region linked via poke-points to other displays that provide more detailed information about the state of the power system.
- Access to the latest unacknowledged alarm messages.
- Ability for operators to acknowledge and/or delete alarm messages on several displays (including one-line diagrams). Alarm messages shall be acknowledged and/or deleted either individually or on a page basis from an operator console.
- Mechanisms to silence audible alarms.

- A chronological history of events or system activity log, archived in files which can be copied to long-term storage media.
- Formatting and printing of event messages.
- All events are registered in a log book. This log book shall be able to keep on line several days of events (up to 1 month at a minimum). It shall be archived by the historical data management application.

The following occurrences shall be processed as alarms:

- Un commanded changes of state of status points
- The failure of a device to respond to a supervisory control action.
- When a numerical value (tele-metered or calculated) goes outside a pair of limits. Returning within a set of limits shall be processed as an event. Dead bands shall be provided to eliminate alarms caused by a value fluctuating about a limit.
- When a SCADA device such as a processor or a logger fails or becomes unavailable.
- Failures of communications with the Radio Communications
- System in general or with a specific RTU.
- Automatic system failover or restart.

Other conditions specifically called out in this specification. CUSTOMER shall be permitted to add, delete, or redefine conditions for alarming at any time before the entire Contractor's design documents are approved.

The following occurrences shall be processed as events:

- Initiation of supervisory control.
- Commanded changes of status points.
- Return within a pair of limits of an analog value.
- Point control including:
- Tag/ remove tag
- Inhibit/ enable alarming
- Deactivate/ activate a point and manual data entry.
- Initiation of Load Control-automatically or manual.
- Remove/restore RTU scanning.
- Inhibit /enable audible alarming.
- Reassignment of console modes and AORs.

- Manual requests for system failover or restart.
- Initiation of emergency load shedding (option).

When a point is alarmed the following shall occur:

- Unless disabled, an audible alarm shall be sounded till manually silenced.
- The symbol, value, or bar graph representing the alarmed status point, analog point, or function shall flash in every display until acknowledged.
- A new alarm message shall be entered in the appropriate alarm summaries. An alarm summary may have several entries for the same point.
- An alarm message shall be entered in the A & E file.

An operator shall be able to inhibit alarming for any point which belongs to an Area of Responsibility that is assigned to the operator's console. When alarming is inhibited for a point no alarm processing shall occur, but otherwise data processing shall proceed as usual. The Alarm inhibit data quality shall be assigned to points for which alarming is inhibited, and these points shall be placed on an Alarms Inhibited Summary display.

4.1.8. Tagging

The SCADA system shall support placement and removal of four different type of control inhibit tags on the devices. The system shall support four types of tags. The placed tags shall be visible on graphical and tabular displays. It shall be possible to add a text message and permit number while placing the tag on the device. The tag placement function shall allow the operators to place tags on devices to prevent them from closing or opening, or to inform the operators of any special condition. Tags could be also placed at substations for informational purposes. Operators shall be able to enter informational texts associated to the tags. Operators shall be allowed to remove tags. The system shall keep track of tag placements along with the name of the operator who issued the request. The following are examples of tags that will be envisaged.

Type 1 tag (Red tag) - Both Closing and Opening operations are inhibited

Type 2 tag (Green tag) - Closing allowed and opening inhibited

Type 3 tag (Yellow tag) - Closing inhibited and opening allowed

4.1.9. Displays Notes

A tool shall be provided for operators to make notes on displays so that they can communicate information to the next shift or other. A rich text editor supporting text and pictures shall be provided for this doing. Display notes, as the name suggests, shall be a repository for information and can be placed at an arbitrary location on a display. They can be used to indicate a work permit. Display notes shall be created for informational purposes, but shall also be associated with a group of tags. When the display note is created, a movable picture representing the display note shall appear on the display which the user can position anywhere on the display.

4.1.10. Play Back

All the SCADA data, including all their modifications, shall be recorded in the DMS system. It should not be necessary to configure any trigger to record data evolutions. This tool shall enable the operator to replay sequences, and to visualize the data evolution both in the schematics displays. The operator shall be able to set a time-date corresponding to the beginning of the sequence and to adjust the replay speed. Once the operator has starts the replay, he shall be able to pause the replay, enter a new time date and restart from this new time date.

4.1.11. Historical Data Management / Reports

Data Capture

A general utility shall be provided for transferring data from real time database to a relational database supporting the SQL standard. The relational database shall be a commercially available product (such as ORACLE or MS SQL Server). For interoperability with other software products, Microsoft ODBC interface shall be supported. The primary functionality of the Historical Data Management software (HIM) shall be to allow collecting historical data from a real-time system into the relational database, from where a variety of tools can be used to produce statistics and reports.

The HIM system shall take care of the definition of the real-time data to be stored along with the periodicity of sampling and duration of storage.

As an example, the following data shall be stored in the historical system:

- All the analogs, calculated or coming from the RTUs, sampled every 15 minutes and stored in daily tables on a duration of 2 months

- All the events of the system stored in monthly tables on a duration of 2 months

Reports Facility

Web based report module shall be provided along with SCADA. The report module shall run on RDBMS backend and generate html / crystal report based reports. Reports must be displayable through an Internet browser. Within its offer, the supplier must propose a tool in order to enable operators to build and customize reports from the historical data gathered into the database of the man machine interface product. This tool has to be able to build in a user-friendly manner, reports about all the system's data. Reports definition shall include the following:

- Format (e.g. layout, titles)
- Substation Modeling

Generation and Viewing of Reports

Report generation shall be query based and available online. The printing of report shall be manual. The hard disk of the report server shall be sized in such a manner so as to include report data for a period of at least year. Tools must be available for automatic archival of report data. The archive data shall be replayed as and when required to view reports as desired by the customer. The periodicity of report shall be shift-wise, daily, monthly and yearly. These reports shall support the possibility to operate processes such as averages, sums, and comparisons on the data presented in the report. The supplier shall provide the following reports:

- Instantaneous Substation Parameters
- Instantaneous Feeder Parameter
- Frequency / Voltage band violation report
- Equipment performance reports
- System Index Reports like SIAFI / SAIDI
- Energy Balance Reports

Resulting reports must be exportable in several formats such as Excel spreadsheets, ASCII format, CSV format, etc.

The following reports/ displays shall be also required:

- Real time display of active and reactive loads of Substations, transformers, Feeders along with name of substation to which it is connected.

- Trending of load curves of loads/ load groups with provision to display (I) hourly load curves, (ii) weekly load curves, (iii) monthly load curves.
- Graphical displays showing the single line diagrams of 33 kV feeders, Substations, substation feeders, HT consumer loads connected with real time display of active and reactive loads.

As option, a pre-selected set of tags can be messaged for alarms through SMS to defined number of mobile telephone numbers through CDMA/GPRS modems.

4.1.12. Data Communications with Other Control Centers

It shall be possible to perform data exchanges with other control centers using the IEC60870-TASE 2 Inter Control Centre Protocols (ICCP). Whatever the type of control center, it shall be possible to exchange at least the following data:

- real-time telemetered data,
- non-telemetered data,
- control data,
- SOE data,
- scheduling data,
- historical data,
- energy accounting data,
- operator messages.

The communication protocol shall support the following data transfer mechanisms:

- One shot data - This mechanism shall be used to transfer data immediately, typically on behalf of a control center application,
- Periodic data - This mechanism shall be used to transfer a set of control center values within a strict time interval,
- Event data - This mechanism shall be used to transfer the data values from the server to the client every time any one of a set of event conditions occur at the server control center,
- Exception data - This mechanism shall be used to transfer only data values which have changed since the last report.

4.1.13. Cyber Security of SCADA Architecture

SCADA systems are implemented with a defence-in-depth strategy to ensure the cyber security of the production environment, with processes at the business level and technical security measures at the network, host, and application layers. The SCADA system should be designed to conform to industry-standard security practices, including those within the NIST guidelines, NERC CIP standard.

Security controls at the application level include:

- The use of secure coding standards, to reduce the risk of software bugs and flaws creating security vulnerabilities
- A system that has been independently tested for security vulnerabilities
- Access Controls designed to enforce authentication and accountability, as well as minimizing the risk of unauthorized access
- Logging and Auditing capabilities that allow for traceability of access and actions

Security controls at the system level include:

- A system built with only those software packages, user accounts and services required for operational use
- Malicious software prevention tools to detect, prevent, deter, and mitigate the introduction, exposure, and propagation of malware
- Allowing only ports and services required for normal and emergency operations to communicate
- File integrity monitoring to determine if unauthorized modifications have been made to application binaries or configuration parameters
- Centralized user management utilizing a directory server

Security controls at the network level include:

- An architecture that includes a strictly defined perimeter
- A DMZ network designed to eliminate direct communication between the critical trusted zone and the external networks
- Network device health monitoring

4.2. SCADA User Interface

This section describes the general requirements of the full graphic user interface for network operations which should work within the user interface provided for distribution system model. The network diagrams shall be displayed by two-dimensional graphical representation. The interface shall be compatible with hardware configurations ranging from high-end control room consoles to executive laptops. A console is an operating position consisting of one or more monitors and user interaction devices. The interface shall support the following functions:

- multi-windowing,
- scrolling, panning, zooming, de-cluttering,
- display navigation, and
- Point and click selection of further layer of detail.

Language of user interface shall be English (operator and maintenance). The graphics system supplied with the system shall be executable on all consoles provided by the Supplier and on personal computers running the MS Windows™ operating systems.

The user interface software shall be based on state-of-the-art web-based technology to present interactive, full-graphics views of system data via LAN, corporate intranet or the internet. It is essential that the same web-based user interface (same navigator, same tools bar, etc.) be available to the operator either for local use in the dispatching center or remotely. For this, it shall not be added more than one server at the dispatching center for the external communications.

Specifically, it shall be possible to:

- visualize the full-graphics displays using a web browser and using also a specific browser equipped with all the infrastructure required by operational activity
- Call up any information supported by a web browser: web page, pdf file, MSWord file, Excel document, any other format supported by a web browser.
- Use all features of the user interface from the browser, including dialog pop-ups, data entry and modification, selecting device, issuing controls
- simultaneously show, in different frames of the web browser, displays presenting real-time data as well as no-real-time like historical data

- customize the user interface by adding links to corporate or external web sites, by inserting standard html web pages
- create scripts to automate display interaction and/or navigation using client-side scripting language like JavaScript or vbscript
- Enhance security for intranet / internet users through the use of ad-hoc technology (SSL sockets, VPN, etc…).

It shall be possible to call-up the operator displays via the web using light-weight clients (web browser) when needed. The web technology shall be natively supported by the applications product, which means that having the displays shown in the web browser shall not bring additional work to the maintenance engineer at display building time. Nor shall it require additional third-party software products like specific plug-ins. Access The web user interface shall support and enforce all security features described in the following section.

4.2.1. Access Security

A mechanism for defining and controlling user access to the SCADA system shall be provided. This security scheme shall be in addition to that included with the operating system. That is, even though a user has logged onto the SCADA network or a processor, access to other application functionality shall be subject to additional security checks such as User Login, Password and with following features:

- Password security shall be provided for access to the system. A system manager or analyst selectively assigns levels of capability through access rights to consoles, specific computers, and/or individual users.
- It shall be possible to assign a level of security for either the consoles or the physical people. When a physical individual connects it-self to the system via a workstation, access rights associated to this session shall depend from the access right defined for the user and the ones granted to the workstation.
- If the workstation has been defined by the system manager as “User centric”, then any user connecting him-self to the system via this workstation shall benefit from the access rights associated to him
- If the workstation has been defined by the system manager as “Workstation-centric”, then any user connecting him-self to the system via this workstation shall benefit from the access rights associated to the workstation

- Finally, if the workstation has been defined by the system manager as “Hybrid”, then any user connecting him-self to the system via this workstation shall benefit only from the access rights common to the user and to the workstation.
- Encrypted passwords and/or strong authentication (one time password, certificates) shall be proposed.
- The transfer of access rights from a physical individual to another shall be possible for the monitoring of critical areas on the system network. When none of the workstations normally connected to these critical areas are connected, the system shall automatically grant the corresponding access rights to another workstation designated in advance as the back-up workstation.
- Each log-on and log-off shall be reported as an event. The event message shall indicate the date and time the procedure was executed, the name of the console and the identification of the user. The log-in status of the user shall be unaffected by any failure recovery procedure in the system. Function and Data Access Authorization (Area of Responsibility)

System security shall be available at multiple levels. Once logged on, access to application capabilities shall be managed by assigning a set of permissions to each workstation and/or user. It shall be possible to assign every point in the real time database to one of the Areas of Responsibility (AOR). It shall then be possible to assign operational responsibility for any combination of AORs to any operator terminal. The permissions allocated to each console shall be stored in the system database. Management of console permissions shall be a function itself subject to permission validation.

