**ODISHA POWER TRANSMISSION CORPORATION LTD**

**(A Govt. of Odisha Undertaking)**

**Regd. Office, Jan path,**

**Bhubaneswar - 751022**

**ODISHA DISTRIBUTION SYSTEM STRENGTHING PROJECT**

# (ODSSP)

# PROJECT MANAGEMENT UNIT

## VOL – II

## Technical Specification

## For

## Engineering, Supply, Erection & Commissioning of 33/11kV Sub-stations With associated lines

## FOR PHASE – II (R)

**TECHNICAL SPECIFICATION**
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CHAPTER - E1

# SCOPE OF WORK

## 1.0 SCOPE OF WORK:

### 1.1 Scope of Work for Sub-station & Line

Bidders are requested to visit the site before participating in the Tender.

Scope of work of the Contractor includes Design, Engineering, Supply, Erection, Testing and Commissioning of all materials & equipment such as –

**Sub-station:**

a) 33/11kV, 3.15MVA /5MVA /8MVA outdoor Power Transformer
b) 33/0.433kV,100 kVA Station Transformer
c) 33kV out door switchyard without door equipment containing Bus bar, VCB, CT, PT, Surge arrestors and isolator with supporting structures.
d) Substation structures.
e) 33kV GIS indoor Switchgear containing Bus bar, VCB, CT, Bus IVT, Relays, multifunction meters, energy meters.
f) 11kV AIS indoor Switchgear containing Bus bar, VCB, CT, Bus IVT, Relays, multifunction meters, energy meters.
g) Distribution Board for both AC & DC
h) Conductors, Insulators, Hardware fitting and Clamps & Connector.
i) 33kV Control and Relay panels with multifunction meter and energy meter in outdoor Substations and Source Substations.
j) Battery & Battery charger
k) RTU for SCADA
l) AB Switches (for 33 and 11 kV), HG fuses (for 33 and 11 kV) for station Transformer.
m) XLPE HT cable, LT Power Cables & their jointing kits, Control Cables & their termination.
n) Earthing.
o) Control Room cum Customer Care Centre Building.
p) Air Conditioner for the building.
q) Fire Fighting equipment.
r) Furniture and PC.
s) Fencing.
t) Boundary wall.
u) Retaining wall.
v) Road.
w) Fire fighting wall.
x) Site surfacing including antiweed treatment.
y) Switchyard illumination.
z) Concrete Cable trench.
aa) Fixing of Danger plate, Bay marking & colour coding.
bb) Excavation of soil for foundation works.
cc) Open cast foundation/Pile foundation.
dd) Leveling of Sub-station area including borrowed earth.

ee) Bay extension in the source Substation with feeder protection.

**Line:-**

a) Survey of 33kV & 11kV lines.
b) Profile plotting for 33kV lines and important crossings of 11kV lines such as river crossing, road crossing, power line/telecommunication line crossing etc.
c) Preparation of pole schedule.
d) Erection of Galvanised GI H pole/ GI Joist Pole/PSC poles Galvanised lattice towers (for river crossing, road crossing) including civil works.
e) Open foundation for H poles/Joist Poles/PSC poles.
f) Open foundation and pile foundation of lattice towers.
g) Stringing of conductors
h) Erection of insulators & other hardware fittings.
i) Erection of stay wires with insulator.
j) Earthing of towers/poles.
k) Fixing of number plates, Phase plates. Danger Boards etc.
l) Underground cable with jointing kits and terminations, cable jointing chambers, in lines associated with GIS substations in Package-5.

1.2 Wherever the source is from an existing 33/11kV S/s of Discom or 132/33 kV or 220/33 kV Grid sub-station of OPTCL , care is to be taken for construction of bays at the existing Substation end for matching with the existing system. The dismantling works if any involved shall also be done as per the direction of the Engineer- in-Charge. Dismantling shall be done by the contractor at his own cost.

1.3 The scope is on the basis of a single/JV Bidder's responsibility, completely covering supply and erection of all the equipment specified under the Specifications including other services. It will include the following:

a) Providing Engineering drawings related to foundation details, structural details of both line & Sub-station work.
b) Providing Equipment data, Operational manual.
c) Preparation of Cable Schedule (in shape of a booklet) etc for the Owner's approval.
d) Packing and transportation from the manufacturer's works to the site.
e) Loading, unloading and transportation as required.
f) Receipt, storage, preservation and conservation of equipment at the site including insurance.
g) Erection, testing and commissioning of all the equipment.
h) Performance and Guarantee tests on completion of commissioning.

The scope of work shall also include all work incidentals for successful operation and commissioning and handing over of works whether specifically

mentioned or not. In general, works are to be carried out by the Contractor in accordance with the stipulations in Conditions of Contract.

1.4 The following items of work are specifically excluded from the Contractors scope of work unless otherwise specifically brought out.

a) Sub-station site selection
b) Land acquisition for sub-station

1.5 **The Chapter E10-1 (NBLS tower and Erection) is not applicable for this tender**. However, the **erection practices mention in this chapter shall be followed** for PC+6 tower and UR+6 tower.

**2.0** Names of Sub-stations under different packages wind velocity considered in that area are tabulated below: The design/engineering philosophy of lines in different wind zones is described in **chapter-E2.**

| **PACKAGE-1(CESU - AIS)** | | | | |
|---|---|---|---|---|
| **Sl.No** | **District** | **Proposed S/s** | **Tapping point** | **Wind velocity** |
| 1 | Cuttack | Gopapur | Gagana Pokhari | 200 km /hr |
| 2 | | Saranda | Near Khuntukanta Tarini Chhaka | |
| 3 | | Bandalo | Near Bindanmia By Pass Chhaka | |
| 4 | | Asureswar | 33/11kV Danpur S/s | 300 km /hr |
| 5 | | Japkuda | Balia Grid | |
| 6 | | Somapur | Raghunathpur 33kV feeder at - Sompur | |
| 7 | | Kula Kapasi | Niali 33/11kV S/s | |
| 8 | Nayagarh | Bijipur | Fategarh 33/11KV Structure | 200 km /hr |
| 9 | | Banigochha | 33/11kv Daspalla S/s | |
| 10 | | Barakoli | Khalisahi | |
| 11 | | Lathipada | Rajpatna Grid | |
| 12 | Puri | Alagum | SAKHIGOPAL S/S | 300 km /hr |
| 13 | | Kalayanpur | 33KV tapping near KALYANPUR VILLAGE | |
| 14 | | Sutan | 33/11kV S/s Konark | |
| 15 | | Bangurigaon | 33/11kV S/s Kakatpur | |
| 16 | Khurda | Basantamal | 33/11kV S/s Nimapara | 300 km /hr |
| 17 | | Sarua | Near Sarua Industrial Estate (33KV Banki Feeder) | |
| 18 | | Trahiachutanagar | 33/11kV S/s Pipili | |

| | | | | |
|---|---|---|---|---|
| 19 | Dhenkanal | Saranga | 4 Pole Structure, Saranga | 160 km/hr |
| 20 | | Mahulpal (Bhuban) | 33/11KV Bhuban S/s | |
| 21 | | Jiral | 33/11kV S/s Mathakaragola | |
| 22 | | Muktapasi | 33/11KV Gundichapada S/s | |
| 23 | | Babandha | 33/11KV Hindol Road Structure | |
| 24 | | Jiridamali | Mathakargola 33KV line | |
| 25 | Anugul | Nakchi | 33/11KV Bamur S/s | 160 km/hr |
| 26 | | Kulad | 132/33 KV Chainpal Grid | |
| 27 | | Hanumanpur | Near Hanumanpur Village | |
| 28 | Kendrapara | Jahara Barimula | Danpur S/S | 300 km /hr |
| 29 | | Chokada | 33kV Luna Feeder | |
| 30 | | Ayatan | 33/11kV S/s Rajkaniaka | |
| 31 | Jagatsinghpur | Duvalo (Borikina) | 33/11kV Sova S/s | 300 km /hr |
| 32 | | Balia (Adhanga) | Baisimouja 33kV feeder at - Basantapur | |
| 33 | | Bhatapada | Taleswar Temple | |
| 34 | | Krishnandapur | 33/11kV Paruna S/s | |
| 35 | | Kothi | From 33/11kV Paradeep S/s | |
| 36 | Jajpur | Kundala | Chandikhol Grid | 300 km /hr |
| **TOTAL** | | **36** | | |

| **Package- 2 (SOUTHO - AIS)** | | | | |
|---|---|---|---|---|
| **SL. NO.** | **District** | **Name of The Project 33/11kV** | **Tapping Point** | **Wind velocity** |
| 1 | Gajapati | AMBAJHARI | GUMMA | 200 km/hr |
| 2 | | RAMAGIRI | R. UDAYAGIRI GRID | |
| 3 | | CHANDRAGIRI | MOHANA via LUHAGUDI | |
| 4 | GANJAM | HATITOTA | BALIPADAR-BUGUDA | 200 km/hr |
| 5 | | KHANDADEULI | 4 POLE STR AT HUMA | 300 km/hr |
| 6 | | M.J. PUR | TAKARADA | |

| | | | | |
|---|---|---|---|---|
| 7 | | NUAPADA | DIGAPAHANDI-CHIKITI | |
| 8 | | RAJPUR (DASIAMARPALLI) | P.S.PUR | |
| 9 | | TABHAPALLI | BUGUDA | |
| 10 | | BANKA | BELAGUNTHA | 200 km/hr |
| 11 | | GAYAGANGDA | TILISINGI S/S | |
| 12 | | DAHA | LALSING | |
| 13 | | PALASPUR | DIGAPAHANDI-ADAPADA | 300 km/hr |
| 14 | | GOJALBADI | SORODA S/S | 200 km/hr |
| 15 | | GALLARY | TILISINGI S/S | |
| 16 | KANDHAMAL | BARAKHAMA | BALLIGUDA | 160 km/hr |
| 17 | | NUAPADAR | PHIRINGIA | |
| 18 | KORAPUT | BAGDERI | KUNDRA | 160 km/hr |
| 19 | | S.B.NUAGAON | KUSUMI | |
| 20 | | HARADULI /JAMMUNDA | RANDAPALLI S/S | |
| 21 | | BALIA | RANDAPALLI S/S | |
| 22 | | NILABADI | BANDHUGAON S/S | |
| 23 | | RAMAGIRI | BOIPARIGUDA | |
| 24 | Rayagada | KEUTAGUDA/ANTAMUDA | EMALIGUDA | 160 km/hr |
| 25 | | KENDUGUDA | AKHUSINGI GRID | |
| 26 | | JALTARA | GUNUPUR | |
| 27 | | HATADAHIKHAL | MUNIGUDA-AMBADOLA FEEDER | |
| 28 | | PITAMAHAL | RAYAGADA-JIMILIPETA FEEDER | |
| 29 | BOUDH | RAMBHIKUTA | HAREKRUSHNAPUR | 160 km/hr |
| 30 | NABARANGPUR | KODINGA | KOSAGUMUDA | 160 km/hr |
| 31 | | CHUTIGUDA | NABARANGPUR-SANAMASIGAON FEEDER | |
| 32 | | ANTASORA | DANGERBHEJA | |

| | | | | |
|---|---|---|---|---|
| 33 | | ANCHALAGUMA | TENTULIKHUNTI GRID | |
| 34 | MALKANGIRI | BADILI | MALKANGIRI | 160 km/hr |
| **Total** | | **34** | | |

| **Package- 3 (NESCO – AIS)** | | | | |
|---|---|---|---|---|
| **SL No** | **DISTRICT NAME** | **Name of The 33/11kV s/s** | **Tapping point** | Wind velocity |
| 1 | BALASORE | Durgadevi (Baliapal) | Bijipur 33/11kV S/s | 300 km / hr |
| 2 | | Manudiha | 33kV Basta feeder | |
| 3 | | Kacheripada (Dahipur) | 33kV Bahanaga feeder | |
| 4 | | Ajodhya | Mitrapur 33/11kV S/s | |
| 5 | | Khantapada | Bahanagar 33/11kV S/s | |
| 6 | | Bishnupur | 33kV feeder | |
| 7 | | Ada | Barahapur 33/11kV S/s | |
| 8 | | Astia(Bati) (Jamujhadi) | Markona 33/11kV S/s | |
| 9 | BHADRAK | Kundibag(Ichhapur) | 33kV Chandaballi feeder | 300 km / hr |
| 10 | | Asura(AdibasiSahi) | Rahanja 33/11kV S/s | |
| 11 | | Bilana | Asuralli 33/11kV S/s | |
| 12 | | Matto | 33kV Chandaballi feeder | |
| 13 | | Manjuri Road | Dahala 33/11kV S/s | |
| 14 | | Malda | Dhamanagar 33/11kV S/s | |
| 15 | MAYURBHANJ | Salabanisahi(Nahadasole) | 33kV Betnoti feeder | 160 km/hr |
| 16 | | Manda(Jamila,Adisahi) | Bisoi 33/11kV S/s | |
| 17 | | Sirsa | Dhangidisole 33/11kV S/s | |
| 18 | | Sapanichua | Shyamakhunta 33/11kV S/s | |
| 19 | | Amarda | Rajghat 33/11kV S/s | |
| 20 | | Ambadalli | 33kV Baripada-Udala feeder | |
| 21 | KEONJHAR | Keonjhar | i) 33 kv Dhenkikote feeder & ii) Judia 33/11 kv s/s | 160 km/hr |
| 22 | | Jagamohanpur | Telkoi 33/1 kv S/s | |
| 23 | | Bhagamunda | Harichandanpur 33/11 kv S/s | |
| 24 | | Musakhori | Patna 33/11 kv S/s | |
| 25 | | Jyotipur | 33 kv Turumunga feeder | |
| 26 | | Kendiposi | 33 kv Patna feeder | |
| 27 | | Basudevpur | Remuli 33/11 kv S/s | |
| 28 | | Karanjia | Champua 33/11 kv S/s | |

| | | | | |
|---|---|---|---|---|
| 29 | | Pipilia | Dhenkikote 33/11 kv S/s | |
| 30 | | Sainkul | Ramachandrapur 33 kv feeder | |
| 31 | | Rekutia | Ghasipura 33kV feeder | |
| 32 | | Salabani | Anandpur 33/11 kv S/s | |
| 33 | | Salania | Orali 33/11 kv s/s | |
| 34 | | Janghira | Naranpur 33/11 kv s/s | |
| 35 | | Sunapentha | Harichandanpur 33/11 kv S/s | |
| 36 | | Dhakotha | Ghasipura 33/11 kv S/s | |
| 37 | | Machhagarh | Saharpada 33kV feeder | |
| 38 | | Basantpur | Jurudi 33/11 kv S/s | |
| 39 | JAJPUR | Damodarpur | Sukinda 33/11 kv S/s | 300 km/hr |
| 40 | | Narasinghpur | Jarka 33kV feeder | |
| **TOTAL** | | **40 nos** | | |

| **Package- 4 (WESCO – AIS) (All projects are in 160 km/hr zone)** | | | |
|---|---|---|---|
| Sl No. | District Name | Name of The Project 33/11kV | Tapping point |
| 1. | Balangir | BAGBAHAL (Belpada) | New 33 KV khariar-Muribhal Feeder |
| 2. | | GUDIGHAT | 33/11 KV substation Muribhal |
| 3. | | Pandripani | Kholan-Sindekela33 KV Feeder |
| 4. | | BUDHABHAL | 33/11 KV substation Deogaon |
| 5. | | KARAMTALA | 33/11 KV substation Saintala |
| 6. | | Bhadra(Kandakhajuri) | 33KV Bolangir- Barpali feeder |
| 7. | | JURIA (Luhasingha) | Patnagarh-Padampur 33 KV Feeder |
| 8. | Kalahandi | Atanguda | 33/11 KV substation Naktiguda |
| 9. | | DASPUR | 132/33 kv s/s Junagarh |
| 10. | | JURA DUBRA | 33/11 kv substation M. Rampur |
| 11. | | TULAPADA | Narla-Rampur 33 kv line |
| 12. | | LADUGAON | 33/11kV Substation Gadramal |
| 13. | Nuapada | LESUNPALLI (Rokal) | 33/11 substation Boden under construction |
| 14. | | CHALNA | 33 kv feeder khariar - Sinapali |
| 15. | Sonepur | Hedkitikira (Kalapathara) | 33KV Line sonpur-Binka |
| 16. | | RAXA CHOWK | 33KV Line Sonpur-Ullunda |
| 17. | Bargarh | KANDAPALA | 33/11kV Substation Bhukta |
| 18. | | UDEYPALI | 33/11 KV Bhatli |
| 19. | | Dasmaile | 33 KV Turunga -Sohela feeder |
| 20. | | Gandturum (Mahulpali) | 33/11KV substation Khuntlipali |
| 21. | | BALITIKRA | 132/33 KV Substation Barpali |
| 22. | | Sarandapali | 33 KV Bijpur Feeder |

| | | | |
|---|---|---|---|
| 23. | | KUNDAKHAI | 33 KV Agalpur-Melchamunda feeder |
| 24. | | LAKHAMARA | 33/11 substation Padampur |
| 25. | Sambalpur | FASIMAL | 33/11KV Jamankira Substation |
| 26. | | KUSUMI | 132/33 kv grid substation kuchinda |
| 27. | | KADALIGARH | 132/33 kv Substation Rairkhol |
| 28. | | Katarbaga | 33KV Loida Feeder |
| 29. | Deogarh | REAMAL | 33/11kV Rengalbeda |
| 30. | Jharsuguda | LAKHANPUR | 132/33 KV substation Remja |
| 31. | Sundargarh | BALISANKARA | 33/11 KV Substation Subdega |
| 32. | | Malda (Oraghat) | 33-KV Joda-Tensa NBLS tower line |
| 33. | | JAREIKELA | 33/11 KV substation Bisra |
| 34. | | DALPOSH | 33/11 KV substation REC |
| 35. | | Hamirpur (Municipality) | 33 KV Chhend-koel Nagar feeder |
| 36. | | BIRKERA | 132/33 KV Kalunga Grid under construction |
| 37. | | BILEIMUNDA | 33/11 substation Garjhanbhal |
| 38. | | Tumbapali | 33 KV Sagarpali- Lefripada line |
| Total | | **38 nos** | |

| **PACKAGE - 5 (CESU, SOUTHCO, WESCO) - GIS** | | | | |
|---|---|---|---|---|
| **Sl.No** | **District** | **Proposed S/s** | **Tapping point** | **Wind velocity** |
| 1 | Anugul | Town | Near Telephone Exchange | 160 km/hr |
| 2 | Khurda | Pradhan Sahi | Ranasinghpur Grid | 300 km/hr |
| 3 | | Dumduma | 4P Near Alu gadi flyover | |
| 4 | | Chakeisiani (Rajdhani College road) | Rajdhani College road | |
| 5 | Rayagada | Amlabhata | 220/132/33 kV Theruvali Grid | 160 km/hr |
| 6 | | Seriguda | Gudari Feeder | |
| 7 | Ganjam | Sakiri | Khalikote-Rambha Line | 300 km/hr |
| 8 | Gajapati | Adava | Mohona S/S | 200 km/hr |
| 9 | | K.Sitapur | Paralakhemundi Grid | |

| | | | | |
|---|---|---|---|---|
| 10 | Bolangir | Madiapali | New 33 KV Bolangir-Dungripali Feeder | 160 km/hr |
| 11 | Jharsuguda | Gandhi Chowk | 132/33 KV substation Remja | 160 km/hr |
| 12 | | Durlaga | Tapping from 33-KV Feeder | |
| 13 | Sambalpur | Kainsar | 132/33KV Ganesh Nagar | 160 km/hr |
| 14 | | Remad | 33/11KV Ainthapali S/s | |
| 15 | Sundargarh | Kalingavihar | 132/33 KV Chhend Grid | |
| | Total | **15nos** | | |

