

**SECTION 7.4 TECHNICAL SPECIFICATIONS OF 33/11KV POWER TRANSFORMERS
(20/26MVA, 16/20MVA) AND 33/0.415KV 250KVA STATION AUXILIARY
TRANSFORMER**

**7.4.1 TECHNICAL SPECIFICATION OF 33/11 KV, 20/26.66MVA POWER
TRANSFORMER**

7.4.1.1 GENERAL

This section of the document includes the design, engineering, manufacture, supply, delivery, offloading, testing & inspection and performance requirements of 33/11KV, 20/26.66 MVA Power transformers and accessories as specified.

7.4.1.2 CLIMATE DATA

The distribution transformers to be supplied against this tender shall be suitable for satisfactory use under the following climatic condition:

Climate	:	Tropical, intense sunshine, heavy rain, humid.
Maximum Temperature	:	40° C
Minimum Temperature	:	03° C
Maximum yearly weighted average temperature	:	30° C
Relative Humidity	:	50-100%
Annual mean Relative Humidity	:	75%
Average annual rain fall	:	3454 mm
Maximum wind velocity	:	200 km/ hour
Maximum altitude above the sea level	:	Sea level to 300 metres
Atmospherically, Mechanical and Chemical impurities	:	Moderately polluted

The information is given solely as a guide for Tenders and no responsibility for its, accuracy will be accepted nor will any claim based on the above be entertained.

Transformer supplied under this contract will be installed in tropical locations that can be considered hostile to its proper operation. Particular problems that shall receive special consideration relate to operation in a hot environment and presence of the insects and vermin.

7.4.1.3 SYSTEM PARTICULARS

SL. NO.	SYSTEM CHARACTERISTICS	VOLTAGE LEVEL
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1.	Normal System Voltage, kV (Voltage Class)	230	132	33	11
3.	Maximum System Voltage, kV	245	145	36	12
4.	System Frequency, Hz	50	50	50	50
5.	Phase Rotation (Anti-Clock wise)	RST	RST	RST	RST
6.	Type of System Grounding	Solid	Solid	Solid	Solid
7.	Rated Fault Level (3-Phase Symmetrical), MVA 3 sec.	16000	6000	1800	500
8.	Basic Insulation Level, kV	750	650	170	75

High Voltage current carrying equipment should be capable of carrying the three phase fault level for a period of 3 Sec.

7.4.1.4 STANDARDS

The equipment specified in this Section of the contract shall conform to the latest edition of the appropriate IEC specifications and other recognized international standard. In particular:

IEC	60076-1	Power transformers (General).
IEC	60076-2	Power transformers (Temperature Rise).
IEC	60076-3	Power transformers (Insulation Levels, Dielectric Tests and External Clearance in air).
IEC	60076-5	Power transformers (Ability to Withstand short circuit)
IEC	60137	Bushings for alternating voltages above 1 kV.
IEC	60156	Method of determination of electrical strength of insulating oils
IEC	60296	Specification for unused mineral insulating oils for transformers and switchgear.
IEC	60551	Measurement of transformer and reactor sound levels.
IEC	60616	Terminal and tapping markings for power transformers.
IEC	722	Guide to lightning and switching impulse testing of power transformers.
IEC	5493	Protective coating of iron and steel structures against corrosion.
IEC	551	Noise and Vibration of power transformer.

7.4.1.5 Technical Specification:

1.	Rated MVA (ONAN/ONAF)	20/26.66MVA
2.	Number of Phases	3 (Three)
3.	Frequency	50 Hz
4.	Winding Insulation	Uniform
5.	Normal Transformation Ratio at No-load and principal tap	33/11 KV
6.	Rated HT Voltage (Phase to Phase)	33 KV
7.	Maximum HT Voltage (Phase to Phase)	36 KV

8.	Rated LT Voltage (Phase to Phase)	11 KV
9.	Maximum LT Voltage (Phase to Phase)	12 KV
10.	Rated Current HT (ONAN/ONAF)	350/ 467 Amps
11.	Rated Current LT (ONAN/ONAF)	1050/1397 Amps
12.	Basic Insulation Level : a) High voltage winding b) Low voltage winding	170 KV 75 KV
13.	Installation	Outdoor, Tropical, High rainfall & Humidity.
14.	Type	Core, Conservator & Oil Immersed
15.	Type of Windings	Double Wound of Electrolytic Copper, free from burs and splinter.
16.	Type of Cooling	ONAN/ ONAF
17.	Coolant	Type- A,Unused insulating mineral oil, free from PCB (polychlorinated biphenyl)
18.	Type of System Earthing	Effectively Earthed
19.	Bushing Material	Porcelain
20.	Type of Base	On wheels with adequate size and 10 M length of rails and fixing arrangement.
21.	Direction of Normal Power Flow	HT-LT
22.	Phase connection :(Δ -Y) a) 33 KV winding with bushing CT b) 11 KV winding with bushing CT	Delta Star
23.	Vector Group	Dyn11
24.	Neutral to be brought out : a) HT b) LT	Nil Yes
25.	Neutral Insulation	Full uniform insulation and 100% loading capacity
26.	Maximum Temperature rise over 40°C ambient at full load & tap change is at normal position : a) Winding by Resistance (°C) b) Oil by Thermometer (°C)	65°C 55 °C
27.	Impulse Front Wave Test Voltage (1.2/50 Micro Sec. Wave Shape) : a) High voltage side b) Low voltage Side	170 KV 75 KV
28.	Power Frequency withstand Test Voltage for 1 (one) Minute : a) High voltage side b) Low voltage Side	70 KV 28 KV

29.	Impedance Voltage at 75°C, at normal ratio and rated frequency, and at ONAN condition.	8.5%
30.	Type of tap changer control	
	Features	<p>The tap changer will be on load auto regulation, remote control and manual. The on load tap changer will immerse in the transformer tank. The diverter switch compartment will be provided with its own oil conservator which, will not be connected to the transformer oil tank.</p> <p>The diverter switch can easily be lifted out of its tank for maintenance and inspection without opening the transformer cover. The on load tap changer will operate by means of a motor drive unit. This unit will install on the side of the transformer.</p>
		<p>OLTC shall be operational from Local control panel, RTCC panel as well as from SAS. Tap position shall also be visible in Local control panel, RTCC panel as well as HMI of SAS. AVR relay shall have IEC-61850 communication protocol for communicating with SAS.</p>
	On Load Tap changer with motor drive unit manufacturer's name & country	MR, Germany/ABB, Sweden.
	Tapping Range :	
	a) HT	17 Tapping \pm 10% in steps of 1.25% i.e. 33 KV \pm 8 x 1.25%
	b) LT	Nil
31.	Bushing CT for differential protection	600/5A on HV, 1800/5A on LV of accuracy class 5P20, burden 30 VA.
32.	Neutral Bushing CT for Standby Earth Fault (SEF) & Restricted Earth Fault (REF) protection	1800/5-5A on LV neutral of accuracy class 5P20, burden 30 VA.
33.	Standard	Design, Manufacture, Testing, Installation and Performance shall be in accordance to the latest editions of the relevant IEC standards.
34.	Transformer Oil	
	Application	Insulating mineral oil for Transformer It will

	be free from PCB (polychlorinated biphenyl)
Grade of oil	Type-A
PHYSICAL PROPERTIES	
Appearance	Liquid and free from suspended matter or sediment
Density at 20 ^o C	0.895 g/cm ³ (maximum)
Flash point (Closed cup)	140 ^o C (minimum)
Kinematics Viscosity at -15 ^o C	800 c St. (Maximum)
Kinematics Viscosity at 20 ^o C	40 c St. (Maximum)
Pour point	-30 ^o C (maximum)
ELECTRICAL PROPERTIES	
Dielectric Strength at 50 Hz (with 2.5 mm standard gap and 40 mm standard depth)	New untreated oil, shall go through filtration treatment before the oil are introduce into the apparatus or equipment. The break down voltage of this oil shall be at least 50KV.
Loss tangent/Dielectric dissipation factor at temp. 90 ^o C, stress 500V/mm to 1000 v/mm and frequency 40 Hz to 62 Hz.	0.05 (maximum)
CHEMICAL PROPERTIES	
Neutralization value	0.3 mg KOH/g (maximum)
Neutralization value after oxidation	0.40 mg KOH/g (maximum)
Total sludge after oxidation	0.05% weight (maximum)
PCB Content	Free from PCB
STANDARDS	Performance and testing of oil shall comply with the latest revision of the relevant standards BS 148: 1972, IEC-60296 or latest revision there on.
35.	FEATURES & ACCESSORIES OF TRANSFORMER:

	<ul style="list-style-type: none"> a) Bushing Insulator on HT and LT. b) Arcing horns on HT and LT bushings. c) Remote Tap Changer Control (RTCC) facility in Transformer HT incoming PCM Panel. d) Oil conservator. e) Buchholz relays in main conservator oil pipe. f) Tap Changer Protective Relay in between conservative and tap changer oil pipe. g) Conservator drain valve, breather and oil level gauge with alarm contact. h) Pressure Relief Device (PRD). i) Dial type thermometers with alarm and trip contracts. j) CT for winding temperature shall be located at mid-phase (Y-phase) of the transformer. k) Radiators with valves. l) Bladder/Airbag in conservator to separate air from oil. m) One inspection hole with cover. n) Facilities for lifting cover and coil assembly from tank. o) Lifting lugs for lifting complete Transformer. p) Base designed for rollers with bi-directional flanged rollers parallel to either Centre line. q) Tank oil sampling, draining valve and oil centrifuging outlets. r) Tank earthing points. s) Fans for forced cooling (ONAF). t) All mounting accessories including rails (2 Nos. rails each 10 Meter long). u) All equipment should be fully tropicalized. v) Painting to approved colour and shade. w) Rating nameplate and diagram plate of stainless steel having engraved letters filled with black enamel paint.
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	<ul style="list-style-type: none"> x) The oil shall be supplied/ delivered in non-returnable sealed containers/ drums. y) The oil shall be fresh, unused, cleaned and free from suspended matter or sediment. z) The test shall be carried out on the oil as to be supplied without drying and degassing. aa) Uninhibited oils must not contain anti-oxidant additives. bb) Laminated, detailed Schematic Diagram of Control Circuit of Transformer & Tap changer inside Marshalling kiosk. cc) Dehydrating Silica-gel breather. dd) Air release plug. ee) Earthing terminals with lugs. ff) Thermometer pockets. gg) Winding temperature indicator with two contacts hh) Bottom mounting channel for 20/26.66MVA ii) Operation and maintenance manual along with troubleshooting procedure and installation guideline/manual shall be supplied with each transformer.
36	<p>Transformers shall be provided with cable boxes for both HV and LV terminals to enable cable connection directly. Cable boxes shall be completed with all necessary fittings in which primary and the secondary bushings shall preferably be of horizontal orientation to ease the cable termination. Cable boxes shall be adequate proportions and designed in accordance with BS6435 or relevant other international standard in such a manner that they can be opened for inspection without disturbing the gland plate or incoming cables(s). Provision for connection of two cables per phase shall be provided.</p> <p>Cable boxes shall be designed for ease of access for jointing and connecting the cable. They shall be constructed to minimize the danger of fragmentation; cast iron boxes shall not be used. Disconnecting links shall be provided in the boxes to facilitate testing of the transformer and cables independently.</p> <p>The Cable boxes shall be of such a design as to prevent ingress of moisture. The Contractor shall guarantee (test certificates shall be supplied as proof) that the air clearances and the creep age path on the bushing connecting to the transformers shall be such that the completed installation shall withstand in air the impulse and power frequency test voltages.</p>
36	<p>Following instructions to be followed for Submission of Test reports & Calculation during drawing approval:</p>
	<ul style="list-style-type: none"> aa) All Type test Report and related routine test report shall be of same transformer of same name plate serial no. bb) Calculation of load loss shall be provided for load loss in all 3(three) tap position (Nominal, Maximum, Minimum).

7.4.1.6 A. INFORMATION REQUIRED

The Tenderer/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information/Documents have to be submitted along with the tender:-

- (a) The Tenderer/Manufacturer shall submit with the bid the testing procedure & list of testing/ measuring equipment, meters etc. used for Factory test witness.
- (c) Construction, Installation, Operation & Maintenance Manual.

B. DOCUMENTATION:

The following documents must be submitted along with the tender, without which the tender shall be considered as non-responsive.

1. Filled up Guaranteed Technical Particular (GTP) of the offered equipment.
2. (a) Letter of authorization for Power Transformer from the Manufacturer, in case, the Bidder is not the manufacturer, in prescribed Form;
(b) Manufacturer's authorization for (On Load tap Changer) OLTC from MR, Germany/ ABB, Sweden in prescribed Form;
3. (a) At least 02 (two) nos. of Manufacturer's Supply Experience for offered type similar or higher capacity rating Power Transformer of same voltage class within the last 05 (five) years i.e. years counting backward from the date of publication of IFT in the newspaper. The Supply Experience covering at least 25% of the Tendered quantity in a single Contract will be considered only.