4.2.2. User Interface Design Standards

Consistent graphic standards shall be applied to all displays, whether standard/conventional or developed specifically for the user. Each display shall be consistent in its use of graphics, commands, menus, colors, selection procedures, and data entry such that data similar in appearance shall have a consistent meaning throughout the system.

4.2.3. User Interaction General Features

The following features shall be included in the user interface. Alternatives may be offered but must be functionally equivalent to the features specified.

Windows

The User Interface must be a multi-windows system. It shall be possible to manage as many as desired displays on the same screen. The system manager shall be able to limit the number of windows a user can open on a single screen.

The system shall provide ways for the operator to arrange a set of predefined windows (and their associated contents) on one or several screens, and to save this arrangement as a single object. Later, it shall be possible to call back this windows arrangement (with their associated contents) as it was previously defined.

Each screen shall support the simultaneous presentation of at least four user-defined windows. These windows shall be in addition to those dedicated for the common display features. The presentation of any display in any window shall be allowed. Window position and dimensions shall be independently adjustable to a screen resolution of four pixels or less. The windows shall be displayed in either overlapping or tiled fashion depending on the window definition of the user. In addition to the defined windows, user definition of windows shall be supported. Efficient techniques for switching between windows on a screen and between screens shall be provided.

Display Selection

It shall be possible to call up any display to viewports of any Operator Console, limited only by any security access restrictions. It shall be possible to call up the same display to more than one Operator Console at the same time. Rapid, convenient, and reliable selection of displays shall be provided using the following methods:

- Selection from a menu display
- Cursor target selection on any menu, graphic, or tabular display
- Selection of an alarm : in this case, it shall call up the one-line display containing the alarm's location,
- Entry of a display name in a display select field,
- Forward and backward paging through a series of displays,
- Selecting a display recall command. This shall cause the display that was on view immediately prior to the current display to be recalled, and,
- Selecting function keys or cursor targets dedicated to displays.
- The user shall be provided window selection techniques to independently direct a display to any window on any screen at the console.

Supervisory Control Initiation

Supervisory control functions shall be performed through dialog boxes that present commands dependent on the type of element to be controlled. As the final step of the supervisory control process, the user shall be presented with a clear description of the device to be controlled and the specific command to be issued and shall be required to confirm the command ("execute") or terminate the command ("cancel"). The system shall issue the command only after the user confirms the operation.

The supervisory control procedure shall support the control permissive check and control interlock requirements.

Manual Data entry

User entry of data shall be facilitated by simple procedures to select the point or points to be entered, enter the value or values, validate the change, and to confirm or cancel the entry. Data entry may use full screen or single point techniques as appropriate.

The full screen entry mode shall be initiated by a single user action and shall simultaneously affect all points on the display for which data entry is possible. The SCADA system shall respond by suspending the updating of and highlighting all points on the display that may be entered. The user shall then enter the new values and request entry of the values. The SCADA system shall perform any validity checks appropriate to the affected points. If there are no invalid entries, the new values shall be written to the database. If there are invalid entries, the invalid entries shall be highlighted and the user presented with the option of correcting the entries or accepting only the valid entries.

Single-point data entry shall be initiated by selecting the point to be entered and commanding the data entry mode. Only the selected point shall be placed in the data entry mode. The remainder of the entry procedure shall be as for full-screen entry.

Device Selection for Control

Control of a power system device or management of a single point (such as manual entry of the value or removing a point from scan) shall only be allowed from one window at one console at a time. Concurrent user action on different areas of a world co-ordinate map or display and concurrent supervisory control or data management of different points on the same display shall be allowed.

Inactivity Timeout

The progress of all user operations shall be monitored. If the user does not complete to a step within a multi-step operation within a pre-defined time, the process shall reset, and the user shall be informed of the reset. A partially completed action shall be reset if the user begins another non-related sequence.

4.2.4. User Guidance

The SCADA system shall respond to all user actions indicating whether the action was accepted, was not accepted, or is pending. For multi-step procedures, the SCADA system shall provide feedback at each step. Indications such as text messages, color changes, and blinking shall provide this feedback.

User Help

General and specific context-sensitive on-line help shall be available to the SCADA system user. Context sensitive means that the help information provided shall be applicable to the next steps or steps in the sequence being performed. Access to user help shall be available by:

- A Help command on the window menu bar;
- A Help button in a dialog box; and
- Topics from a Help menu
- Pressing help key or poke target on the specific field.

The Help menu shall present a list of topics available for reference. The topics shall refer to the SCADA system user documents. The ability to scroll through the topic's explanatory text shall be supported.

The Help button in a dialog box and help key shall present the text of the SCADA system user documents where use of the dialog box is explained. The user shall be able to scroll through this text. Exit from the help facility shall return the user to the same point in the sequence for which help was requested.

Context sensitive help facilities shall be provided for each application software package and operator display. The capability to easily edit or add additional help facilities in the future shall be provided.

The provided help facility shall also support:

- search mechanism
- navigation links between related topics within the help documents
- select/copy mechanism
- print facilities

4.2.5. Trending

The SCADA system shall include facilities to generate graphic trend curves for real-time and historical data. Selection of a trend shall be automatically called and displayed, by selecting any value by the operator, without the need to go back in the configuration tools. Selecting a point and designating a trend curve shall result in the display of a dialog box where the user can enter information on how the selected point is to be displayed:

- Value name
- Trend direction
- Scaling factor
- Offset
- Trend number and color (for multiple trends on one display)
- Time base values
- Trend rate
- Trend start time (historical data)
- Trend period (historical data).

Minimum of sixteen tracks shall be displayable in the same window. Each curve having its own scale. Curves colors shall be selectable independently from at least a 256 color range. It shall be possible to associate the trend or bar-chart display to any display in the same window. It shall be possible to view the graphical trend of real time & historical values (of other day) simultaneously on common X-axis. Trending in tabular displays should be also possible.

4.2.6. Dynamic Network Colouring & Circuit Tracing

The Dynamic Network Coloring shall enable the SCADA system operator to visualize the operational conditions present in the electrical system network. Electrical conditions shall be automatically particularized on the SCADA system one-lines. Power system lines and cables shall be colored using a set of user-predefined colors according to their electrical status:

- overload conditions
- energization / de-energization status
- Grounding status

4.2.7. Displays

A means shall be provided to produce printed copies of any display on printer. Color displays shall be translated for black and white printers using a mapping table (or similar) that can be changed by the user.

Power System Overview

The power system overview shall facilitate the operator's navigation between geographically distinct operating areas. It will present a geographic view of all the power system under SCADA system responsibility. The user shall be able to navigate between substation displays or network displays by selecting poke points on the overview display.

Network Displays

Network Displays are the main user interface for Network operation. From those displays, the operator shall be able to:

- send controls to the substation through the SCADA system
- update the Network database for non-remotely controlled equipment
- Place other items manually: tags, grounds, cuts, etc.

The system shall support two types of such displays – Geographical & Schematics. The geographical shall support a static geographical background & dynamic network representation. The schematic shall give a functional view of power flows.

Primary Substation One-Line

These displays show the interconnected elements of individual substations. The elements shall include buses, incoming and outgoing lines, transformer banks, circuit breakers, capacitor banks, and disconnects. The displays shall present tele-metered and calculated data, including all alarm conditions. Highlighting and colors shall be used to distinguish the operating states of the different substation elements shall be consistent with all other one-line displays. The user shall be able to interact with the substation one-line displays to perform any associated user interactions such as data entry and supervisory control.

The SCADA system shall support the capability to assign a digital picture or text file to any device located on a one-line display. It shall be possible to open the picture or text file by selecting from a pull down menu once the device has been selected. If selected, the picture or text file shall immediately be opened in a window on the active display.

The user shall be able to navigate to other substation displays from poke points on line segments on the one-line. The user shall also be able to call-up the associated substation tabular display from a poke point on the one-line.

Substation Tabular

These displays list the value of measured and calculated data associated with each substation as well as related information such as alarm limits. The user shall be able to interact with the substation tabular displays to perform any associated user interaction such as data entry, supervisory control, tagging and scan requests. The user shall be able to call-up the associated substation one-line display from a poke point located on the tabular display.

These displays shall be built-in displays of the SCADA system; no modeling shall be required to obtain them. Upon call-up, they shall display all the current contents of the database. Points displayed shall be all non-spare database points that are associated with the substation:

- For status points - The information displayed for each point shall include :
    - Name descriptors
    - All data attributes
    - Current status
    - Quality codes and tags
    - Unique point ids.
- For analog points - The information displayed for each point shall include :
    - Name descriptors
    - All data attributes
    - Current value
    - All limit values
    - Quality codes
    - Unique point ids.
- For accumulator points - The information displayed for each point shall include :
    - Name descriptors

- All data attributes
- Current value
- Quality codes
- Unique point ids

- For calculated points - The information displayed for each point shall include :
  - Name descriptors
  - All data attributes
  - Current value
  - All limit values, if applicable
  - Quality codes
  - Unique point ids.

The substation tabular displays shall be linked as pages of multi-page substation displays which shall also include the substations one-line diagrams and scratchpad displays.

It shall be possible to perform point-related functions such as acknowledging of alarm, tagging, and supervisory control, from both the one-line and tabular station displays.

Access Control Display

This display shall allow a designated authority to control user access to the SCADA system either through the console or through the web interface. The display shall enable the designated authority to enter, modify, and delete user IDs and passwords and to assign console areas-of-jurisdiction and operating modes.

Alarm Summary

Alarm summaries shall be provided to show power system and SCADA system alarms sized for 600 entries. When called to a screen or window, the most recent alarms shall be presented first.

The user shall be able to acknowledge and delete messages on the display. Flashing shall identify unacknowledged alarms (to facilitate reading unacknowledged messages, only the time field shall flash).

When the full complement of alarm messages will not fit on a single page, multiple pages shall be provided and a message shall appear on each page of the display, indicating there are more alarm messages on other pages. If the capacity of the alarm summaries is limited and an alarm summary display becomes full, the oldest messages shall be automatically deleted and the

newest messages shall be added. It shall be possible to perform any alarm interaction from the alarm summary displays.

A single user action shall be used to call an alarm summary that presents only those alarms for the jurisdictions assigned to the console from which the display is called. All alarms in all classes shall be presented. The user shall be able to filter the alarms to present selected classes. The operator shall be able to call up a predefined display or portion of the world map which is associated with an alarm by pointing the cursor to the alarm's entry in the summary.

Event Summary & System Activity Log

The event summary shall be similar to the alarm summary with the exception that all alarms and events as well as records of user actions (such as supervisory control commands, tag placement, and data management actions) shall be listed. The system activity log display shall present all important system events in a timely manner. The content of the display shall be similar to the information sent to the printer.

Abnormal Summary

This display shall list devices and values that are not in their normal state. Measured, calculated, and manually-entered status, analog, and accumulator data points shall be included. The displays shall show the off-normal data points in the following groups:

- Status points for which the present measured state is different from the normal state stored in the database
- Analog and accumulator points with current values exceeding alarm limits

For those points with an undefined normal state, the system shall provide a convenient mechanism for redefining their normal states. The off-normal status displays shall use dynamic coloring facilities to identify the different conditions associated with the points.

Alarm Inhibit Summary

This display shall list devices and data values for which the user has suspended alarm processing. The summary shall be an information only display. No user interaction shall be associated with it.

Tag Summary

This display shall list and describe all active tags for all devices. The user shall be able to place or remove a tag from this summary. Information on this display shall list each device tagged and

shall include: date and time of tag placement, user who placed the tag, tag level, station identifier, device identifier, and comment field.

Manual Replace Summary
This display shall list all points that have been replaced by manual entries. The user shall be able to change the manual entry of a point from this summary for those points assigned to the console. For each point, there shall be facilities for fast access to the display containing the point, such that the user can further modify the value or return the point to automatic data acquisition.

Application Program Displays
All displays associated with all specified application programs and functions shall be provided. Displays that allow the user to interact with SCADA system application programs shall use a common look-and-feel approach. The information provided shall help expedite the user's interactions.

Memos
From the consoles or through web, users shall be able to assign memos that contain directly entered free-form text and graphics to displays. It shall be possible to assign memos to any display and at any location within a display. A unique icon or indicator shall be provided that will visually highlight to the user that a memo is assigned to the display. The memo icon shall be visible at all de-clutter levels during a zoom operation.

Study Displays
Study displays shall utilize the same displays as those used for display of real-time data, with different layers or overlays allowing access to both real-time and study data. Studies displays shall be easily recognizable by the operator at a first glance on the screen. It shall not be necessary to provide additional study input and output displays for any display used in the real-time system.

Communications Control Display
This display shall show the current communication status for RTU communication channels and shall allow RTUs to be put into and out of scan. RTU communication statistics including error rates for the previous hour shall be shown on this display. SCADA system shall continuously monitor the primary communication channels currently used for data exchange with each RTU.