CHAPTER - E2

# GENERAL TECHNICAL CLAUSES & DESIGN

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OF
GENERAL TECHNICAL CLAUSES

# PART - A

# GENERAL TECHNICAL CLAUSES

## 1. 0 GENERAL PARTICULARS OF SYSTEM

### 1.1 Substation Philosophy:

**1.1.1.** There will be two types of Substations.

i. GIS Indoor Substation (Package-5): 33kV side will be with GIS Indoor Switch gear Panel and 11kV side will be with AIS Indoor Switch gear Panel. In 33kV GIS Switchgear Panel, bus bar, VCB and Disconnector will be inside $SF_6$ Gas chamber. Others may be kept as per manufacturer's type tested design.

ii. 33kV outdoor substation (Package 1, Package -2, Package -3 and Package- 4) – 33 kV side will be with outdoor equipment and 11 kV side will be with AIS Indoor switch gear panel with bus bar, breaker, CTs etc.

1.1.2. The substation sites with SBC up to and including 10 tonne per square metre will have pile foundation for control room and compound wall. In other areas there will columns by open cast method.

1.1.3 Normally the Switchyard will be 0.6 mtr above the road level and control room 0.6 mtr above the Switchyard level except in the following Substations in flood prone area where the control room will be 1.0 mtr above the highest flood level. The drawings and BoQ for Substations in flood prone are have been prepared considering the control room 2.0 mtr above the road (ground) level. The contractor will redesign the buildings taking into considearation the HFL of the area and revise the BoQ after approval of redesigned buildings. Payments will be made as per the revised BoQ on prorata basis.

**Name of Sub stations in flood prone area**

| Sl no | Name of Discom | Name of district | Name of substation |
|---|---|---|---|
| 1. | **CESU** | CUTTACK | KULAKAPASI |
| 2. | | PURI | KALYANAPUR |
| 3. | | | BANGURIGAON |
| 4. | | JAGATASINGHPUR | DUVALO |
| 5. | | | BALIA |
| 6. | | | KRISHNANANDAPUR |
| 7. | | JAJPUR | KUNDALA |
| 8. | **SOUTHCO** | GANJAM | NUAPADA |
| 9. | | | TABHAPALI |
| 10. | **NESCO** | BALASORE | MANUDIHA |
| 11. | | | DURGADEVI |
| 12. | | BHADRAK | BILANA |
| 13. | | | KUNDIBAG(ICHHAPUR) |
| 14. | | | MATTO |
| 15. | | | MALDA |
| 16. | | JAJPUR | NARASINGHPUR |
| 17. | | KEONJHAR | SALABANI |
| 18. | | | SALANIA |

1.1.4 11kV XLPE cables from power transformer to indoor switchgear panel in sub stations will be of three core aluminium, armoured, earthed type 400 sq mm (in AIS substation) and 630 sq mm (in GIS substation). LT cables shall be of 3 and half core aluminium, XLPE, unarmoured, Control cables shall be of copper conductor, PVC insulated, unarmoured type

**1.2 Line Philosophy:**

i. Lines associated with GIS substation (Package – 5)

a) In area with wind velocity 300 km/hr (detailed in clause no. 2.0 of Chapter 1- Scope of work):

33 kV incoming lines will be single core, 400 sq mm aluminium, metallic sheathed, unarmoured Underground cables and 11 kV out going lines will be 3 core, 300 sq mm aluminium, armoured Underground cables. 33 kV incoming lines will be with four nos. single core cables (one spare Cable) & 11 kV out going lines will have no spare Cables.

b) In area with wind velocity 200 km/hr and 160 km/hr (detailed in clause no. 2.0 of Chapter 1- Scope of work):

33kV incoming lines and 11kV out going line to GIS substations will be with 11mtr GI Joist single poles up to $10^0$ deviation, Single Pole GI Joist pole with guy wire for more than $10^0$ but up to $60^0$ deviation and DP structure using 11 Mtr GI RS Joist for deviation of more than $60^0$ up to $90^0$.

Normal Span length shall be 50 mtr for 33 kV lines and 60 mtr for 11 kV lines.

ii. Lines associated with AIS Substations (Package -1, 2, 3 and 4)

a) In area with wind velocity 300 km/hr (detailed in clause no. 2.0 of Chapter 1- Scope of work):

33 kV incoming lines will be with GI 11 mtr height single H pole (drawings uploaded) up to $10^0$ deviation, Single GI H pole with guy wire for more than $10^0$ but up to $60^0$ deviation, DP structure using 11 Mtr GI RS Joist for deviation of more than $60^0$ up to $90^0$.

11 kV out going lines will with 11mtr height GI RS Joist single pole up to $10^0$ deviation, GI RS Joist single pole with guy wire for more than $10^0$ but up to $60^0$ deviation, DP structure using 11 Mtr GI RS Joist for deviation of more than $60^0$ up to $90^0$.

Normal Span length shall be 50 mtr for both 33 kV lines and 11 kV lines.

b) In area with wind velocity 200 km/hr (detailed in clause no. 2.0 of Chapter 1- Scope of work):

33kV incoming lines and 11kV out going lines will be with 11mtr GI Joist single poles up to $10^0$ deviation, Single Pole GI Joist pole with guy wire for more than $10^0$ but up to $60^0$ deviation and DP structure using 11 Mtr GI RS Joist for deviation of more than $60^0$ up to $90^0$.

Normal Span length shall be 50 mtr for 33 kV lines and 60 mtr for 11 kV lines.

c) In area with wind velocity 160 km/hr (detailed in clause no. 2.0 of Chapter 1- Scope of work):

33kV incoming lines will be with 11mtr GI Joist single poles up to $10^0$ deviation, GI Joist single pole with guy wire for more than $10^0$ but up to $60^0$ deviation and DP structure using 11 Mtr GI RS Joist for deviation of more than $60^0$ up to $90^0$.

11kV out going lines will be with 10mtr PSC single poles up to $10^0$ deviation, 10 mtr PSC pole with guy wire for more than $10^0$ but up to $60^0$ deviation and DP structure using 11 Mtr GI RS Joist for deviation of more than $60^0$ up to $90^0$.

Normal Span length shall be 60 mtr for 33 kV lines and 70 mtr for 11 kV lines.

iii. Road crossings will be with DP structure with 13 mtr long GI Joist pole. Where clearance will not be sufficient, it will be with PC or PC+6 mtr lattice GI tower (drawing uploaded).

iv. For river crossing of 33kV & 11kV Line,

For Span Length from 100mtr – 450mtr shall be with PC+6 Tower & 11 Mtr H Pole DP as anchoring and for more than 450mtr shall be with UR+6 Tower & 11 Mtr H Pole DP as anchoring.

For Span Length from 70mtr to100mtr, it shall be with 14mtr H Pole DP & 11 Mtr H Pole DP as anchoring.

v. All 33 kV over head lines will be with 148 sq mm All Aluminium Alloy Conductor (AAAC) and 11 kV lines with 100 sq mm AAAC.

1.3 **Transformer Capacity**:

In GIS sub stations, the transformers will be of 2X5 MVA or 2X8MVA capacity. In AIS substations, the transformers will have 2X3.15 or 2X5 MVA or 2X8 MVA capacity.

1.4 **RTU for SCADA compatibility**:

There is a plan to have SCADA system in future. However RTUs will be installed now, and will be connected to a local PC for Local Data Monitoring System (LDMS)

**1.5 Qualifying requirement of vendors;**

The material offered shall be procured from short listed vendor at Chapter **E-23** and shall have been successfully Type Tested during last five years on the date of bid opening.

For other items which are not in the vendor list, the material offered shall be in accordance with the REC specifications and procured from a vendor who must have at least three years experience in manufacturing of the same. In case of non availability of REC standard for any of these materials, they shall be as per the IS.

The materials shall have been successfully type tested during last five years on the date of bid opening. The front page of type test report showing the evidence of successful type test of the items asked for in our Tender Specification can be uploaded with the signature of bidder. The full text of the type test report is to be submitted at the time of signing the agreement or within one month of LOA.

If OPTCL desires, will ask for another type test, even though type test has been conducted during last five years from bid submission date. In such cases OPTCL shall bear the transportation charges of the equipment to testing laboratory and type test charges. But if there is difference in design/manufacture/raw material having offered and now tested, all cost for the type test will be to contractor's account.

**All items except GIS equipment shall be manufactured in India.**

**For GIS Equipment, the following criteria are to be fulfilled:**

I. The $SF_6$ Gas Insulated Switchgear (GIS) equipment (33 kV or higher voltage class) should have been manufactured from its manufacturing base in INDIA.

II. The manufacturer must have been installed at least Two (02) nos. of GIS substations (33 kV or higher voltage class $SF_6$ Gas Insulated switchgear with minimum 3 bays in each substation) in India and the same must be in satisfactory operation for a minimum period of one (01) year, reckoned from the date of bid opening.

III. The Manufacturer shall have to furnish type test report of $SF_6$ gas insulated sub-station equipment duly Designed, Manufactured, Tested (as per IEC standard) which, shall not be older than Ten (10) years, as on date of bid opening.

Type Test should have been conducted at any of the following internationally reputed testing laboratories,

(a) KEMA (Holland)
(b) CESI (Italy)
(c) CERDA (France)
(d) PHELA (Germany)
(e) KERI (S.Korea).
(f) CPRI, India

IV. A manufacturer who does not meet the requirement as specified in serial (II & III) above , but has established production line in India for manufacturing of $SF_6$ Gas Insulated Switchgear (GIS) based on technological support of its parent company (Holding Company) can also be considered provided that they (Parent company) have manufactured, type tested (as per IEC standard) of such equipment & with the following stipulation :-

(a) The manufacturer's parent company (Holding Company) has manufactured, type tested (as per IEC standard).

(b) The parent company (Holding Company) meets qualifying requirements stipulated under serial II and III above.

(c) The manufacturer shall furnish followings:

(1) An undertaking (jointly with the parent company (Holding company) to Guarantee quality, timely supply, performance and warranty obligations for a period of five (05) years as specified for the equipment(s) in the parent company's (Holding Company) letter head, which is required to be submitted at the time of signing/execution of the contract agreement.

(2) Such manufacturer should submit valid collaboration agreement for technology transfer / license to design, manufacture, test and supply GIS equipment(s) in India at the time of bidding.

V. The manufacturer shall submit a list of its past supply experience or of the parent company (Holding company) for last Five (05) years & Owner's certificate regarding the satisfactory operation/performance for at least one year for the number of substations and bays at Sl II as mentioned above of 33 kV or above voltage class GIS equipment in India.

**2.0 Layout arrangement:**

Single line diagram and lay out drawings have been furnished in the bid in Chapter **E21**. The work shall be done as per the single line diagram and layout arrangements. The bay lay out in the source sub-stations shall be prepared by the contractor in line with the existing arrangement and approved by the Engineer-in-Charge.

**3.0 Soil data**

Soil investigations in sub-stations and lines have not been made. The Contractor shall investigate the soil properties and soil bearing capacity as part of the scope of work. Bidder can do the soil investigation at its cost for bidding purpose.

**4.0 Completeness and accuracy of information**

The Contractor shall note that the information provided in the bidding document and relevant schedules/Annexures may not be complete or fully accurate. For his own interest the Contractor is advised to make site visits and fully satisfy himself regarding site conditions in all respects, and shall be fully responsible for the complete design and engineering of the Sub-stations.

**5.0 DRAWINGS ATTACHED WITH TENDER DOCUMENT**

Drawings and Technical Particulars provided in Chapter **E21** in Chapter **E24** respectively are a part of the specification. Bids shall be prepared by the Bidder based on information provided in the drawings and Technical Particulars/ Schedules. The bidder shall fill up his offered values in the column provided. However, these values shall not be inferior to the values which the OWNER has specified in the specification in different chapters.

The bidder shall furnish the drawings and Guaranteed Technical Particulars for those items which have not been provided in Chapter E21 & E-24 along with the

bid. However the contractor will get these drawings and the GTP approved before supply/erection of the materials. Contractor shall supply the materials and execute the works as per these drawings and GTP.

## 6.0 COMPLIANCE WITH SPECIFICATION

In the event of there being any inconsistency between the provisions of the General conditions of contract (GCC and the provisions in Technical Specification, the provisions of the General conditions of contract shall take precedence for commercial matters and the provisions of Technical Specification shall take precedence in respect of technical matters.

In case of inconsistency between Technical specification & Price Schedule/Bid proposal Sheet, quantities of various items as specified in the bid proposal sheet shall be considered for quoting however the work shall be executed as specified in the Technical specification and payment will be made as per the work executed.

## 7.0 TEST AND MAINTENANCE EQUIPMENT

The Contractor shall supply the test and maintenance equipment specified in the Chapter **E19** of the TS as part of the contract works, and quote price in the Price Schedule.

## 8.0 SPARES

### a) General

The Contractor shall provide the mandatory spares detailed in the price schedule with their price. Mandatory spares shall be supplied as part of the Works under this specification.

The spares shall include consumable items sufficient for an operational period of 5 (five) years after commissioning, as well as essential replacement parts to cover the event of a break-down which would affect the availability or safety of the equipment. Spares shall be available during the life of the equipment.

The Contractor shall ensure that sufficient spare parts and consumable items are available for his own use during commissioning of the plant. Spares ordered by the Owner shall not be used by the Contractor without the written consent of the Engg In charge and any spares so used by the Contractor during the commissioning of the plant shall be replaced by the Contractor at the Contractor's expense.

Any spare Equipment, parts and tools shall be subject to the same specification, tests and conditions as similar material supplied under the Scope of Works of the Contract. They shall be interchangeable and suitable for use in place of the corresponding parts supplied with the plant and must be suitably marked and numbered for identification and prepared for storage by greasing or painting to prevent deterioration.

All spare Equipment or materials containing electrical insulation shall be packed and delivered in cases suitable for storing such parts or material over a period of years without deterioration. Such cases shall have affixed to both the underside

and topside of the lid a list detailing its contents. The case will remain the property of the Owner.

## 9.0 TRAINING

**9.1** In accordance with GCC, three categories of training shall be imparted as follows:

a) Indoor /out door major equipment maintenance

b) Operator familiarization

c) Installation and commissioning techniques

d) Use and maintenance of testing equipment and T&P materials

One person for each Sub-station will be trained for a period of **7 days**, on Indoor /out door major equipment maintenance, Operator familiarization, Installation and commissioning techniques. For testing equipment, the training period shall be fixed as per the requirement.

**9.1.1 Indoor/out door equipment maintenance:** Training to be imparted on operation and maintenance of transformers, switchgear, VCB, CT, IVT, isolators, battery charger, relays, meters, cable jointing, RTU etc.

**9.1.2 Operator familiarization:**

This course shall familiarise the Engineers/operators with the system and its use in operating and controlling. The course shall ensure that the control room staffs are completely familiar with all operational aspects of the equipment including software management. The means of obtaining special data, report logs and all other facilities which would enable the operators to be fully conversant with the system, shall also be incorporated.

**9.1.3 Installation and commissioning techniques:**

The Owner's staff or its authorised representative will be present during the installation and commissioning period and it is essential that they be fully involved in any on-site corrections or modifications to hardware and software equipment.

**9.1.4 Testing Equipment:**

The equipment manufacturer shall demonstrate the testing procedure along with calibration technique on site.

**9.2 Proposals for training and manning**

For each course recommended the following information shall be provided:

a) Course name and identification

b) Short description of the curriculum

c) Level of competency required for each course, this can be mutually decided between the contractor and the owner.

d) Date and duration

e) Maximum number of staff that can attend

f) Location

g) Other important information

The times at which the various training courses will take place shall be stated, and fully documented notes shall be available to the Owner not later than two months before the commencement of the course.

All training course notes and documentation shall be in the English language.