Manufacturer's supply experience (supported by copy of Contract Agreement and Certificate from purchaser) shall be furnished in the following format:

Sl. No.	Name, Address, Phone & Fax No. of the Purchaser	Contract No. & Date/NOA	Contract Value	Description of materials with Quantity	Date of Completion of Supply

- (b) At least 02 (two) nos. Manufacturer's Satisfactory Performance Certificates (supported by the Supply Record) from Electricity Utility as End User depicting that the offered type similar or higher capacity rating Power Transformer of same voltage class has been supplied within last 10(ten) years i.e. years counting backward from the date of publication of IFT in the newspaper and has been in satisfactorily service for at least 02(two) years. The Satisfactory Performance Certificate (SPC) shall be in End User's official pad and shall contain end-user's full mailing address, e-mail address, website address and fax/telephone number for the convenience of authentication.
- (c) The following provision will be applicable for purchasing less or equal to 10 (Ten) nos. of 33/11kV, 20/26.66MVA Power Transformer from new local manufacturers: **Not Applicable**

- i. At least 02(two) nos. of Manufacturer's Supply Experience for offered type similar or higher capacity rating Power Transformer of same voltage class within the last5 (Five) years; years counting backward from the date of publication of Invitation for Tender (IFT) in the newspaper. The Supply Experience covering at least 5% of the Tendered quantity in a single Contract will be considered only.

Manufacturer's supply experience (supported by copy of Contract Agreement/ Work Order /Certificate from purchaser) shall be furnished in the following format:

Sl. No.	Name, Address, Phone No. E-mail & Fax No. of the Purchaser	Contract No. & Date	Contract Value	Description of material with Quantity	Date of completion of supply
1.					
2.					

- ii. At least 02 (Two) nos. of Manufacturer's Satisfactory Performance Certificates (supported by the supply record) from public/private organization as End User depicting that the offered type similar or higher capacity rating Power Transformer of same voltage class has been supplied within last 10 (ten) years; years counting backward from the date of publication of IFT in the newspaper and has been in satisfactorily service for at least 02 (two) year. The Satisfactory Performance Certificate(s) shall be in End User's official pad and shall contain End User's full mailing address, e-mail address, website address, fax/telephone number for the convenience of authentication.
- iii. The New Manufacturer shall submit the following document with the Tender document:
- a) Location of the Factory & layout plan.
 - b) List of Capital Machineries (Related to manufacturer of the Tendered goods).
 - c) Factory Project Profile
 - d) Production Line description.
 - e) List of Key Personnel (with Bio-data).
 - f) Source of raw materials.
 - g) Testing facilities & calibration certificates of testing equipment.
- iv. New Local Manufacturer's factory/manufacturing plant shall be inspected by the Tender Evaluation Committee (TEC) and/or TEC nominated members, to assess the New Manufacturer's production capability and will submit a report regarding Technical and Financial aspect in comparison to the information and document furnished by Tenderer. If the assessment report is not satisfactory, the related tender proposal of the tenderer will be considered as Non-Responsive.

All costs regarding visiting & inspection shall be borne by the New Manufacturer.

Factory shall be inspected by Tender Evaluation Committee (TEC) and/or TEC nominated members as per following guide lines:

1. Location of the Factory & layout plan.
2. List of Capital Machineries (Related to manufacturer of the Tendered goods)
3. Factory Project Profile
4. Production Capacity (Yearly)
5. Production Line description.
6. List of Key Personnel (with Bio-data)
7. Testing Facilities as per IEC 60076 there on.
8. Source of raw materials.
9. A sample of the offered type Power Transformer shall be tested during factory inspection at manufacturer's testing laboratory.

All other clauses of the specification and Guaranteed Technical Particulars (GTP) except Supply record & Performance Certificate (Clause no. 3 (a) & 3(b)) shall be applicable for tender Submission and Evaluation.

4. Cross-sectional Drawing showing the arrangement of core and windings of the offered type Transformer.
5. Type Test Certificates, Reports & Special Tests for offered type similar MVA rating power transformer for Type Test Certificates, Reports & Special Tests for offered capacity MVA rating power transformer for same voltage class from any short-circuit testing liaison (STL) Member [http://www.stl-liaison.org/web/03_Members.php] Testing Organization or Laboratory or from their authorized Laboratories as per relevant IEC standard. The type test report shall include at least the following tests along with results:
 - a) Temperature Rise Test
 - b) Lightning Impulse Test
 - c) Short circuit withstands test report of HV-LV

The Type Test Certificates, Reports & Special Tests of higher capacity MVA rating for same voltage class power transformer shall also be acceptable for evaluation purpose only. However the prospective tenderer(Contractor) shall have to confirm satisfactory Type Test Certificates, Reports & Special Tests of offered capacity MVA Rating power transformer for same voltage class prior to pre Delivery Inspection from above mentioned laboratories with mentioned Tests at least. All cost related to these tests shall be borne by the contractor.

6. Loss calculation, short circuit calculation and temperature rise calculation. Tenderer's quoted No load Loss and Full load loss shall be supported by loss calculation. Moreover, Tenderer shall submit the characteristic curve (flux vs Loss/Kg) of core materials.

7.4.1.7 CAPITALIZED COST:

Bidder shall declare guaranteed No Load Loss and Full Load Loss value in GTP. Any Tenderer quoted the No Load Loss & Full Load Loss above the upper limit of the loss as

mentioned in GTP (Section 8, Clause 8.01, Sl No.3.9) in Tender Document will not be considered for further evaluation & treated as non- responsive. The Tenderer who will quote the No Load Loss & Full Load Loss below the lower limit of No Load Loss & Full Load Loss as mentioned in GTP (Section 8, Clause 8.01, Sl No.3.9) In that case during evaluation Capitalization cost will be calculated only on the basis of the lower limit of No Load Loss & Full Load Loss. Tenderers quoted No load Loss and Full load loss shall be supported by test reports from independent testing laboratory. In case of difference between the loss value declared in the offer and the loss value to be found in the type test report, the higher loss value will be taken into account for the purpose of loss capitalization.

The fixed and running losses are to be low as consistent with reliable and economical use of materials. The cost of losses is to be minimized and the following capitalized parameters will be used in the evaluation of the transformer:

$$C = 68,706 \times e \times P_0 + 54,964 \times e \times P_{FL}$$

Where,

C = Capitalized cost of transformer loss in Bangladesh Taka.

e = Energy Cost, Tk. 6.00/KWh

P_{FL} = Full Load losses at rated voltage, normal ratio and rated frequency in ONAF condition at 75°C in KW + Auxiliary loss in KW

P₀ = No load losses at rated voltage, normal ratio and rated frequency in KW

The cost of energy (C) will be added to the quoted prices to arrive at the evaluated cost of the transformer.

The contract will be cancelled if losses exceed the guaranteed value by an amount in excess of followings:

Total losses : 10%

Component : 15% of each component loss (Unless the total losses exceeds 10%).

7.4.1.8 SHIPPING:

All the delicate components shall be dismantled and packed in strong wooden boxes having inside lined with metallic sheets with proper sealing to protect the content from accidental direct exposure to weather during storage. The holes of the transformer tank shall be sealed with proper metal plate and gaskets to prevent leakage of oil and its contamination with atmospheric moisture. The transformer shall be shipped with radiators, busing conservator etc. dismantled but the tank filled with oil. The transformer oil from radiators and conservator shall be shipped in non-returnable drums. The bushing shall be shipped in oil sealed containers to avoid moisture absorption during shipment and storage. Oil shall be complying with IEC-60296.

7.4.1.9 The bushings shall have high factor of safety against leakage to ground and shall be so located as to provide adequate electrical clearances between bushings and grounded parts. Bushings of identical voltage rating shall be interchangeable. All bushings shall be equipped with suitable terminals of approved type and size & shall be suitable for bimetallic

connection. The insulation class of the high voltage neutral bushing shall be properly coordinated with the insulation class, of the high voltage winding. Each bushing shall be so coordinated with the transformer insulation so that all flash over will occur outside the tank. All main winding and neutral leads shall be brought out through “out door” type bushings which shall be so located that the full flashover strength will be utilized and the adequate phase clearance shall realised. All porcelain used in bushings shall be of the wet process, homogeneous and free from cavities or other flaws. The glazing shall be uniform in colour and free from blisters, burrs and other defects.

7.4.1.10 HT BUSHING:

Provide 3 porcelain outdoor type, oil filled, impulse tested bushing with arcing horns of standard gap and bolted type terminal connectors, with head shrink rubber insulated cap suitable for connection to the incomes leads of 1Cx500 Sq.mm Cu. XLPE cable per phase.

7.4.1.11 LT BUSHING:

Provide 4 porcelain outdoor type bushing with bolted type connectors, suitable for connection to outgoing leads of 2x1Cx630 Sq.mm Cu. XLPE cable per phase and suitable for head shrink termination.

7.4.1.12 FAULT CONDITIONS:

The transformer shall be capable of withstanding, on any tapping, for three seconds without damage an external short circuit between phases. The transformer winding shall be capable of withstanding for three seconds without damage a short circuit between one phase and earth with the neutral of the transformer directly earthed. For the purposes of this clause a fault level of 1800 MVA at the transformer 33KV terminals shall be assumed.

Evidence shall be submitted with the Tender as to the extent to which the manufacturer has provided or is able to prove either by calculation or test the ability of the specified transformers to withstand on any tapping, without damage under service conditions, the terminal and dynamic effects of external short circuit.

The Bid shall state tin the Technical Schedule a brief description of those transformers or parts thereof, which have been subjected to short circuit tests or for which short circuit calculations are available. It is preferred that this information relates to designs comparable with the transformers bidder but in the event this is not so the Engineer reserves the right to require calculating to prove that the design of transformers tendered will satisfactorily comply with this clause : such calculations being in accordance with the latest revision of IEC/ BS standard.

7.4.1.13 NOISE:

Vibration and noise levels of all transformers and auxiliary plant shall be in accordance with the IEC 551 and its latest version. The contract price shall include noise level tests to be carried out on one transformer.

7.4.1.14 HARMONIC SUPPRESSION:

Transformer shall be designed with particular attention to the suppression of harmonic voltages especially the third and fifth harmonics and to minimize the detrimental effects resulting there from.

7.4.1.15 IMPEDANCE AND REGULATION:

The Bidder shall be state in the Technical Schedules guaranteed values of impedance measured on normal and extreme tapping and the voltage regulation from no load to CMR at unity power factor and at 0.9 lagging power factor with constant voltage across the higher voltage windings.

7.4.1.16 MAGNETIC CIRCUIT:

The design of the magnetic circuit shall be such as to avoid static discharge development of short circuit paths internally or to the earthed clamping structure and the production of flux components normal to the plane of the laminations. Each lamination shall be insulated with a material stable under the action of pressure and hot oil.

The winding structure and major insulation shall be designed to permit an unobstructed flow of cooling oil through core cooling oil ducts to ensure efficient core cooling.

The magnetic circuit shall be insulated from all structural parts and shall be capable of withstanding a test voltage to core bolts and to the frame of 2000 volts rms for one minute.

7.4.1.17 FLUX DENSITY:

Cores shall constructed from clod rolled grain oriented steel sheets. Provided the contractor can provide adequate evidence that there will be no adverse effects due to stray flux heating of core with the quality of steel employed, designs may be offered such that when operating under the most onerous conditions, flux density in any part of the magnetic circuit does not exceed 1.7 Tesla.

The Contractor shall determine the operating conditions under which the maximum flux density will be attained within the following simultaneously applied limits.

- Frequency : 50 Hz
- LV and HV : Up to but not exceeding the specified maximum System voltage.
Voltage
- Load : The transformer may be subjected to intermittent overloading of 150% rated MVA at 0.8 power factor lagging in accordance with IEC-60035.

The maximum flux densities anticipated under these conditions are to be stated in Technical Schedules (GTP).

- a) The windings shall be of high-conductivity electrolytic copper.
- b) The transformer windings shall have uniform insulation as defined in the latest revision of IEC standard. The insulation of the coils shall be such as to develop the full electrical strength of the windings. All materials used in the insulation and assembly of the windings shall be insoluble, non-catalytic and chemically inactive in the hot transformer oil, and shall not soften or otherwise be adversely affected under the operating conditions.
- c) The transformers shall be designed to withstand the impulse voltage levels and the power frequency voltage tests specified in the Technical Schedules.
- d) The winding shall be located in a manner which will ensure and that they remain Electro-statically balanced and that their magnetic centers remain coincident under all conditions of operation.
- e) The winding shall also be thoroughly seasoned during manufacture by the application of axial pressure at a high temperature for such length of time as will ensure that further shrinkage is unlikely to occur in service.
- f) All electrical connections within windings shall be brazed to withstand the shocks, which may occur through rough handling and vibration during transport switching and other transient service conditions.
- g) Coil clamping rings shall be of the on on-magnetic steel or insulating materials built up from flat laminations. Auxiliary laminated material other than Bakelite paper is not to be used. Where Bakelite paper rings are used with the layers of paper lying in the axial direction, the rings may be relied upon to provide the major insulation between the windings and frame subject to there being adequate creepage distance. Any metal pieces in contact with laminated rings shall be designed and secured so that they do not weaken the electrical or the mechanical properties of the rings. If the winding is built up of section or of disc-coils separated by spacers, the clamping arrangement shall be ensure that equal pressure are applied to all columns of spacers.
- h) The winding shall be so designed that all coil assemblies of identical voltage ratings shall be interchangeable and field repairs can be readily done, without special equipment. The coils shall be supported between adjacent sections by insulating spacers and the barriers, bracings and other insulation used in the assembly of the windings shall be arranged to ensure a free circulation of the oil and to reduce hot spots in the windings. The insulation paper shall be of high quality and the value of degree of polymerization shall not be less than 1200 dp and the necessary test certificate shall be submitted along with the Pre -delivery inspection report. Provision shall be made in the tank, for taking sample, in future, of paper for testing purpose and location shall be easily accessible and indicated on the transformer tank by affixing special caution plate.