The backup channel used for communication with RTU shall also be monitored periodically for its healthiness, without any manual intervention and alarm shall be generated in case it fails. The SCADA system shall have the feature to detect failure of primary channel and making automatic fail over to back up channel.

Other Displays

Specific display requirements necessary to support the specified functions for other application functions are described throughout this Specification.

Note: Bidders are encouraged to highlight any additional features/functions in their solutions.

5. DMS

5.1. DMS Function Description

The following DMS functions shall be supported:

- Topology Processing
- Temporary Modifications
- Network Analysis Functions
- Switching Operations
- Network Optimizer
- Study Mode
- Integrated Outage Management
- Network Simulator

5.1.1 Topology Processing

The Topology states that shall be shown on the display are,

- **Normal** – the lines shall be shown in the nominal feeder color.
- **De-energized** – the lines shall be shown with a white halo.
- **Abnormally energized** – the lines shall be shown in the color of the energizing feeder with cross-hatching in the color of the normal feeder.
- **Parallel Loop** – Any condition where a section of the network is energized from more than one point, either from the same feeder or from a neighboring feeder, is considered a parallel loop. The parallel path shall be identified with a yellow halo (configurable) and the related line sections shall be shown in a single color (typically magenta) with cross hatching in the normal feeder color.
- **Power flow Mismatch** – this refers to a multiphase line section where there are both energized and de-energized phases or the direction of the power-flow in one of the phase is opposite to the other phases. The affected line sections shall be identified with and orange (configurable) halo.
- Grounded network sections that are de-energized and have one or more grounds applied shall be identified with a green halo.

The topology processor shall run locally on each client to ensure fast response to network changes and reduce the network traffic and server loads. In addition to status change updates the topology processor shall perform network trace functions on the local client. These traces shall have no effect on the operations model or other clients viewing the network. The trace functions shall allow operators to easily identify energization sources or end points of a network section. Traces shall be indicated by a cyan halo applied to all of the affected devices, including laterals and customers which may not be visible on the current display. A trace shall be performed by selecting a point on the network and then using the toolbar buttons. Traces shall recognize the current dynamic state of the network including temporary modifications.

The trace functions available shall be:

Downstream Trace: Traces from the selected point out to all the downstream extents of the network. The system status message shall display the number of customers and transformers included in the trace. If a downstream trace is performed on a de-energized section of network, the trace shall identify all devices electrically connected to the selected point.

Connectivity Trace: Identifies all the circuit elements on the most direct path between the two selected points on the network if electrically possible. Feeders shall be normally modeled in such a way as to prevent traces passing through the feeder head and via the substation bus.

Switchable Section Trace: For a selected line section, the switchable section trace identifies all of the line sections, including laterals, between bounding feeder backbone switches. The system status message shall display the number of customers and transformers within the bounded section. This shall allow an operator to identify the switches needed to isolate or energize a point in the network and obtain a count of the number of customers and/or transformers that will be affected.

Phase Tracing: Upstream and downstream traces of individual phases may be performed using this function, allowing the operator to identify the path of a given phase through an unbalanced section of the network such as an underground residential loop.

5.1.2 Temporary Modifications

Temporary modifications are made to the distribution network to isolate faults, restore services or allow maintenance work to be undertaken. These modifications are performed by field crews

and must be reflected in the network operations model in order to maintain the correct network topology. Tools shall be provided to allow operators to apply cuts, jumpers, temporary switches and grounds to any point in the network and enter a name/description for the modification. A summary display shall be available that lists the jumpers, cuts and grounds that are currently applied.

Cuts are used to place a temporary break in any line segment in the network. The “cut” object is actually a temporary in-line switch and so the status can be changed as required. It shall be possible to select a symbol to show either a cut or a temporary switch. It shall be possible to apply the cut to one or more of the available phases of the conductor. A mandatory description entered on the cut popup shall become the display label, and any information entered in the explanation field shall be displayed as a tool-tip. Once placed, it shall be possible to open, close and tag the cut or temporary switch in the same way as a standard disconnect switch. The topology of the network shall be automatically updated to reflect the changes caused by the placement of the cut.

It will be possible to place jumpers to provide a temporary, switchable connection between two points in the network in the system display. The initial state of the jumper may be set to open or closed. A jumper popup shall automatically show the available phases for connection, but it shall be possible to show other partial or cross phase connections if required. A popup shall warn the operator about abnormal connections such as all phases not being connected or the nominal voltage being different at the two connection points. The mandatory description entered for the jumper shall become the display label and any information entered in the explanation field shall be displayed as a tool-tip. Once the jumper has been placed, the switch symbol in the midpoint of the jumper may be selected and opened or closed in the same way as a standard disconnect switch. The topology of the network model shall automatically be updated accordingly. It shall be possible to reposition the centre node of a jumper.

Temporary grounds can only be placed, for obvious reasons, on de-energized line sections. These grounds represent the physical grounds placed on lines for safety purposes during maintenance and construction. It shall be possible to place a temporary ground on one or more available phases in the system display. A mandatory description shall become the ground label and any information entered as the explanation shall be displayed as a tooltip. The placement of the ground shall change the de-energization halo on the line (typically white) to the grounded

halo (typically green). If a line segment is re-energized while a temporary ground is still applied, the ground shall automatically be removed from the display.

5.1.3 Network Analysis Functions

Network Analysis shall be provided to allow users to study the current state of the network or future network conditions. Power flows shall be solved for all types of network configurations including meshed, radial and unbalanced networks. Individual phase voltages shall be calculated at all nodes and power flows shall be calculated for all feeder segments. The network analysis function shall also calculate system losses and loads at distribution feeder nodes. A limit monitor shall identify feeder voltage violations and line flows that are outside of acceptable operating limits. The network view shall be used as the input and display system. The network analysis functions shall also include network optimization functions to provide network reconfiguration and load management. The following network analysis functions shall be included:

- **Distribution Power Flow (DPF) –** This function shall calculate the complex voltages at all nodes and the power flows through all line segments in the distribution network. The DPF shall include a bus load allocation function to provide estimates for the loads (kW and kVAR) at each feeder node and a limit monitor to check the DPF solution for line flows and voltages that are outside of defined operating limits.
- **Power Quality Analysis (PQA) –** PQA capability shall be provided to determine the extent of feeder voltage violations including voltage imbalance. This function shall estimate the portion of time when a nodal voltage is beyond its limits.
- **Loss Analysis (LA) –** This function shall calculate the technical losses for transformers and circuits.
- **Protection Validation (PRV) –** This function shall calculate the maximum and minimum short circuit current for a phase-to-phase or phase-to-ground fault at any point in the distribution network. The calculated fault currents are used to verify that each segment of the feeder is properly protected.
- **Load Model –** This function shall model the loads.
- **Fault Location –** This function shall use information from protection relays and fault detectors to determine the likely location of a fault on a feeder.

Then network analysis functions shall be executable in both real-time and study modes. The real-time mode shall utilize the current power system conditions (SCADA measurements and schedules) to evaluate the system. The functions shall be capable of being triggered to run periodically on pre-specified events or on operator demand. The trigger events shall include:

- Topology change.
- Feeder overloads and voltage violations as detected by SCADA.
- Sudden feeder load and primary substation bus voltage changes.

In study mode, operational data shall be retrieved from either a saved case or a snapshot of the real-time system. Studies for future times shall be estimated using typical load shape values. The load shape information shall be based on the study time and the day type. The forecast state of network switching shall be obtained by applying existing or planned switching orders to the network model.

The Distribution Power Flow (DPF) shall find a phase domain solution to the unbalanced power system model including individual bus phase voltages, phase angles and network power flows. The DPF shall be capable of modeling and solving any unbalanced power network configuration including meshed and radial systems. DPF shall take into account the following network model attributes:

- Three different phase voltages at the substation supply bus.
- Non-linear load-to-voltage dependencies.
- Automatic control actions of locally controlled capacitors and feeder voltage regulators.
- Distribution transformer voltage drops.
- Voltage-dependent distribution transformer coil and core losses.

Line and underground cable charging

The DPF shall solve both radial and meshed networks with multiple supply buses as well as support of transformers at the substation. The DPF algorithm shall provide solutions for all or part of the network with equal efficiency. To perform a power flow analysis on a distribution network it is necessary to have complete and accurate information on all the loads in the network. Loads at the lower voltage levels are not usually measured and so for these load values to be determined an estimation procedure is required. A Bus Load Allocation (BLA)

procedure shall be used to allocate loads (kW and KVAR) to buses that do not have telemetry, automatically accounting for other metered loads.

The BLA function shall be provided and shall use the real-time measurements from SCADA and pre-defined system information to scale the distribution system loads to the real-time measurements. The expected value at a given date/time shall be obtained by multiplying the nominal load by a scaling factor that reflects the energy usage for that specific time. The allocation procedure shall minimize the number of power flow iterations required to maximize the performance of the overall process. The BLA function shall have the following capabilities:

- Allocation of loads for both radial and meshed distribution networks.
- Incorporation of system losses during the allocation procedure.
- Support for multiple load models associated with a single network node.
- Support for three phase and single phase load models associated with a three phase network node.
- Estimation of loads to be restored after an outage (either planned or unplanned) as a function of the allocated load and cold load pickup models that account for outage duration and load type
- In real-time mode, inputs to the BLA shall be handled in the following priority order:
    - Feeder manual entry – overrides all SCADA feeder measurements.
    - Valid SCADA measurements.
    - Substation power transformer state estimator data (if available from an Energy Management System).
    - Load schedules and historical load data.

During real-time power flow executions, historical correction factors shall be updated and stored for a configurable number of daily time periods for each day type for each load. Typically, the system will be configured to store one historical correction value per day type per load. The number of stored historical values may be increased by the system administrator recognizing that this must be balanced against the performance impact, which increases proportionally to the overall size of the database.

When there is a temperature adjustment schedule for the load, the temperature effects shall be taken out of the stored load scaling factor. For example, if the load is increased by 5% due to high temperatures, then the adjusted scaling factor shall be reduced by 5%. By doing this, the

temperature effects shall not be included twice when performing a power flow in the study mode. In study mode, the historical load data (determined from real-time power flow executions), temperature data (manually entered) and temperature adjustment schedules shall be used to allocate the nodal loads. The loads shall be scaled using the historical load scaling factors. If a feeder manual entry has been set, this value shall be used to scale all loads similar to the procedure used for the real-time mode. The temperature adjustment schedule shall provide a scaling factor based on the current temperature. For each load category, there shall be an associated temperature adjustment schedule.

A limit monitor (LIM) function shall be provided that identifies all limit violations based upon the most recent DPF solution. All load (and station bus) voltages and line flows calculated by the DPF shall be checked against their limits. Values outside of an acceptable range shall be defined as a limit violation. Tabular displays shall be provided that show a comprehensive list of all violations. A single alarm message only shall be sent to the centralized alarm system. The violations shall also be displayed as colored halos on the geographic network view. At high zoom levels the individual components shall be marked with halos to indicate voltage or overload violations. At lower zoom levels the entire line segment shall be shown with a halo.

The following limits shall be checked by the LIM function:

- Normal and emergency voltage deviation limit at a distribution substation bus
- Normal and emergency voltage quality limit at equivalent customer terminals
- Voltage imbalance limit of a three-phase node at customer terminals
- Flow limits on lines, switching devices, capacitors, transformers, and reactors (in Amps, kVA, or MVA)
- Flow imbalance limit on three-phase line segments

A station exception summary display shall be provided to show a summary of key data points from the DPF solution and with following features:

The display shall be ordered such that the station with the most significant problem is listed at the top.

- It shall be possible to navigate to a feeder exception summary display by clicking on a

Station name.

- It shall be possible to navigate to individual network components with limits exceeded by clicking on a value in the feeder exception summary.

The DPF Substation Results display provides additional DPF solution results for the selected substation. It shall be possible to show DPF solution results for a particular network component in a pop-up window by selecting the device on the network view and clicking the appropriate button on a toolbar.

A Power Quality Analysis (PQA) function shall be provided that is responsible for estimating the quality of the electricity supply voltage. The function shall calculate the voltage quality based on accumulated Power Quality Indices (PQI). The PQI represents the deviation of load voltage from quality limits. Quality values shall be calculated on-line and then stored for daily and monthly reports. The function shall allow distribution engineers to monitor the power quality in terms of the degree of normal and imbalanced voltage limit violations. Three power quality indices shall be computed:

- High voltage Power Quality Index, which is the sum over all loads of the product of the load (kW) and the amount by which the voltage at the load exceeds the normal high quality limit (kW* High voltage deviation).
- Low voltage Power Quality Index, which is the sum, over all loads of the product of the load (kW) and the amount by which the voltage at the load violates the normal low quality limits (kW* Low voltage deviation).
- Imbalance voltage Power Quality Index, which is the sum over all loads of the product of the three phase load (kW) and the amount by which the negative sequence voltage at the load exceeds the imbalanced voltage quality limit (kW* Imbalance voltage deviation).