## 10.0 ERECTION AT SITE AND ACCOMMODATION

The Contractor shall provide, at his own cost and expense, all labour, plant and material necessary for unloading and erection at the Site and shall be entirely responsible for its efficient and correct operation.

The Contractor shall be responsible for arranging and providing all living accommodation services and amenities required by his employees.

### 10.1 SUPERVISION AND CHECKING OF WORK ON SITE

All work on site included in the Contract scope of works shall be supervised by a sufficient number of qualified representatives of the Contractor.

Before putting any plant or Equipment into operation the Contractor shall satisfy himself as to the correctness of all connections between the plant and Equipment supplied under this and other contracts. The Contractor shall advise the Engg In charge in writing, giving seven days, when the plant or Equipment is ready for inspection or energisation.

## 11.0 COMPLIANCE WITH REGULATIONS

All Equipment and material supplied, and all work carried out shall comply in all respects with such of the requirements of all Regulations and Acts in force in India as are applicable to the Contract Works and with any other applicable regulations to which the Owner is subject.

The Contractor shall fully inform himself of the requirements of the local Laws, Regulations and rules in-force in the State of Orissa, especially with respect to local employment laws, licensing requirements, electrical safety rules and regulations, building regulations and planning procedures.

The Contractor shall be responsible for applying for all necessary licenses; including Electrical Contractors License, Workman's Permits and Certificates of Competency for Supervisors, and local Government approvals required for the contract works and for the payment of all necessary fees associated with such licenses and approvals.

Correspondence with the Electrical Inspector shall be conducted through the Engg In charge, but the Contractor shall provide all necessary information, regarding the contract works, as may be required by the Electrical Inspector.

Additionally the Contractor shall also follow the minimum regulations on safety, employees' welfare, industrial relation etc. as stipulated under the relevant Acts and Rules.

## 12.0 INSURANCE

### 12.1 **General**

In accordance to the clause 69 of **the General Conditions of Contract (Erection)**, the following provisions will apply towards insurance**.**

12.2 **Workmen's Compensation Insurance**

This insurance shall protect the Contractor against all claims applicable under the Workmen's Compensation Act, 1948 (Government of India). This policy shall also cover the Contractor against the claims for injury, disability, disease or death of his or his sub-contractor's employees, which for any reason are not covered under the Workman's Compensation Act, 1948.

12.3 **Comprehensive auto mobile insurance**

This insurance shall be in a such a form to protect the Contractor against all claims for injuries, disability, disease and death to members of public including the OWNER's men and damage to the property of others arising from the use of motor vehicles during on or off the Site operations, irrespective of the ownership of such vehicles. The minimum liability covered shall be as herein indicated:

| | | |
|---|---|---|
| 1) Fatal Injury | : | Rs. 100,000/- each person |
| 2) Property | : | Rs. 200,000/- each occurrence |
| 3) Damage | : | Rs. 100,000/- each occurrence |

* As per latest prevailing Govt. rules.

12.4 **Comprehensive General Liability Insurance**

This insurance shall protect the Contractor against all claims arising from injuries, disabilities, disease or death of members or public or damage to property of others, due to any act or omission on the part of the Contractor, its agents, its employees, its representatives and sub-contractors or from riots, strikes and civil commotion.

The hazards to be covered will pertain to all works and areas where the Contractor, its sub-contractors, agents and employees have to perform work pursuant to the Contracts.

The above are only an illustrative list of insurance covers normally required and it will be the responsibility of the Contractor to maintain all necessary insurance coverage to the extent both in time and amount to take care of all its liabilities either direct or indirect, in pursuance of the Contract.

# PART – B

# GENERAL TECHNICAL CLAUSES FOR DESIGN

## 1.0 DESIGN AND STANDARDISATION

All Equipment shall be designed to ensure satisfactory operation in all atmospheric conditions prevailing at the Site(s) and during such sudden variation of load and voltage as may be met with under working conditions on the system, including those due to faulty synchronising and short circuit.

The design shall incorporate all reasonable precautions and provisions for the safety of those concerned in the operation and maintenance of the Contract Works and of associated works supplied under other contracts.

Where the Specification does not contain characteristics with reference to workmanship, equipment, materials and components of the covered equipment, it is understood that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended.

In case where the equipment, materials or components are indicated in the specification as 'similar' to any special standard, the Engg.-In-charge shall decide upon the question of similarity. When required by the Specification; or when required by Engg.-In-charge the Contractor shall submit, for approval, all the information concerning materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Contractor.

The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expense. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements and shall be used throughout the design. All joints and fastenings shall be so devised, constructed and documented that the component parts shall be accurately positioned and restrained to fulfill their required function.

All outdoor Equipment and fittings shall be designed so that water cannot collect at any point. Grease lubricators shall be fitted with nipples and where necessary for accessibility, the nipples shall be placed at the end of extension piping.

All water and oil pipe flanges shall be to IS 6392/BS 4504 or other equivalent standard, as regards both dimensions and drilling, unless otherwise approved.

Cast iron shall not be used for chambers of oil filled Equipment or for any part of the equipment which is in tension or subject to impact stresses.

Kiosks, cubicles and similar enclosed compartments shall be adequately ventilated to restrict condensation. All contactor or relay coils and other parts shall be suitably protected against corrosion.

All Equipment shall be designed to obviate the risk of accidental short circuit due to animals, birds, insects, mites, rodents or micro-organisms.

Corresponding parts shall be interchangeable. Where required by the Engg. In charge the Contractor shall demonstrate this quality.

## 2.0 QUALITY ASSURANCE

The quality assurance arrangements shall conform to the relevant requirements of ISO 9001 or ISO 9002 as appropriate.

The systems and procedures which the Contractor will use to ensure that the Works comply with the Contract requirements shall be defined in the Contractor's Quality Plan for the Works.

The Contractor shall operate systems which implement the following:

**Hold Point** "A stage in the material procurement or workmanship process beyond which work shall not proceed without the documented approval of designated individuals or organisations."

The Engg. In charge written approval is required to authorise work to progress beyond the Hold Points indicated in approved Quality Plans.

**Notification Point** "A stage in material procurement or workmanship process for which advance notice of the activity is required to facilitate witness."

If the Engg. In charge / his authorised person does not attend after receiving documented notification in accordance with the agreed procedures and with the correct period of notice then work may proceed.

The following will be the hold points in the contract

i) Sub-structure (Foundation concreting in substation and line)
ii) Roof casting
iii) Stringing of conductor
iv) Acceptance Tests of materials to be supplied in Manufactures premises
v) Stage inspection of transformers
vi) Testing and Commissioning

### 2.1 **Quality plans**

The Contractor shall draw up for each section of the work Manufacturing Quality Plans (MQP) and Field Quality Plan (FQP), which shall be submitted to the Engg. In charge for approval at least two weeks prior to commencement of the particular section. Each Quality Plan shall set out the activities in a logical sequence and, unless advised otherwise, shall include the following:

a) An outline of the proposed work and program sequence
b) The duties and responsibilities assigned to staff ensuring quality of work for Contract
c) Hold and Notification points
d) The inspection of materials and components on receipt
e) Reference to the Contractor's work procedures appropriate to each activity
f) Inspection during fabrication/construction
g) Final inspection and test

**Non-conforming product**
The Contractor shall retain responsibility for the disposition of non-conforming items.

2.2 **Monitoring of quality arrangements**
During the course of the Contract the Engg. In charge will monitor the implementation of the Quality Assurance arrangements. Monitoring will be by surveillance of the activities at work locations and/or by formal audits of the adherence of the Contractor to the systems and procedures which constitute his Quality Assurance arrangements. Corrective actions shall be agreed and implemented in respect of any deficiencies

The Contractor shall provide any facilities, including access, which may be required by the Engg. In charge for monitoring activities.

## 3.0 HEALTH, SAFETY AND ENVIRONMENT (HSE) PLAN

3.1 **General**

Within one month of award of contract the Contractor shall produce an HSE Plan for the contract and submit for the approval of the Engg. In charge. The HSE Plan is described in the following sections.

The primary objective of the HSE Plan is for the contractor to demonstrate that he has the capability to carry out the contract work in a cost effective manner, giving due consideration to the Health, Safety and Environmental management of both his own employees, those of the Owner and anyone who may be affected by his activities.

3.2 **General structure of HSE Plan**

The HSE Plan shall conform to the following general structure:

i. Statutory obligations are complied with
ii. Safety training, both general induction and trade specific, is given to all site employees.
iii. Appropriate personal safety equipment regulations are developed and enforced.
iv. Regular Safety meetings are held with all Site contract employees.
v. Safety inspections are carried out and reported.
vi. Accident statistics are prepared and issued monthly and are displayed at site.
vii. All Lost Time or serious incidents are reported to OPTCL within 8 hours.
viii. Adequate first aid and medical facilities are provided and maintained at Site(s) to handle routine medical examinations, illness, and accidents.
ix. Appropriate emergency services and procedures are in place at the Site(s) including evacuation to the nearest hospitals.
x. Entrance to Site(s) is controlled, monitored and recorded.
xi. Appropriate security measures are enforced.

## 4.0 PROGRESS REPORTING

The Contractor shall submit for approval, the detailed project schedule for engineering, material procurement, site mobilisation, man and machine deployment, delivery, erection, testing, commissioning, and handing over programme etc. in line

with the outline project schedule furnished by the owner in corrigendum. The Contractor shall submit periodical progress reports (weekly, fortnightly, monthly and quarterly) whose details will be in accordance with GCC and will be decided at the time of signing the contract agreement. The reports shall show clearly and accurately the position of all activities associated with engineering, material procurement, works tests, shipping, site erection, testing and commissioning with regard to the agreed contract programme.

In addition to the routine monthly progress report the Contractor shall also submit to the Engg. In charge by the 25th day of every month, a man hour schedule for the following month, detailing the man hours scheduled for that month, skill-wise and area-wise.

The preferred format for presentation of programmes is the latest version of MS Project. The programmes and monthly updates shall be submitted on CD.

The position on material procurement shall give the date and details of orders placed and indicate the delivery date quoted by the manufacturer. If any delivery date has an adverse affect on the contract programme the Contractor shall state the remedial action taken to ensure that delays do not occur.

The position on manufacture shall indicate the arrival of material, the progress of manufacture and date at which the equipment will be ready for transport. Any events that may adversely affect completion in the manufacturer's works shall also be reported.

All works tests executed shall be listed and the test-results shall be remarked upon. Any test failures shall be highlighted and the Contractor shall detail the necessary steps taken in order to avoid any adverse affect on the contract completion dates.

The despatch of each order shall be monitored on the progress report giving the date by which the equipment will be available for transport, the estimated time of arrival on site and the dates actually achieved.

The site works shall be segregated into foundation, super structure erection, equipment installation, control room building construction, testing & commissioning etc for reporting purposes and each section of the site works shall be monitored giving the percentage completion and the estimated completion date in accordance with the contract programme. The number of men working on site, both labour and supervisory staff, shall be reported together with any incidents or events that may affect the progress of site works.

Any delays which may affect any milestone or final completion dates shall be detailed by the Contractor who shall state the action taken to effect contract completion in accordance with the contract programme.

The contractor shall provide two copies of the progress report to the Engg. In charge.

## 5.0 STANDARDS

Except where otherwise specified or implied, the Contract Works shall comply with the latest edition of the relevant Indian Standards, International Electro technical Commission (IEC) standards and any other standards mentioned in this Specification. The Contractor may submit for approval, equipment or materials

conforming to these specifications. In case of conflict the order of precedence shall be (1) IS, (2) IEC.

Reference to a particular standard or recommendation in this Specification does not relieve the Contractor of the necessity of providing the Contract Works complying with other relevant standards or recommendations.

**The contractor shall furnish a copy of all standards (IEC/IS) within one month of LOA**

## 6.0 LANGUAGE AND SYSTEM OF UNITS

The English language shall be used in all written communications between the Owner and the Contractor with respect to the services to be rendered and with respect to all documents and drawings procured or prepared by the Contractor pertaining to the work, unless otherwise agreed by the Owner.

It is required that danger plates, equipment designation labels or plates, instruction notices on plant and general substation notices be written in English, Hindi and Odia. Control switch and lamp labels, indicator lamp and annunciator inscriptions shall be in English only.

The Contractor must furnish a schedule giving the English, Hindi and Oriya version of all labels, notices, etc., for approval.

The design features of all equipment shall be based on the SI system of units.

## 7.0 CORRESPONDENCE, DRAWINGS, APPROVAL PROCEDURE AND SAMPLES

### 7.1 Correspondence

All correspondence shall be addressed to the Project Manager, Project Management Unit-33/11kV, OPTCL or the Engineer-In-charge.

### 7.2 Drawings and samples

Within 15 days of contract commencement the Contractor shall submit, for approval by the Engg. In charge a schedule of the drawings to be produced detailing which are to be submitted for “Approval” and which are to be submitted “For Information Only”. The schedule shall also provide a programme of drawing submission, for approval by the Engg. In charge that ensures that all drawings and calculations are submitted within-two months.

All drawings submitted by the Contractor shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, the external connections, fixing arrangement, and the dimensions, required for installation and interconnections with other equipment and materials, clearances and spaces required for installation and interconnections between various portions of equipment and any other information specifically requested in the specification.

All dimensions marked on drawings shall be considered correct although measurement by scale may differ from general arrangement drawings. Detailed drawings shall be worked to where they differ from general arrangement drawings.

All detail drawings submitted for approval shall be to scale not less than 1: 20. All important dimensions shall be given and the material of which each part is to be constructed shall be indicated on the drawings.

All documents, drawings and samples shall be submitted in accordance with the provisions of this Specification and shall become the property of the Owner.

All drawings and calculations, submitted to the Engg. In charge shall be on international standard size paper, A0, A1, A2, A3 or A4. All such drawings and calculations shall be provided with a contract title block and shall be assigned a unique project drawing number; the contact title block and project numbering system shall be agreed with the Engg. In charge.

**All drawings for approval shall have the OPTCL-LOGO.**

Technical drawings must be shown, in such a form that the information necessary to construct an installation or part of an installation must be understandable by the technicians/skilled workmen responsible for construction and supervision. The drawings must therefore conform to following standards.

For presentation of design drawings and circuit documents IEC Publication 617 or equivalent standards for graphical symbols are to be followed.

Script sizes and thickness of scripts and lines be selected so that if reduced by two stages the alphanumeric characters and lines are still perfectly legible so as to microfilm them.

7.3 **Approval procedure**

The Contractor shall submit all drawings and samples for approval in sufficient time to permit modifications to be made if such are deemed necessary, and the drawings and samples to be re-submitted without delaying the initial deliveries or completion of the Contract Works. The following schedule shall be adhered for submission, approval, re-submission and final distribution drawings/ documents.

| | |
|---|---|
| Initial submission: | All drawings, designs and documents requiring approval of Engg. In charge - not later than 30 days from award of contract. |
| Approval /comments of 1st submission: | Within 15 days of receipt. |
| Re-submission where required: | Within 7 days of receipt including postal time both ways. |
| Approval/comments of re-submission: | Within 7 days of receipt. |
| Submission of distribution copies: | Within 15 days of approval. |

Three copies of all drawings shall be submitted for approval and three copies for any subsequent revision. The Engg. In charge reserves the rights to request any additional information that may be considered necessary in order to fully review the drawings. Drawings for approval shall be submitted as paper prints and shall bear the approved contract references. Submittal should where possible be staggered to facilitate maintenance of the above schedule.

If the Engg. In charge is satisfied with the drawing, one copy will be returned to the Contractor marked with "**Approved**" stamp. If the Engg. In charge is not totally satisfied with the drawing, then "**Approved subject to comment**" status will be given to it and a comment sheet will be sent to the Contractor. If the drawing does not comply with the requirements of the specification then it will be given "**Not Approved**" status and a comment sheet will be sent to the Contractor. In both the latter cases the Contractor will have to modify the drawing, update the revision column and resubmit for final approval.

Following approval copies of final drawings will be required as given below.

a) Hard Copies on paper (Blue print or Xerox) : Equal to the number s/s in the package

b) Computer CD ROM : 1 copy

Any drawing or document submitted for information only should be indicated as such by the Contractor. Drawings submitted for information only will not be returned to the Contractor unless the Engg-In-charge considers that such drawings do need to be approved, in which case they will be returned suitably stamped with comments.

Drawings, samples and models submitted by the Contractor and approved by the Engg-In-charge shall not be departed from without the instruction in writing of the Engg-In-charge.

The Contractor shall be responsible for any discrepancies or errors in or omissions from the drawings, whether such drawings have been approved or not by the Engg-In-charge. Approval given by the Engg-In-charge to any drawing or sample shall neither relieve the Contractor from his liability to complete the Contract Works in accordance with this Specification and the conditions of contract nor exonerate him from any of his guarantees.

### 7.4 **Final as-built drawings**

After completion of work on site all drawings shall be revised where necessary to show the equipment as installed and three copies submitted duly signed by site-in-charge. Following approval, twenty prints shall then be provided as required by the Engg-In-charge and shall be of sufficient detail to enable all parts to be identified. The contractor shall also submit, where possible, digitally stored copies of all as-built drawings on disc or CD-ROM (02nos. CD-ROM i.e. one is readable and other is editable) in a format compatible with the Owner's drawing system.

### 7.5 **Operation and Maintenance Manuals**

Three months prior to the contractual completion date for each substation site the Contractor shall forward to the Engg-In-charge through PMC, two copies of the Operation and Maintenance Manual unique to the substation site being handed over.

After approval by the Engg-In-charge the Contractor shall deliver ten (10) copies of the complete manual.

The Taking over Certificate will not be issued until the required numbers of approved copies of the manuals have been provided by the Contractor.

The manuals shall be as complete and as specific as possible and shall incorporate documentation that is specific to the materials and equipment used on the contract.

Because the nature of the work varies from site to site the manuals will have to be tailored to the specific needs of each site.