7.4.1.19 INTERNAL EARTHING ARRANGEMENT:

All metal parts of the transformer with the exception of the individual core lamination, core bolts

and associated individual clamping plates, shall be maintained at some fixed potential.

The top main core clamping structure shall be connected to the tank body by a copper strap and the bottom main core clamping structure shall be earthen by one or more of the following methods:

- by connection through vertical tie rods to the top structure.
- by direct metal-to-metal contact with the tank base maintained by the weight of the core and windings.
- by connection to the top structure on the same side of the core as the main earth connection to the tank.

The magnetic circuit shall be earthed to the clamping structure at one point through a removable link placed in an accessible position just beneath an inspection opening in the tank cover and which, by disconnection, will enable the insulation between the core and clamping plates, etc. to be tested at voltages up to 2 KV for the purpose of checking deterioration during service. The connection to the link shall be on the same side of the core as the main earth connection. These requirements are mandatory.

Magnetic circuits having an insulated sectional construction shall be provided with a separate link for each individual section and the arrangement of the connections shall be subject to the approval of the Engineer.

Where oil ducts or insulated barriers parallel to the plane the laminations divide the magnetic circuits into two or more electrically separates parts, the ducts and insulating barriers which have the thickness greater than 0.25, mm are to be bridged with tinned copper strips so inserted as to maintain electrical continuity.

Where coil-clamping rings are of metal at each potential, each rings shall be connected to the adjacent core clamping structure on the same side of the transformer as the main earthing connection.

Main earthing connections shall be a cross-sectional area of not less than 100mm² but connections inserted between laminations may have cross sectional areas reduced 20mm² when in close thermal contact with the core.

7.4.1.20 CORE

The core shall be constructed from high grade cold rolled non-ageing grain oriented silicon steel laminations, M4 or Superior Grade. Only prime quality CRGO sheets should be used in the transformers and no Second/Defective/Scrap CRGO finds way into transformers. Therefore regarding quality control following documents are to be furnished with the Post – delivery inspection report.

1. Invoices of supplier
2. Mill's test certificate
3. Packing list.
4. Bill of lading
5. Bill of entry certificate by custom
6. Description of material, electrical analysis, Physical inspection, certificate for surface defects, thickness and width of the material.

It is to note that, using seconds/defective CRGO sheets or load losses found to be more than stipulated limit, heavy penalty will be imposed or the suppliers will be black listed.

7.4.1.21 TRANSFORMER TANK

The Transformer Tank shall be welded construction fabricated from high tensile steel plate and shall be designed to withstand full vacuum. The transformer shall have air seal type oil conservator tank at the top.

- a) The transformer tank and cover shall be fabricated from good commercial grade low carbon steel suitable for welding and of adequate thickness.
- b) The transformers tank shall be capable of withstanding full vacuum without deflection.
- c) The plates (tank & Cover) shall have the following minimum thickness.

Length of Transformer Tank	Minimum Thickness	
	Side Plates	Bottom Plates
Less than 2500 mm	Min 6 mm	Min 9 mm
Greater than 2500 mm	Min 9 mm	Min 12 mm

- d) The base of each track shall be so designed that it is possible to move the complete transformer unit in any direction without injury when using rollers, plates or rails. A design, which required that slide rails be placed in a particular position, is not to be used. 20/26.66 MVA and lower rate transformers shall be provided with base plates having bi-directional wheels for placing on rails.
- e) An inspection window with a welded flange & a bolted cover shall be provided on the tank cover. The manhole shall be of a sufficient size to ease access to the lower ends of the bushings, terminals etc.
- f) Lifting eyes or lugs shall be provided on all parts of the transformers requiring independent handling during assembly or dismantling. In addition, the transformer tank shall be provided with lifting lugs and bosses properly secured to the sides of the tank for lifting the transformers either by crane or by jacks. The design of the tank, the lifting lugs and bosses shall be such that the complete transformer assembly filled with oil can be lifted with the use of those lugs without any damage or distortions.
- g) The tank shall be provided with two suitable copper alloy or any other suitable material lugs for the purpose of grounding.

- h) The tank shall be so designed that with the cores and windings in position there shall be no possibility of air or gas being trapped when filling the tank with oil. Likewise, water shall not be trapped on the exterior of the tank.
- i) The tank shall be fitted with pockets for a thermometer and the bulb of a winding temperature indicator and an oil temperature indicator.
- j) Necessary drain valves, filter valves, vales to take oil sample etc shall be provided.

7.4.1.21.1 Conservator Tank

A conservator tank shall be mounted above the highest point of the oil circulating system of the equipment. Tanks shall be formed of substantial steel plate. Connections between the main tank and the conservator shall be such that air or gas is not entrapped and the Buchholz relays can be correctly installed. One end of the conservator shall be fixed by bolts so that it can be removed to enable the tank to be cleaned. The capacity of each conservator tank shall be adequate to accommodate the expansion and contraction of oil in the whole system, over the extreme range possible in operation, i.e. equipment unenergised in an ambient temperature of 5 deg. C to the condition corresponding to maximum oil temperature rise. Conservator shall be fitted with:-

(a) A hydro compensator for separating oil and air. A dehydrating breather shall be used for the air intake of the hydro compensator. Alarm for leak of the hydro compensator shall also be provided.

(b) At least one magnetic oil level indicator type visible from ground level and indicating the oil levels over the range specified above. The oil level indicator shall be marked to indicate the correct oil level with the oil at a temperature of 5 deg. C, 30 Deg. C and 90 deg. C. The temperature markings shall preferably be integral with the level indicating device but subject to the approval of the Authority.

(c) Low oil alarm initiating device.

7.4.1.21.2 Pressure Relief Device

The transformer shall be fitted with a pressure relief device designed to protect the tank from damage and to control the expulsion of oil during an internal fault. The pressure relief device shall be of the spring-loaded diaphragm type capable of opening fully within two milliseconds of detecting an excess pressure, and shall fully reseal after release of the exceeded pressure. Corrosion resistant materials shall be used and a visual indication of operation shall be provided. Two pairs of normally open contacts and a suitable terminal box shall be provided for remote electrical indication and tripping.

7.4.1.21.3 Gaskets

Any gaskets provided with the transformers shall be suitable for making oil tight joints, and there shall be no deleterious effects of either gaskets or oil when the gaskets are continuously in contact with hot oil. No gaskets shall be used in which the material of the gasket is mounted on a textile backing. Exterior gaskets shall be weatherproof and shall not be affected by strong sunlight.

7.4.1.22 Oil

All transformers shall be filled to the required level with new, unused, clean, standard mineral oil after treatment in compliance with IEC 60296 & BS 148.

7.4.1.23 ACCESSORIES

7.4.1.23.1 Winding Temperature Indicator

The transformer shall be provided with a winding temperature indicator and combined alarm and trip relays of approved design. The alarm and trip settings shall be adjustable. The winding Temperature Indicator shall also be provided with additional contacts for automatic 'start/stop' of cooling plant (fans). It shall be fitted with dial indicator calibrated in degrees Celsius and fitted with a hand reset pointer the highest temperature attained. The winding temperature indicator shall be so mounted in the transformer marshalling kiosk so that the dial is not more than 1500 mm from ground level. The cover shall be equipped with a viewing aperture of adequate size, fitted with clear, reinforced glass.

7.4.1.23.2 Oil Temperature Indicators

The transformer shall be provided with an oil temperature indicator of approved design incorporating contacts and relay(s) for initiating alarms and trips. The indicator shall be fitted with a dial calibrated in degrees Celsius, with a hand reset pointer to register the highest temperature attained.

The oil temperature indicator shall be mounted in the transformer marshalling kiosk so that the dial is not more than 1500 mm from the ground level and the cover shall be equipped with viewing aperture of adequate size, fitted with clear, reinforced glass.

7.4.1.23.3 Buchholz relay

A Buchholz relay with alarm and tripping contacts to detect accumulation of gas and sudden changes of oil pressures, complete with two shut-off valves and flange coupling to permit easy removal without lowering oil level in the main tank, a bleed valve for gas venting and test valve shall be provided. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation & taking gas sample.

7.4.1.23.4 Breathers

Each transformer and tap changer conservator shall be provided with a silica gel breather complete with oil seal, oil level indication window and a sight glass for inspection of the silica gel. Due to the climatic conditions at site, this breather shall be liberally sized and one size larger than would be fitted for use in a temperate climate.

A visual indication of the extent to which the drying agent has absorbed moisture is preferred, showing how much active material remains effective.

Maintenance free breather shall have sensor controlled heating apparatus. The supply voltage shall be 230V AC. Adequate cable shall be provided to connect with marshalling box.

7.4.1.23.5 Padlocks

The supplier shall provide padlockable handles and non-ferrous padlocks with duplicate keys for tap changer control panel and kiosks door to prevent all unauthorized access and operation.

7.4.1.23.6 The other accessories shall be provided is listed below

- a) Ladder permanently fixed with transformer tank
- b) Dial Thermometer with pocket for oil temperature indicator with one set of alarm and one set of trip contacts and maximum reading pointer.

7.4.1.24 Marshalling Kiosk (box):

Marshalling box shall be connected at one side of transformer. It shall consist of WTI (winding temperature indicator) and OTI (oil temperature indicator), magnetic oil gauge and Buchholz relay and other control terminals. WTI are in two numbers, one for HV and other for LV. It shall also consist of all auxiliary contactors as required in the order to make necessary potential free contacts for remote alarm and tripping, a heater which is used to absorb the moisture in the box, SPN socket outlet, complete with switch and HRC fuse for hand lamp connection.

7.4.1.25 Painting

The minimum standards acceptable are :

- a) cleaning by shot blasting to Grade Sa 2.5 of ISO 8501-1
- b) All sheet steelwork shall be degreased, pickled and phosphated in accordance with IEC 60076.
- c) Interior surface of mechanism chambers, boxes and kiosks, after preparation, cleaning and priming shall be painted with one coat of zinc chromate primer, one coat of phenolic based undercoating, followed by one coat of phenolic based finishing paint to white colour followed by a final coat of anti-condensation white paint of a type and make to the approval of purchaser. A minimum overall paint film thickness of 150 microns shall be maintained throughout.
- d) Exterior steel work and metalwork, after preparation and priming shall be painted with one coat of zinc chromate primer, one coat of phenolic based under coating and two coat of micaceous iron oxide paint, then painted with final coat of phenolic based hard gloss finishing paint of the light grey shade to provide an overall minimum paint thickness of 200 microns.

7.4.1.26 Galvanizing

All galvanizing shall be carried out by the hot dip process, in accordance with specification ISO 1460. However, high tensile steel nuts, bolts and spring washers shall

be electro galvanized. The zinc coating shall be smooth, continuous and uniform. It shall be free from acid spots and shall not scale, blister or be removable by handling or packing. There shall be no impurities in the zinc or additives to the galvanic bath which could have a detrimental effect on the durability of the zinc coating.

Before pickling, all welding, drilling, cutting, grinding etc must be complete and all grease, paint, varnish, oil, welding slag etc completely removed.

The weight of zinc deposited shall be in accordance with the stated in BS 729, ISO 1460 and shall be not less than 0.61Kg/sq. mtr. with minimum thickness of 86microns for items of thickness more than 5mm, 0.46Kg/sq.mtr. (64microns) for items thickness between 2mm and 5 mm and minimum 0.33kg/sqmm (47microns) for the item less than 2mm thick. Repair of galvanizing on site will generally not permitted.

7.4.1.27 Terminal marking

Each terminal including the neutral shall be clearly marked on both the primary and secondary side in accordance with the diagram of connection supplied with the transformers.

The terminal marking shall be clear and permanent. Painted markings are not acceptable. The winding shall be leveled as follows:

High voltage	:	3 phases	A B C
Low voltage	:	3 phases and neutral	a b c n

7.4.1.28 EVALUATION CRITERIA

- a) The Tenders will be evaluated on the basis of the capitalized cost of the Transformer losses.
- b) Bidder will declared/ guaranteed No-Load loss and Full load loss value, otherwise the bid will be **rejected**.
- c) Bidders declared/ guaranteed percentage impedance value shall be within the specified value, otherwise the bid will be **rejected**.