The PQA shall also calculate the portion of the time when the voltage or imbalance is beyond limits and the amount of consumed energy under different voltage deviations or imbalance. The PQA computation shall be conducted for each individual feeder. In real-time mode the PQA function shall compute the PQI indices after the DPF execution. The user shall be able to view current PQI solution values for a particular distribution transformer by selecting on the component from the geographic or schematic displays. The following information shall be shown:

- High voltage power quality index.

- Low voltage power quality index.
- Imbalance voltage power quality index.

The DPF shall calculate all voltage and power flow values from the substation primary bus to the equivalent load nodes based on existing operating conditions. Loss Analysis shall use the DPF results to calculate instantaneous technical losses in the actual distribution system. The losses shall be calculated per phase for every device included in the DPF. The substation losses display shall show the losses for a selected substation and associated feeders. Losses for individual devices shall be displayed by selecting the device and opening an analyst output popup screen. A loss analysis function shall calculate real and reactive losses for substation power transformers and distribution circuits including feeder regulators and distribution transformers as well as the total circuit loss.

Analysis of the distribution system under short-circuit fault conditions shall provide information regarding circuit breaker selection, relay settings and the potential for damage to equipment if it is not properly protected. A protection validation function (PRV) shall simulate faults and detect unprotected or improperly protected regions of the network. PRV is not a time-domain function and shall not consider distribution network transients. After a distribution power flow is run in real-time mode, the PRV shall use the unbalanced power system network model to calculate the fault currents at each node and check the values against the relay settings of each protection zone and protective device. The protection zone shall be bounded by breakers and re-closers but not fuses. The function shall compare the minimum fault current on each protected zone against the relay settings and compare the maximum fault current against the interruption rating of the breaker / re-closer. Improperly protected zones or relay settings shall be alarmed. The results of the PRV analysis for each feeder shall be shown in a substation protection validation summary display.

Loads shall be modeled in the system model separate from the transformers. The load attributes shall include the following:

- ID
- Name
- Connectivity (A, B, C, N connections and wye)

- Nominal (initial) real and reactive power (per phase) provided by Asset Management System (or GIS), based upon customer billing data. Nominal data provided shall be peak or averaged.
- Number of customers each load shall be assigned to one load category. The load category shall provide the required data for accurately estimating the values of the real and reactive nodal power loads (in the BLA function).
- The load category shall include the following attributes.
    - Typical load shapes for similar days shall be used where a similar day is defined by the following:
        - The month (season)
        - Type of day (e.g., Monday, Weekday, Friday, Saturday, Sunday, & special days)
        - Daily regional average ambient temperature
    - Load-to-voltage dependencies (real power and reactive power)
    - Load data accuracy (expressed as a percent of the initial load value)
    - Incremental customer rates, modeled as set of Rs/kW data points
    - Power quality requirements expressed as:
        - Voltage limits (normal and emergency)
        - Voltage imbalance
        - Penalties for violating quality limits
    - Information necessary for creating a secondary circuit equivalent modeling the voltage drop in the secondary circuits between the distribution transformer and the equivalent remote load center

A fault location process shall provide enhanced input to the outage management function by using tele-metered information from relays and fault location devices to automatically determine the suspected location of a fault. The fault location process shall function as follows:

The DMS shall receive trigger information from un-commanded status changes or tele-metered fault indicator devices via the SCADA interface. The target feeder shall be identified and the system shall wait for some time period to allow all measurements to be received and re-closer sequences to complete. This period shall be configurable but would normally be around 30 seconds. At the end of the period the latest data for the feeder shall be captured (fault indicators and fault current, if available). Based on the fault indicator states, the system shall highlight the

switchable section that contains the suspected fault location). If available, fault current values from the protection relay shall also be used to calculate the suspected fault location. The fault current shall be compared against short circuit calculations for each section of the feeder to identify the section or sections where the fault may have occurred. The results shall be graded into three levels of likelihood and presented as colored halos on the real-time network view. The coincidence of the halos from the fault detector and/or fault current calculations shall indicate the most likely location of the fault. The fault location analysis itself shall does not issue any alarms. The operator shall be notified of fault-related problem through SCADA alarms (e.g. breaker status changes, fault detectors) which shall direct the operator to the area of the network where the analysis has been performed. The operator may enable the display of the fault location halos from the toolbar.

5.1.4 Switching Operations

Switching operations software shall be provided for performing switching changes on the network for the purposes of maintenance, network reconfiguration, and restoration of unplanned outages and augmentation of the distribution network. The network switching operations shall support switching orders and safety documents.

Switching orders shall be created directly by selecting devices from the user's view of the electrical network. Switching orders shall also be generated automatically by the network optimization functions such as Fault Isolation & Service Restoration (FISR). The execution of switching orders shall follow a process in which the switching order guides the operator to the relevant device for each step, monitors the system for the correct switching operation and then acknowledges the successful completion of the action. The execution process shall update the status of non tele-metered switches in the network model to ensure that the model always reflects the current status of the system. It shall be possible to simulate the effect of a switching order by applying it to the study network model prior to execution of the order on the live network.

Safety documents shall be created and associated with the relevant switching orders. The issue and release of safety documents shall be interlocked with the execution of the related switching orders. The switching operations shall act on the system model as with all other functions and the operation of the switching orders and safety documents shall be managed by the switching order server. The switching operations functionality shall cover the complete scope of the switching process including:

- Fast and accurate creation of switching orders directly from the geographic network view
- Switching can be performed against a step-by-step switching log in addition to formal switching orders
- Simulation of the switching order against a network study model of the network, based on projected conditions and the planned time of switching.
- Management of the execution of the switching order by verifying that each step has been correctly completed
- Save and retrieve switching orders for record keeping and later use
- Automated creation of “back out” switching orders to reduce the workload required to create the switching necessary to return the network to its original state.
- Allow the dispatcher to modify a partly executed switching order in cases of equipment failure or an unexpected problem .The switching operations shall support customization via plug-in modules to support the specific rules and procedures and the look of switching order and safety documents presently being utilized. Switching operations shall be integrated with the network optimizer application to enable selected switching plans generated by the optimizer functions to be automatically converted to formal switching orders.

5.1.5 Network Optimizer

A network optimizer shall be provided that includes advanced network reconfiguration and load management tools that augment the functionality of the network analysis system. These tools shall assist the dispatcher to operate the system in an optimal fashion during both normal operation and outage conditions. The functionality provided by the network optimizer shall include,

Load and Volt/Var Management (LVM)

- Fault Isolation and Service Restoration (FISR)
- Automatic Feeder Reconfiguration (AFR)
- Planned Outage Study (POS)

Output switching plans created by the network optimizer shall be executable manually by the dispatcher or fed to the switching operations module to be turned into a complete switching

order. The LVM tools shall provide both advisory and closed-loop (SCADA) control of selected network facilities associated with control of power quality. The Load and Volt/Var Management (LVM) function shall provide recommendations to improve the voltage quality and provide reactive support to the surrounding distribution system. The LVM shall be a three-phase algorithm and shall provide the capability to support a variety of purposes by activating selected constraints and controls and applying different optimization objective functions. The objective ranking shall be based upon criteria such as the number of customers without service, losses, radial conditions, flow and voltage violations, the VAR requirements or the computed reliability index and cost of infeasible constraints. Constraints such as the requirement for radial connections, switching actions, or reliability calculations shall be directly given rupee or influencing rupee costs. LVM shall be executable in the following modes:

- **Closed-Loop –** LVM directly issues commands for the control of substation capacitors, feeder capacitors and feeder voltage regulators (single phase or three phase) for a pre-defined objective function. Advisory – LVM generates a recommended plan for the control of voltage devices which is presented to the dispatcher. After review, the dispatcher can manually select the plan for execution.
- **Study** - LVM uses the study DPF base case configuration as the starting point. The user can then modify network conditions to analyze “what-if” scenarios.

LVM shall execute in Real-time with the following triggers:

- A change in circuit connectivity or change of status
- If during the optimization process the status of a circuit is changed, LVM will stop and re-optimize based on the new situation
- If during execution there are unsuccessful operation, LVM will re-optimize (on demand) after the dispatcher tags the malfunctioning devices to exclude them from the solution
- Significant change in the voltage quality index
- Limit violation from designated monitoring points in the distribution network
- Voltage or VAR controller failure (based on tags) and restoration after a failure (removal of a tag)
- Communication to restore a Voltage/VAR controller after it has failed (e.g., based on pseudo-tags entered by the dispatcher).

The LVM shall support the following problem formulations

Problem Formulation	Description
Reduction of overloads and violations	No overloads and voltage violations are allowed in the distribution lines and buses.
Minimize demand	All enabled controls are moved to reduce the station demand (kW) to the lowest feasible value, subject to the user-selected voltage and flow constraints.
Reactive area support	This will strive to achieve a target power factor at the distribution substation high side bus. The area target power factors are pre-defined in lookup tables based upon area load. The user- selected limits will be respected.

It shall be possible to apply following constraints to an LVM solution:

- Voltage quality limits at the customer sites (normal, emergency)
- Flow limits for distribution elements
- User or database defined voltage limits for given sites in the distribution primaries
- Limits on the number of capacitor switching operations per day
- Limits on the time interval between consecutive capacitor switching operations
- Limits on switching electrically close capacitors (“back-to-back” capacitors)

A Fault Isolation and Service Restoration function (FISR) shall be provided to optimally restore service to distribution customers. In the case of a sustained outage, FISR shall create a

Switching Plan which isolates the faulted area and provides service restoration by using optimal feeder reconfigurations, including cascading reconfiguration to off-load one feeder in order to pick up part of the load of an adjacent feeder. FISR shall be capable of defining one or more operational objectives, including

- **Minimizing un-served kW –** The minimum unserved kW problem formulation finds restoration plans that restore as much load (kW) as possible while respecting the user-specified limit sets. This problem formulation shall have two variants: Auto Only – plan uses only SCADA controlled switches and Auto + Manual – plan uses all types of switches
- **Minimizing customer minutes interrupted (CMI) –** This problem formulation finds restoration plans that minimize the total number of CMI. The calculated CMI value is determined based on manual and automatic switch operation times.
- **Minimizing the number of switching operations –** The minimum number of switching operations problem formulation finds restoration plans that minimize the total number of switching operations and
- **Minimizing voltage drop along the reconfigured feeders – T**his finds restoration plans that minimize the voltage drop between the highest voltage and the lowest voltage along the feeder.

The problem formulation shall specify the network and operational constraints including segment overloads, voltage violations, and relay settings. The results of the FISR analysis shall be presented to the operator as a table. The viable solutions shall be shown in a ranked order based on a set of pre-defined criteria. It shall be possible to select a plan to display the individual steps of the plan. To avoid closing into a fault, FISR shall always first isolate the faulted section from the un-faulted de-energized section, and then restore the un-faulted de-energized section. FISR shall always close the upstream protective devices that tripped to restore the loads upstream of the fault. It shall be possible to import a FISR plan into the switching orders application.

FISR shall be triggered manually either by placing a fault symbol on the real-time network view or opening the network solution window. The FISR function shall run in two modes:

- **Closed loop mode –** the best plan is automatically selected and executed. Only SCADA controlled switches can be included in closed loop plans.

- **Advisory mode –** the plans are presented to the operator in ranked order. The selected plan can then be sent to switching operations to automatically create a formal switching order.

An Automatic Feeder Reconfiguration (AFR) function shall be provided that creates switching plans to optimally unload overloaded segments and to optimize the location of normally-open points in a distribution circuit. The function shall be used to reduce overloads on both, substation transformers or feeder segments. The function shall take into account peak load conditions within a user-configured time window. Similar to the other network optimization functions, AFR shall support a number of problem formulations that define one or more operational objectives, including minimizing the number of switching operations, improving reliability, reducing overloads and voltage violations and minimizing power losses. The AFR functions shall be manually executed in real-time or study mode, and shall be activated either automatically based on SCADA observations or network analysis calculations or manually by operator request. The AFR output shall provide a set of recommended switching actions to the operator.

The AFR shall optimize the location of normally open points by moving the normally open points in a distribution circuit which has different frequencies of faults for elements, different number of customers connected to feeder sections, and different reliability values for different load categories to change the cumulative reliability for the circuit. This objective shall be selected by an engineer/planner's request and shall include a set of prioritized optimization criteria. The function shall suggest alternative combinations of open points that satisfy the combination of selected constraints and optimization criteria.

A "Return to Normal" mode shall be provided to generate a switching plan that restores all switching to their normal state for a given substation or group of substations with the minimum interruption of supply to customers. The mode shall be used as the final restoration process after the cause of an outage has been repaired. The results shall be presented as a set of valid switching plans. The operator shall select the most appropriate plan for automatic transfer to a formal switching order.