All precautions and warnings relative to the safety of life and equipment shall be included in the manuals.

The manuals should also show exploded views wherever required. Mass and size of parts and quantities of oil

Each item shall be labeled to indicate its mass, quantity of oil (if any) and any special handling instructions.

## 8.0 GENERAL REQUIREMENTS

### 8.1 **Bolts and nuts**

All bolts, studs, screw threads, threads, bolt heads and nuts shall comply with the Indian Standard.

Except for small wiring, current carrying terminal bolts or studs, for mechanical reasons, shall not be less than 6 mm in diameter.

All nuts and pins shall be adequately locked.

Wherever possible bolts shall be fitted in such a manner that in the event of failure of locking resulting in the nuts working loose and falling off, the bolt will remain in position.

All bolts, nuts and washers placed in outdoor positions shall be treated to prevent corrosion, by hot dip galvanising or electro galvanising to service condition. Appropriate precautions shall be taken to prevent electrolytic action between dissimilar metals.

Where bolts are used on external horizontal surfaces where water can collect, methods of preventing the ingress of moisture to the threads shall be provided.

Each bolt or stud shall project at least one thread but not more than three threads through its nut, except when otherwise approved for terminal board studs or relay stems. If bolts and nuts are placed so that they are inaccessible by means of ordinary spanners, special spanners shall be provided.

The length of the screwed portion of the bolts shall be such that no screw thread may form part of a shear plane between members.

Taper washers shall be provided where necessary.

Protective washers of suitable material shall be provided front and back on the securing screws.

**In the Price Schedule , the price quoted for each item shall be inclusive of Nuts, Bolts, Washers and other petti materials require for completion of the structures, Towers etc irrespective of their mention.**

## 8.2 Galvanising.

### 8.2.1 General

All machining, drilling, welding, engraving, scribing or other manufacturing activities which would damage the final surface treatment shall be completed before the specified surface treatment is carried out.

### 8.2.2 Galvanising

All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use shall be hot dip galvanised. High tensile steel nuts, bolts and spring washers shall be electro galvanised to service condition. All steel conductors including those used for earthing and grounding (above ground level) shall also be galvanised according to IS 2629.

All galvanising shall be applied by the hot dip process and shall comply with IS 2629, IS 2633, IS 4759, IS 1367 or IS 6745.

All welds shall be de-scaled, all machining carried out and all parts shall be adequately cleaned prior to galvanising. The preparation for galvanising and the galvanising itself shall not adversely affect the mechanical properties of the coated material.

The threads of all galvanised bolts and screwed rods shall be cleared of spelter by spinning or brushing. All nuts shall be galvanised with the exception of the threads which shall be oiled. Surfaces which are in contact with oil shall not be galvanised or cadmium plated.

Partial immersion of the work will not be permitted and the galvanising tank must therefore be sufficiently large to permit galvanising to be carried out by one immersion.

Galvanising of wires shall be applied by the hot dip process and shall meet the requirements of IS 2141.

The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum thickness of coating shall be 86 microns for all items thicker than 5 mm. For items of less than 5 mm thickness requirement of coating thickness shall be as per BS 729. For surface which shall be embedded in concrete, the zinc coating shall be a minimum of 800 gm/sq.m.

The galvanised surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects such as discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

After galvanising no drilling or welding shall be performed on the galvanised parts of the equipment excepting that nuts may be threaded after galvanising. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanisation.

The galvanised steel shall be subjected to six one minute dips in copper sulphate solution as per IS 2633.

Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanising tests should essentially be performed as per relevant Indian Standards:

a) Coating thickness
b) Uniformity of zinc
c) Adhesion test
d) Mass of zinc coating

Galvanised material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

## 8.3 Cleaning, painting and tropicalisation

### 8.3.1 General

All paints shall be applied in strict accordance with the paint manufacturer's instructions.

All painting shall be carried out on dry and clean surfaces and under suitable atmospheric and other conditions in accordance with the paint manufacturer's recommendations.

An alternative method of coating equipment such as with epoxy resin cast-based coating powders will be permitted, subject to the approval of the Engg-In-charge and such powders shall comply with the requirements of IEC 455. The Contractor shall provide full details of the coating process to the Engg-In-charge for approval.

It is the responsibility of the Contractor to ensure that the quality of paints used shall withstand the tropical heat and extremes of weather conditions specified in the schedules. The paint shall not peel off, wrinkle, be removed by wind, storm and handling on site and the surface finish shall neither rust nor fade during the service life of the equipment.

The colours of paints for external and internal surfaces shall be in accordance with the approved colour schemes.

### 8.3.2 Works painting processes

All steelworks, plant supporting steelworks and metalwork, except galvanised surfaces or where otherwise specified, ISO standards**.** All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS 6005 "Code of Practice for phosphating iron and sheet steel". All surfaces shall then be painted with one coat of epoxy zinc rich primer, two pack type, to a film thickness of 50 microns. This primer shall be applied preferably by airless spray and within twenty minutes but not exceeding one hour of shot blasting.

All rough surfaces of coatings shall be filled with an approved two pack filler and rubbed down to a smooth surface.

The interior surfaces of all steel tanks and oil filled chambers shall be shot blasted in accordance ISO, and painted within a period of preferably twenty minutes, but not

exceeding one hour with an oil resisting coating of a type and make to the approval of the Engg-In-charge.

The interior surfaces of mechanism chambers, boxes and kiosks, after preparation, cleaning and priming as required above, shall be painted with one coat zinc chromate primer, one coat phenolic based undercoating, followed by one coat phenolic based finishing paint to a light or white colour. For equipment for outdoor use this shall be followed by a final coat of anti-condensation paint of a type and make to the approval of the Engg. In charge to a light or white colour. A minimum overall paint film thickness of 150 microns shall be maintained throughout.

All steelworks and metalwork, except where otherwise specified, after preparation and priming as required above shall be painted with one coat metallic zinc primer and two coats of micaceous iron oxide paint followed by two coats of either phenolic based or enamel hard gloss finished coloured paint to the approval to an overall minimum paint film thickness of 150 microns.

Galvanised surfaces shall not be painted in the works.

All nuts, bolts, washers etc., which may be fitted after fabrication of the plant shall be painted as described above after fabrication.

The painted metal works shall be subjected to paint qualification test as per IEEE-Std 37.21 -1985 clause 5.2.5.

### 8.3.3 **Site Painting**

After erection at site, the interior surfaces of mechanism chambers and kiosks shall be thoroughly examined, and any deteriorated or mechanically damaged surfaces of such shall be made good to the full Specification described above.

After installation/erection at site all surfaces of steel works and metal work shall be thoroughly washed down. Any deteriorated or otherwise faulty paint-work removed down to bare metal and made good to the full Specification described above, then painted one further coat of phenolic based undercoating and one coat phenolic based hard gloss finishing paint to provide an overall minimum paint film thickness of 200 microns.

Any nuts, bolts, washers, etc., which have been removed during site erection, or which may be required to be removed for maintenance purposes shall be restored to their original condition.

All paint work shall be left clean and perfect on completion of the works.

### 8.3.4 **Colour Schemes**

The Contractor shall propose a colour scheme for the Sub-station for the approval of Engg-In-charge. The decision of Engg-In-charge shall be final. The scheme shall include:

a) Finishing colour of indoor equipment
b) Finishing colour of outdoor equipment
c) Finish colour of all cubicles
d) Finishing colour of various auxiliary system equipment including piping.
e) Finishing colour of various building items.

All steel structures, plates etc. shall be painted with non-corrosive paint on a suitable primer. It may be noted that normally all electrical equipment of the Owners switchyard are painted with shade 631 of IS:5 and Owner will prefer to follow the same for this project also. All indoor cubicles shall be of same colour scheme. For other miscellaneous items colour scheme will be subject to the approval of the Engg. In charge.

**Table for Recommended colour schemes**

| Sl. No. | Equipment | Application Environment | | | |
|---|---|---|---|---|---|
| | | Indoor | | Outdoor | |
| | | Colour | Code IS:5 | Colour | Code IS:5 |
| **33/11 kV Class Equipment** | | | | | |
| 1 | Transformers | - | - | Light grey | 631 |
| 2 | Marshalling boxes, CTs, PT's, CVT's, Surge counter casings, junction boxes etc. | Light Admiralty grey | 697 | Light Admiralty grey | 697 |
| 3 | Control and Relay Panels, PLCC cabinets, RTU panel etc. | Smoke grey | 692 | - | - |
| 4 | Porcelain parts i.e. insulators | Dark brown | 412 | Dark brown | 412 |
| 5 | All structures/ metallic parts exposed to atmosphere | Hot dip galvanised | | | |
| **33kV Class equipment** | | | | | |
| 6 | Switchgear cubicles | Smoke grey | 692 | Light grey | 631 |
| 7 | Control and relay panels | Smoke grey | 692 | - | - |
| | LT switchgear | | | | |
| 8 | LT switchgear exterior | Smoke grey | 692 | Light grey | 631 |
| 9 | ACDB/ MCC | Smoke grey | 692 | Light grey | 631 |
| 10 | DCDB | Smoke grey | 692 | — | — |
| 11 | LT bus duct in side enclosure | Matt Paint | | — | — |
| 12 | LT bus duct outside enclosure | Smoke grey | 692 | — | — |
| 13 | Motors | Smoke grey | 692 | Light grey | 631 |
| 14 | Diesel generator engine | Smoke grey | 692 | — | — |
| 15 | Diesel generator | Smoke grey | 692 | — | — |
| 16 | LT transformers | Smoke grey | 692 | Light grey | 631 |

| | | | | | |
|---|---|---|---|---|---|
| 17 | Battery charger | Smoke grey | 692 | — | — |
| 18 | Mimic diagram<br>33kV<br>11kV<br><br>415V | <br>Sky blue<br>Signal red<br>Canary<br>yellow<br>Middle<br>brown | <br>101<br>537<br>309<br><br>411 | <br><br><br>-<br>-<br><br>- | <br><br><br>-<br>-<br><br>- |
| | Miscellaneous | | | | |
| 19 | Control modules and console inserts | Smoke grey | 692 | Light grey | 631 |
| 20 | Lighting package equipment outside | Light grey | 631 | Light grey | 631 |
| 21 | Lighting package equipment inside | Glossy white | | Glossy white | |
| 22 | Water pipes | sea green | 217 | sea green | 217 |
| 23 | Air pipes | Sky blue | 101 | Sky blue | 101 |
| 24 | Transformer oil pipes | Light brown | 410 | Light brown | 410 |
| 25 | Fire Installations | Fire red | 536 | Fire red | 536 |
| 26 | Insulating oil/ gas treatment plant | Gulf red | 473 | Gulf red | 473 |

8.4 **Provision for exposure to hot and humid climate**

Outdoor equipment supplied under the Specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity, heavy rainfall and environment favourable to the growth of fungi and mildew. The indoor equipments located in non air-conditioned areas shall also be of same type.

8.4.1 **Anti-condensation Provisions:**

Space heaters where provided shall be suitable for continuous operation at 240V supply voltage. On-off switch and fuse shall be provided.

One or more adequately rated permanently or thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heaters to minimise deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature at approximately $10^0$C, above the outside air temperature to prevent condensation. This shall be demonstrated by tests.

8.4.2 **Fungi static treatment**

Besides the space heaters, special moisture and fungus resistant varnish shall be applied to parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface or part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

8.4.3 **Ventilating specifications**

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass or galvanised steel to prevent the

entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

8.4.4 **Labels and plates**

All Equipment shall be clearly labeled indicating, where necessary, its purpose and service positions. Each phase of alternating current and each pole of direct current equipment and connections shall be coloured in an approved manner to distinguish phase or polarity.

The material of all labels and the dimensions, legend, and method of printing shall be to approval. The surface of indoor labels shall have a matt or satin finish to avoid dazzle from reflected light.

Colours shall be permanent and free from fading. Labels mounted on black surfaces shall have white lettering. **'**Danger' plates shall have red lettering on a white background. Please refer to drawing no. ODSSP/LINE/15.

All labels and plates for outdoor use shall be of non corroding material. Where the use of enameled iron plates is approved, the whole surface including the back and edges shall be properly covered and resistant to corrosion. Protective washers of suitable material shall be provided front and back on the securing screws.

Labels shall be engraved in Hindi, English and Oriya. Name plates shall be white with black engraved lettering and shall carry all the applicable information specified in the applicable items of the Standards.

Any other relevant information which may be required for groups of smaller items for which this is not possible e.g. switch bays etc. a common name plate in Oriya with the title and special instructions on it shall be provided.

No scratching, corrections or changes will be allowed on name plates.

All equipment mounted on front and rear sides as well as equipment mounted inside the panels shall be provided with individual name plates with equipment designation engraved.

On the top of each panel on front as well as rear sides large name plates with bold size lettering shall be provided for circuit/ feeder/ cubicle box designation.

All front mounted equipment shall be also provided, at the rear, with individual name plates engraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate tracing of the wiring. The name plates shall be mounted directly by the side of the respective equipment wiring.

Name plates of cubicles and panels may be made of non rusting metal or 3 ply lamicoid. These name plates may be black with white engraved lettering.

The name plate inscription and size of name plates and letters shall be submitted to the Engg-In-charge for approval.
The name plates of the Equipment shall include, at least, the information listed below, together with any other relevant information specified in the applicable standards:

a) Concise descriptive title of the equipment
b) Rating and circuit diagrams

c) Manufacturer's name, trade-mark, model type, serial number
d) Instruction book number
e) Year of manufacture
f) Special instructions, if any, about storage, transportation, handling etc.

Each measuring instrument and meter shall be prominently marked with the quantity measured e.g. kV, A, MW etc. All relays and other devices shall be clearly marked with manufacturers name, type, serial number and electrical rating data.

Danger plates and plates for phase colours shall be provided as per requirement. The Contractor shall devise a system to designate equipment and sub-systems. The nameplates/labels displaying these designations shall be installed at appropriate locations. Whenever motion or flow of fluids is involved, plates showing direction of motion or flow shall also be provided.

8.5 **Padlocks**

For each item of plant the Contractor shall provide a pad lockable handle and a non-ferrous padlock with different key changes in order to prevent access to control cabinets, cubicles and relay panels. The Contractor shall provide two keys for each lock and a master key for each substation.

Cabinets for the accommodation of padlocks and keys, whilst not in use, shall be provided and shall be suitably labeled so that keys will be readily identifiable.

8.6 **Earthing**

Metal parts of all equipment other than those forming part of an electrical circuit shall be connected directly to the main earth system via two separate conductors of adequate capacity at two different points.

All main members of structural steelworks shall be earthed by galvanised iron flat connections bonded by welding or bolting to the steelworks.

Connections to Equipment and structures shall be made clear of ground level, preferably to a vertical face and protected as appropriate against electrolytic corrosion. They shall be made between clean surfaces and of sufficient size and pressure to carry the rated short circuit current without damage.

Earth bars installed directly into the ground should normally be laid bare and the trench back-filled with a fine top soil. Where the soil is of a hostile nature, special precautions must be taken to protect the earth bar, the method used being subject to the agreement of the Engg. In charge.

Joints in earth bars shall be welded and then coated with a suitable anti-corrosion protection treatment.

Facilities shall be provided on the earth bar run between equipment and the base of structures, comprising a looped strip, so as to permit the attachment of portable earth connections for maintenance purposes.

The cross sectional area of the earth bar and connections shall be such that the current density is not greater than 100 A/mm$^2$ for a 3 second fault duration.

8.7 **Lubrication**

Bearings which require lubrication either with oil or grease shall be fitted with nipples.

## 9.0 PRODUCTION PROCESS REQUIREMENTS

### 9.1 Castings

#### 9.1.1 General

All castings shall be true to pattern, free from defects and of uniform quality and condition. The surfaces of castings which do not undergo machining, shall be free from foundry irregularities. The castings shall be subject to NDT, chemical, mechanical and metallographic tests. Details of the same shall be furnished to Engg.-In-charge for review/approval. Magnetic particle inspection (MPI) test, wherever applicable, shall be carried out in longitudinal and transverse direction to detect radial and axial cracks.

### 9.2 Welding

All welding shall be in accordance with the corresponding Indian standards.

## 10.0 WIRING, CABLING AND CABLE INSTALLATION IN SUB STATION

### 10.1 Cubicle wiring

Panels shall be complete with interconnecting wiring between all electrical devices in the panels. External connections shall be achieved through terminal blocks. Where panels are required to be located adjacent to each other all inter panel wiring and connections between the panels shall be carried out internally. The Contractor shall furnish a detailed drawing of such inter panel wiring. The Contractor shall ensure the completeness and correctness of the internal wiring and the proper functioning of the connected equipment.

All wiring shall be carried out with 1.1 kV grade, PVC insulated, single core, stranded copper wires. The PVC shall have oxygen index not less than ‘29’ and Temperature index not less than 250C. The wires shall have annealed copper conductors of adequate size comprise not less than three strands

The minimum cross sectional area of the stranded copper conductor used for internal wiring shall be as follows:

a) All circuits excepting CT circuits and energy metering circuit of VT 2.5 sq.mm

b) All CT circuits and metering circuit of VT 2.5 sq. mm

All internal wiring shall be supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters and troughs shall be used for this purpose.

Cubicle connections shall be insulated with PVC to IEC 227. Wires shall not be jointed or teed between terminal points.

Bus wires shall be fully insulated and run separately from one another. Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panels running throughout the entire length of the panel suite. Longitudinal troughs extending throughout the full length of panel shall be preferred for inter panel wiring.

All inter connecting wires between adjacent panels shall be brought to a separate set of terminal blocks located near the slots of holes meant for the passage of the inter connecting wires. Interconnection of adjacent panels on site shall be straightforward

and simple. The bus wires for this purpose shall be bunched properly inside each panel.