7.4.1.29 Acceptance criteria of transformer loss and percentage impedance during factory test:

Transformer will be tested during technical orientation & quality acceptance and will be accepted if the measured transformer losses are within the offered value or within the following tolerance with deduction of amount from the contract price as below:

- i) Any component loss (No load loss or Full load loss) may exceed up to 15% of the offered component loss, provided that the total loss (No load loss + Full load loss) shall not exceed 10% of the offered total loss. If any component loss exceeds 15% of the offered component loss, the full consignment will be rejected.
- ii) Total loss (No load loss + Full load loss) may exceed up to 10% of the offered total loss. If it exceeds 10%, the full consignment will be rejected.
- iii) Percentage Impedance may vary up to $\pm 10\%$ of the specified value. If the value exceeds the tolerance ($\pm 10\%$), the full consignment will be rejected.

Transformer will be tested during factory test witness and will be accepted if the measured transformer losses are within the offered value or within the acceptable limit as specified in (i), (ii) and (iii) provided an amount will be deducted from the Contract price for the loss(s) exceeding the offered/declared loss(s) according to the following formula:-

Amount to be deducted from the Contract price

$$= \text{Contract Price} \times \left\{ \frac{\text{Measured loss} - \text{Specified loss /declared loss}}{\text{Specified loss/declared loss}} \right\} \times \%MT$$

Where,

Measured Loss (in KW)	Measured Average No load Loss* 1+ Measured Average Full Load Loss* 2.
Offered Loss (in KW)	Offered No Load Loss + Offered Full load loss
Transformer Economic Life	20 Years

%MT (Percentage of Monetized Transformer) = % of the Monetized Transformer found during factory test witness by BPDB's inspection team whose measured loss(s) (No load loss or Full load loss or Both) exceed the offered loss (No load loss or Full load loss or Both) but remain within acceptable limit. For example : If total no. of transformers to be inspected is 80 and the no. of selected transformers during QAT/pre-delivery inspection is 8, 6 nos. are found within the offered losses and 2 nos. are found exceeding the offered losses then the %MT will be $(2/8) \times 100 = 25\%$

* 1 Measured Average No Load Loss = [Sum of the measured No-load losses of the tested transformer(s) exceeding the offered No-load loss ÷ Nos. of tested transformer(s) which exceeds the offered No-load loss]

* 2 Measured Average Full Load Loss = [Sum of the measured Full-load losses of the tested transformer(s) which exceeding the offered Full-load loss ÷ Nos. of tested transformer(s) which exceeds the offered Full-load loss]

7.4.1.30 Mandatory SPARE PARTS

As per Price Schedule.

7.4.1.31 Approval of Drawings

The supplier shall submit the following drawings in AutoCAD format and in hard copy for the approval of the purchaser within commencement period.

1. Full Technical Specification and Guaranteed Technical Particulars
2. Max. Temp. Rise of Winding & Oil over 40°C ambient supported by Load Losses and Heat Dissipation by Radiator and also Short Circuit Calculation along with thermal & mechanical calculations on the basis of proposed Design Data.
3. General outline drawing showing front, side elevation and plan of the transformer and accessories with detailed dimensions. The clearances between HV and LV terminals and ground should also to be shown.
4. Drawings of each type of bushings, lifting dimensions, clearance between HT and LT terminals and ground, quantity of insulating oil, name plate details etc.

5. Large scale drawings of high and low-tension windings of the transformers showing the nature and arrangement of insulators and terminal connections.
6. Schematic control and annunciation wiring diagram for all auxiliary equipment (temperature indicator, alarm circuits, Buchholz relay, PRV, WTI, OTI, OLTC, cooling control etc, Schematic diagram showing the flow of oil in the cooling system, Large scale drawing of high and low tension winding of the transformer showing the nature and arrangement of insulation and terminal connections
7. Drawing/ Wiring diagram showing construction and mounting details of marshalling boxes.
8. Operation and maintenance guide for transformer and OLTC.
9. Detailed loading drawing to enable the Purchaser to design and construct foundations for the transformer.
10. Installation, Operation and maintenance manual along with troubleshooting procedure.

No work shall be performed in connection with the fabrication and manufacture of the Testing Equipment until the technical data and drawings have been approved. The manufacturing of the equipment shall be strictly in accordance with the approved drawings and no deviation shall be permitted without the written approval of the purchaser.

The cost of supplying drawings and specifications shall be borne by the supplier.

At the time of delivery of Equipment, the supplier shall supply three (3) sets of all approved technical data and drawings in bound book form along with manufacturer's original catalogue of the Equipment.

7.4.1.32 Tests at Manufacturers Works:

7.4.32.1 General

Functional electrical, material, mechanical and hydraulic tests shall be carried out at manufacturers' premises. The extent and method of recording the results shall be agreed by the Purchaser in ample time to enable the tests to be satisfactorily witnessed or to make any changes to the proposed program of tests.

7.4.1.32.2 Material Tests:

The supplier shall provide test pieces free of charge as required to enable the quality of the material to be determined at the supplier's expense. Purchaser may at its own discretion and by specific arrangement accept certified particulars of tests carried out in the absence of his authorized representative.

7.4.1.32.3 Type Test:

Type tests are required on all items to prove the general design of the goods offered. The Bidders shall submit the type test report of offered item from STL member testing laboratories.

7.4.1.32.4 ROUTINE TESTS:

All items shall be subjected to routine tests in accordance with the relevant latest version of IEC, BS & BDS standards at the manufacturers works and shall include, but not be limited to, an operational test.

7.4.1.33 TECHNICAL ORIENTATION AND QUALITY TEST WITNESS :

The following test shall be carried out as per latest version of IEC or equivalent standard unless otherwise mentioned at the manufacturer premises or other places where the test facilities are available:-

Acceptance Tests:-

1. Measurement of turn ratio test;
2. Vector group test;
3. Measurement of winding resistance;
4. Measurement of insulation resistance;
5. Measurement of no load loss & no-load current;
6. Measurement of impedance voltage & load loss;
7. Dielectric withstands Tests;
8. Transformer oil test;
9. Temperature rise test.
10. Separate source voltage withstand test.
12. Tap-changer operation test
14. Dimension and physical check.
15. Magnetic balance test.
16. 33kV & 11kV Bushing CT test (measurement of insulation resistance, polarity, ratio, burden, knee voltage & current, CT secondary winding resistance etc.
17. OTI, WTI, Buchholz, PRD etc. measurement meters and devices calibration & operational functionality check.

The purchaser can carry-out the testing of any no. of transformers during Quality Test Witness. But, the testing of transformers during Quality Test Witness will not be less than 10% at random basis of the transformer ready for inspection but in any case it will not be less than 3 nos. The manufacturer will provide all arrangements for the testing of transformers desired by the purchaser in his factory.

Where the supplier provides for tests on the premises of the supplier or of any manufacturer of the supplier, except where otherwise specified, shall provide free of charge such assistance, labor, materials, electricity, fuel, stores, apparatus and instruments as may be requisite and as may be reasonably demanded to carry out such test efficiently. These test shall be performed as per relevant IEC/BS Standard or equivalent and only routine tests as agreed upon, will be performed.

As and when the purchaser is satisfied that any materials/equipment shall have passes the tests referred to in this clause, purchaser shall notify the contractor in writing to that effect.

Should any inspected/tested goods fail to conform to the specification, the Purchaser shall have the right to reject any of the item or complete batch if necessary. In that case Supplier have to replace the Equipment and to make good of them without any financial involvement to the Purchaser. In case any of the Equipment found not conforming with the specification at the time of post landing Inspection, the supplier will in no way be relieved from the responsibility of replacing them on making them good at their own cost, despite the Equipment were found good at the time of Factory Acceptance Test. Nothing in this clause shall in any way release the supplier from any warranty or other obligations under the contract.

No goods shall be packed, prepared for shipment/delivery unless it has been approved and written instruction has been received by the Purchaser.

7.4.1.34 POST LANDING INSPECTION:

Post landing inspection shall be done immediately after arrival of the goods/materials at the designated store of BPDB; the Engineer & representative from consignee shall conduct Post Landing Inspection in presence of the representative of Supplier. The program of such inspection shall be intimated to the representative of Supplier by BPDB upon arrival of the materials at BPDB store of the Inspector(s) to be selected for test witnessing. Any defect or damage have been found at post-delivery inspection, the defective or damaged panels/materials/ goods to be repaired/ replaced by the Bidder/ supplier at his own cost.

7.4.2 Technical Specification of 33/11 KV, 16/20 MVA Power Transformer

7.4.2.1 GENERAL

This section of the document includes the design, engineering, manufacture, supply, delivery, offloading, testing & inspection and performance requirements of 33/11KV, 16/20 MVA Power transformers and accessories as specified.

7.4.2.2 CLIMATE DATA

The distribution transformers to be supplied against this tender shall be suitable for satisfactory use under the following climatic condition:

Climate	:	Tropical, intense sunshine, heavy rain, humid.
Maximum Temperature	:	40 ⁰ C
Minimum Temperature	:	03 ⁰ C
Maximum yearly weighted average temperature	:	30 ⁰ C
Relative Humidity	:	50-100%

Annual mean Relative Humidity	:	75%
Average annual rain fall	:	3454 mm
Maximum wind velocity	:	200 km/ hour
Maximum altitude above the sea level	:	Sea level to 300 metres
Atmospherically, Mechanical and Chemical impurities	:	Moderately polluted

The information is given solely as a guide for Tenders and no responsibility for its, accuracy will be accepted nor will any claim based on the above be entertained.

Transformer supplied under this contract will be installed in tropical locations that can be considered hostile to its proper operation. Particular problems that shall receive special consideration relate to operation in a hot environment and presence of the insects and vermin.

7.4.2.3 SYSTEM PARTICULARS

SL. NO.	SYSTEM CHARACTERISTICS	VOLTAGE LEVEL			
		230	132	33	11
1.	Normal System Voltage, kV (Voltage Class)	230	132	33	11
3.	Maximum System Voltage, kV	245	145	36	12
4.	System Frequency, Hz	50	50	50	50
5.	Phase Rotation (Anti-Clock wise)	RST	RST	RST	RST
6.	Type of System Grounding	Solid	Solid	Solid	Solid
7.	Rated Fault Level (3-Phase Symmetrical), MVA 3 sec.	16000	6000	1800	500
8.	Basic Insulation Level, kV	750	650	170	75

High Voltage current carrying equipment should be capable of carrying the three phase fault level for a period of 3 Sec

7.4.2.4 STANDARDS

The equipment specified in this Section of the contract shall conform to the latest edition of the appropriate IEC specifications and other recognized international standard. In particular:

IEC	60076-1	Power transformers (General).
IEC	60076-2	Power transformers (Temperature Rise).
IEC	60076-3	Power transformers (Insulation Levels, Dielectric Tests and External Clearance in air).
IEC	60076-5	Power transformers (Ability to Withstand short circuit)
IEC	60137	Bushings for alternating voltages above 1 kV.
IEC	60156	Method of determination of electrical strength of insulating oils
IEC	60296	Specification for unused mineral insulating oils for transformers and switchgear.
IEC	60551	Measurement of transformer and reactor sound levels.
IEC	60616	Terminal and tapping markings for power transformers.
IEC	722	Guide to lightning and switching impulse testing of power transformers.
IEC	5493	Protective coating of iron and steel structures against corrosion.

IEC	551	Noise and Vibration of power transformer.
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7.4.2.5 Technical Specification:

1.	Rated MVA (ONAN/ONAF)	16/20MVA
2.	Number of Phases	3 (Three)
3.	Frequency	50 Hz
4.	Winding Insulation	Uniform
5.	Normal Transformation Ratio at No-load	33/11.55 KV
6.	Rated HT Voltage (Phase to Phase)	33 KV
7.	Maximum HT Voltage (Phase to Phase)	36 KV
8.	Rated LT Voltage (Phase to Phase)	11 KV
9.	Maximum LT Voltage (Phase to Phase)	12 KV
10.	Rated Current HT (ONAN/ONAF)	280/ 350 Amps
11.	Rated Current LT (ONAN/ONAF)	840/1050 Amps
12.	Basic Insulation Level : a) High voltage winding b) Low voltage winding	170 KVp 75 KVp
13.	Installation	Outdoor, Tropical, High rainfall & Humidity.
14.	Type	Core, Conservator & Oil Immersed
15.	Type of Windings	Double Wound of Electrolytic Copper, free from burs and splinter.
16.	Type of Cooling	ONAN/ ONAF
17.	Coolant	Type- A, Unused insulating mineral oil, free from PCB (polychlorinated biphenyl)
18.	Type of System Earthing	Effectively Earthed
19.	Bushing Material	Porcelain
20.	Type of Base	On Wheels On wheels with adequate size and 10M length of rails and fixing arrangement.
21.	Direction of Normal Power Flow	HT-LT
22.	Phase connection :(Δ -Y) a) 33 KV winding with bushing CT b) 11 KV winding with bushing CT	Delta Star
23.	Vector Group	Dyn11
24.	Neutral to be brought out : a) HT b) LT	Nil Yes
25.	Neutral Insulation	Full uniform insulation and 100% loading capacity.
26.	Maximum Temperature rise over 40 ⁰ C ambient at full load & tap change is at normal position : a) Winding by Resistance (⁰ C) b) Oil by Thermometer (⁰ C)	65 ⁰ C 55 ⁰ C
27.	Impulse Front Wave Test Voltage (1.2/50 Micro Sec. Wave Shape) :	

	a) High voltage side b) Low voltage Side	170 KVp 75 KVp
28.	Power Frequency withstand Test Voltage for 1 (one) Minute : a) High voltage side b) Low voltage Side	70 KV 28 KV
29.	Impedance Voltage at 75 ⁰ C, at normal ratio and rated frequency, and at ONAN condition.	8.5%
30.	Type of tap changer control	
	Features	The tap changer will be on load auto regulation, remote control and manual. The on load tap changer will immersed in the transformer tank. The diverter switch compartment will be provided with its own oil conservator which, will not be connected to the transformer oil tank. The diverter switch can easily be lifted out of its tank for maintenance and inspection without opening the transformer cover. The on load tap changer will operate by means of a motor drive unit. This unit will install on the side of the transformer.
		OLTC shall be operational from Local control panel, RTCC panel as well as from SAS. Tap position shall also be visible in Local control panel, RTCC panel as well as HMI of SAS. AVR relay shall have IEC-61850 communication protocol for communicating with SAS
	On Load Tap changer with motor drive unit manufacturer's name & country	MR, Germany/ ABB, Sweden/ HM, China.
	Tapping Range : a) HT b) LT	17 Tapping \pm 10% in steps of 1.25% i.e. 33 KV \pm 8 x 1.25% Nil
31.	Bushing CT for differential protection	400/5A on HV, 1200/5A on LV of accuracy class 5P20, burden 30 VA.
32.	Neutral Bushing CT for Standby Earth Fault (SEF) & Restricted Earth Fault (REF) protection	1200/5-5A on LV neutral of accuracy class 5P20, burden 30 VA.
33.	Standard	Design, Manufacture, Testing, Installation and Performance shall be in accordance to the latest editions of the relevant IEC standards.
34.	Transformer Oil	
	Application	Insulating mineral oil for Transformer It will be free from PCB (polychlorinated biphenyl)
	Grade of oil	Type-A
	PHYSICAL PROPERTIES	

Appearance	Liquid and free from suspended matter or sediment
Density at 20 ⁰ C	0.895 g/cm ³ (maximum)
Flash point (Closed cup)	140 ⁰ C (minimum)
Kinematics Viscosity at -15 ⁰ C	800 c St. (Maximum)
Kinematics Viscosity at 20 ⁰ C	40 c St. (Maximum)
Pour point	-30 ⁰ C (maximum)
ELECTRICAL PROPERTIES	
Dielectric Strength at 50 Hz (with 2.5 mm standard gap and 40 mm standard depth)	New untreated oil, shall go through filtration treatment before the oil are introduce into the apparatus or equipment. The break down voltage of this oil shall be at least 50KV.
Loss tangent/Dielectric dissipation factor at temp. 90 ⁰ C, stress 500V/mm to 1000 v/mm and frequency 40 Hz to 62 Hz.	0.005 (maximum)
CHEMICAL PROPERTIES	
Neutralization value	0.03 mg KOH/g (maximum)
Neutralization value after oxidation	0.40 mg KOH/g (maximum)
Total sludge after oxidation	0.10% weight (maximum)
PCB Content	Free from PCB
STANDARDS	Performance and testing of oil shall comply with the latest revision of the relevant standards BS 148 : 1972, IEC-60296 or latest revision there on.
35.	FEATURES & ACCESSORIES OF TRANSFORMER:
	<ul style="list-style-type: none"> a) Bushing Insulator on HT and LT. b) Arcing horns on HT and LT bushings. c) Supply of Remote Tap Changer Control (RTCC) facility as per technical specification & GTP. d) Oil conservator. e) Buchholz relays in main conservator oil pipe. f) Tap Changer Protective Relay in between conservative and tap changer oil pipe. g) Conservator drain valve, breather and oil level gauge with alarm contact. h) Pressure Relief Device (PRD). i) Dial type thermometers with alarm and trip contracts. j) CT for winding temperature shall be located at mid-phase (Y-phase) of the transformer. k) Radiators with valves. l) Bladder/Airbag in conservator to separate air from oil. m) One inspection hole with cover. n) Facilities for lifting cover and coil assembly from tank. o) Lifting lugs for lifting complete Transformer. p) Base designed for rollers with bi-directional flanged rollers parallel to either Centre line. q) Tank oil sampling, draining valve and oil centrifuging outlets.

	<ul style="list-style-type: none"> r) Tank earthing points. s) Fans for forced cooling (ONAF). t) All mounting accessories including rails (2 Nos. rails each 10 Meter long). u) All equipment should be fully tropicalized. v) Painting to approved colour and shade. w) Rating nameplate and diagram plate of stainless steel having engraved letters filled with black enamel paint. x) The oil shall be supplied/ delivered in non-returnable sealed containers/ drums. y) The oil shall be fresh, unused, cleaned and free from suspended matter or sediment. z) The test shall be carried out on the oil as to be supplied without drying and degassing. aa) Inhibited oils must not contain anti-oxidant additives. bb) Laminated, detailed Schematic Diagram of Control Circuit of Transformer & Tap changer inside Marshalling kiosk. cc) Dehydrating Silica-gel breather. dd) Air release plug. ee) Earthing terminals with lugs. ff) Thermometer pockets. gg) Winding temperature indicator with two contacts hh) Bottom mounting channel for 16/20 MVA ii) Operation and maintenance manual along with troubleshooting procedure and installation guideline/manual shall be supplied with each transformer.
<p>36</p>	<p>Transformers shall be provided with cable boxes for both HV and LV terminals to enable cable connection directly. Cable boxes shall be completed with all necessary fittings in which primary and the secondary bushings shall preferably be of horizontal orientation to ease the cable termination. Cable boxes shall be adequate proportions and designed in accordance with BS6435 or relevant other international standard in such a manner that they can be opened for inspection without disturbing the gland plate or incoming cables(s). Provision for connection of two cables per phase shall be provided.</p> <p>Cable boxes shall be designed for ease of access for jointing and connecting the cable. They shall be constructed to minimize the danger of fragmentation; cast iron boxes shall not be used. Disconnecting links shall be provided in the boxes to facilitate testing of the transformer and cables independently.</p> <p>The Cable boxes shall be of such a design as to prevent ingress of moisture. The Contractor shall guarantee (test certificates shall be supplied as proof) that the air clearances and the creep age path on the bushing connecting to the transformers shall be such that the completed installation shall withstand in air the impulse and power frequency test voltages.</p>

37	Following instructions to be followed for Submission of Test reports & Calculation:
	<p>aa) All Type test Report and related routine test report shall be of same transformer of same name plate serial no.</p> <p>bb) Calculation of load loss shall be provided for load loss in all 3(three) tap position (Nominal, Maximum, Minimum).</p>

7.4.2.6 (A) INFORMATION REQUIRED

The Tenderer/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information/Documents have to be submitted along with the tender:-

- a) The Tenderer/Manufacturer shall submit with the bid the testing procedure & list of testing/ measuring equipment, meters etc. used for Factory test witness.
- b) Construction, Installation, Operation & Maintenance Manual.

7.4.2.7 CAPITALIZED COST:

Bidder shall declare guaranteed No Load Loss and Full Load Loss value in GTP. Any Tenderer quoted the No Load Loss & Full Load Loss above the upper limit of the loss as mentioned in GTP in Tender Document will not be considered for further evaluation & treated as non- responsive. The Tenderer who will quote the No Load Loss & Full Load Loss below the lower limit of No Load Loss & Full Load Loss as mentioned in GTP. In that case during evaluation Capitalization cost will be calculated only on the basis of the lower limit of No Load Loss & Full Load Loss. Tenderers quoted No load Loss and Full load loss shall be supported by loss calculation, otherwise the bid will also be treated as non- responsive.

The fixed and running losses are to be low as consistent with reliable and economical use of materials. The cost of losses is to be minimized and the following capitalized parameters will be used in the evaluation of the transformer:

$$C = 68,706 \times e \times P_0 + 54,964 \times e \times P_{FL}$$

Where,

- C = Capitalized cost of transformer loss in Bangladesh Taka.
- e = Energy Cost, Tk. 6.00/KWh
- P_F = Full Load losses at rated voltage, normal ratio and rated frequency in ONAF condition at 75⁰C in KW + Auxiliary loss in KW
- P₀ = No load losses at rated voltage, normal ratio and rated frequency in KW

The cost of energy (C) will be added to the quoted prices to arrive at the evaluated cost of the transformer.

The contract will be cancelled if losses exceed the guaranteed value by an amount in excess of followings:

Total losses : 10%

Component : 15% of each component loss (Unless the total losses exceeds 10%).

7.4.2.8 SHIPPING:

All the delicate components shall be dismantled and packed in strong wooden boxes having inside lined with metallic sheets with proper sealing to protect the content from accidental direct exposure to weather during storage. The holes of the transformer tank shall be sealed with proper metal plate and gaskets to prevent leakage of oil and its contamination with atmospheric moisture. The transformer shall be shipped with radiators, busing conservator etc. dismantled but the tank filled with oil. The transformer oil from radiators and conservator shall be shipped in non-returnable drums. The bushing shall be shipped in oil sealed containers to avoid moisture absorption during shipment and storage. Oil shall be complying with IEC-60296.

7.4.2.9 BUSHING:

The bushings shall have high factor of safety against leakage to ground and shall be so located as to provide adequate electrical clearances between bushings and grounded parts. Bushings of identical voltage rating shall be interchangeable. All bushings shall be equipped with suitable terminals of approved type and size & shall be suitable for bimetallic connection. The insulation class of the high voltage neutral bushing shall be properly coordinated with the insulation class, of the high voltage winding. Each bushing shall be so coordinated with the transformer insulation so that all flash over will occur outside the tank. All main winding and neutral leads shall be brought out through “out door” type bushings which shall be so located that the full flashover strength will be utilized and the adequate phase clearance shall realized. All porcelain used in bushings shall be of the wet process, homogeneous and free from cavities or other flaws. The glazing shall be uniform in colour and free from blisters, burrs and other defects.

7.4.2.10 HT BUSHING:

Provide 3 porcelain outdoor type, oil filled, impulse tested bushing with arcing horns of standard gap and bolted type terminal connectors, with head shrink rubber insulated cap suitable for connection to the incomes leads of 1Cx500 Sq.mm Cu. XLPE cable per phase.

7.4.2.11 LT BUSHING:

Provide 4 porcelain outdoor type bushing with bolted type connectors, suitable for connection to outgoing leads of 2x1Cx630 Sq.mm Cu. XLPE cable per phase and suitable for head shrink termination.

7.4.2.12 FAULT CONDITIONS:

The transformer shall be capable of withstanding, on any tapping, for three seconds without damage an external short circuit between phases. The transformer winding shall be capable of withstanding for three seconds without damage a short circuit between one phase and earth with the neutral of the transformer directly earthed. For the purposes of this clause a fault level of 1800 MVA at the transformer 33KV terminals shall be assumed.

Evidence shall be submitted with the Tender as to the extent to which the manufacturer has provided or is able to prove either by calculation or test the ability of the specified transformers to withstand on any tapping, without damage under service conditions, the terminal and dynamic effects of external short circuit.

The Bid shall state in the Technical Schedule a brief description of those transformers or parts thereof, which have been subjected to short circuit tests or for which short circuit calculations are available. It is preferred that this information relates to designs comparable with the transformers bidder but in the event this is not so the Engineer reserves the right to require calculating to prove that the design of transformers tendered will satisfactorily comply with this clause : such calculations being in accordance with the latest revision of IEC/ BS standard.

7.4.2.13 NOISE:

Vibration and noise levels of all transformers and auxiliary plant shall be in accordance with the IEC 551 and its latest version. The contract price shall include noise level tests to be carried out on one transformer.

7.4.2.14 HARMONIC SUPPRESSION:

Transformer shall be designed with particular attention to the suppression of harmonic voltages especially the third and fifth harmonics and to minimize the detrimental effects resulting there from.

7.4.2.15 IMPEDANCE AND REGULATION:

The Bidder shall be state in the Technical Schedules guaranteed values of impedance measured on normal and extreme tapping and the voltage regulation from no load to CMR at unity power factor and at 0.9 lagging power factor with constant voltage across the higher voltage windings.

7.4.2.16 MAGNETIC CIRCUIT:

The design of the magnetic circuit shall be such as to avoid static discharge development of short circuit paths internally or to the earthed clamping structure and the production of flux components normal to the plane of the laminations. Each lamination shall be insulated with a material stable under the action of pressure and hot oil.

The winding structure and major insulation shall be designed to permit an unobstructed flow of cooling oil through core cooling oil ducts to ensure efficient core cooling.

The magnetic circuit shall be insulated from all structural parts and shall be capable of withstanding a test voltage to core bolts and to the frame of 2000 volts rms for one minute.

7.4.2.17 FLUX DENSITY:

Cores shall be constructed from cold rolled grain oriented steel sheets. Provided the contractor can provide adequate evidence that there will be no adverse effects due to stray flux heating of core with the quality of steel employed, designs may be offered such that when operating under the most onerous conditions, flux density in any part of the magnetic circuit does not exceed 1.7 Tesla.