A "Planned Outage Studies" (POS) shall be provided to recommend switching plans to support planned outages. POS shall only be available in study mode. The user shall specify the network device that is to be taken out of service and POS will generate one or more possible

switching plans. POS shall first transfer the affected load and then isolate the specified device to prevent unnecessary dropping of load. If the substation is selected then POS shall develop a plan to off- load all substation power transformers. The operator shall be able to prioritize the optimization of the switching plan by selecting

An appropriate problem formulation including:

- Minimum un-server kW (Auto Only)
- Minimum un-served kW (Auto + Manual)
- Minimum customer minutes interrupted
- Minimum number of switching operations
- Minimum voltage drop along the reconfigured feeders
- The POS results shall be shown in tabular displays which show switching device actions for each recommended plan, statistics and performance indices. It shall be possible to import the selected POS plan directly into the switching operations function to automatically create a formal switching order. This switching order shall be executable in study mode to fully verify the operations.

5.1.6 Study Mode

A study mode shall be provided that allows the network view, analysis and optimization functions to be run stand-alone on the client workstation. This environment shall be independent of the real-time operations. It shall be possible for operators and control room support staff to perform detailed analysis of planned operations and “what-if” analysis immediately prior to executing the operation in the real-time environment.

Study mode shall use the same static models as real-time but with a separate instance of the dynamics in order to preclude the requirement to separately set-up and maintain a study environment. Changes made to the study mode instance of the network area shall be applied only to the operator’s workstation and shall not be visible to others.

It shall be possible to run both real-time and study modes concurrently on the same workstation. Display background colors shall be used to clearly differentiate real-time and study-mode displays. Study mode shall use the same toolbars, menus and displays as real-time. It shall be possible to initialize the study mode environment from the nominal model, from real- time or

from a previously saved study environment. Tools shall be provided to allow the operator to quickly create the required study environment. It shall be possible to save a study environment, once it has been set up. A setup tool shall allow the operator a range of options as to the data that is included. It shall be possible to share a common library of saved study cases between operators and control room support staff for further analysis, review or archiving.

5.1.7 Outage Management

An Outage Management System shall form an integral component of the DMS system. It shall allow operators to manage unscheduled and scheduled outages from within a unified operating environment that integrates real-time DMS, SCADA, crew monitoring and switching orders.

The Network Outage Management software shall collect and coordinate all available information about the outages on the network. In the case of unplanned outages, customer calls, AMI observations, SCADA operations, and emergency services calls shall be analyzed to assist in determining the most likely point at which customer supply has been interrupted. From initial notification of a fault through prediction, crew assignment, fault isolation and return-to-normal switching, the operator shall be able to work from a single set of network views. All necessary information for each phase of the job shall be clearly presented in a way that allows the operator to manage each outage efficiently while also staying aware of other network activity.

The Network Outage Management shall be designed to handle major storm situations and provide high-performance and effective tools. The software shall have the ability to easily divide or combine areas of responsibility and therefore balance with operator's workload. A comprehensive and flexible record keeping function shall automatically provide all of the necessary information for regulatory reporting requirements.

An Outage Information Summary shall be provided and have a range of displays that can be easily configured by the operator to present the information in the most effective form. Tabular summaries of Affected Feeders, Outage Incident Details, Assigned Crews and Area Notes shall be available and be arranged and re-sized as required. The data within each table shall be sorted by clicking on the column headers. It shall be possible to find individual items by entering a relevant fragment of text in the filter box. The summary display shall also include a geographic overview to indicate the location and predicted extent of each outage at the feeder or station level. The status and severity of an outage shall be indicated through the use of colors.

Additional information such as crew locations, service areas, main roads and towns shall also be displayed. It shall be possible to locate each incident quickly on the real-time geographic view.

Network Performance Indices

System performance indices (e.g. SAIDI, SAIFI) give a standardized measure of the performance of the distribution network with regard to the frequency and duration of unplanned outages.

The calculation of system performance indices shall be performed and based on the IEEE 1366-2003. The indices shall be calculated using a batch process that is run at regular intervals or on-demand.

Performance indices such as CAIDI, CAIFI, CMI and momentary outages (MAIFI and MAIFI) e required for regulatory reporting shall also be included in the performance index reports although they may be calculated in a separate process depending on the data sources.

Unplanned / Planned Outage Management

A high level of integration of the DMS application suite shall be provided to ensure that unplanned and planned outages are handled in a consistent manner. All types of outages shall be presented on the Outage Information summary as well as the geographic network view.

Combined with the network view, the operator shall have access to displays that coordinate Outage Incidents, Switching Orders, work crews and scheduled outages. Switching Orders for scheduled outages and emergency restorations shall all be managed in the same way. They shall be built using the same tools and recorded in a shared repository. A combination of scheduled tasks and restoration work shall be assignable to work crews as required.

Outage History

A Historical Reporting function shall be provided to ensure complete records of all outages are available for future analysis. Information shall be retrieved from this history on a per-customer/address basis.

The Historical Reporting tool shall be usable to perform extensive research on:

- Cause Analysis
- Customer Reliability Indices

- Division/Operating Center Outages
- Trouble Summary by Division/Operating Center
- Overhead and Underground Summary
- Recurring Trouble Summary
- Worst Performing Devices
- Worst Performing Feeders
- Crew Assignments
- Closed Cases of Trouble

Crew Monitor/Assign

The assignment of crews to outages and the monitoring of their current location and status shall be performed directly on the Outage Management Displays. Crew symbols shall be positioned on the geographic network view or the Outage Information overview. Colors shall be used to indicate crew status. Vehicle type, crew names and assignment status shall be displayed as a tool-tip. A search facility shall be provided to allow for rapid identification of any crew by name, job or truck ID. It shall be possible to include additional information Crew Monitor/Assign function including:

- Crew foreman, phone number or radio
- Identification of non-company crew
- Crew status (Assigned, dispatched, needed, on Job, Standing By, Meal Break, etc)
- How long has the crew been working
- Next assigned job (filled in by dispatcher)
- Location of next assigned job
- Search (position to on geographic display) by crew name (or by foreman)
- Search by truck ID
- Estimated time of completion of current job/remaining time to completion
- Actual time of completion of current job
- Type of crew truck

- Number in crew
- Assignable crew labels (e.g. crew name with radio number, radio number only, and generic crew names such as one to indicate status “patrolled, needs transformer”)

5.1.8 Network Simulator

Overview

The Network Simulator shall provide an integrated system utilizing the same software components, interfaces and user interface as the real-time network management system. This system shall be utilized to train dispatchers in both routine and emergency operations that accurately represent the behavior and response of the real system.

The simulation instance of the network model shall be automatically created as part of the standard modeling update process, meaning that no additional work shall be required to create the simulation and the training simulator is always up to date with the real-time network model. The simulator view of the network shall be differentiated from the real-time and study views by the background color.

The training simulator shall support the complete user interface of the integrated DMS software. The simulation engine shall also able to exchange data with a SCADA simulation, providing an environment for the following types of training:

- User Interface presentation and navigation
- Tagging
- Switching Operations (manual and supervisory)
- Topology processing, including feeder coloring and tracing
- Annotations
- SCADA operations and alarms
- Network Analysis
- Network Optimization
- Study Mode and Real-Time operations

Network Analysis & Optimization functions

The simulation engine shall include a power flow solution and event script capability. This shall provide the simulation the ability to feed power flow-related data points to the simulated SCADA

and support training and testing of the network analysis and optimization functions. The simulator view shall allow the instructor to control the operation of the "physical network" independent of the operator's displays but with the same style of interface and the same range of tools.

When a fault is placed on the simulator view of the network, the simulator shall trace upstream to the first protective device (fuse, circuit breaker etc.) and cause it to operate. The customers (and/or their AMI meters) that are de-energized shall generate trouble calls in accordance with call-response parameters that have been set. If the outage affected any SCADA-controlled devices, then the appropriate messages shall be sent to the SCADA simulation. A realistic representation of network events shall be provided to the operators.

Event list

An event list shall provide the means of creating and playing scripts for network training simulation. Events list shall include:

- Faults on lines
- Faults on transformers
- Customer calls
- Modify call rate (OMS) parameters
- Switch changes
- Pause (pauses execution of script, allowing the instructor to resume execution at an appropriate point)
- Measurements

The event scripter shall provide a quick and easy method of adding events to a script. A geographic network view shall be used to point and click on the required device, then allow the type of event to be selected. It shall be possible to edit or delete events within the script. The time sequence of events shall be easily changed.

Fault scripts shall also be automatically generated to simulate a defined scenario. The scenario shall be built up by defining the probabilities of different types of events causing faults on lines, transformers and customers. The stations to be included and a time scale for the scenario shall be selectable. The system shall then calculate a list of faults. The fault list shall be saved as a

script or merged into an existing script. The scenarios shall also be saved separately so that they can be used with different scripts. It shall be possible for the overall execution timing of a script to be compressed or expanded as required. The execution time for each event shall be re-scaled proportionately. It shall be possible for scripts to be saved and recalled or shared with other users via the common library.

6. SCADA DMS Control Centre

Typical SCADA / DMS control Centre configuration at Auto Nagar Substation will be as shown in Annexure 2.

Main Components of the SCADA / DMS Control Centre are as follows:

- **Servers**
  - SCADA application server
  - DMS application server
  - HIS / RDBMS Server
  - Network Management System (NMS) Server
  - Web Servers
  - Front End Server (Communication front End) FEP (CFE) Server
  - Backup/Recovery system
- **Operator Work Stations**
- **Video Projection System**
- **Printers**
- **Auxiliary Power Supply**
- **Time and Frequency system**

6.1. Servers

6.1.1. SCADA Application Server

SCADA application server will host the SCADA application which is required to have all the functions and user interface requirements specified in Chapter 4.

The minimum hardware configuration of the server shall be:

- 2.4 GHZ each processor (in case the offered server is RISC & EPIC based processor speed shall be at least 1.2GHz)
- Minimum 2 Processors
- 8GB Main memory (RAM)
- 320 GB Hard disk drive
- CD R/W drive
- 21” TFT color monitor
- Keyboard & Mouse
- Dual 10/100/1000Mbps Ethernet

6.1.2. DMS Application Server

DMS application server will host the SCADA application which is required to have all the functions and user interface requirements specified in Chapter 5.

The minimum hardware configuration of the servers shall be:

- 2.4 GHZ each processor (in case the offered server is RISC & EPIC based processor speed shall be at least 1.2GHz)
- Minimum 2 Processors
- 8GB Main memory (RAM).
- 320 GB Hard disk drive
- CD R/W drive
- 21" TFT color monitor
- Keyboard & Mouse
- Dual 10/100/1000Mbps Ethernet

6.1.3. HIS/RDBMS Server

Redundant HIS application server shall be provided with common sufficient memory for mass historical data storage and retrieval. The details of the information to be handled by HIS sever is given in section 4.1.11. The minimum hardware configuration shall be:

- 2.4 GHZ each processor (in case the offered server is RISC & EPIC based processor speed shall be at least 1.2GHz)
- Minimum 2 Processors
- 8GB Main memory (RAM)
- 4 x 160 GB external hard disk SAS Disc 10KRPM, Hot pluggable (RAID 5 Configured) – (bidder may calculate the HDD requirement based on the details given in section 4.1.11 and provide based on the calculation)
- CD R/W drive
- 21" TFT color monitor
- Keyboard & Mouse
- Dual 10/100/1000Mbps Ethernet

6.1.4. NMS Server

Redundant NMS servers shall be used for configuration management, fault management & performance monitoring of servers, workstations, routers & LAN equipments etc. The detailed requirements of NMS server are given in 7.2.

The minimum hardware configuration of the server shall be:

- 2.4 GHZ each processor (in case the offered server is RISC & EPIC based processor speed shall be at least 1.2GHz)
- Minimum 2 Processors
- 8GB Main memory (RAM)
- 320 GB Hard disk drive
- CD R/W drive
- 21" TFT color monitor
- Keyboard & Mouse
- Dual 10/100/1000Mbps Ethernet

6.1.5. FEP (CFE) Server

The redundant FEP server shall be a functional unit that offloads the task of communication & pre processing between RTUs/FRTUSs & SCADA/DMS servers. All RTUs/FRTUs shall be connected to CFE through IEC 60870-5-104 link. For any existing RTUs/FRTU that is to be integrated, interface must be available to use existing protocols. Free slots shall be made available inside the FEP server, so as additional communication boards can be plugged-in to meet the network future expansion. Each channel shall be assigned a different protocol and the front-end shall be able to manage several protocols in parallel.

The redundancy of front-end servers shall allow handling of RTUs/FRTUs connected either through single channel or redundant channels. In both cases, one FEP server shall be able to take control of all RTUs/FRTUs channels. In order to meet network's expansion behind the full capacity of a pair of FE servers, it shall be possible to connect additional FE servers' pairs to the LANs. Each communication line shall be able to support its own communication protocol. The CFE shall comply with VPN / SSL based security for connecting with IEC 60870-5-104 nodes on public networks. Further the nodes and CFE shall be self certified by manufacturers as NERC/CIP compliant to comply with future smart grid requirements.