Wire termination shall be made with solder less crimping type and tinned copper lugs which firmly grip the conductor. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. Numbers 6 and 9 shall not be included for ferrules purposes unless the ferrules have numbers underscored to enable differentiation. (i.e. 6 and 9).

Fuses and links shall be provided to enable all circuits in a cubicle, except a lighting circuit, to be isolated from the bus wires.

The DC trip and AC voltage supplies and wiring to main protective gear shall be segregated from those for back-up protection and also from protective Equipment for special purposes. Each such group shall be fed through separate fuses from the bus wires. There shall not be more than one set of supplies to the Equipment comprising each group. All wires associated with the tripping circuits shall be provided with red ferrules marked “Trip”.

It shall be possible to work on small wiring for maintenance or test purposes without making a switchboard dead.

The insulation material shall be suitably coloured in order to distinguish between the relevant phases of the circuit.

When connections rated at 380 volt and above are taken through junction boxes they shall be adequately screened and “DANGER” notices shall be affixed to the outsides of junction boxes or marshalling kiosk.

Where connections to other equipment and supervisory equipment are required the connections shall be grouped together.

## 10.2 LV power cabling

**LVAC** cable terminals shall be provided with adequately sized, hot pressed, cast or crimp type lugs. Where sweating sockets are provided they shall be without additional clamping or pinch bolts. Where crimp type lugs are provided they shall be applied with the correct tool and the crimping tool shall be checked regularly for correct calibration. Bi-metallic joints between the terminals and lugs shall be provided where necessary.

Terminals shall be marked with the phase colour in a clear and permanent manner.
A removable gland plate shall be provided by the Contractor. The Contractor shall be responsible for drilling the cable gland plate.

Armoured cables shall be provided with suitable glands for terminating the cable armour and shall be provided with an earthing ring and lug to facilitate connection of the gland to the earth bar.

## 10.3 Multi-core cables and conduit wiring

External multi-core cabling between items of main and ancillary equipment shall form part of the Contract Works and shall consist of un-armoured multi-core cable with stranded copper conductors PVC insulated and PVC over sheathed complying with the requirements of IEC 227 and 228 as applicable.

Multi-core cable for instrumentation and control purposes shall be supplied with 2.5 $mm^2$ stranded copper cores. Multi-core cables for CT and VT circuits shall be supplied with two by 2.5 $mm^2$ stranded copper cores and the cores shall be identified by the phase colour.

Where conduit is used the runs shall be laid with suitable falls and the lowest parts of the run shall be external to the equipment. All conduit runs shall be adequately drained and ventilated. Conduits shall not be run at or below ground level.

Multi-core cable tails shall be so bound that each wire may be traced to its cable without difficulty. Where cables are terminated in a junction box and the connections to a relay or control cubicle are continued in conduit, the spare cores shall be taken through the conduit and terminated in the cubicle. The dc trip and ac voltage circuits shall be segregated from each other as shall the circuits to main protective gear be segregated from those for back-up protection.

The screens of screened pairs of multi-core cables shall be earthed at one end of the cable only. The position of the earthing connections shall be shown clearly on the diagram.

All wires on panels and all multi-core cable cores shall be crimped with the correct size of crimp and crimping tool and will have ferrules which bear the same number at both ends. At those points of interconnection between the wiring carried out by separate contractors where a change of number cannot be avoided double ferrules shall be provided on each wire. The change of numbering shall be shown on the appropriate diagram of the equipment. The same ferrule number shall not be used on wires in different circuits on the same panels.

The Contractor shall provide a two (2) metre loop of spare cable at both ends of all multi-core cable runs and shall leave sufficient lengths of tails at each end of the multi-core cables to connect up to the terminal boards. The Contractor shall also strip, insulate, ring through and tag the tails and shall also seal the cable boxes. The Contractor shall be responsible for re-checking the individual cores and for the final connecting up and fitting of numbered ferrules within all equipment provided on this contract.

The drilling of gland plates, supply and fitting of compression glands and connecting up of power cables included in the Contract scope of work shall be carried out under this contract.

## 10.4 **Laying and installing of cables:**

### 10.4.1 General

For cable laying the following shall apply:

a) Switchyard area - In concrete cable troughs (cable trench having cable racks with cable trays)

b) Control Room - On cable racks consisting of slotted type and ladder type cable trays

c) Buildings - Conduits Directly buried cables shall be used wherever necessary with the approval of Engg. In charge.

### 10.4.2 Laying of cable

Cables shall be laid in concrete troughs provided under this contract or drawn into pipes or ducts or on cable racks or directly buried as may be required by the Engg. In charge. Concrete troughs shall be designed so that the cables are supported on cable support systems and the supports shall be arranged so as to allow the segregation of power, control (including CT and VT circuits) and communications cables onto different layers of cable supports. All cable supports shall be earthed in accordance with IS 3043. The minimum vertical separation between layers of cable tray shall be not less than 300 mm**.**

The cable support system shall be designed and constructed to carry the required cables without undue crowding of the supports and without overloading the supports. The maximum number of layers of cable that shall be permitted on a single cable support shall be three. The width of the cable supports shall be selected to ensure that the supports are not crowded, the cable supports are not overloaded and that sufficient space is provided in the cable trough to allow for personnel access during and after cable installation. The width of cable supports should not exceed 750 mm.

Cables shall be laid direct in the ground only at the discretion of the Engg. In charge. All cables laid direct in the ground outside buildings shall be laid in a trench and protected by reinforced concrete slabs or cable tiles.

For auxiliary cables the top of the slab or tile shall be at a depth not less than 300 mm below the surface of the ground and there shall be a layer of fine well packed riddled earth 75 mm thick in between the cable and the bottom of the trench and between the top of the cable and the underside of the slab.

The Contractor shall be responsible for the proper laying of all cables in the ground. Where cables in the same trench are laid over each other, they shall be separated by not less than 75 mm of riddled earth. The riddled earth used for this purpose shall have been passed through a screen having a 12 mm square mesh. Where cables pass under roadways they shall be laid in pipes at a depth not less than 800 mm below the surface.

The Contractor shall be responsible for the excavation of trenches which shall include all pumping and baling required and the provision of all necessary labour, plant, tools, water, additional soil, fuel or motor power for such purposes.
Cables in trenches will be inspected by the Engg. In charge before the trenches are backfilled.

The running of communications and power cables along the same route shall be avoided as far as possible. Where this is not possible they shall be segregated, the one group from the other. Power and communication cables shall be laid in separate tiers. For other than directly buried cables the order of laying of various cables shall be as follows:

d) Power cables on top tiers.

e) Control/ instrumentation and other service cables in bottom tiers.

10.4.3 Cable tags and markers

Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.

The tag shall be of aluminium with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS 280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables.

Location of cables laid directly in the ground shall be clearly indicated with cable marker made of galvanised iron plate.
Location of buried cable joints shall be indicated with a cable marker having an additional inscription "**Cable joint**".

Cable markers shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road and drain crossings.
Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct, conduit entry and at every twenty meters (20 m) in cable tray/trench runs. Cable tags shall

be provided inside switchgear, motor control centers, control and relay panels etc.. and wherever required for cable identification when a number of cables enter together through a gland plate.

The price of cable tags and markers shall be included in the installation rates for cables/conduits quoted by the Bidder.

10.4.4 Cable supports and cable tray mounting arrangements in control room

The control room will normally be provided with embedded steel inserts on concrete floors/walls for the purpose of cabling in the control room. The supports shall be secured by welding to these inserts or available building steel structures. However, in cases where no such embedded steel inserts are available, the same shall have to secure to the supports on walls or floors by suitable anchoring.

10.4.5 Cable support structure in switchyard cable trenches

The contractor shall fabricate and install cable support structures in cable trenches. These supports shall be provided at 750 mm spacing along the run of cable trenches.

Cable supports and cable racks shall be fabricated from standard structural steel members, channels, angles and flats of required size. The fabrication, welding and erection of these structures shall conform to the relevant clauses of this Specification, in addition to the specification given herein.

## 10.5 **Termination of cables and wires**

Where cables leave the Equipment in an upward direction the cable boxes shall be provided with a barrier joint to prevent leakage of cable oil or compound into the Equipment. Where cable cores are liable to contact with oil or oil vapour the insulation shall be unaffected by oil.

PVC sheathed cables shall be terminated by compression glands complying with BS 6121 (or equivalent).

Auxiliary PVC insulated cables shall be terminated with compression type glands, clamps or armour clamps complete with all the necessary fittings.

Colours shall be marked on the cable box, cable tail ends and single core cables at all connecting points and/or any positions the Engg. In charge may determine. Cable boxes shall be provided with suitable labels indicating the purpose of the supply where such supply is not obvious or where the Engg. In charge may determine.

All cables shall be identified and shall have phase colours marked at their termination.

All incoming and outgoing connections shall be terminated at a terminal block. Direct termination into auxiliary switches will not be accepted.

## 10.6 **DEGREES OF PROTECTION**

Degrees of protection shall be provided in accordance with IEC 144 and IEC 529 and be as follows:

f) For outdoor applications, IP 55.

g) For indoor applications where purpose built accommodation is provided, e.g. switch and control and relay rooms in auxiliary plant buildings, IP 41.

h) Where dust can adversely affect equipment within the enclosure, this equipment should be separately housed with a degree of protection of IP 51.

i) For indoor applications where the equipment is housed in the same building as that enclosing water and steam operated equipment, the degrees of protection stated in the previous paragraph shall be up-rated to IP 44 and IP 54 respectively.
Where more severe environments exist, e.g. steam and oil vapour or other deleterious chemical environments, special measures will be necessary and the degree of protection required will be specified separately.

The Contractor shall submit a schedule for providing the degree protection to various control boxes, junction boxes etc. for the Engg. In charge's approval.

## 10.7 SUPPLY VOLTAGE

All incoming supplies of greater than 125 V to earth shall have their termination shrouded by a suitable insulating material.

The auxiliary supply voltages on site shall be as follows:

| Nominal Voltage V | Variation | Frequency Hz or DC | Phase | Wires | Neutral Connection |
|---|---|---|---|---|---|
| 430 | ±10% | 50(-5%, +3%) | 3 | 4 | Solidly earthed |
| 240 | ±10% | 50(-5%, +3%) | 1 | 2 | Solidly earthed |
| 220 | 187V - 242V | DC | DC | 2 | Isolated 2 wires |
| 48 | 43V - 53V | DC | DC | 2 | +ve earthed |

## 10.8. ERECTION CONDITIONS

### 10.8.1 General

The following shall supplement the conditions already contained in the other parts of these specifications and documents and shall govern that portion of the work on this Contract to be performed at Site.

### 10.8.2 Regulation of local authorities and statutes

The Contractor shall comply with all the rules and regulations of local authorities during the performance of his field activities. He shall also comply with the Minimum Wages Act, 1948 and the payment of Wages Act (both of the Government of India and Govt of Orissa ) and the rules made thereunder in respect of any employee or workman employed or engaged by him or his Sub-Contractor.
All registration and statutory inspection fees, if any, in respect of his work pursuant to this Contract shall be to the account of the Contractor. However, any registration, statutory inspection fees lawfully payable under the provisions of the statutory laws and its amendments from time to time during erection in respect of the substation ultimately to be owned by the OWNER, shall be to the account of the OWNER. Should any such inspection or registration need to be re-arranged due to the fault of the Contractor or his Sub-Contractor, the additional fees to such inspection and/or registration shall be borne by the Contractor.
The Contractor shall ensure that he obtains, from the Government of Orissa, an Electrical Contractor's Licence and a supervisory certificate of the appropriate grade to allow him to execute the electrical works included in the Contract. The Contractor shall ensure that all workmen possess Workman Permits, issued by the Government of Orissa, for engagement in the Contract Works.

10.8.3 **Inspection, testing and inspection certificates**

The provisions of the General Conditions of Contract shall also be applicable to the erection portion of the Works. The Engg. In charge shall have the right to re-inspect any equipment though previously inspected approved by him at the Contractor's works, before and after the same are erected at Site.

## 10.9 Contractor's field operation

10.9.1 General

The Contractor shall inform the Engg. In charge in advance of field activity plans and schedules for carrying-out each part of the works. Any review of such plans or schedules or methods of work by the Engg. In charge shall not relieve the Contractor of any of his responsibilities towards the field activities. Such reviews shall not be considered as an assumption of any risk or liability by the OWNER or any of his representatives, and no claim of the Contractor will be entertained because of the failure or inefficiency of any such plan or schedule or method of work reviewed. The Contractor shall be solely responsible for the safety, adequacy and efficiency of plant and equipment and his erection methods.

10.9.2 Progress Report

Progress reports shall be provided by the Contractor to the Engg. In charge in accordance with the relevant parts of this specification. Appropriate photographs shall accompany the monthly progress reports.

## 10.10 Facilities to be provided by the contractor

10.10.1 Unloading

Contractor shall make his own arrangement for unloading the equipment at site.

10.10.2 Tools, tackle and scaffoldings

The Contractor shall provide all the construction equipment tools, tackle and scaffoldings required for offloading, storage, pre-assembly, erection, testing and commissioning of the equipment covered under the Contract. He shall submit a list of all such materials to the Engg. In charge before the commencement of pre-assembly at Site. These tools and tackles shall not be removed from the Site without the written permission of the Engg. In charge.

## 10.11 First-Aid and general hygiene

The Contractor shall provide necessary first-aid facilities for all his employees, representatives and workmen working at the site. At all times at least ten percent of all Contractors personnel assigned to the worksite shall be shall be trained in administering first-aid.

The labour colony, offices and residential areas of the Contractor’s employees and workmen shall be kept clean and neat to the entire satisfaction of the Engg. In charge. Proper sanitary arrangements shall be provided by the Contractor in work-areas, offices and residential areas of the Contractor.

Waste oil shall be disposed of in a manner acceptable to the Engg. In charge. Under no circumstances shall waste oil be dumped into uncontrolled drains.

## 10.12 Security

The Contractor shall have total responsibility for all equipment and material in his custody, stored, loose, semi-assembled and/or erected by him at Site. The Contractor shall make suitable security arrangements including employment of security personnel to ensure the protection of all materials, equipment and works from theft, fire, pilferage and any other damages and loss.

**10.13 Materials handling and storage**

All the equipment furnished under the Contract and arriving at Site shall be promptly received, unloaded and transported and stored in the stores by the Contractor.

Contractor shall be responsible for examining the complete shipment and notifying the Engg. In charge immediately of any damage, shortage, discrepancy etc. for the purpose of Engg. In charge's information only. The Contractor shall submit to the Engg. In charge every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages during transit, handling, storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

The Contractor shall maintain an accurate and exhaustive record detailing all equipment received by him for the purpose of erection and keep such record open for the inspection of the Engg. In charge.

All equipment shall be handled carefully to prevent any damage or loss. All equipment stored shall be properly protected to prevent damage. Equipment from the store shall be moved to the actual location at an appropriate time so as to avoid damage of such equipment at Site.

All the materials stored in the open or dusty location shall be covered with suitable weather-proof and flameproof covering material.

The Contractor shall be responsible for making suitable indoor facilities for the storage of all equipment which requires to be kept indoors.

## 11.0 CONSTRUCTION MANAGEMENT

**11.1 General**

Time is the essence of the Contract and the Contractor shall be responsible for performance of his Works in accordance with the specified construction schedule. If at any time the Contractor is falling behind the schedule, he shall take necessary action to make good for such delays by increasing his work force or by working overtime to accelerate the progress of the work and to comply with schedule and shall communicate such actions in writing to the Engg. In charge, providing evidence that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.

**11.2 Field office records**

The Contractor shall maintain at his Site office up-to-date copies of all drawings, specifications and other supplementary data complete with all the latest revisions thereto. The Contractor shall also maintain in addition the continuous record of all changes to the above contract documents, drawings, specifications, supplementary data, etc. effected at the field. On completion of his total assignment under the Contract, such drawings and engineering data shall be submitted to the Engg. In charge in the required number of copies.

**11.2 Protection of property and Contractor's liability**

The Contractor will ensure provision of necessary safety equipment such as barriers, sign-boards, warning light and alarms, personal protective equipment etc. to provide adequate protection to persons and property. The Contractor shall be responsible for giving reasonable notice to the Engg. In charge and the owners of public or private property and utilities when such property and utilities are likely to be damaged or injured during the performance of his works, and shall make all necessary arrangements with such owners, related to removal and/or replacement or protection of such property and utilities.

## 12.0 CODE REQUIREMENTS

The erection requirements and procedures to be followed during the installation of the equipment shall be in accordance with the relevant Indian/International Standards/Regulations, ASME codes, accepted good engineering practice, drawings and other applicable Indian codes and laws and regulations.

## 13.0 OWNER'S SUPERVISION

To eliminate delays and avoid disputes and litigation, it is agreed between the Parties to the Contracts that all matters and questions shall be referred to the OWNER and without prejudice the Contractor shall proceed to comply with the OWNER's decision.

The work shall be performed under the direction and supervision of the Engg. In charge. The scope of the duties of the Engg. In charge, pursuant to the contract, will include but not be limited to the following:

j) Interpretation of all the terms and conditions of these documents and specifications.

k) Review and interpretation of all the Contractors drawing, engineering data etc.

l) Witness or authorise his representative to witness tests and trials either at the manufacturer's works or at site, or at any place where work is performed under the Contract.

m) Inspect, accept or reject any equipment, material and work under Contract.

n) Issue certificate of acceptance and/or progressive payment and final payment certificates.

o) Review and suggest modification and improvements in completion schedules from time to time.

p) Supervise the Quality Assurance program implementation at all stages of the Works.

## 14.0 TESTING AND INSPECTION

The Contractor shall carry out the tests stated in accordance with the General conditions of Contract, without extra charge as in the opinion of the Engg. In charge are necessary to determine that the Contract Works comply with this Specification. The tests shall be carried out generally in accordance with the relevant IEC's or IS or equivalent standards. The specific details of testing and inspection are given in the appropriate section of this Specification.