The Contractor shall determine the operating conditions under which the maximum flux density will be attained within the following simultaneously applied limits.

- Frequency : 50 Hz
- LV and HV Voltage : Up to but not exceeding the specified maximum System voltage.
- Load : The transformer may be subjected to intermittent overloading of 150% rated MVA at 0.8 power factor lagging in accordance with IEC-60035.

The maximum flux densities anticipated under these conditions are to be stated in Technical Schedules (GTP).

7.4.2.18 WINDINGS:

- g) The windings shall be of high-conductivity electrolytic copper.
- h) The transformer windings shall have uniform insulation as defined in the latest revision of IEC standard. The insulation of the coils shall be such as to develop the full electrical strength of the windings. All materials used in the insulation and assembly of the windings shall be insoluble, non-catalytic and chemically inactive in the hot transformer oil, and shall not soften or otherwise be adversely affected under the operating conditions.
- i) The transformers shall be designed to withstand the impulse voltage levels and the power frequency voltage tests specified in the Technical Schedules.
- j) The winding shall be located in a manner which will ensure and that they remain Electrostatically balanced and that their magnetic centers remain coincident under all conditions of operation.
- k) The winding shall also be thoroughly seasoned during manufacture by the application of axial pressure at a high temperature for such length of time as will ensure that further shrinkage is unlikely to occur in service.

- l) All electrical connections within windings shall be brazed to withstand the shocks, which may occur through rough handling and vibration during transport switching and other transient service conditions.
- m) Coil clamping rings shall be of the on on-magnetic steel or insulating materials built up from flat laminations. Auxiliary laminated material other than Bakelite paper is not to be used. Where Bakelite paper rings are used with the layers of paper lying in the axial direction, the rings may be relied upon to provide the major insulation between the windings and frame subject to there being adequate creepage distance. Any metal pieces in contact with laminated rings shall be designed and secured so that they do not weaken the electrical or the mechanical properties of the rings. If the winding is built up of section or of disc-coils separated by spacers, the clamping arrangement shall be ensure that equal pressure are applied to all columns of spacers.
- h) The winding shall be so designed that all coil assemblies of identical voltage ratings shall be interchangeable and field repairs can be readily done, without special equipment. The coils shall be supported between adjacent sections by insulating spacers and the barriers, bracings and other insulation used in the assembly of the windings shall be arranged to ensure a free circulation of the oil and to reduce hot spots in the windings. The insulation paper shall be of high quality and the value of degree of polymerization shall not be less than 1200 dp and the necessary test certificate shall be submitted along with the Pre-delivery inspection report. Provision shall be made in the tank, for taking sample, in future, of paper for testing purpose and location shall be easily accessible and indicated on the transformer tank by affixing special caution plate.

7.4.2.19 INTERNAL EARTHING ARRANGEMENT:

All metal parts of the transformer with the exception of the individual core lamination, core bolts and associated individual clamping plates, shall be maintained at some fixed potential.

The top main core clamping structure shall be connected to the tank body by a copper strap and the bottom main core clamping structure shall be earthen by one or more of the following methods:

- by connection through vertical tie rods to the top structure.
- by direct metal-to-metal contact with the tank base maintained by the weight of the core and windings.
- by connection to the top structure on the same side of the core as the main earth connection to the tank.

The magnetic circuit shall be earthed to the clamping structure at one point through a removable link placed in an accessible position just beneath an inspection opening in the tank cover and which, by disconnection, will enable the insulation between the core and clamping plates, etc. to

be tested at voltages up to 2 KV for the purpose of checking deterioration during service. The connection to the link shall be on the same side of the core as the main earth connection. These requirements are mandatory.

Magnetic circuits having an insulated sectional construction shall be provided with a separate link for each individual section and the arrangement of the connections shall be subject to the approval of the Engineer.

Where oil ducts or insulated barriers parallel to the plane the laminations divide the magnetic circuits into two or more electrically separates parts, the ducts and insulating barriers which have the thickness greater than 0.25, mm are to be bridged with tinned copper strips so inserted as to maintain electrical continuity.

Where coil-clamping rings are of metal at each potential, each rings shall be connected to the adjacent core clamping structure on the same side of the transformer as the main earthing connection.

Main earthing connections shall be a cross-sectional area of not less than 100mm² but connections inserted between laminations may have cross sectional areas reduced 20mm² when in close thermal contact with the core.

7.4.2.20 CORE

The core shall be constructed from high grade cold rolled non-ageing grain oriented silicon steel laminations, M4 or Superior Grade. Only prime quality CRGO sheets should be used in the transformers and no Second/Defective/Scrap CRGO finds way into transformers. Therefore regarding quality control following documents are to be furnished with the Post – delivery inspection report.

1. Invoices of supplier
2. Mill's test certificate
3. Packing list.
4. Bill of lading
5. Bill of entry certificate by custom
6. Description of material, electrical analysis, Physical inspection, certificate for surface defects, thickness and width of the material.

It is to note that, using seconds/defective CRGO sheets or load losses found to be more than stipulated limit, heavy penalty will be imposed or the suppliers will be black listed.

7.4.2.21 TRANSFORMER TANK

The Transformer Tank shall be welded construction fabricated from high tensile steel plate and shall be designed to withstand full vacuum. The transformer shall have air seal type oil conservator tank at the top.

- k) The transformer tank and cover shall be fabricated from good commercial grade low carbon steel suitable for welding and of adequate thickness.
- l) The transformers tank shall be capable of withstanding full vacuum without deflection.
- m) The plates (tank & Cover) shall have the following minimum thickness.

Length of Transformer Tank	Minimum Thickness	
	Side Plates	Bottom Plates
Less than 2500 mm	Min 6 mm	Min 9 mm
Greater than 2500 mm	Min 9 mm	Min 12 mm

- n) The base of each track shall be so designed that it is possible to move the complete transformer unit in any direction without injury when using rollers, plates or rails. A design, which required that slide rails be placed in a particular position, is not to be used. 16/20 MVA and lower rate transformers shall be provided with base plates having bi-directional wheels for placing on rails.
- o) An inspection window with a welded flange & a bolted cover shall be provided on the tank cover. The manhole shall be of a sufficient size to ease access to the lower ends of the bushings, terminals etc.
- p) Lifting eyes or lugs shall be provided on all parts of the transformers requiring independent handling during assembly or dismantling. In addition, the transformer tank shall be provided with lifting lugs and bosses properly secured to the sides of the tank for lifting the transformers either by crane or by jacks. The design of the tank, the lifting lugs and bosses shall be such that the complete transformer assembly filled with oil can be lifted with the use of those lugs without any damage or distortions.
- q) The tank shall be provided with two suitable copper alloy or any other suitable material lugs for the purpose of grounding.
- r) The tank shall be so designed that with the cores and windings in position there shall be no possibility of air or gas being trapped when filling the tank with oil. Likewise, water shall not be trapped on the exterior of the tank.
- s) The tank shall be fitted with pockets for a thermometer and the bulb of a winding temperature indicator and an oil temperature indicator.
- t) Necessary drain valves, filter valves, vales to take oil sample etc shall be provided.

7.4.2.22 Conservator Tank

A conservator tank shall be mounted above the highest point of the oil circulating system of the equipment. Tanks shall be formed of substantial steel plate. Connections between the main tank and the conservator shall be such that air or gas is not entrapped and the Buchholz relays can be

correctly installed. One end of the conservator shall be fixed by bolts so that it can be removed to enable the tank to be cleaned. The capacity of each conservator tank shall be adequate to accommodate the expansion and contraction of oil in the whole system, over the extreme range possible in operation, i.e. equipment unenergised in an ambient temperature of 5 deg. C to the condition corresponding to maximum oil temperature rise. Conservator shall be fitted with:-

- (a) A hydro compensator for separating oil and air. A dehydrating breather shall be used for the air intake of the hydro compensator. Alarm for leak of the hydro compensator shall also be provided.
- (b) At least one magnetic oil level indicator type visible from ground level and indicating the oil levels over the range specified above. The oil level indicator shall be marked to indicate the correct oil level with the oil at a temperature of 5 deg. C, 30 Deg. C and 90 deg. C. The temperature markings shall preferably be integral with the level indicating device but subject to the approval of the Authority.
- (c) Low oil alarm initiating device.

7.4.2.23 Pressure Relief Device

The transformer shall be fitted with a pressure relief device designed to protect the tank from damage and to control the expulsion of oil during an internal fault. The pressure relief device shall be of the spring-loaded diaphragm type capable of opening fully within two milliseconds of detecting an excess pressure, and shall fully reseal after release of the exceeded pressure. Corrosion resistant materials shall be used and a visual indication of operation shall be provided. Two pairs of normally open contacts and a suitable terminal box shall be provided for remote electrical indication and tripping.

7.4.2.24 GASKETS

Any gaskets provided with the transformers shall be suitable for making oil tight joints, and there shall be no deleterious effects of either gaskets or oil when the gaskets are continuously in contact with hot oil. No gaskets shall be used in which the material of the gasket is mounted on a textile backing. Exterior gaskets shall be weatherproof and shall not be affected by strong sunlight.

7.4.2.25 OIL

All transformers shall be filled to the required level with new, unused, clean, standard mineral oil after treatment in compliance with IEC 60296 & BS 148.

7.4.2.26 ACCESSORIES

7.4.2.26.1 Winding Temperature Indicator

The transformer shall be provided with a winding temperature indicator and combined alarm and trip relays of approved design. The alarm and trip settings shall be adjustable. The winding Temperature Indicator shall also be provided with additional contacts for automatic 'start/stop' of cooling plant (fans). It shall be fitted with dial indicator calibrated in degrees Celsius and fitted with a hand reset pointer the highest temperature attained. The winding temperature indicator shall be so mounted in the transformer marshalling kiosk so that the dial is not more than 1500 mm from ground level. The cover shall be equipped with a viewing aperture of adequate size, fitted with clear, reinforced glass.

7.4.2.26.2 Oil Temperature Indicators

The transformer shall be provided with an oil temperature indicator of approved design incorporating contacts and relay(s) for initiating alarms and trips. The indicator shall be fitted with a dial calibrated in degrees Celsius, with a hand reset pointer to register the highest temperature attained.

The oil temperature indicator shall be mounted in the transformer marshalling kiosk so that the dial is not more than 1500 mm from the ground level and the cover shall be equipped with viewing aperture of adequate size, fitted with clear, reinforced glass.

7.4.2.26.3 Buchholz relay

A Buchholz relay with alarm and tripping contacts to detect accumulation of gas and sudden changes of oil pressures, complete with two shut-off valves and flange coupling to permit easy removal without lowering oil level in the main tank, a bleed valve for gas venting and test valve shall be provided. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation & taking gas sample.

7.4.2.26.4 Breathers

Each transformer and tap changer conservator shall be provided with a silica gel breather complete with oil seal, oil level indication window and a sight glass for inspection of the silica gel. Due to the climatic conditions at site, this breather shall be liberally sized and one size larger than would be fitted for use in a temperate climate.

A visual indication of the extent to which the drying agent has absorbed moisture is preferred, showing how much active material remains effective.

Maintenance free breather shall have sensor controlled heating apparatus. The supply voltage shall be 230V AC. Adequate cable shall be provided to connect with marshalling box.

7.4.2.26.5 Padlocks

The supplier shall provide pad lockable handles and non-ferrous padlocks with duplicate keys for tap changer control panel and kiosks door to prevent all unauthorized access and operation.

7.4.2.26.6 The other accessories shall be provided is listed below

- a) Ladder permanently fixed with transformer tank
- b) Dial Thermometer with pocket for oil temperature indicator with one set of alarm and one set of trip contacts and maximum reading pointer.

7.4.2.27 Marshalling Kiosk (box):

Marshalling box shall be connected at one side of transformer. It shall consist of WTI (winding temperature indicator) and OTI (oil temperature indicator), magnetic oil gauge and Buchholz relay and other control terminals. WTI are in two numbers, one for HV and other for LV. It shall also consist of all auxiliary contactors as required in the order to make necessary potential free contacts for remote alarm and tripping, a heater which is used to absorb the moisture in the box, SPN socket outlet, complete with switch and HRC fuse for hand lamp connection.

7.4.2.28 Painting

The minimum standards acceptable are:

- e) cleaning by shot blasting to Grade Sa 2.5 of ISO 8501-1
- f) All sheet steelwork shall be degreased, pickled and phosphated in accordance with IEC 60076.
- g) Interior surface of mechanism chambers, boxes and kiosks, after preparation, cleaning and priming shall be painted with one coat of zinc chromate primer, one coat of phenolic based undercoating, followed by one coat of phenolic based finishing paint to white color followed by a final coat of anti-condensation white paint of a type and make to the approval of purchaser. A minimum overall paint film thickness of 150 microns shall be maintained throughout.
- h) Exterior steel work and metalwork, after preparation and priming shall be painted with one coat of zinc chromate primer, one coat of phenolic based under coating and two coat of micaceous iron oxide paint, then painted with final coat of phenolic based hard gloss finishing paint of the light grey shade to provide an overall minimum paint thickness of 200 microns.