All FEPs shall not have open ports other than needed for protocol traffic / SCADA traffic, and shall have an audit trace of all login attempts / connection attempts. This FEP shall exchange data through secured SSL / VPN and encryption of protocol traffic whether it is a public network

or a dedicated one. The equipment should take control command from designated Master IP address only and no other IP.

All RTU/FRTU shall be connected to the SCADA/DMS Control Center.

RTU Communication Card / Module shall support VPN / SSL Security / Encryption of data coming to it through Public network, and then send over private & secure Utility network to the SCADA Control Center.

The Communication Servers shall be able to process time – stamped data and can be directly connected to GPS device for time synchronization

The minimum hardware configuration of the server shall be:

- 2.4 GHZ each processor (in case the offered server is RISC & EPIC based processor speed shall be at least 1.2GHz)
- Minimum 2 Processors
- 8GB Main memory (RAM)
- 320 GB Hard disk drive
- CD R/W drive
- 21" TFT color monitor
- Keyboard & Mouse
- Dual 10/100/1000Mbps Ethernet

6.1.6. Backup/Recovery System

A suitable backup and recovery system may be provided to take complete system/ OS/ Database backup.

6.2. Operator Workstations

The operator Workstation console shall be used as a Man Machine Interface (MMI) by dispatcher for interacting with all SCADA/DMS system. Operator Workstation consoles shall also be used as development console to take up developmental / maintenance activities such as generation / updating of database, displays etc & to impart training.

Each workstation shall consist of dual monitors & single keyboard and a cursor positioning device/mouse.

The user shall be able to switch the keyboard and cursor-positioning device as a unit between both monitors of console. The minimum hardware configuration of operator workstation shall be:

- 2.4 GHz Processor , Dual Processor
- 2 GB RAM
- 250 GB Hard disk drive
- 48x24x48 CD R/W drive
- Two 21" TFT color monitors
- Graphic adaptor cards
- Two speakers for audible alarms with configurable tones
- Keyboard & Mouse
- Dual 10/100/ 1000 Mbps Ethernet ports

TFT Color Monitor

The TFT monitor shall have flat panel color screen. The following is the minimum characteristics of TFT color monitors

S. No	Specification	For 21"monitor
1	Diagonal Viewable size	21"
2	Viewing angle	Sufficiently wide horizontal & vertical viewing angles
3	Dot Pitch	0.28 mm
4	Resolution	1280x1024 minimum
5	Color support	16 million
6	Refresh rate	Minimum 75Hz
7	On screen control	yes
8	Anti glare & anti static	yes
9	Tilt , Swivel	yes

6.3. Engineering Systems

Specification of engineering system is same as that of operator workstations.

6.4. Video Projection System

The contractor shall provide a video projection system based on modular DLP (Digital Light Processing) technology. All the screen modules of the VPS system shall be suitable to form combined high resolution projection images. The VPS system will be used to project displays of SCADA/DMS system independently of workstation console monitors. All the operations envisaged from workstation console (dispatcher) shall be possible from VPS also.

The Contractor shall supply all necessary hardware and software, including the drivers, adapters and memory to seamlessly integrate the video projection system with the user interface requirements described in the specification.

The video projection systems shall be rear projection systems and shall be complete with all projection modules, supporting structures and cabling. Design & installation of the video projection systems shall be coordinated with the Employer during project implementation. The requirement for Video Projection System is as follows:

- VPS screen with 2x3 matrix with each module minimum 67" diagonal
- VPS Graphics controller shall be interfaced to the SCADA/DMS system through dual LAN connectivity.
- Each projector shall provide a minimum resolution of 1024X768 pixels. The rear projection screens shall be capable of displaying full resolution of the source.
- The VPS shall be capable of supporting multiple display modes in which one or more modules show one or more SCADA/DMS displays concurrently as selected by the user.
- This system shall provide the same functional display capability as the full graphics workstations.
- The VPS shall have a horizontal & vertical viewing angle of approximately 160 degrees. The half gain angle shall be at least 40 degrees with a tolerance of $\pm$ 5 degrees for both horizontal & vertical directions.
- The overall brightness of individual projector shall be at least 550 ANSI lumens. The luminance measured at the screen shall be 100 candelas/sqm minimum.
- The projection bulb (lamp) shall have an average operating life of 9,000 hours (typical).
- Centre to corner brightness shall be generally uniform.
- The configuration of the VPS (no. of screens and size of each screen) is defined in the BOQ
- The VPS controller shall have audio-video signal input module to interface with video conferencing equipment, CCTV, VCD/DVD players. The VPS controller shall support three types of video signal inputs (PAL, SECAM, NTSC)

6.5. Auxiliary Power Supply

The computer system should be suitable for operation with single-phase, 230 $\pm$10% V_{an}, 50 $\pm$5.0% Hz power supply. To ensure uninterrupted & regulated power supply to computer system, suitable rating UPS are envisaged under auxiliary power supply specification. All cables supply, laying & their termination between UPS panel & computer system shall be in the scope of contractor.

The input circuit breakers are provided in the UPS for protection against short circuits, any additional fuses, switches and surge protection if necessary to protect the hardware shall also be supplied by the Contractor.

The auxiliary power to all computer system hardware shall be fed from parallel operating UPS system. On interruption of input AC power to UPS, the load shall be fed through UPS inverter through its batteries.

The minimum Requirements from Auxiliary Power Supply are as follows:

- Technology Micro processor based IGBT, High Frequency Switching Sinusoidal multiple PWM
- Battery Sealed Maintenance Free Batteries, Backup Hours: 4 Hours for all equipments in the SCADA / DMS Control Centre
- Accessories; All necessary interconnecting cabling from source to UPS & UPS to Control equipments

In case of battery capacity low conditions (due to prolonged failure of input supply to UPS), the computer system shall go for orderly shutdown to avoid corruption of any applications. The orderly shutdown of computer system can be implemented either through RTU (where UPS alarms shall be wired to RTU) or through suitable interface with UPS Supplier software.

6.6. Printers

Except for the output capabilities unique to any printer type (such as extended character sets, graphic print and color features), there shall be no limitations on the use of any printer to perform the functions of any other printer. All the SCADA/DMS system printers shall have dual LAN interface either directly or through internal/external print servers. Printers for DTS &

development system shall have single LAN interface. The characteristics for each type of printer are described below:

INKJET PRINTER:

- Printing speed Up to 6ppm for black printing & 5ppm for color printing.
- Interface Ethernet, Paper Size A4
- Resolution up to 4800 by 1200 optimized dpi color printing on premium photo paper, 1200 by 1200 input dpi
- Shall have input and output trays
- Shall have landscape and portrait print orientation

B & W LASER REPORT PRINTER:

- Printing speed 25 pages per minute, Resolution 1200 x 1200 dpi
- Print orientation Portrait, landscape, reverse landscape
- Format A4 size paper, Paper capacity Input 1100 sheets, output 300 sheets
- Interface Ethernet
- Memory buffer of at least 48 Mbyte

6.7. Time and Frequency System

GPS based time facility, using Universal Time Coordination (UTC) source, shall be provided for time synchronization of computer system at SCADA/DMS control centre. The time receiver shall include an offset adjustment to get the local time. It shall have propagation delay compensation to provide an overall accuracy of $\pm$1.5microsec. The GPS system shall have dual 10/100/1000Mbps LAN interface. The GPS receiver shall be provided in redundant configuration

The time receiver shall detect the loss of signal from the UTC source, which shall be suitably indicated. Upon loss of signal, the time facility shall revert to its internal time base. The internal time base shall have a stability of 2ppm or better.

The GPS system shall include digital displays for time and date in the format DDD: HH:MM:SS (the hour display shall be in 00 to 23 hour format).

GPS system shall also be used to drive separate time, day & date indicators which shall be wall mounted type. The display for time shall be in the 24-hour, HH:MM:SS format. The display for the day & date shall be xxx format (MON through SUN) & DD: MM: YYYY respectively.

Contractor shall provide wall mounted type digital display units for time, day, date & frequency indication. The display of frequency shall be in the xx.xx Hz format. The frequency shall be derived from 230V AC supply.

Each digit on the time, day and frequency indicators shall be at least 7.5 cm in height and shall be bright enough for adequate visibility in the control room from a distance of 15 meters.

The offered GPS clock shall also provide at least one 2 MHz (75 ohm interface confirming to ITU-T G.703) synchronization interface to meet the time synchronization requirement of the communication system This interface shall confirm to the requirements specified in ITU-T G.811 for accuracy, jitter, wander etc. Alternatively, a separate GPS clock for synchronization of communication system is also acceptable.

7. SCADA / DMS Communication

7.1. Fibre Optic

Substations and Control Centre Communication

The communication will be on an optical fiber ring (OPGW / UG) to provide alternate routes for connectivity of the SCADA network.

The captive OFC network to be laid along with transmission lines will be in the underground mode. This OFC based communication should cover all the substations as the data transmission requirements from these will be increasing day by day especially to cover video surveillance. As the OFC will be running in parallel with the underground HT power cables, these should be non- metallic that is without any metallic armoring. These will need to be laid in HDPE ducts at depth below 1.5 meters to protect them from rodent attacks. To cover any future requirements as well as for extra revenue through leasing of dark fibers a minimum of **12 fiber OF cable** is recommended.

Alternate communication network as back up for Substation communication:

To make the communication subsystem highly reliable and resilient some back up communication media is required in case of failure of main media. For this data connectivity from Public Telco's **(3G)** which is available from multiple providers should be availed. The connectivity from two different operators can be obtained for each location (Dual SIM).

Optimal route for the network and also a method of laying the network (underground/overhead etc.);

As mentioned above the communication media has to be laid along the Power transmission lines and should be underground for reliability. The route will be mapped with the final route of power transmission cables.

To connect the existing sub-stations, the spur links of optical fibre cables will be laid from the nearest point of new cable routes. These will be laid as per the existing standard followed by BSNL for such cables requiring these to be laid below 1.5 meter to make them rodent proof.

11 kV Feeder Communication

The Fiber cable shall be single mode, multi fiber armored with protective media suitable for underground laying along with heavy HT power cables. There shall not be any crush or bend due to the adjacent HT cables, for which proper strengthening sheath shall be in built with fiber cables.

The cabling in the main net between Substations and RMUs shall be minimum of 12 fibers and the cabling in the loop net between RMUs and DTCs shall be minimum of 8 fibers. The approximate total length of main net will be about 157.2 Kms and loop net will be 117.4 Kms.

The single mode fibers shall be within the standard attenuation, dispersion levels that are available in the market for this particular type of control mode operations.

7.2. NMS Specifications

NETWORK MANAGEMENT SYSTEM

The Contractor shall provide a network management system (NMS) also referred as NMS to provide operational support for network. The NMS shall allow complete management of supplied systems with FCAPS capabilities. The supplied NMS shall be able to manage the complete Communication network elements, supplied by bidder. The NMS system shall be provided as a rack mounted server. The interface to each network shall be a Q3 interface as defined in ITU-T recommendation G.773.

7.2.1. Requirements from management system

The NMS design concept, functional and informational architecture and physical architecture shall be in compliance with ITU-T recommendation M3010 and G.784. NMS shall also include the monitoring of the Ethernet interfaces, primary multiplexer card/unit and tele protection Interfaces for configuration, alarm and performance monitoring.

a. The equipment shall be managed through F interface on Local Craft terminal as described in ITU-T G.773.
b. The equipment shall be managed through Q3 interface on central management terminal as described in ITU-T G.773. The Q3 interface shall comply specifications given by ITU-T.
c. The equipment shall support DCC channel for remote management of node via gateway.
d. The equipment shall support DCC-R and/or DCC-M pass-through.
e. Management of equipment via F1 byte or VC12 is desirable.
f. Craft terminal and NMS shall be capable of all type of configurations, provisioning, performance management, fault rectification (Faults which can be rectified remotely) and software upgrade/downgrade.
g. The bidder shall clearly mention all details of NMS system (Server HW/OS/Application), software licenses, software/OS versions, No of client licenses and any other hardware or license required for management.

h. The EMS shall provide the inventory information to the network management layer (NML) / service management layer (SML) so that SML is able to create base activate a service to the customer automatically. This shall also assist SML in providing the network inventory to which the SML shall add the customer identification and maintain this information is its data base.
i. The EML shall be able to show inventory based on the available device inventory in terms of circuit utilization and inter connecting links.
j. The NMS of the equipment shall have the capability of supporting minimum of 16 bit programmable address to be assigned to NE's. This will be over and above of the fixed address, if any.
k. NMS/EMS/ Craft shall indicate the presence and absence of any physical module in hardware elements. It shall also indicate the usage of module i.e., how many ports are in use which interface is in use and which are free to be used etc.
l. The EMS shall be able to discover and keep the device information
m. The EMS shall able to keep track on any changes in the network inventory reported chronologically

Fault Management

Fault management is concerned with detecting, diagnosing, bypassing, directing service restoral and reporting on all the network elements and systems. Minimum specific requirements that shall be satisfied include the following;

a. Display equipment status in a consistent fashion regardless of the source of the data on a graphical display. Status shall be displayed through the use of colors on nodes as well as through text.
b. Obtain status and detect faults through periodic polling, processing of unsolicited alarms and error events and periodic testing for connectivity.
c. Maintain an alarm summary of unacknowledged alarm events on the management station display and maintain a log of all received alarms. The operator shall be able to acknowledge and clear alarms individually and as a group. The use of alarm correlation techniques is encouraged to minimize the proliferation of alarms caused by a single common event. All alarms shall be configurable as critical alarms, major alarms and minor alarms with different colors.

d. Provide the capability of diagnose and isolate failures through analysis of error and event reports and through the use of both on-line and off-line diagnostic tests and display of monitored data.
e. The criteria for fail over shall be configurable as automatic fail over to redundant equipment wherever possible and through operator initiated actions where automatic fail over is not possible. The status of fail over shall be reported to the NMS.
f. Track network equipment failure history.
g. Each failure and clearance shall be time stamped. The equipment shall support the alarm surveillance of detection and reporting of relevant events and conditions that lead to the generation of alarm.
h. In STM-16 system, this management functionality shall provide the information regarding degradation of the Optical paths etc.
i. It shall be desirable if the supplier ensures that the system has measurement capability to provide certain important parameters like Optical power measurements of input channels and of STM-1 Central office equipment, Line system and remote terminal.