All materials used shall be subjected to such routine tests as are customary in the manufacture of the types of plant included in the Contract Works. These materials shall withstand satisfactorily all such tests.

All tests shall be carried out to the satisfaction of the Engg. In charge, in his presence, at such reasonable times as he may require, unless agreed otherwise. Not less than two weeks notice shall be given to the Engg. In charge in order that he may be represented if he so desires. As many tests as possible shall be arranged together. Two hard copies of the Contractor's test reports and test sheets shall be supplied to the Engg. In charge for approval.

The Owner can at any time enter the premises of manufacturer/contractor without any obstruction to verify the quality of materials under manufacture.

Measuring Equipment shall be approved by the Engg. In charge and if required shall be calibrated at the expense of the Contractor at an approved laboratory.

The Contractor shall be responsible for the proper testing of the work completed or plant or materials supplied by a sub-contractor to the same extent as if the work, plant or materials were completed or supplied by the Contractor himself.

All Equipment, instruments and connections required for the above tests shall be provided by the Contractor, but the Engg. In charge may permit the use for the tests on site, any instruments and Equipment which may be provided permanently on site as part of the contract works conditional upon the Contractor accepting liability for any damage which may be sustained by such equipment during the test.

The contractor shall supply suitable test pieces of all materials as required by the Engg. In charge. If required by the Engg. In charge, test specimens shall be prepared for check testing and forwarded at the expense of the Contractor to an independent testing authority selected by the Engg. In charge.
Any costs incurred by the OWNER in connection with inspection and re-testing as a result of a failure of the subject under test, or damage during transport, or erection on site before take-over by the OWNER, shall be to the account of the Contractor.
No inspection or lack of inspection or passing by the Engg. In charge of work, plant or materials, whether carried out or supplied by the Contractor or sub-contractor, shall relieve the Contractor from his liability to complete the Contract Works in accordance with the Contract or exonerate him from any of his guarantees.

The cost of travelling, Lodging and Fooding of the owner's personnel during inspection at Manufacturer's premises will be taken care by the owner.

## 15.0 FIRE PRECAUTIONS

All Equipment, connections and cabling shall be designed and arranged to minimise the risk of fire and any damage which might be caused in the event of fire. When cabling is carried out as part of this Contract the Contractor shall be responsible for sealing all holes in floors, walls, roofs etc. through which the cabling may pass.
The work procedures that are to be used during the erection shall be those which minimise fire hazards to the maximum extent practicable. Combustible materials, combustible waste and rubbish shall be collected and removed from the site at least once each day. Fuels, oils and volatile or flammable materials shall be stored away from the construction site and equipment and material stores in appropriate safe containers.
All Contractor's supervisory personnel and at least ten percent all of workers shall be trained for fire-fighting and shall be assigned specific fire protection duties. At least ten percent of all personnel assigned to site at any one time shall be trained for fire fighting.
The contractor shall provide sufficient fire protection equipment of the types and sizes for the ware-houses, office temporary structures, labour colony area etc. Access to such fire protection equipment shall be easy and kept open at all time.

## 16.0 SPANNERS AND SPECIAL TOOLS

A complete set of spanners shall be supplied for each station to fit every nut and bolt head on the Equipment supplied under this Contract, together with all special tools required for the adjustment and maintenance of the equipment. These tools shall be mounted in a lockable cabinet at each substation, also to be provided under this Contract. Eye bolts which have to be removed after use shall be accommodated in the cabinets.

Spanners and other maintenance equipment provided under the Contract shall not be used for the purpose of erection of the contract Works.

Any special devices, slings or tackle necessary for the complete overhaul of the plant shall be handed over to the Engg. In charge in working order on completion of the Contract.

On delivering any or all of these tools to the Engg. In charge, a signature shall be obtained from the Engg. In charge's representative. Any tools not signed for shall be deemed not to have been delivered.

## 17.0 RUNWAY BEAMS, EYE BOLTS AND LIFTING TACKLE

Runway beams shall comply with the requirements of BS 2853, or its equivalent, and shall be tested after erection in accordance with this standard and this Specification. The Contractor shall be responsible for the provision of the appropriate test certificates which must be in accordance with Appendix C of BS 2853.

All slings, eye bolts and other lifting tackle provided shall be proof tested to twice the safe working load and suitably marked with embossed labels to show clearly the safe working loads.

## CHAPTER – E3

# TECHNICAL SPECIFICATION
# FOR
# SYSTEM & CLIMATIC CONDITIONS

**1.0. SYSTEM PARAMETERS**

| Sl. No | Description of Technical Parameter | Unit | Data | |
|---|---|---|---|---|
| 1 | Nominal system voltage | $kV_{rms}$ | 33kV | 11kV |
| 2 | Maximum system voltage | $kV_{rms}$ | 36kV | 12kV |
| 3 | Power frequency with stand voltage | $kV_{rms}$ | 70kV | 28kV |
| 4 | Lightning impulse withstand voltage<br>1) Line to earth<br>2) Across isolating gap | KV p (for 1.2 / 50µs) | 170kVp<br>195kVp | 75 kVp<br>85 kVp |
| 6 | System frequency | Hz | 50 | |
| 7 | Variation in frequency | % | -5%, +3% | |
| | Continuous current rating (out door equipment) | Amp | 1250 | 1250 |
| 8 | Continuous current rating (Indoor Equipment) | Amp | 630 | 630 |
| | Continuous current rating (Indoor Bus Bar) | Amp | 800 | 1250 |
| 9 | Symmetrical short circuit current | kA | 25kA | |
| 9.1 | Duration of withstand of short circuit current | Second | 3 | |
| 10 | Symmetrical Internal Arc current | kA | 25kA | |
| 10.1 | Duration of Arc current | Second | 1 | |
| 11 | Dynamic short circuit current rating | kAp | 62.5kA | |
| 13 | Conductor spacing for AIS layouts<br>Phase to ground<br>Phase to phase | <br>meters<br>meters | <br>3.7<br>1.5 | <br>2.8<br>0.76 |
| 14 | Design ambient temperatures | °C | 50 | |
| 15 | Pollution level as per IEC- 815 and 71 | | III | |
| 17 | Maximum fault clearing time | ms | not exceeding 1 50ms | |
| 18 | Safety clearances<br>1. Section clearance<br>a) Ground clearances (between ground and bottom most part of energised object)<br>b) Horizontal clearance between the fence and energised object<br>c) Horizontal clearance between the road | metres<br>metres<br><br><br>metres<br>metres | 4<br><br>4<br><br><br>As per I.E. Rules<br><br>As per I.E. Rules | 3<br><br>3<br><br><br>As per I.E. Rules<br><br>As per I.E. Rules |

| | | | | |
|---|---|---|---|---|
| | energised part of the nearby equipment | | | |
| 19 | Bay width (out door) | metres | 5.5 | 4.0 |
| 20 | Height of bus equipment interconnection from ground (out door) | metres | 4 | 3.5 |
| 21 | Height of strung busbar (out door) | metres | 5.5 | 4.0 |

## 2.0 CLIMATIC CONDITIONS

The service conditions shall be as follows:

1 .Maximum altitude above sea level 1 ,000m

2.Maximum ambient air temperature 50°C

3. Maximum daily average ambient air temperature 35°C

4.Minimum ambient air temperature 0°C

5.Maximum relative humidity 95%

6.Average number of thunderstorm days per annum (isokeraunic level) 70

7.Average number of rainy days per annum 120

8.Average annual rainfall 150cm

9. Earthquakes of an intensity in horizontal direction - equivalent to seismic acceleration of 0.3g

10. Earthquakes of an intensity in vertical direction - equivalent to seismic acceleration of 0.15g
(g being acceleration due to gravity)

13 .Wind velocity: 300 km/hr, 200 km/hr and 160 km/hr as detailed in chapter 1.

Environmentally, some of the regions, where the work will take place includes coastal areas, subject to high relative humidity, which can give rise to condensation. Onshore winds will frequently be salt laden. On occasions, the combination of salt and condensation may create pollution conditions for outdoor insulators. Some places are in heavily industrial polluted areas. Therefore, outdoor material and equipment shall be designed and protected for use in exposed, heavily polluted, salty, corrosive and humid coastal atmosphere.

## CHAPTER – E4

# SWITCHGEAR FOR GIS/AIS

## TECHNICAL SPECIFICATION

## For

**PART – A** **33 kV Indoor Switchgear Panel for GIS (Gas Insulated Switchgear)**

**PART – A.1** **33 KV Indoor Switchgear Panel for GIS (Gas Insulated Switchgear) and AIS (AIR Insulated Switchgear) - General**

**PART – B** **11 KV Indoor Switchgear Panel for AIS (AIR Insulated Switchgear)**

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OF
**PAR T – A (Technical Specification for 33 KV Indoor Switchgear for GIS)**



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**PAR T – A.1 (33 KV Indoor Switchgear panel for GIS and AIS-General)**

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**PAR T –C (Technical Specification for 11 KV Indoor Switchgear panel for AIS)**

# PART – A

## Technical Specification

## For

## 33 kV Indoor Switchgear Panel for GIS (Gas Insulated Switchgear)

# TECHNICAL SPECIFICATION FOR 33kV GAS INSULATED SWITCHGEAR

## 1.0 SCOPE:

This specification covers design, manufacture, testing at manufacturer's works, packing, forwarding & supply of 33kV Gas Insulated Indoor Switchgear complete with all accessories for trouble free and efficient performance including installation and commissioning of $SF_6$ 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 anddisconnector | IEC 62271-102 / EN 62271-102 |
| Busbarearthing 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 |

## 3.0DESIGN 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 – 25KA for 1 Sec
Partition class- PM
Internal arc classification - AFL (Authorised person access permitted from front & lateral side) for the panels with no rear access required.

3.4 INSULATING GAS**:**

Insulating gas Type SulphurHexafluoride ($SF_6$)

Design pressureat 20 °C for 36 kV Class - 0.05 MPato 0.1 MPa

## 4.0 TECHNICAL DATA

4.1 BUS RATING:

33 kV GIS, 25 kA 3s, Single Bus Bar 800 A @ max. 50 °C

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 tested minimum | 25 kA 1 s |

**Dimensions:**

| | |
|---|---|
| Cubicle width max. | 600mm |
| Cubicle depth maximum | 2000 mm |
| Cubicle height max. | 2500 mm |

**Properties:**

| | |
|---|---|
| Pressure relief duct | Not Required |
| $SF_6$Pressure control | IDIS |
| Voltage Indication System | IVIS |
| Control Panel | mechanical |
| Mech. Operation | Closed door |

## 5.0DESIGN FEATURES OF $SF_6$ GAS INSULATEDSWITCHGEAR:

GIS Circuit Breaker shall be of fixed type enclosed in the $SF_6$ gas tank. Withdrawablel facility is not applicable in case of GIS Switchgear.

### 5.1 GENERAL DESCRIPTION:

The $SF_6$iinsulated 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 $SF_6$ 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 of:

**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)

Busbar Module - A gas filled, clad compartment, which is totally segregatedfrom the circuit breaker compartment with regardto gas handling. The busbar module incorporates:

- Three-position switch.
- Three-phase copper busbar system

**C) Cable / Instrument Transformer compartment.**

A metal-enclosed, air/gas insulated compartment for easy maintenance, with:

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

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 – $SF_6$Gas insulated
- Busbar compartment – $SF_6$Gas insulated

- Cable connection / transformer clad compartment are to be equipped with individual pressure relief devices - Air Insulated / $SF_6$Gas insulatedcompartment for easy access and maintenance.

## 5.3 SWITCHGEAR OPERATOR INTERFACES REQUIREMENTS:

- A standard mechanical user interface, ergonomically Positioned at a convenient height, **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, disconnector& 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 $SF_6$ 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 $SF_6$ 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 centrePanel 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 $SF_6$ Gas also have to be provided.

**The switchgear units shall be divided into several gas-filled compartments, sealed from each other by gas-tight partitions including bus bar compartments of two adjacent panels, so that any leakage may be quickly localized and limited within enclosure of one panel & can be indentified immediately.**

**All the live parts including the VCB, Three position Disconnector, and main busbar shall be encapsulated in stainless steel enclosure filled with $SF_6$ 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 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.

**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 button
- 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 DISCOONECTORS AND EARTHING SWITCHES:

Isolators Disconnectors or Discoonectors combined with earthing switches (3 position switches) shall be motor operated. In case of emergency, manual operation or through a separate switch 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.

**IVT shall be placed in a separate Panel.**

### 8.1 CURRENT TRANSFORMERS:

The **Current Transformers** shall be toroidal type. 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.

**33kV Line CT**

Toroidal type Current Transformer

CT Primary Current: 400-200 A

CT Secondary Current: 1-1-1A

Core 1: Cl-0.2S / 15 VA,

Core 2: Cl-PS .

Core3: Cl-PS

**33kV Transformer CT**

Toroidal type Current Transformer

CT Primary Current: 400-200 A

CT secondary Current: 1-1-1A

Core 1: Cl-0.2 S / 15 VA,

Core 2: Cl-PS

Core 3: Cl-PS

(The Contractor shall calculate the CT burden as per relay and metering requirement during detail engineering with CT/ VT Burden calculation)

**Cable Termination:**

Cable terminals to be readily accessible from the front and located at a convenient connection height. System shall be in accordance with EN 50181 for terminal cross sections up to 630 mm2, up to incl. 36 kV. For connection of various cable types via cable screw-type plugs and terminal adapters Facilities to connect several cables per phase. With the cables connected, cable testing shall not require the installation of any supplementary equipment.

Cable testing must be feasible from the panel front and without disconnecting these cables.

Cable testing shall be possible from the panel front using DC or AC, with the cables connected.

**Cable compartment shall be completely covered by metal enclosure for operator's safety.**

**"To provide a maximum of personal safety all operation and maintenance as well as connecting of cables must be possible from the front of the panels".**

**"Cable testing must be feasible from the panel front and without disconnecting these cables".**

## 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 for Line 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

For Transformers, in addition to the above, the following protection shall be provided

* Differential protection for transformer (87T)
* Restricted earth-fault for transformer (87N)

## 11.0 BUS IVT

33kV Bus IVT shall be housed in a separate Panel Panel with plug in type with a disconnector and it shall be air insulated / gas insulated.

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

* Overvoltage (59)
* Under voltage (27)
* Frequency Relay (81 O/U)

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.

### 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:

- Insulation resistance
- Functional test of the fully installed and wired equipment delivered.

### 12.5 **BASIC Technical Requirements**-

**The following Basic Technical Requirements at chapter-E24 are required to be furnished by the bidders for 33kV GIS**:

Basic Technical Requirement for 33KV Cubicle GIS,
Schedule GTP for 33KV GIS FOR BREAKERS / PANELS,
Schedule GTP for 33KV CURRENT TRANSFORMERS,
Schedule GTP for 33KV INDUCTIVE VOLTAGE TRANSFORMERS,
Schedule GTP for NUMERICAL RELAYS

# PART –A.1

# Technical Specification

## 33 KV Indoor Switcgear Panel
## for
## GIS and AIS – General

## Technical Specification for 33 kV Indoor Switcgear Panel for GIS and AIS

### 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,Disconnectoretc) for use in the 33/11KV primary substations under the distribution networks. The 33kV GIS Switchgear shall be with a Disconnector.

In case of AIS Switchgear there shall not be any Disconnector.

There shall be separate Indoor Panel for IVT.

The equipments must be type tested.

### 1.1 Description of the Switchgear Panels for GIS & AIS.

Indoor switchgears for GIS/AIS should be provided in a cubicle, which shall be erected inside a building. Separate switchgear panels for 33kV GIS &AIS and 11kV 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.

The **33kV GIS Switchgear shall be with a Disconnector** and **AIS Switchgear without any Disconnector**. There shall be separate Indoor Panel for IVT.

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 $SF_6$ 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<br>**IEC:62271-100 &**200 | | High voltage alternatingcurrent Circuit Breakers general Requirement. |
| IEC:694 | IS : 12729 | Common clauses of high voltage switch-gear and control gear standards (for voltage exceeding 1000V). |
| IEC:60 | IS : 9135 | High Voltage testing techniques. |
| IEC:427 | IS:13516 | Method of synthetic testing of HV .A.C 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.C 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.

### 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 may be of aluzinc material or CRCA. 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 **AIS circuit breaker** (VCB) **shall be mounted on *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.

The **GIS Circuit Breaker** shall be of fixed type enclosed in the $SF_6$ gas tank. **Withdrawable facility is not applicable in case of GIS Switchgear.**

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. 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 &Bus-bar shall be 800 Amp for **Indoor Switchgear irrespective of AIS & GIS** and 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 AIS 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.

**In case of GIS**, the VCB is Fixed type and shall be Mounted inside the stainless tank insulted with $SF_6$ Gas. The Stainless Tank is sealed for Life time and Vacuum bottles are to be replaced by changing the gas,

when required. 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**(<2.5p.u)**on all switching circuits, capacitive and inductive to IEC:62271-100 & 200and 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 | 800A |
| ii) | For Interrupter | 630A |
| iii) | For Outgoing Feeders/ For Incomer | 630A |
| 6 | Rated Internal Arc for Panels for 1 Sec | 25kA |
| 7 | Rated short circuit making current (peak) | **62.5 kA** |
| 8 | Rated short time current withstand capability for 3 sec. | 25kA |
| 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 1.2/50µsec, wave of +ve and -ve polarity | 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 |

## 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, opening and 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. 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 trippingby**2nos 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**. There shall be separate switch for electrical operation of the VCB.

- 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 AC. 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.