7.4.2.29 Galvanizing

All galvanizing shall be carried out by the hot dip process, in accordance with specification ISO 1460. However, high tensile steel nuts, bolts and spring washers shall be electro galvanized. The zinc coating shall be smooth, continuous and uniform. It shall be free from acid spots and shall not scale, blister or be removable by handling or packing. There shall be no impurities in the zinc or additives to the galvanic bath which could have a detrimental effect on the durability of the zinc coating.

Before pickling, all welding, drilling, cutting, grinding etc must be complete and all grease, paint, varnish, oil, welding slag etc completely removed.

The weight of zinc deposited shall be in accordance with the BS 729, ISO 1460 and shall be not less than 0.61Kg/sq. mtr. with minimum thickness of 86microns for items of thickness more than 5mm, 0.46Kg/sq.mtr. (64microns) for items thickness between 2mm and 5 mm and minimum 0.33kg/sqmm (47microns) for the item less than 2mm thick. Repair of galvanizing on site will generally not permitted.

7.4.2.30 Terminal marking

Each terminal including the neutral shall be clearly marked on both the primary and secondary side in accordance with the diagram of connection supplied with the transformers.

The terminal marking shall be clear and permanent. Painted markings are not acceptable. the winding shall be leveled as follows:

High voltage	:	3 phases	A B C
Low voltage	:	3 phases and neutral	a b c n

7.4.2.31 EVALUATION CRITERIA

- a) The Tenders will be evaluated on the basis of the capitalized cost of the Transformer losses.
- b) Bidder will declared/ guaranteed No-Load loss and Full load loss value, otherwise the bid will be **rejected**.
- c) Bidders declared/ guaranteed percentage impedance value shall be within the specified value, otherwise the bid will be **rejected**.

7.4.2.32 ACCEPTANCE CRITERIA OF TRANSFORMER LOSS AND PERCENTAGE IMPEDANCE DURING FACTORY TEST:

Transformer will be tested during technical orientation & quality acceptance and will be accepted if the measured transformer losses are within the offered value or within the following tolerance with deduction of amount from the contract price as below:

- i) Any component loss (No load loss or Full load loss) may exceed up to 15% of the offered component loss, provided that the total loss (No load loss + Full load loss) shall not exceed 10% of the offered total loss. If any component loss exceeds 15% of the offered component loss, the full consignment will be rejected.
- ii) Total loss (No load loss + Full load loss) may exceed up to 10% of the offered total loss. If it exceeds 10%, the full consignment will be rejected.
- iii) Percentage Impedance may vary up to $\pm 10\%$ of the specified value. If the value exceeds the tolerance ($\pm 10\%$), the full consignment will be rejected.

Transformer will be tested during factory test witness and will be accepted if the measured transformer losses are within the offered value or within the acceptable limit as specified in (i), (ii) and (iii) provided an amount will be deducted from the Contract price for the loss(s) exceeding the offered/declared loss(s) according to the following formula:-

Amount to be deducted from the Contract price

$$= \text{Contract Price} \times \{(\text{Measured loss} - \text{Specified loss /declared loss}) \div \text{Specified loss/declared loss}\} \times \%MT$$

Where,

Measured Loss (in KW)	=	Measured Average No load Loss* 1+ Measured Average Full Load Loss* 2.
Offered Loss (in KW)	=	Offered No Load Loss + Offered Full load loss
Transformer Economic Life	=	20 Years

%MT (Percentage of Monetized Transformer) = % of the Monetized Transformer found during factory test witness by BPDB's inspection team whose measured loss(s) (No load loss or Full load loss or Both) exceed the offered loss (No load loss or Full load loss or Both) but remain within acceptable limit. For example : If total no. of transformers to be inspected is 80 and the no. of selected transformers during QAT/pre-delivery inspection is 8, 6 nos. are found within the offered losses and 2 nos. are found exceeding the offered losses then the %MT will be $(2/8) \times 100 = 25\%$

* 1Measured Average No Load Loss = [Sum of the measured No-load losses of the tested transformer(s) exceeding the offered No-load loss ÷ Nos. of tested transformer(s) which exceeds the offered No-load loss]

* 2Measured Average Full Load Loss = [Sum of the measured Full-load losses of the tested transformer(s) which exceeding the offered Full-load loss ÷ Nos. of tested transformer(s) which exceeds the offered Full-load loss.

7.4.2.33 Mandatory SPARE PARTS

- As per Price Schedule.

7.4.2.34 Approval of Drawings

The supplier shall submit the following drawings in AutoCAD format and in hard copy along with the documents as per following list for the approval of the purchaser within commencement period.

11. Full Technical Specification and Guaranteed Technical Particulars
12. Max. Temp. Rise of Winding & Oil over 40⁰C ambient supported by Load Losses and Heat Dissipation by Radiator and also Short Circuit Calculation along with thermal & mechanical calculations on the basis of proposed Design Data.
13. Calculation of Total full Load loss (I²R loss, winding eddy current loss & Stray loss etc.) at ONAN & ONAF condition for nominal Tap, Tap 1 & 17.

14. Calculation of No-load loss and current.
15. Calculation of flux density, Core diameter, Gross cross-sectional area of Core, Net cross-sectional area of Core, Core weight, Stack thickness and Mean length of core along with the drawing of window height, Core leg center etc.
16. Calculation of LV, HV & Tap winding dimension, Cross sectional area of LV, HV, Tap winding, Copper Weight (LV, HV & Tap winding) and Oil volume.
17. Calculation of Cooling at ONAN & ONAF condition for Total Losses at Tap 17.
18. Calculation of percentage impedance at ONAN & ONAF condition for nominal Tap, Tap 1 & 17.
19. Calculation of temperature rise for Top Oil, mean Oil, LV & HV winding at ONAN & ONAF condition for nominal Tap, Tap 1 & 17.
20. General outline drawing showing front, side elevation and plan of the transformer and accessories with detailed dimensions. The clearances between HV and LV terminals and ground should also to be shown.
21. Drawings of each type of bushings, lifting dimensions, clearance between HT and LT terminals and ground, quantity of insulating oil, name plate details etc.
22. Large scale drawings of high and low-tension windings of the transformers showing the nature and arrangement of insulators and terminal connections.
23. Schematic control and annunciation wiring diagram for all auxiliary equipment (temperature indicator, alarm circuits, Buchholz relay, oil surge relay, PRV, MOG, WTI, OTI, AVR relay, OLTC, cooling control etc, Schematic diagram showing the flow of oil in the cooling system, Large scale drawing of high and low tension winding of the transformer showing the nature and arrangement of insulation and terminal connections.
24. Drawing/ Wiring diagram showing construction and mounting details of marshalling boxes.
25. Operation and maintenance guide for transformer and OLTC.
26. Detailed loading drawing to enable the Purchaser to design and construct foundations for the transformer.
27. Installation, Operation and maintenance manual along with troubleshooting procedure.
28. Catalogue and Manual of Core, Cu winding, Buchholz relay, oil surge relay, PRV, MOG, WTI, OTI, AVR, OLTC, Bushing CT, Radiator, Cooling Fan etc.

No work shall be performed in connection with the fabrication and manufacture of the Testing Equipment until the technical data and drawings have been approved. The manufacturing of the equipment shall be strictly in accordance with the approved drawings and no deviation shall be permitted without the written approval of the purchaser.

The cost of supplying drawings and specifications shall be borne by the supplier.

At the time of delivery of Equipment, the supplier shall supply three (3) sets of all approved technical data and drawings in bound book form along with manufacturer's original catalogue of the Equipment the office of Director, Design & Inspection-II, BPDB, 9/B, Motijheel C/A, Dhaka, Bangladesh, Telephone # 88-02-9550404.

7.4.2.35 TESTS AT MANUFACTURERS WORKS:

7.4.2.35.1 GENERAL

Functional electrical, material, mechanical and hydraulic tests shall be carried out at manufacturers' premises. The extent and method of recording the results shall be agreed by the Purchaser in ample time to enable the tests to be satisfactorily witnessed or to make any changes to the proposed program of tests.

7.4.2.35.2 MATERIAL TESTS:

The supplier shall provide test pieces free of charge as required to enable the quality of the material to be determined at the supplier's expense. Purchaser may at its own discretion and by specific arrangement accept certified particulars of tests carried out in the absence of his authorized representative.

7.4.2.35.3 TYPE TEST:

Type tests are required on all items to prove the general design of the goods offered. The Bidders shall submit the type test report of offered item from internationally reputed independent testing laboratory.

7.4.2.35.4. ROUTINE TESTS:

All items shall be subjected to routine tests in accordance with the relevant latest version of IEC, BS & BDS standards at the manufacturers works and shall include, but not be limited to, an operational test.

7.4.2.36 TECHNICAL ORIENTATION AND QUALITY TEST WITNESS :

The following test shall be carried out as per latest version of IEC or equivalent standard unless otherwise mentioned at the manufacturer premises or other places where the test facilities are available:-

Acceptance Tests:-

1. Measurement of turn ratio test;
2. Vector group test;
3. Measurement of winding resistance;
4. Measurement of insulation resistance;
5. Measurement of no load loss & no-load current;
6. Measurement of impedance voltage & load loss;
7. Dielectric withstands Tests;
8. Transformer oil test;
9. Temperature rise test.
10. Separate source voltage withstand test.
11. Tap-changer operation test
12. Dimension and physical check.

13. Magnetic Balance Test
14. Leak Testing with pressure
15. 33kV & 11kV Bushing CT test (measurement of insulation resistance, polarity, ratio, burden, knee voltage & current, CT secondary winding resistance etc.
16. OTI, WTI, Buchholz, PRD etc. measurement meters and devices calibration & operational functionality check.

The purchaser can carry-out the testing of any no. of transformers during Quality Test Witness. But, the testing of transformers during Quality Test Witness will not be less than 10% at random basis of the transformer ready for inspection but in any case it will not be less than 3 nos. The manufacturer will provide all arrangements for the testing of transformers desired by the purchaser in his factory.

Where the supplier provides for tests on the premises of the supplier or of any manufacturer of the supplier, except where otherwise specified, shall provide free of charge such assistance, labor, materials, electricity, fuel, stores, apparatus and instruments as may be requisite and as may be reasonably demanded to carry out such test efficiently. These test shall be performed as per relevant IEC/BS Standard or equivalent and only routine tests as agreed upon, will be performed.

As and when the purchaser is satisfied that any materials/equipment shall have passes the tests referred to in this clause, purchaser shall notify the contractor in writing to that effect.

Should any inspected/tested goods fail to conform to the specification, the Purchaser shall have the right to reject any of the item or complete batch if necessary. In that case Supplier have to replace the Equipment and to make good of them without any financial involvement to the Purchaser. In case any of the Equipment found not conforming with the specification at the time of post landing Inspection, the supplier will in no way be relieved from the responsibility of replacing them on making them good at their own cost, despite the Equipment were found good at the time of Factory Acceptance Test. Nothing in this clause shall in any way release the supplier from any warranty or other obligations under the contract.

No goods shall be packed, prepared for shipment/delivery unless it has been approved and written instruction have been received by the Purchaser.

7.4.2.37 POST LANDING INSPECTION:

Post landing inspection shall be done immediately after arrival of the goods/materials at the designated store of BPDB; the Engineer & representative from consignee shall conduct Post Landing Inspection in presence of the representative of Supplier. The program of such inspection shall be intimated to the representative of Supplier by BPDB upon arrival of the materials at BPDB store of the Inspector(s) to be selected for test witnessing. Any defect or damage have been found at post-delivery inspection, the defective or damaged panels/ materials/ goods to be repaired/ replaced by the Bidder/ supplier at his own cost.