Configuration Management

Configuration management is concerned with management, display and control of the network configuration. Minimum specific requirements that shall be satisfied include the following:

a. Provide tools to establish and maintain the backbone topology and configuration information and provide graphical maps depicting the configurations.
b. Gather descriptive information about the current configuration of the equipment. Provide operator displays and prepare reports.
c. Provide tools for planning, establishing and changing the static equipment configuration. Provide for changes to the equipment configuration in response to equipment failures, planned upgrades and operator requests to take equipment offline for testing.
d. Provide verification testing to support new equipment installation.
e. Have specification and setting of all NE's installed.

Performance Management

Performance Management is concerned with evaluation of the use of network equipments and their capability to meet performance objectives. Minimum specific requirements that shall be satisfied include the following:

a. Provide support for an operator to initiate, collect and terminate performance metrics under normal and degraded conditions.
b. Monitor signal quality and history. Provide operator controls to monitor performance of specified events, measures and resources. Specifically provide displays to permit operator for activities mentioned below.
c. Select/De-select network equipments, event and threshold parameters to monitor.
d. Set monitoring start time and duration or end time.
e. Set monitoring sampling frequency
f. Set/change threshold values on selected performance parameters.
g. Generate alarm events when thresholds are exceeded.
h. Set multiple thresholds on certain performance parameters. Alarm categories include as a minimum, a warning and a failure.
i. Calculate selected statistical data to measure performance on select equipment based on both current and historical performance data maintained in performance logs.
j. Provide graphical displays of point to point and end to end current performance parameter values. Provide tabular displays of current, peak and average values for performance parameters.
k. Generate reports on a daily, weekly, monthly and yearly basis containing system statistics.

Security Management

The NMS shall be provided with security features to limit access to monitoring and control capabilities to only authorized personnel. One access level of system administrator and at least two levels of operator access (Write and read only) shall be provided. The system administrator shall be able to create, define and modify operators with different access levels, network domains and perform all kind of maintenance and up-gradation of the NMS system. Operator with “Read only” access shall be able only to view network parameters. Operator with “Write” access level shall be able to access database, command control and test functions. Human error and conflict detection are also required. Such errors and access violations shall be reported to the offending user as error message and warnings.

8. Bill of Quantity

Substation Automation (IEC 61850 compliant)			
S. No	**item**	**Units**	**Quantity**
1	Local SCADA	Nos	38
2	IED	Nos	As required
3	Bay Controllers	Nos	As required
4	B/W Printers	Nos	19
5	Gate way (with support IEC-60870-5-104)	Nos	19
6	Ethernet switch (Compliant to IEC 61850)	Nos	As Required
Services			
7	Engineering, wiring, testing, commissioning and Training	LS	LS

SCADA / DMS

S. No	**Item**	**Item description**	**Units**	Quantity
1	FRTU's (for 33 kV feeder)	for RMU	Nos.	5
2	FRTU's (for 11 kV feeder)	Cat i for CSS	Nos.	102
		Cat ii for mini RMU	Nos.	272
		Cat iii for RMU	Nos.	79
Services				
3	Engineering, wiring, testing, commissioning and Training		LS	LS

SCADA / DMS Control Centre (at Autonagar Grid Substation)

S. No	Item	Quantity	Nos.
1	HIS / RDBMS servers	Nos.	2
2	SCADA servers	Nos.	2
3	SCADA Operator workstations	Nos.	2
4	DMS servers	Nos.	2
5	DMS Operator workstations	Nos.	2
6	FEP Servers	Nos	2
7	Video Projection System	Nos	1
8	Peripheral Servers	Nos.	2
9	Web Server	Nos	2
10	Engineering Work Stations	Nos	2
10	Back up Recovery System	Lot	1
11	Color Printers	Nos.	2
12	B/W Printers	Nos.	2
13	LAN	Nos	2
Services			
14	Engineering, Wiring, Testing , commissioning & Training	LS	LS

Note: All the necessary software shall be provided along with the servers. (For Example: SCADA and DMS software for SCADA and DMS servers)

Substation and Control Centre Communication

SL. No.	Item Description	Unit	Total Qty
Equipment			
1	SDH Base OLT Equipment with 2xCentral processing Cards, Distributed dual power Supply	Nos.	23
2	Agg. Cards with 2x STM1, 2x E1 and 4 FE ports	Nos.	46
3	STM-1 SFP	Nos.	50
4	DDF	Nos.	23

SL. No.	Item Description	Unit	Total Qty
5	Ethernet DDF	Nos.	23
6	Installation accessories	Nos.	23
7	NMS (1 server, Licenses, 4 Craft terminals) (as per specifications)	Nos.	1
	Mandatory Spares		
8	SDH Base Equipment with 2xCentral processing Cards, Distributed dual power Supply cards and accessories (10%)	Nos.	1
	Services-Equipment		
9	Installation Commissioning and site testing for SDH	Nos.	23
10	Installation Commissioning and site testing for NMS system	Nos.	1
11	Training for Nominated Engineers (No of engineers 10, 5 day each, one batch)	Nos.	1
B	**OF Cable**		
12	Unarmored, 12 fiber OF cable as per G.652D specs	Km	238
13	HDPE duct (40/33 mm)	Km	238
	Services-OF Cable		
14	Laying of duct and OFC along power cable	Km	238
C	**Alternate media**		
15	Procurement of 3G SIM's (2*25)	Nos.	46

Note: Wherever there is UG cable, OFC with duct will be laid along with UG cable. Where Overhead lines are present, the OFC with duct will be layed separately as per BSNL specs.

11 kV feeders Communication

S. No	item	Item description	Units	Quantity
1	Fiber optic cables	16 fiber Arm	km	157.19
		8 fiber Arm	km	117.34
2	Supply of HDPE duct	Dia 40/33 mm	km	275
3	Fiber optic terminal units and	-	lump Sum	-

	accessory			
4	Laying of duct and Cable	-	km	275

Note: Bidder has to include any other equipment required and not included here for complete implementation of project

33kV Network Map of Berhampur, Gopalpur & Chatrapur City

33/0.4kV Waterworks S/S

H-Pole 4km

132/33kV Ambagada Grid

4P

Luchapada Feeder 6.5km

4P

6.5km

9.0km

0.2km

33/11kV Ambagada S/S

0.5km

33/11kV Lochapada S/S

3.0km

33/11kV New Medical S/S

1km

33/11kV Medical S/S

H-Pole 7.4km

6.5km

220/132/33kV Narendrapur Grid

0.2km

33/11kV Narendrapur S/S

33/11kV Ambapua S/S

NBLS 2.5km

33/11kV Lingarajpur S/S

4km

3km

132/33kV Chatrapur Grid

1.78km

33/11kV Chatrapur S/S

H-Pole 17.5km

3.5km

9.6km

H-Pole 5km

4.0km

33/11kV Corporation Road S/S

3km

RMU

3km

33/11kV Municipalty Kalyan Mandap S/S

4km

2km

33/11kV Nilakantha Nagar S/S

33/11kV Bidyutpur Colony S/S

8.0km

1.5km

3.0km

0.5km

33/11kV Ankuli S/S

H-Pole 10km

H-Pole 4.7km

H-Pole 22km

33/11kV Rangeilunda S/S

3.5km

3.5km

33/11kV Lathi S/S

8 km

5km

2.5km

4.68km

RMU

33/11kV Goods Shed S/S

0.75km

RMU

H-Pole 10km

33/11kV MES S/S

NBLS Tower 6.22km

33/11kV Gopalpur S/S

132/33kV Autonagar Proposed Grid

8.0km

H-Pole 8.0km

1.5km

RMU

3.68km

5 km

Chikiti Feeder

4km

33/11kV Kanisi S/S

2km

2km

RMU

Towards Jagapur S/S

33/11kV Existing S/S

33/11kV Proposed S/S

132/33kV Existing Grid

132/33kV Proposed Grid

33kV Existing OH Line

33kV Proposed OH Line

33kV Proposed UG Line

Drawn Using

MiPower

Power System Analysis Package

33kV Network Map of Berhampur, Gopalpur & Chatrapur

CLIENT

Southern Electricity Supply Company ORISSA

Berhampur,Ganjam
Orissa - 760004

Power Research and Development Consultants Pvt. Ltd.

P R D C®

विज्ञानेन जातानि जीवन्ति

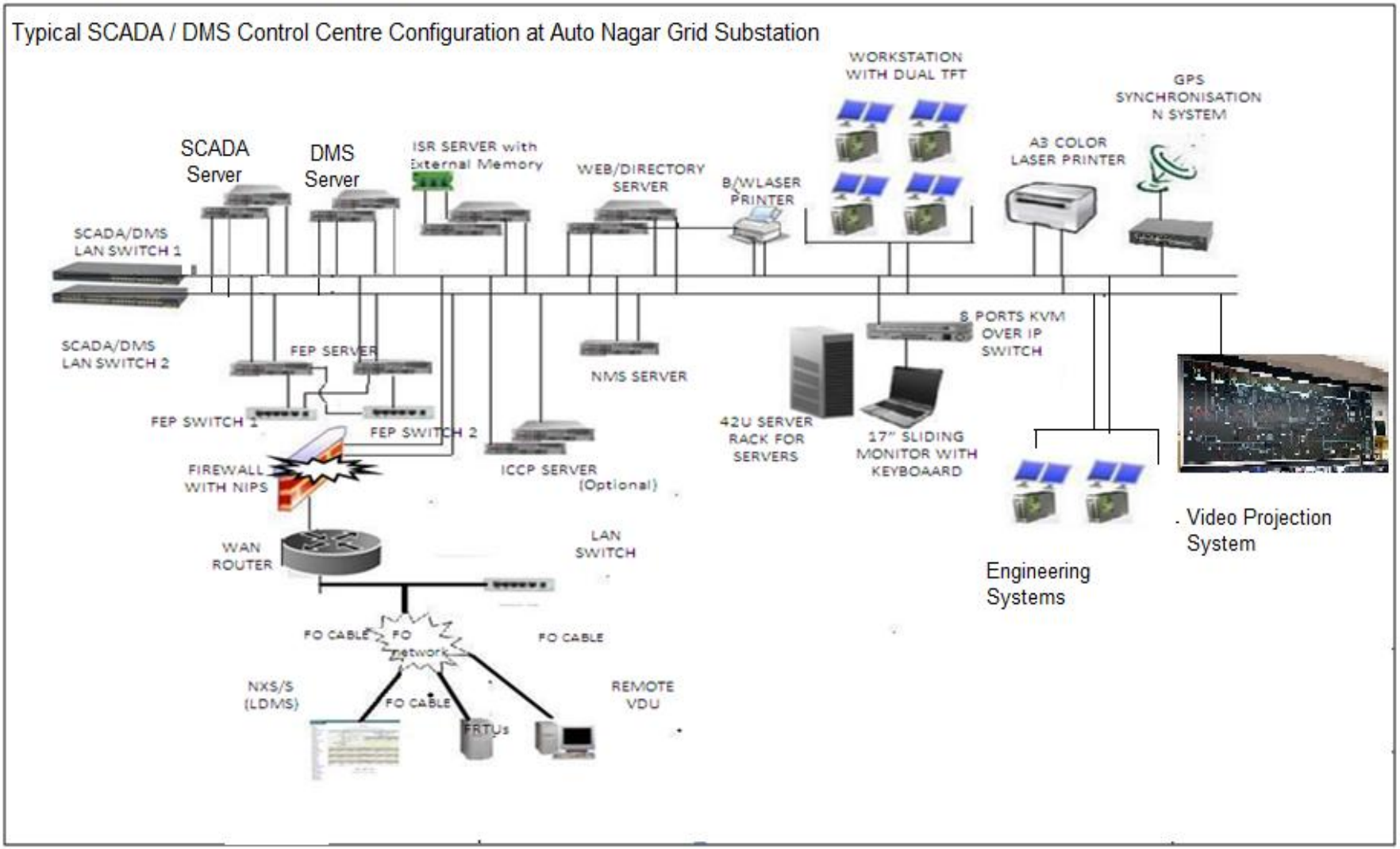
5, 11th cross, 2nd stage,
West of chord road,
Bangalore - 560 086, Karnataka
Tel: +91- 80 - 2319 2159 / 4245 5555,
Fax: +91- 80 - 2319 2210 / 4245 5556
E-mail - prdc@vsnl.com
Web site: www.prdcinfotech.com