## 9.0THERMAL 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 85% to 115% of normal voltage
Frequency: from -5% to +3% in variationof normal frequency

DC supply: Voltage for voltage variation of Tripping : 70% - 110%
Voltage variation of Closing : 85% - 110%

**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.

**For AIS, 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.

**For GIS,** the 3-position of the DISCONNECTOR switch shall be ON-OFF-EARTH.

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**

**For AIS,**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, i.e. on withdrawl of the breakers the shutters shall automatically operate to cover the contacts.Further, all the compartments are electrically & mechanically segregated from each other.Hence it is possible to work on the Busbar compartment being completely isolated from the breaker compartment.There shall be positive indications for TEST/SERVICE position; However isolated position is indicative by the open door itself. But, 33kV GIS is Fixed Type and Mounted inside the stainless tank insulted with $SF_6$ Gas. The Stainless Tank is sealed for Life time.

**For GIS, Safety shutters are not applicable**.

## 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 Resign Cast bushing so 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.

**But, 33kV GIS is Fixed Type and Mounted inside the stainless tank insulted with $SF_6$ Gas**. The Stainless Tank is sealed for Life time.

## 14.0 AUXILIARY SWITCH AND AUXILIARY PLUG &SOCKET

There shall be minimum 6NO and 6NC contacts in breaker auxiliary switch (10 amps DC rating) and shall be provided in each circuit breaker.However, additional contact shall be made available by using Contact Multiplier Relay/Contact Multiplication Relay.

## 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.

## 15.0 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, ooze, shrink or collapse during service.

16.2.2Polarity 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.

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

16.2.4Secondary 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 3 second. Out of three cores one Core having 0.2s class (Metering) & other two cores having PS (Protection) class accuracy.

**Current Ratio: 400-200/1-1-1 Amp**
**No. of Cores: 03**
**Burden: 15 VA for each core**

**Technical Requirements**

| **Sl. No** | **Particulars** | **Requirements** |
|---|---|---|
| 1 | Function | To control 33kV 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)<br>400-200/1-1-1-A | Category- B (For Feeder)<br>400-200/1-1-1 A |
| 4 | Rated Burden (VA) | Core:1: 15 VA ,<br>Core:2: 15 VA,<br>Core:3:15 VA | Core:1: 15 VA ,<br>Core:2: 15 VA,<br>Core:3:15 VA |
| 5 | Class of Accuracy | Core:1: 0.2s ,<br>Core:2: PS,<br>Core:3: PS | Core:1: 0.2s ,<br>Core:2: PS,<br>Core:3: PS |
| 6 | Instrument Security Factor | Core- 1:- <5 | Core- 1:- <5 |
| 7 | Purpose | Core:1: Metering ,<br>Core:2: Differential,<br>Core:3:O/C&<br>E/F & REF | Core:1: Metering ,<br>Core:2: Spare<br>Core:3:O/C& E/F<br>& REF |
| 8 | Rated/Highest system Voltage | 33/36kV | |
| 9 | Short Time Rating | 25KA rms for 3 seconds | |
| 10 | Power frequency 1 min voltage withstand level/ Insulation Level:<br>-Impulse Voltage1.2/50 µs 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:

Type tested equipment/materials are acceptable. Type tests should have been conducted in last five years. The Type Test must have been as per OPTCL requirement. If OPTCL desires another type test, it has to be conducted. In such case OPTCL will bear the transportation of equipment/material and type test charges.

- 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).

**17.2 INDOOR VOLTAGE TRANSFORMER (IVT):**

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

| **Sl. 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) | Each Core shall be 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 rms | 70kV |
| ii) | Impulse withstand voltage to earth with 1.2/50 µsec wave of +ve and —ve polarity (peak) | 170kV |
| 10 | One minute power frequency withstand voltage of secondary winding (rms) | |
| | Between phase to earth | 3kV |
| | Between sections | 3kV |
| 11 | Rated voltage factor | |
| | Continuous | 1.2 |
| | For 30 seconds | 1.5 |
| | | |

* The burden indicated is the minimum acceptable to the Owner. 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).

## 18.0 **GENERAL FOR IVT**

18.1

The voltage transformers to be supplied under this specification shall be Epoxy Resin Cast of Indoor type with 3nos single phase in a separate Panel 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 **Epoxy Resin Cast type** complying with IEC 185.

### 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 in IVT**

**For AIS**, 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 molded 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 IVT shall be in a separate Panel with extended Bus bar. Digital display voltmeter shall be installed on IVT panel.**

**For GIS**, Fuse Protection in is not applicable, since the IVT's are directly Plug-in type with disconnecting switch.

## 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: 03
Burden: 15VA 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 kip) withstand. Phase identification shall be made at the end by colored tape.

**Note:** - **In GIS switchgear**, Bus bars, VCB, Disconnect or shall be in the $SF_6$ Gas chamber. The bus bar shall not be solid insulated.

## 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 25kA 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 casting and cable armor which are also connected to the earth bus. Earth bus must be tested for 25kA 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 earthling switch cannot be operated. Earth Switch should be fully type tested for STC withstand of 25kA for 1seconds.

## 24.0 CABLE COMPARTMENT

**For Vis**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 maximum 750 mm shall be provided for cable termination.

**For GIS**, the GIS Cable compartment cover is interlocked with disconnector switch & CB. Therefore, unless the earth switch & CB is closed we cannot open the cable compartment door which ensures more saftey.

## 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 auxilliary 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 &110V 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.

## 28.0 PROTECTION RELAYS FOR TRANSFORMER:

The offered relays shall be multifunction numerical type only. The auxiliary 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 &110V 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 at least two stages.

28.2 **Transformer Differential Relay:**

The Transformer Differential protection relay shall consist of two winding protection, two REF protections, V/F protection etc.Differential protection besides REF protection is required for 3.15MVA, 5.0MVA &8.0MVA Transformer. Over Fluxing Protection is standard protection of transformers.The input to this relay is the secondary IVT supply. However, setting will be decided at the time of commissioning.

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. It should have also continuous supervision of hardware and software 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 for O/C Relay, Stage- 1 & 2 can be used either a DT or IDMT characteristics & 3rd & 4th Stage shall be with Instantaneous Definite Time. However, directional or non-directional features are site selectable) 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 $I_n$ 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 $I_n$ 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. For E/F Relay, Stage- 1 & 2 can be used either a DT or IDMT characteristics. 3rd & 4th Stage shall be with Instantaneous Definite Time. However, directional or non-directional features are site selectable.

Both the stages Shall have a current setting range of 0.01 to 8 Amp 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.However, MIMIC display is not mandatory.
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. Display of harmonics in relay is not mandatory.

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

4. The relay shall have at least 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 **(i.e. RJ45 or FO)** 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.

6. The Relay shall have facility for Time synchronization on IRIG B or SNTP 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 at least 6 optically isolated inputs and atleast7 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.

i.) Circuit breaker maintenance information.

ii.) Broken conductor detection by measuring $I_2/I_1$ .

iii.) 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.

iv.) The relay shall also have the feature of Inrush blocking through $2^{nd}$ harmonic detection.

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

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

vii.) 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 $2^{nd}$ harmonics or other inrush restraint features and also should be stable under normal over fluxing conditions. Magnetizing 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. Downloading from the relay memory to the computer memory will be done.

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 DC component relay** filter, which is used to remove the Homopolar component from the phase currents is DC component and the relay shall have the filter component.

*****Instantaneous Differential Trip.
*****$2^{nd}$and $5^{th}$ 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 ($5^{th}$ 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.(to know transformer oil and winding temperature, which is optional)
**4.**The Battery voltage (DC supply )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 non volatile 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 synchronizationVia communicationVia demodulated IRIG-B/ SNTP 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 **IEC 61850.**

*Closed terminal needed for **06 CT input** for differential (LV & HV side of Transformer), **02 CT input** (HV & LV neutral of Transformer) for REF and three voltage input (for over fluxing protection, PT supply from LV/HV side).

* 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. The input to this relay is the secondary IVT supply. However, setting will be decided at the time of commissioning.

(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 50ºC. The temperature of the interior shall not exceed 65ºC.

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' (IEC 61850 – Communications, IEC 60255 -Insulation / Dielectric / EMC / Mechanical / Enviornmental etc) and functional type tests listed under **CIGRE Study Committee 34** (Protection) Report on simulator, Network analyser 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.

*. Each bay should be provided with a Multifunction meter having following features:-
* Features: By level monitoring of all electrical parameters of V,I,$\phi$,cos$\phi$,Hz,KVA,KVAR,KW&KWH.TrueRMS measurement
* Accuracy: 0.2s
*. User selectable display ranges. (CT/PT).
*. Auto scrolling/Manual display
*. RS 485 communication port with MODBUS RTU protocol.Compatible for data logging & SCADA application.
*. Inbuilt Real time clock with calendar.
*. 3phase,4 wire,3 element or as per requirement.(to be decided during detail Engineering).
*. Quadrant of operation: 04 Quadrant.
*. Display: Bright red 7-segment LED display.
*. HMI: Through Front panel tactile keys.
*. Indication: Phase voltage, Phase current ,Line voltage, Frequency, Power factor, KVA,KVAR,KW,KVAH,KVARH,KWH.
*. Voltage input: 63.5/110V
*. Current Input: 1 A
*. Auxiliary supply: 85-250 V AC or 48 V DC
*. VA burden: 15VA
*. Frequency Range: 45 to 55 Hz
*. Power factor range: 0.1 lag -1 -0.1 lead
*. Over voltage: 130% continuously & 200% for 30 sec
*. Over current: 2 times continuous, 20 times for 1 sec.
*. Response time: 200 ms
*. Class of accuracy: 0.2s as per IEC 60687, IS 14697
*. Complies to EMI: IEC 61000-4-5,3,4
*. Display resolution: upto 1 decimal
*.Output: Two communication port with optical isolation.RS 485 communication port with MODBUS RTU protocol.
*.CT shorting provision should be there.
*.Mounting: Flush panel mounting.
*. Dimensions:144X144 mm
*.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)** A12 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 2.5mm$^2$. 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 otherdevices 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, nutsand 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: 630A.
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 DIMENSION

The dimension for **33kV GIS** shall not exceed

**600mm (Width) X 2000mm (Depth) X2500mm (Height)**

The dimension for **33kV AIS** shall not exceed

**1200mm (Width) X3200mm (Depth) X 2700mm (Height)**

The dimension for **11kV AIS** shall not exceed

**800 mm (Width)X2100mm (Depth)X2500mm (Height)**

## 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 IEC62271-100or as per latest amended IEC.

- **Short time rating for 3 seconds** as per IEC 62271-100,62271-200 or as per latest amended IEC.
- **Temperature rise test** as per IEC 62271-200or as per latest amended IEC.
- **Capacitor bank switching** for 400A minimum & cable charging 25 A test as per IEC 62271-100 For test duties 1 to 4 or as per latest amended IEC.
- **Degree of protection test** as per IEC 62271-200 or as per latest amended IEC.
- **Lightning impulse voltage test** as per IEC 62271-100 ,62271-200 or as per latest amended IEC.
- **Internal arc test of 25 kA 1sec** in all the three high voltage compartments as per IEC 62271-200 or as per latest amended IEC.

## 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 **front page** of the Type Test report showing the evidences of the tests, duly signed by the bidder shall be uploaded along with the bid.

The following Type tests of VCB should have done:

1) Short Time withstand current
2) Temperature Rise
3) Lightning Impluse Test
4) Internal Arc Test
5) Make & Break Test duties
6) Power frequency voltage test
7) Partial discharge test
8) Resistance measurement test
9) Tightness test
10 )Closing Characteristic test
11) Opening Characteristic tests

The VCB shall be of**M2, C2 & E2 duty class.**

# PART - B

# TECHNICAL SPECIFICATION
# FOR
# 11KV Indoor Switchgear Panel for AIS

## 1.0 REQUIREMENTS

This specification covers design, engineering, manufacture, testing, and inspection of 11 KV indoor Air Insulated Switchgear Panel (provided with Vacuum circuit Breaker & CT, IVT etc) for use in the 33/11KV primary substations under the distribution networks. 11 kV Switchgear shall have Vacuum breakers & CT etc. The 11kV side of 33/11kV Sub-station shall be of AIS switchgear irrespective of AIS / GIS Sub-station. Hence, there shall not be any Disconnector on 11kV side Indoor Switchgear. There shall be separate Indoor Panel (2nos.) for IVT at 11kV side. The Switchgear must have type tested.

### 1.1 Description of the Switchgear Panels for 11 kV AIS.

Indoor switchgear for AIS should be provided in a cubicle, which shall be erected inside a building. Separate Switchgear Panels for feeder & transformer of 11 kV AIS system are to be considered. Care should be taken during manufacturing of the same as the equipment like VCB & CT are to be installed in the panel individually. The 11kV side of 33/11kV Sub-station shall be of AIS switchgear irrespective of AIS / GIS Sub- Station. Hence there shall not be any Disconnector on 11kV side Indoor Switchgear. **There shall be separate Indoor Panels (2nos.)for IVT at 11kV side**. Vibration is inevitable as mechanical operation for closing the VCB may cause problem and its performance will be affected. Foundation shall be designed to take care of the vibration and dynamic force during closing and tripping.

The circuit breakers switchgear panels to be supplied against this specification shall be required to control the LV side of 33/11 kV power transformers in the primary sub-stations and also the incoming 11kV feeders or the outgoing feeders in these sub-stations. The switchgear panels shall be suitable for 3 phase 50Hz solidly grounded neutral system and shall have normal current carrying capacity of 630 Amp & **Bus-bar shall be 1250 Amp** for Indoor Switchgear and symmetrical short circuit breaking capability as mentioned hereunder.

## 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<br>IEC: 62271-100 & 200 | | High voltage alternating current circuit breakersgeneral 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.C 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 AC 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 | AC 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.C 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.

## 3.0 BASIC TECHNICAL REQUIREMENTS:

The Vacuum circuit breakers shall comply toE2, M2 and C2 category and are required to meet the following basic technical requirements.
(Reference standards IEC:62271 - 100 & 200 or as per latest amended IEC and associated standards listed in this specification.

**Basic Technical Requirements**

| Sl. No | Particulars | Requirements |
|---|---|---|
| 1 | Service type | Indoor |
| 2 | No. of Poles | 3 |
| 3 | Nominal system voltage | 11kV |

| | | |
|---|---|---|
| 4 | Highest system voltage | 12kV |
| 5 | Rated normal current at 50°C | |
| | For Bus-bar | 1250A |
| | For Interrupter | 630A |
| | For Outgoing Feeders/ For Incomer & Bus Sections | 630A |
| 6 | Rated Internal Arc tested for 1 Sec | 25kA |
| 7 | Rated short circuit making current (peak) | 62.5 kA |
| 8 | Rated short time current withstand capability for 3 sec. | 25kA(Panel)/25kA |
| 9. | Rated insulation level: | |
| | One minute power frequency withstand voltage to earth (wet and dry) rms | 28kV |
| | Impulse withstand voltage to earth with 1.2/50 µsec, wave of +ve and —ve polarity (Peak) | 75kV |
| 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 | 48 V D.C |

## 4.0 SYSTEM CONDITIONS:

The breakers are to be suitable for indoor operation. Please refer chapter E3 of Technical Specification on SYSTEM conditions.

## 5.0 11 KV VACUUMCIRCUIT BREAKERS

### 5.1 GENERAL

The circuit breakers mounted on a withdrawable truck for AIS along with CT, Control & relay Panels shall be suitable for indoor installations with vacuum as interrupting media incorporating separate interrupters of 630A rating for each phase mounted on single frame. Internal Arc withstand for 11kV & 33kV VCB must be 25kA for 1 sec. **There is no line PT in the scope**. **Bus IVT will be in a separate Panel.**There shall be a common drive mechanism actuating for interrupters, which must work in synchronism. These shall be a common drive mechanism actuating the interrupters, which must work in synchronism. These breakers shall be provided with suitable local control while provision shall be made for remote control. All the signals going in DCS shall be through hardwire.

**5.2** The entire circuit breaker with its operating mechanism shall be mounted on a **horizontal draw-out type chassis/ trolley inserted into a floor standing sheet steel(Withdrawable truck for AIS)**enclosure suitable for withstanding electromagnetic/ electro-dynamic forces of both symmetrical and asymmetrical faults. It shall have plug- in off load type isolating main and auxiliary contacts with all necessary safety features, door limit switch etc.

**5.3** The Panel shall be fabricated from 2 mm thick **CRCA Sheet Steel/ Alu-Zinc** while load bearing member and cable entry plate shall be of 3mm thick. The partition /inside wall suitable for coupling with identical units on either sides to form Switch board. The circuit breaker Panel shall be such that when the withdrawable part is being removed the metal shutters can be opened with a lever, for an example to inspect the mating contacts or locked with a padlock. The upper portion (access to the Bus bar) and the lower portion (access to the termination compartment) can be unscrewed with the metal shutters closed. This makes it possible to work in the Busbar compartment with the termination compartment fully partitioned off, and vice versa. The breaker shall be provided with **three** distinct positions namely **Service, Test** and **Isolate.**

**5.4** 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 **(<2.5pu**) on all switching circuit, capacitive and inductive to IEC:62271 - 100 & 200and other associated standards mentioned in the clause of this specification.

**5.5** The **connecting terminal for Cables** shall have silver plating of at least **10** micron thickness. The design of the circuit breaker shall be such that inspection and replacement of contacts, coils, vacuum bottles and any worn or damaged components can be carried out quickly and with ease. The contact gaps shall be adjustable to allow for wear.

**5.6** The mechanism and the connected interrupters shall satisfy the mechanical endurance requirements of IEC: 62271 - 100 & 200 or as per latest amended IEC and all additional requirements specified herein.

**6.0 Interrupting media (Vacuum):**

**6.1** 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.

**6.2** 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.

**7.0 Auxiliary contacts**

**7.1** Auxiliary contacts (6NO + 6NC) of 48 Volt D.C grade and 10 amps DC rating shall be provided in each circuit breaker.However, additional contact shall be made available by using contact multiplier relay/Contact multiplication relay can be used.