7.4.3 TECHNICAL SPECIFICATION OF 33/.415kV, 250kVA STATION TRANSFORMER

7.4.3.1 GENERAL SPECIFICATION:

1.	Installation	Outdoor, Tropical, High Rainfall & Humidity
2.	Type	Oil type, step down, cooling method-ONAN
3.	Coolant	Air natural
4.	Method of Cooling	AN
5.	Phases	3 (Three)
6.	Frequency	50 Hz.
7.	Winding	Two windings of high conductivity copper
8.	KVA Rating	250 KVA
9.	Rated Voltage at no-load	33/0.415 kV
10.	Vector Group	Dyn11
11.	Percentage Impedance at 75°C, %	6 %
12.	No Load Loss	Max 812 Watts
13.	Load losses at rated full load at nominal tap at 75° C, Watts	Max 3637 Watts
14.	LV Maximum Temperature Rise at full load over ambient temperature	100
15.	HV Maximum Temperature Rise at full load over ambient temperature	100
16.	Insulation Material	Class F
17.	Noise Level (Maximum)	55 dB
18.	Magnetization current at normal voltage	5.56 A@LV
19.	Maximum ambient temperature	50 °C

7.4.3.2 Major Components

H.T. WINDING :	
Nominal rated voltage	33 kV
Maximum system voltage	36 kV
Basic insulation level (minimum)	170 kV
Tap Changer	+3x2.5%, 0, -3x2.5% of rated kV & all fully rated capacity. Tap Changer shall be off load type, manually operated from an external five-position mechanism.
Inter phase connection	Delta
Bushings	Porcelain, outdoors type with arcing horns of standard gap, mounted on top of tank. Quantity - 3 Nos.
Power frequency withstand voltage for one minute	70 kV

L.T WINDING :	
Nominal rated voltage	415 volts
Highest system voltage	457 volts
Inter phase connection	Y (Wye) with neutral brought out.
Bushings	Porcelain, outdoor type, mounted on the side of tank. (Longest side) Quantity – 4 nos.
Power frequency withstand voltage for one minute	2.5kV

7.4.3.3 Features and Accessories

- a) All bolts and nuts connected with transformer tank, conservator, radiator etc. shall be of non-ferrous metal. If it is ferrous metal, it shall be hot dip galvanized as per standard ASTM A90/ BS EN ISO 1461:1999.
- b) Lugs for lifting & towing complete unit.
- c) Facilities for lifting core & coil assembly.
- d) Base designed for platform mounting on poles.
- e) Each H.T. bushing shall have bolted type bimetallic connector suitable for accommodating ACSR conductor having Dia. range from 9mm to 14.5mm.
- f) Each L.T. bushing shall have bolted type bimetallic connector for accommodating copper/AAC of area range 2x70mm² to 2x120mm².
- g) The L.T. bushing shall be installed on the side/ top lengthwise of the transformer body. However radiator shall be avoided on this side on the body.
- h) Earthing terminals at the bottom corners of Tank.
- i) Name plate with transformer rating & winding diagram made of stainless steel shall have engraved letters filled with black enamel.
- j) The tank & radiator or flanged radiator shall be painted with two coats of gray finishing paint on suitable prime coats.
- k) Transformer capacity with Sl.No. and BPDB Contract No. should be marked with emboss/ engrave on the transformer tank adjacent to name plate easily visible from ground.
- l) HT and LT bushing shall be outdoor porcelain type
- m) Set of sundries such as similar wiring terminals boards and glands for multi-core 0.415KV Power cables, 33KV terminal connectors suitable for ACSR etc.
- n) IEC 60076-11 or other equivalent Standard is to be followed for design, manufacture, testing and performance test.

7.4.3.4 Information Required

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

- a) Manufacturer's Printed Catalogue describing Specification and Technical Data for crucial components of offered 33/0.415KV, 250KVA, 3-Phase, Dyn11dry type station transformer.
- b) Detail dimensional drawings of offered 33/0.415KV, 250KVA, 3-Phase, Dyn11dry type station transformer.
- c) Manufacturer's valid ISO 9001 Certificate;

7.4.3.5 ACCEPTANCE CRITERIA OF TRANSFORMER LOSS AND PERCENTAGE IMPEDANCE DURING FACTORY TEST WITNESS

Transformer will be tested during factory test witness and will be accepted if the measured transformer losses are within the specified value or within the following tolerance with deduction of money from the quoted/ contract price as below :

- i) Each component loss (No load loss or Full load loss) may exceed up to 15% of the specified component loss, provided that the total losses cannot be exceeded 10% of the specified total losses.
- ii) Percentage Impedance may vary up to $\pm 10\%$ of the specified value.
- iii) The purchaser can carryout the testing of any no. of transformers during pre-delivery inspection. But, the testing of transformers during pre-delivery inspection will not be less than 10% at random basis of the transformer ready for inspection but in any case it will not be less than 2 nos. The manufacturer will provide all arrangements for the testing of transformers desired by the purchaser in his factory.
- iv) If the results of any transformer exceeds the specified losses and impedance (each component loss exceeds more than 15% or total loss exceeds more than 10% of the specified losses or percentage impedance exceeds $4\pm 10\%$ then the whole lot will be rejected or on request of the supplier/manufacturer every transformer may be tested (Transformer losses, percentage impedance, vector group test etc.) at his factory premises/CERS, BPDB by the BPDB inspection team. If the said transformers are tested by the BPDB inspection team at the manufacturers/suppliers premises, then the testing fees at the rate of Tk. 2000/- (Two thousand) per transformer shall be paid by the supplier through invoice in advance. If the said transformers are tested at CERS, BPDB all the expenditure for carrying, loading/unloading and testing fees fixed by the CERS are to be borne by the supplier in advance. After completion of the test, the transformer passes the test will be properly sealed by the inspection team. The supplier will be liable to protect those seal up to delivery to the BPDB's designated Store(s).

The transformers which pass the tests will be accepted by BPDB subject to fulfillment of the other qualification criteria as per contract. The remaining transformers failed to qualify the tests will be rejected.

- v) If the measured loss(es) (No load loss or Full load loss or Both) of the tested sample transformer(s) during factory test witness by the BPDB's inspection team and test performed by BUET/ DUET/ CUET/ KUET/ RUET exceed the specified loss (No load loss or Full load loss or Both) but remain within acceptable limit as specific in clause 7.11(i) & (ii), then an amount will be deducted from the Contract price for the loss(s) exceeding the specified loss(s) (No load loss or Full load loss or Both) according to the following formula :

Amount to be deducted from the Contract price

$$= \text{Contract Price} \times \{(\text{Measured Loss} - \text{specified Loss}) \div \text{specified Loss}\} \times \% \text{MT}$$

Where, Contract Price = Total Contract Price

Price

Measured Loss = Measured Average No-load Loss*¹ + Measured Average Full Load Loss*².

Specified Loss = Specified No Load Loss + Specified Full load loss

%MT (Percentage of Monitized Transformer) = % of the Monitized Transformer found during factory test witness by the BPDB's inspection team and test performed by BUET/ DUET/ CUET/ KUET/ RUET whose measured loss(es) (No load loss or Full load loss or Both) exceed the specified loss (No load loss or Full load loss or Both) but remain within acceptable limit. For example : If total no. of transformers to be inspected is 100 and the no. of selected transformers during pre-delivery inspection is 10, 8 nos. are found within the specified losses and 2 nos. are found exceeding the specified losses then the %MT will be $(2/10) \times 100 = 20\%$

*1 Measured Average No Load Loss = $\frac{[\text{Sum of the measured No-load losses of the tested transformer(s) exceeding the specified No-load loss}]}{\text{Nos. of tested transformer(s) which exceeds the specified No-load loss}}$

*2 Measured Average Full Load Loss = $\frac{[\text{Sum of the measured Full-load losses of the tested transformer(s) which exceeding the specified Full-load loss}]}{\text{Nos. of tested transformer(s) which exceeds the specified Full-load loss}}$

It is to be noted that if the measured value found less than or equal to specified value, no benefits will be given to the supplier/ manufacturer. In this case, the tested transformers whose loss (No load loss or Full load loss or both) have not exceed the specified loss, will not be taken into account for averaging the measured loss for using the above formula.

7.4.3.6 APPROVAL OF DRAWINGS

Calculation for the Max. Temp. Rise of Winding & Oil over 40°C ambient supported by Load Losses and Heat Dissipation by Radiator and also Short Circuit Calculation along with thermal & mechanical calculations on the basis of proposed Design Data.

7.4.3.7 TRANSFORMER CORE AND COILS

Transformers core and coils must be new, unused, and clean.

Supporting frames of the core and coils of transformers shall be designed to accommodate variations in tank height.

The core and coil assembly shall have the core and coils rigidly connected to the tank and suitably closed lugs shall be provided for removing the core and coil assembly from the tank.

Transformer Sl. no. should be marked with emboss on the Supporting frames of the core and coils of each transformers minimum in 2(two) places.

7.4.3.8 TRANSFORMER SEALING

A satisfactory lid-sealing gasket shall be provided on each of these transformers to maintain the seal at extremes of operating temperature. A cold oil level (COL) mark shall be provided inside each transformer marked COL.

7.4.3.9 FINISHES

a) Painting

Painting ferrous metal work is to be provided with an effective vapour sealing paint finish, applied generally in accordance with BS 5493 and /or other recognised international standard.

Paint shall be applied to produce a uniform film. Edges corners, crevices, welds, bolts, and rivets shall receive special attention to maintain the required thickness.

Before painting or compound, all un-galvanised parts shall be completely clean and free from rust, scale and grease and all external rough metal surfaces on the casting shall be filled.

The paint system shall be in accordance with best practice for hot and humid locations in a highly aggressive environment. A description of the paint system is to be used and the proposed method of application shall be fully described in the Tender.

All external surfaces shall receive a minimum of three coats of paint. The primary coat shall contain an approved rust inhibitor and shall be applied as soon as possible after the completion of the surface preparation. The second coat shall be of oil and weather resisting nature and have a shade of colour easily distinguishable from the primary. The final coat shall be of oil and weather resisting and non-fading glossy paint of a colour agreed by the Engineer.

b) Non-ferrous parts and Bright Steel parts

All exposed metal liable iron corrosion during transport is to be appropriately protected by casting with an approved anti-rusting composition. Other non-ferrous parts shall be adequately protected against corrosion during shipment or in service.

c) Galvanizing

Galvanizing where applicable shall be applied by the hot dipped process generally in accordance with ASTM A90/ BS EN ISO 1461:1999 or equivalent standard of metal surface unless specified otherwise.

The zinc coating shall be smooth clean and of uniform thickness and free from defects. The preparation of galvanizing itself shall not adversely affect the mechanical properties of the coated material.

All drilling, punching, cutting, shaping and welding of parts shall be completed and all burrs shall be removed before the galvanizing process is applied.

Surfaces that are in contact with oil shall not be galvanized or cadmium plated.

7.4.3.10 RATING PLATE

A brass or stainless steel rating plate shall be fitted to each transformer. The information shall be deeply etched including the diagram of the connections of the windings, the vector diagram showing the general phase relations of the transformer, and a diagrammatic plan of the transformer cover showing the terminal positions and marking and other essential particulars. The plate shall be mounted in an accessible position and preferably adjacent to the tapping switch if this is located on the side of the tank.

The rating plate shall be fitted below the LV terminals. Rating and diagram plates shall be attached by a 5 mm brass screw in each corner to 20 mm mild steel brackets welded horizontally approximately 20 mm from the tank side. The following information is to be

provided on the rating and diagram plate in the English language – clearly and indelibly marked.

- * Transformer type
- * Manufacturer's name
- * Manufacturer's serial number
- * Year of Manufacture
- * Number of phases
- * Rated power
- * Rated frequency
- * Rated voltages
- * Rated currents
- * Connection symbol
- * Impedance voltage at rated current
- * Type of cooling
- * Total mass
- * Mass of insulating oil
- * Insulation levels
- * Details regarding tapings

Each Transformer should be marked with emboss or welded on the body easily visible from the ground, with letters of size mentioned against each word(s)/ sentence(s) below:

BPDB (40 mm)

Contract No & Date: (20 mm)

Sl. No.:----- of -----KVA ----- (20 mm)

Note :

- a) Sl. No.ofKVA is meant for particular No. of the Transformer out of the contracted quantity under this contract.
- b) The above marking on the body of the transformer shall be done in addition to the normal nameplate of the transformer. The nameplate shall be continuous welded on the body of the Transformer before Pre-delivery inspection.

7.4.3.11 TERMINAL MARKING

All transformers shall have the primary and secondary terminal markings plainly and indelibly marked on the transformer adjacent to the relevant terminal. These markings shall preferably be 25 mm in height. The terminal marking shall be embossed on the body of the Transformer with respective color code.

7.4.3.12 TERMINAL LEADS

Outgoing leads shall be brought out through bushings. The leads shall be such that the core and coils may be removed with the least possible interference with these leads, and they shall be specially supported inside the transformer to withstand the effects of vibration and short circuits.

7.4.3.13 BUSHINGS

All bushings shall be porcelain clad, and shall be of the highest quality. They shall be sealed in a manner to prevent ingress of moisture and to facilitate removal. The neutral bushings and stems shall be identical to those provided for phase terminations. Bushing stems, nuts and washers shall be made of brass.

7.4.3.14 EARTHING CONNECTIONS

Earthing connections shall be provided with connection facilities for 2x50 mm² copper stranded conductor. The bolts shall be located on the lower side of the transformer and be of M12 size; each shall be clearly indicated with an engraved 'earth symbol'. Two earthing connections are required on each transformer.

7.4.3.15 GASKETS

Any gaskets provided with the transformers shall be suitable for making oil tight joints, and there shall be no deleterious effects of either gaskets or oil when the gaskets are continuously in contact with hot oil. No gaskets shall be used in which the material of the material of the gasket is mounted on a textile backing. Exterior gaskets shall be weatherproof and shall not be affected by strong sunlight.

7.4.3.16 TAPINGS

Five voltage tapings shall be provided on the primary side of each transformer and shall give: + 2.5%, 0, - 2.5%, - 5% and -7.5% steps of the primary nominal voltage. The tapings shall be selected by an 'off load' tapping switch with an external hand wheel with provision for locking onto a selected tapping. The switch shall have a positive action designed to eliminate the possibility of stopping in an intermediate position. The shaft shall be adequately sealed so that no seepage of oil occurs under all conditions of service. The voltage operating positions, together with tap change positions shall be clearly and indelibly marked.