Feeder Name : 33kV Network Map of Berhampur, Gopalpur & Chatrapur

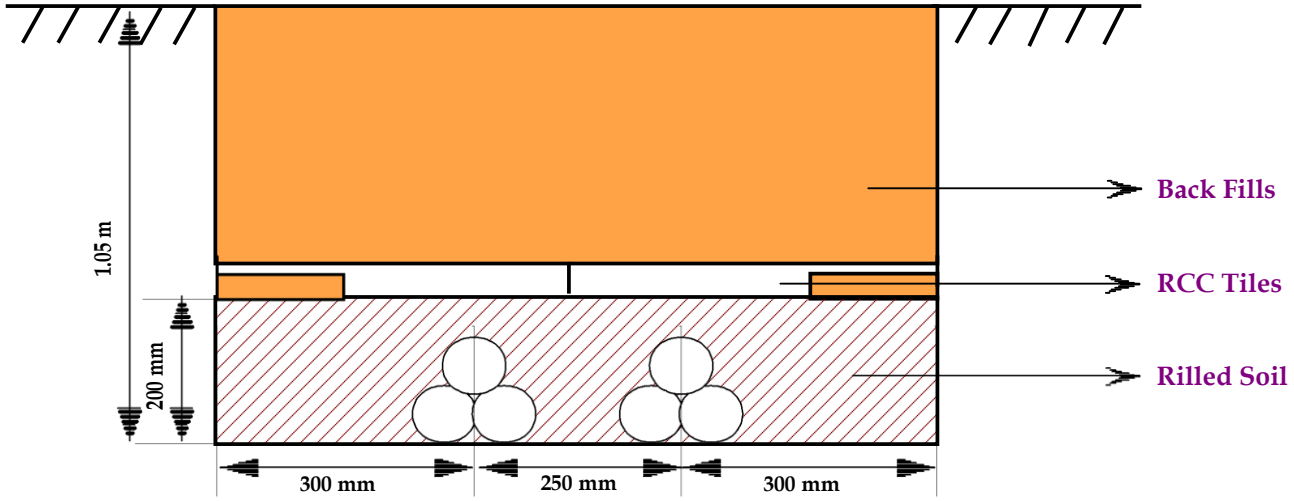
DWG No: SLD-HT-EXI-PROP-01

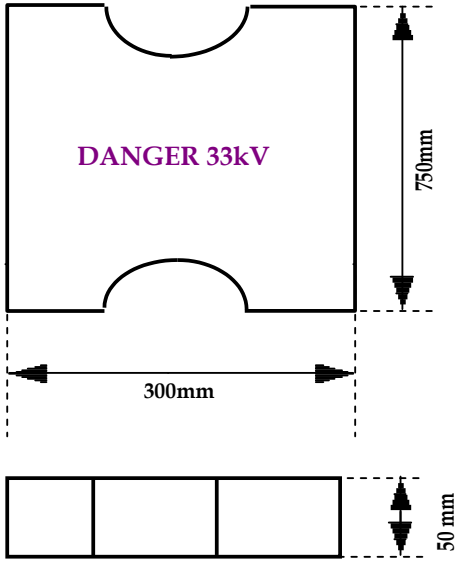
Annexure-1

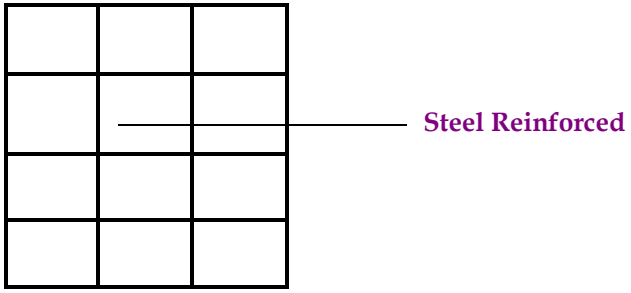
Typical SCADA / DMS Control Centre Configuration at Auto Nagar Grid Substation



33kV DOUBLE CIRCUIT LAYING ARRANGEMENT

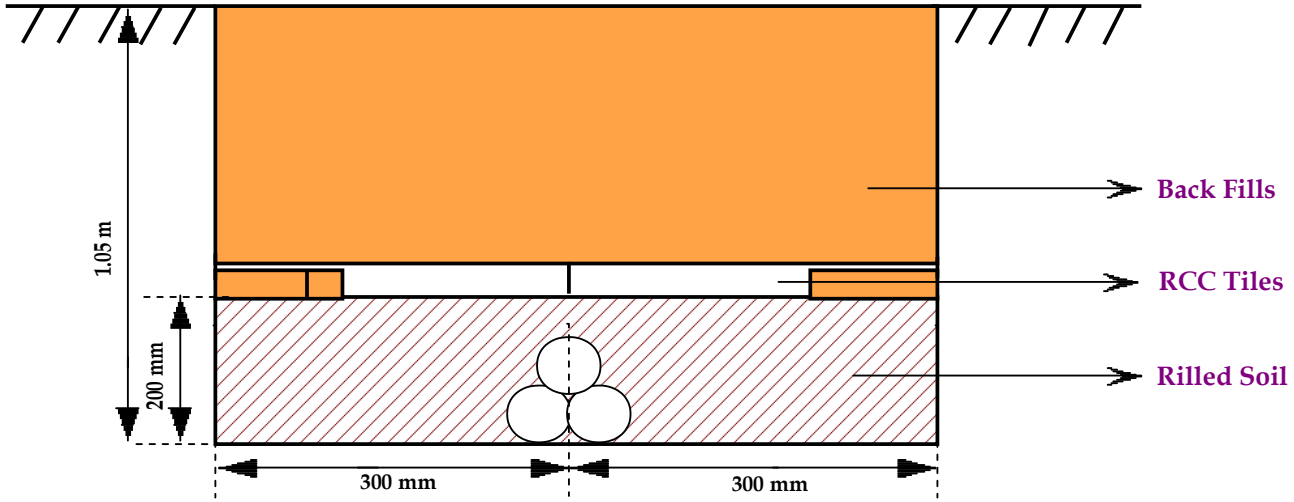


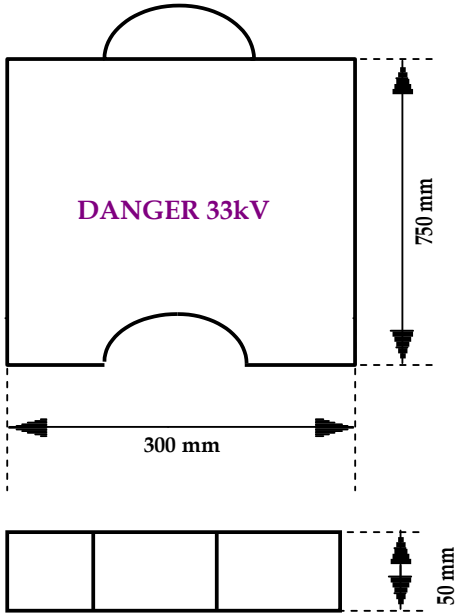


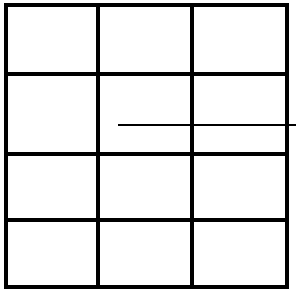


Prepared By:- OPTCL

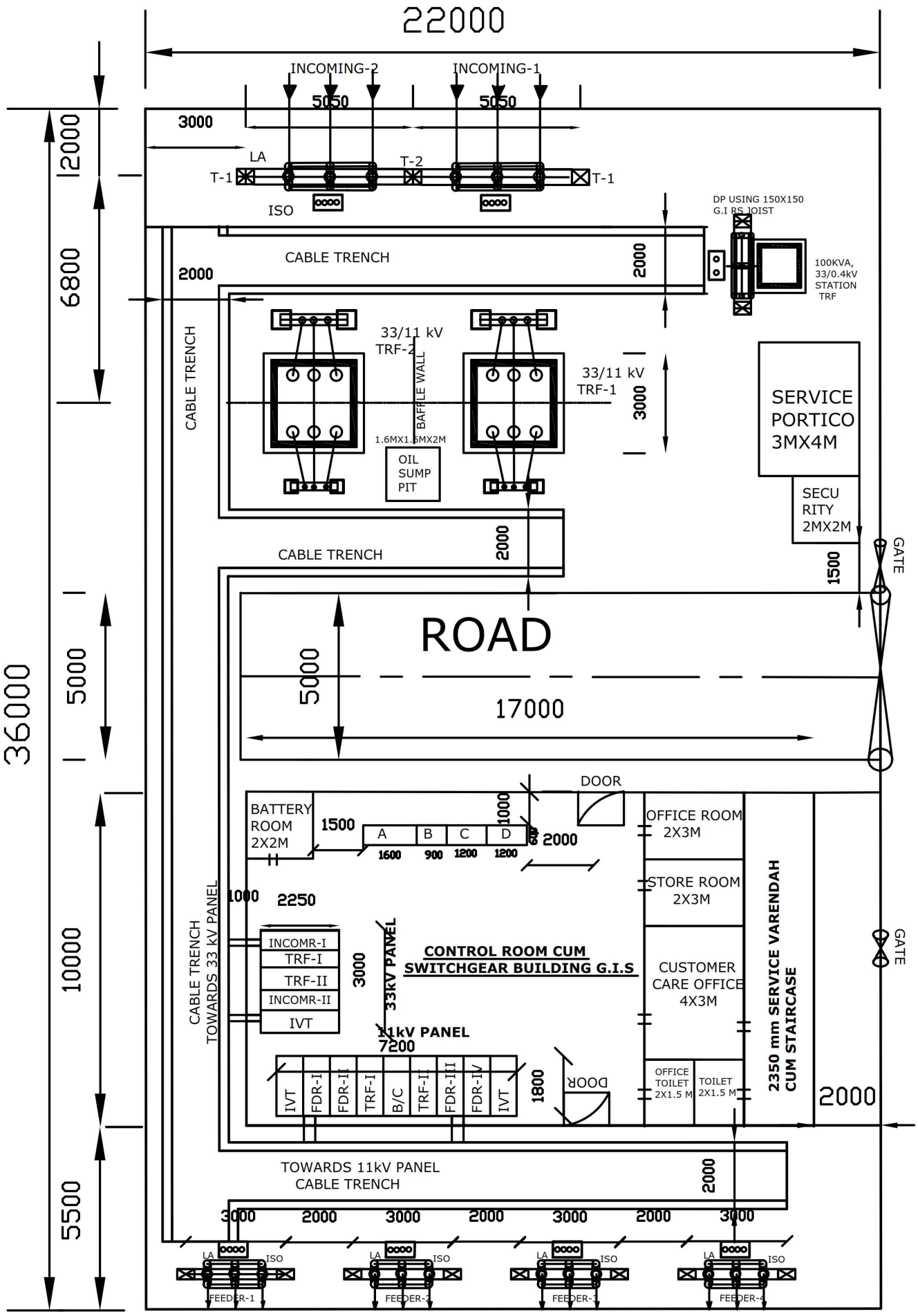
33kV SINGLE CIRCUIT LAYING ARRANGEMENT







Prepared By:- OPTCL



SUB-STATION LAYOUT(GIS)

NOTE:-
A-CHARGER ROOM
B-ACDB ROOM
C-RTCC 1 ROOM & RTCC 2 ROOM
D-RTU ROOM

MAJOR CHANGES:-
1.Road inside switchyard area is minimised to 5M.
2.Size of Rooms inside Control Room is adjusted.
3.Service Varendah cum Staircase,Cable tranch showing layout,Service Portico,Baffel Wall,Oil Sump Pit are incorporated
4.Overall Switchyard area is maximize as per our Scope i.e 36 M x 22 M