**8.0 Indication**

**8.1**

A mechanically operated circuit breaker position indicator of non-corroding material shall be provided in a location visible from the operating side of the breaker without the necessity to open the mechanism door. **The**

**word 'OFF' in white letter on green background** shall be used to indicate that the breaker is in the opening position and the word **'ON' in white letters on a red background** to indicate that the breaker is in the closed position. The drive for the device shall be positive in both directions and provision shall be made for local and remote electrical indication.

**8.2** Indication of spring charging condition shall be provided as mentioned in this Specification. Mechanical counters to record the number of closing operations shall be provided for each circuit breaker mechanism.

**9.0 Operation and controls**

**9.1** The breaker shall normally be operated by electrical control with electrical trippingby**2 nos. Shunt trip coils.** Provision shall be made for local electrical operation and mechanical operation.There shall be a separate switch for electrical operation of the VCB.

**9.2** 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 contact type with rear terminal connections. The close push button shall be of **green colour** and the open push button **red colour**.There shall be a separate switch for electrical operation of the VCB.

- Mechanical push to trip button shall be provided for manual tripping with front door closed 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.

**9.2** 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.

**9.3** 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.

**10.0 CURRENT TRANSFORMERS**

**10.1** 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. The Class of insulation for

CT's shall be **CLASS E or better**. **The CT/PT's shall be cast Epoxy Resin Cast type and shall be either window or wound type**.

**10.2 Core**

**10.2.1** 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.

**10.2.2** 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.

**10.3 Windings**

**10.3.1**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.

**10.3.2** 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 the Owner.

**10.3.3**The continuous current rating of the primary winding shall be**120%**(one hundred and twenty percent) of the normal rated current.

**10.3.4** Secondary windings of current transformers shall be used for metering,Instrumentation and protection and shall be rated for continuous current of **120% (**one hundred and twenty percent) of normal rated current of primary winding.

Current transformers shall be three core window/bar primary. Maximum VA burden shall be of 15 VA and shall be rated for full short circuit current 25 kA for 3 second. Out of three cores one Core having **0.2S class** (Metering) & other two cores having **PS** (Protection) class accuracy.

**10.3.5. FEEDER PANEL:**

**Current Ratio: 400-200/1-1-1 Amp**
**No. of Cores: 03**
**Burden: 15 VA for each core**

**10.3.6 TRANSFORMER PANEL:**

**Current Ratio: 400-200/1-1-1 Amp**
**No. of Cores: 03**
**Burden: 15 VA for each core**

## 11.0 Fittings and accessories

**11.1** Fittings and accessories listed below shall be supplied with each current transformer:

- Bimetallic connectors suitable for connecting 185-400mm$^2$ XLPE insulated Aluminimum Cables.
- Two earthing terminals and strips with necessary nut, bolts and washers;
- Name and rating plate;
- LV terminals with connection diagram:
- Mounting nuts, bolts and washers;

**11.2** Any other fittings deemed essential by the Supplier shall also be supplied with each current transformer.

### 11.3 Basic technical requirement for CT's

Knee Point Voltage shall be 400V for both 33kV & 11kV CT.
Maximum excitation current at Vk=25mA.

Ratings: The CTs shall confirm to the following ratings and other particulars of the circuit breakers:

**Technical Requirements**

| **Sl. No** | **Particulars** | **Requirements** | |
|---|---|---|---|
| 1 | Function | To control 11 kV Feeder & LV side of 33/11kV power transformers of ratings between 3.15MVA to 12.5MVA | |
| 2 | Requirement | The CTs in the 11 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: 0.2S , Core:2: PS, Core:3: PS | Core:1: 0.2S , Core:2: PS, Core:3: PS |
| 6 | Instrument Security Factor | Core- 1:- <5 | Core- 1:- <5 |

| | | | |
|---|---|---|---|
| 7 | Purpose | Core:1: Metering ,<br>Core:2: Differential,<br>Core:3:O/C&<br>E/F & REF | Core:1: Metering ,<br>Core:2: Spare<br>Core:3:O/C&<br>E/F & REF |
| 8 | Rated/Highest system Voltage | 11/12 kV | |
| 9 | Short Time Rating | 25 kA rms for 3 seconds | |
| 10 | Power frequency 1 min voltage withstand level/ Insulation Level:<br>-Impulse Voltage1.2/50 µs wave withstand level - | **28 kV/75kVp** | |

**12.0Tests**

**12.1** 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:

**12.2 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);

**12.3 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).

**Routine test of brought out equipment shall be carried out by the respective Vendor in presence of the Owners(OPTCL) representative.**

**13.0 POTENTIAL TRANSFORMER**

13.1 **BASIC TECHNICAL REQIREMENTS****

The 11 kV Indoor voltage transformers(**IVT**) are required to meet the following basic technical requirements (Reference standards: IEC:186, IS:3156 and associated standards listed in the specification):

| Sl. No | Particulars | Requirements |
|---|---|---|
| 1 | Type | Single phase |
| 2 | Nominal system voltage, phase to phase | 11 kV |
| 3 | Application | Instrumentation, Metering and Protection |
| 4 | Number of secondary windings | 2 |
| 5 | Rated normal burden* | **15VA**for each Core |
| 6 | Rated primary voltage | 11000/√3 |
| 7 | Rated secondary voltage | 110V/√3-110V/√3 |
| 8 | Class of accuracy | 0.2/3P |
| 9 | Rated insulation level: (Primary winding) | |
| i) | One minute power frequency withstand | 28kV |
| ii) | Impulse withstand voltage to earth with | 75kV |
| 10 | One minute power frequency withstand | |
| 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 Owner. 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).

****There is no line PT. Bus IVT (PT) will be in separate panel. Burden will be 15VA for each Core.**

## 13.2 GENERAL

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

### 13.3 Duty requirement

**13.3.1** 11 kV Voltage transformer for all the indicating instruments and measuring meters in the primary substation on 11kV side. It shall be of indoor, **1-Phase or 3- phase Epoxy Resign Cast type.**

### 13.4 Core

**13.4.1** 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.

**13.4.2** 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 or over voltages.

### 13.5 Windings

**13.5.1** The primary and secondary windings shall be electrolytic copper of high purity and conductivity and covered with double paper insulation or super enamel coating. The conductor shall be of adequate cross-section so as to limit the temperature rise even during maximum over voltages.

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

**13.5.3** 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.

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

**13.5.5** 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.

## 14.0 Fitting and Accessories

14.1Fittings and accessories listed below shall be supplied with each voltage transformer:

- HV terminals
- Two earthing terminals with necessary nuts, bolts and washers
- Name and rating plate
- Secondary terminal box with LV terminal connections
- Mounting nuts, bolts and washers
- LV HRC cartridge fuses for the protection of secondary winding

- HV HRC cartridge fuses for the protection of Primary winding

14.2 Any other fitting deemed essential by the contractor shall also be supplied along with each voltage transformer:

14.3 The name and rating plate shall contain all the particulars as provided in IEC:186 and also the name of the Owner and year of manufacture. They shall comply with the clause termed label in this specification.

**15.0 Fuse protection**

The Primary winding shall be protected by HRC Fuses in suitable holder designed by the manufacturers.

15.1 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.

**16.0 Circuit diagram**

16.1 A durable copy of the circuit wiring diagram shall be affixed to the inner side of the terminal box cover. Labels shall be provided inside the cover to describe the functions of various items of equipment.

**17.0 TERMINATION**

17.1 The equipment shall be supplied with HV electrical connection terminals of a size and rating appropriate for all the duties, including overload duty specified for the equipment. The terminals shall be of the bi-metallic type.

**18.0 EARTHING TERMINAL**

18.1 Two earthling terminals complete with necessary hardware shall be provided on each voltage transformer for connection to earth continuity conductors. They shall be of electroplated brass and of adequate size to carry the earth fault current.

18.2 The earthing terminals shall be identified by means of appropriate symbol marked in a legible and indelible manner adjacent to the terminals.

**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.

Type tested equipment/materials are acceptable. Type tests should have been conducted in last five years. The Type Test must have been as per OPTCL requirement. If OPTCL desires another type test, it has to be conducted. In such case OPTCL will bear the transportation of equipment/material and type test charges.

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

19.4 **TEMPERATURE RISE:**

The temperature rise of any part of the voltage transformer under continuous operating and exposed in the direct rays of the sun shall not exceed the permissible limits as provided in IEC publication 186 or IS:3156. These shall not be exceeded when corrected for the difference between the ambient temperature at site and the ambient temperature specified in the standard 62271-200/100, with silver plate joint. The correction proposed shall be stated in the bid.

## 20.0 PROTECTIVE RELAY & CONTROL PANEL

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

Control Panel **(in-built)** 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:

(i) Triple pole IDMTL type combined over current (3Nos) & Earth fault (1No) relay (Draw out type) preferably Communicable numerical relay of reputed make with supporting Protocol IEC:61850and that should be type tested with IEC protocol 61850**.**

**The detailed Specification are as indicated in 33 kV Indoor Switchgear Panel (SlNo. 14)**

## 21.0MULTIFUNCTION METER

**GENERAL**

Multifunction Meter will be installed on the top of the Switchgear Panel.

*. Each bay should be provided with a Multifunction meter having following features:-

* Features: By level monitoring of all electrical parameters of V,I,$\phi$,cos$\phi$,Hz,kVA,kVAR,kW&kWH.True RMS measurement

* Accuracy: 0.2s.
*. User selectable display ranges. (CT/PT).
*. Auto scrolling/Manual display
*. RS 485 communication port with MODBUS RTU protocol.Compatible for data logging & SCADA application.
*. Inbuilt Real time clock with calendar.
*. 3phase,4 wire,3 element or as per requirement.(to be decided during detail Engineering).
*. Quadrant of operation: 04 Quadrant.
*. Display: Bright red 7-segment LED display.
*. HMI: Through Front panel tactile keys.
*. Indication: Phase voltage, Phase current ,Line voltage, Frequency, Power factor, kVA,kVAR,kW,kVAH,kVARH,kWH.
*. Voltage input: 63.5/110V
*. Current Input: 1 A
*. Auxiliary supply: 85-250 V AC or 48 V DC
*. VA burden: 15VA
*. Frequency Range: 45 to 55 Hz
*. Power factor range: 0.1 lag -1 -0.1 lead
*. Over voltage: 130% continuously & 200% for 30 sec.
*. Over current: 2 times continuous, 20 times for 1 sec.
*. Response time: 200 ms
*. Class of accuracy: 0.2s as per IEC 60687, IS 14697
*. Complies to EMI: IEC 61000-4-5,3,4
*. Display resolution: upto 1 decimal
*.Output: Two communication port with optical isolation.RS 485 communication port with MODBUS RTU protocol.
*.CT shorting provision should be there.
*.Mounting: Flush panel mounting.
*. Dimensions:144X144 mm
*.Ambient condition: working: 0-55 deg cent,5-95% RH

**21.1**

**(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 alarm& trip, Winding temp alarm& Trip, Bucholtz Alarm & Trip, MOG alarm, PRV Trip etc)

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

(i)Test terminal Blocks- Test terminal Block need be provided for testing meters in test position.

| | | |
|---|---|---|
| ii) Indication Lamp(48V LED type) | DC | **Red**- Breaker 'ON'<br>**Green**- Breaker 'OFF'<br>**Ambe**r- Breaker 'AUTO TRIP'<br>**Blue**- Spring charge indication.<br>**White**-Healthy Trip illuminated push bottom switch |

21.2 **In Built Control- Relay Panel in the In Door VCB (Mounted on the Top of VCB Panel)**

**22.0 Panel wiring and accessories.**

22.1 **Wiring**

Each panel shall be supplied with all internal wiring complete.

22.2 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. 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.

22.3 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 not be less than 2.5mm$^2$. For CT secondary wiring, two such wires shall be used in parallel.CT, PT & all other control wiring shall be 2.5 Sq mm.

22.4 **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 confirming 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.

22.5 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.

**23.0 Terminal blocks**

**23.1** Terminal blocks of brass studs rated for 10 amps continuous current, 1100 volt 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. **10%** (Ten percent**)** spare terminals shall be provided.

## 24.0 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**.

**24.1** 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.**

## 25.0 Circuit diagram

26.1 **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.**

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

## 26.0 OPERATING MECHANISM

### 26.1 General

26.1.1 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.

26.1.2 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.

26.2 **Spring mechanism (In case of Spring Charged VCB)**

26.2.1 The spring operating mechanism shall be with spring charging motor, opening and 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.

26.2.2 It shall be possible to hand charge the operating spring with the circuit breaker ineither 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.

26.2.3 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.

26.2.4 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.

26.2.5 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.

26.3 **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.

26.4 **AUXILIARY POWER SUPPLY**

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

a) 230V,50Hz Single phase- For spring charging motor AC

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

26.5 The DC supply shall be from **Battery Bank**

26.6The mechanism shall be designed to operate satisfactorily despite fluctuations of auxiliary power supplies as under:

AC supply: Voltage From 85% to 115% of normal voltage
Frequency variation From-5% to +3% in variation

DC supply: Voltage for voltage variation of Tripping : 70% - 110%
Voltage variation of Closing : 85% - 110%

26.7 Temperature Rise test:

The temperature rise and the maximum temperature of any part of the circuit breaker under continuous load condition and exposed in the direct rays of the sun shall not exceed the permissible limits as provided in Table V of IEC publication 694 or table 4 of IS:12729. These limits shall not be exceeded when corrected for the difference between the ambient temperature at site and the ambient temperature specified in the standard. The correction proposed shall be stated in the tender.

## 27.0 TESTS

### 27.1**Type test and Routine test**

The circuit breakers shall be subjected to routine and type tests in accordance with the standards listed in this specification including the following IEC and IS standards with the latest amendments:

- Circuit breakerIEC:62271 - 100 & 200and relevant other standards
- Porcelain insulator IEC:233 and IS:5621 and relevant other standards

The tests shall include but not limited to the following:

### 27.2 **Short circuit tests**

The circuit breaker shall satisfactorily perform the out of phase and short circuit duties specified in **IEC:62271-100 & 200,** IEC:17A(Sect.)438 and IEC:17A/CD/474 and IS:13516.
The circuit breaker shall be capable of performing at least twenty five (25) open operations at the rated short circuit current before maintenance or inspection is required.

### 27.3 **Dielectric tests**

At zero gauge loss of vacuum inside the interrupter chamber, the open contacts shall withstand continuously, the rated phase to ground voltage and it shall be possible to break normal current in these conditions. During the dielectric type tests, no flashover external or internal shall be acceptable.

The circuit breakers shall be subjected to a power frequency AC voltage test for one minute in dry and wet conditions and there shall be no external flash over to earth.

27.4 **Mechanical endurance**

In addition to the requirements of IEC:56, an extended mechanical endurance test is required to show that the circuit breaker is capable of at least 10,000 operations at no load in accordance with IEC:17A/474/CD or as per latest amended IEC. Between the specified test series in IEC:17A/474/CD, some maintenance such as lubrication and mechanical adjustment is allowed and shall be performed in accordance with manufacturer's instructions. Change of contracts is not permitted.

27.5 **Duty requirement tests**

Apart from auto-reclosing and the other duties mentioned above, the breakers shall be able to perform the following duties for which type tests are to be conducted as per IEC:56 or IS:13118.

1. Breaking the steady and the transient magnetising current of the transformer.
2. Breaking 25% of rated fault current at twice the rated voltage as per IEC/IS.
3. Cable charging breaking current.
4. Single capacitor bank breaking current.
5. Capacitor bank in rush making current.

Test for the resistance of the main circuit shall also be conducted.

27.6 **Temperature rise test**

Temperature rise test is to be conducted on the circuit breaker and the accessories in accordance with **IEC:62271-100 & 200 or latest amended IEC.** The temperature rise shall be limited as per this specification.

**28.0 PERFORMANCE REQUIREMENTS**

The supplier shall declare the circuit breaker opening and closing times at 120 percent, 100 percent and 70 per cent of the rated voltage of the opening and closing devices when measured at the terminals of the trip and closing coils. The minimum make break time at rated voltage and total break time of the CB shall be stated. The total break time must not exceed 60ms.

**29.0 EARTHING**

29.1 All metal parts not intended for carrying current or not alive shall be connected to duplicate earthing system and suitable electroplated brass earthing terminals shall be provided on each circuit breaker in conformity with

**IEC:62271-100 &200.** Suitable identification mark for the earth terminals shall be provided adjacent to the terminal.

29.2 The size of the earth continuity conductor shall be large enough to reduce the potential rise of the metal frame of the breaker in the even of fault to minimum but in any case not more than 10V. The size of the conductor shall also be adequate to restrict the temperature rise without causing any damage to the earth connection in the case of fault. No riveted joints in the earth conducting path shall be permissible and only bolted joints of adequate size shall be provided with nuts, bolts and plain spring washers. The surfaces to be jointed shall be perfectly flat without any unevenness to ensure that there is no contact resistance.

29.3 An earth busbar of copper strip shall be provided inside the local control cabinet to which all earthing connections must be made. The earth busbar shall be terminated into two electroplated brass earthing terminals of adequate size with nuts, bolts and washers for connecting to earth continuity conductor mentioned above.

## 30.0 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 **front page** of the Type Test report showing the evidences of the tests, duly signed by the bidder shall be uploaded alongwith the bid.

The following Type tests of VCB should have been done:

1) Short Time withstand current
2) Temperature Rise
3) Lightning Impluse Test
4) Internal Arc Test
5) Make & Break Test duties
6) Power frequency voltage test
7) Partial discharge test,
8) Resistance measurement test
9) Tightness test
10 )Closing characteristic test
11) Opening Characteristic tests

The VCB shall be of**M2, C2 & E2 duty class.**