SECTION 7.2 TECHNICAL SPECIFICATIONS OF

33/11 KV 10/13.33 MVA & 20/26.67 MVA POWER TRANSFORMER
AND
33/.4 KV 200 KVA & 50 KVA STATION AUXILIARY TRANSFORMER

7.2.1 Technical Specification of 33/11 KV, 10/13.33 MVA Power Transformer

7.2.1.1 GENERAL

This section of the document includes the design, engineering, manufacture, supply, delivery, offloading, testing & inspection and performance requirements of 33/11KV, 10/13.33 MVA Power transformers and accessories as specified.

7.2.1.2 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	:	40^0 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.

7.2.1.3 SYSTEM PARTICULARS

SL. NO.	SYSTEM CHARACTERISTICS	VOLTAGE LEVEL			
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	1500	500
8.	Basic Insulation Level, kV	750	650	170	75

7.2.1.4 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.

7.2.1.5 Technical Specification:

1.	Rated MVA (ONAN/ONAF)	10/13.33 MVA
2.	Number of Phases	3 (Three)
3.	Frequency	50 Hz
4.	Winding Insulation	Uniform
5.	Normal Transformation Ratio at No-load	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)	175 / 233 Amps
11.	Rated Current LT (ONAN/ONAF)	525 / 700 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	Mineral Oil as per IEC-60296
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 insulation and 100% loading capacity
26.	Maximum Temperature rise over 40^0C ambient at full load & tap change is at normal position : a) Winding by Resistance (^{0}C) b) Oil by Thermometer (^{0}C)	 65^0C 60 ^{0}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 75^0C, 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.
	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	300/5A on HV, 900/5A on LV of accuracy class 5P20, burden 20 VA.
32.	Neutral Bushing CT for Standby Earth Fault (SEF) & Restricted Earth Fault (REF) protection	900/5-5Aon LV neutral of accuracy class 5P20, burden 20 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	Class-1
	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:**
	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) One inspection hole with cover. m) Facilities for lifting cover and coil assembly from tank. n) Lifting lugs for lifting complete Transformer. o) Base designed for rollers with bi-directional flanged rollers parallel to either Centre line. p) Tank oil sampling, draining valve and oil centrifuging outlets. q) Tank earthing points. r) Fans for forced cooling (ONAF). s) All mounting accessories including rails (2 Nos. rails each 10 Meter long). t) All equipment should be fully tropicalized. u) Painting to approved colour and shade. v) Rating nameplate and diagram plate of stainless steel having engraved letters filled with black enamel paint. w) The oil shall be supplied/ delivered in non-returnable sealed containers/ drums. x) The oil shall be fresh, unused, cleaned and free from suspended matter or sediment. y) The test shall be carried out on the oil as to be supplied without drying and degassing. z) Uninhibited oils must not contain anti-oxidant additives. aa) Laminated, detailed Schematic Diagram of Control Circuit of Transformer & Tap changer inside Marshalling kiosk. bb) Maintenance free dehydrating Silica-gel breather with self regulating heating element. cc) Air release plug. dd) Earthing terminals with lugs. ee) Thermometer pockets. ff) Winding temperature indicator with two contacts gg) Bottom mounting channel (min. size of channel shall be 10/13 MVA. hh) Operation and maintenance manual along with troubleshooting procedure and installation guideline/manual shall be supplied with each transformer.
36	**Following instructions to be followed for Submission of Test reports & Calculation:**
	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).

7.2.1.6 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 loss calculation, otherwise 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_{FL} = Full Load losses at rated voltage, normal ratio and rated frequency in ONAF condition at 75^0C in KW + Auxiliary loss in KW
- P_0 = 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%).

7.2.1.7 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.

7.2.1.8 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.

7.2.1.9.1 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 ACSR Gross Beak (636 MCM) conductor.

7.2.1.9.2 LT BUSHING:

Provide 4 porcelain outdoor type bushing with bolted type connectors, suitable for connection to outgoing leads of one numbers of 300 Sq.mm XLPE,, single core copper conductors per phase and suitable for head shrink termination.

7.2.1.10 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 1500 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.

7.2.1.11 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.

7.2.1.12 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.

7.2.1.13 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.

7.2.1.14 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.

7.2.1.15 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 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).

7.2.1.16 WINDINGS:

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 then 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 sports 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.

7.2.1.17 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 insolating 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.

7.2.1.18 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.

7.2.1.19 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 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.

7.2.1.20.1 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.

7.2.1.20.2 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.

7.2.1.20.3 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 material of the gasket is mounted on a textile backing. Exterior gaskets shall be weatherproof and shall not be affected by strong sunlight.

7.2.1.21 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.

7.2.1.22 ACCESSORIES

7.2.1.22.1 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.

7.2.1.22.2 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.

7.2.1.22.3 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.

7.2.1.22.4 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.

7.2.22.5 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.

7.2.1.22.6 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.

7.2.1.23 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.

7.2.1.24 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 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.
d) Exterior steel work and metalwork, after preparation and priming shall be painted with one coat od xinc 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.

7.2.1.25 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 o impurities in the zinc or additivies 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.

7.2.1.26 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

7.2.1.27 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.**

7.2.1.28 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 ±10% of the specified value. If the value exceeds the tolerance (±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

= Contract Price x {(Measured loss - Specified loss /declared loss) ÷ Specified loss/declared loss} X %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)x100=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.

7.2.1.29 Mandatory SPARE PARTS

The Supplier shall provide for every five transformers the following mandatory spares:

•One HV Bushing

•One LV Bushing

•One complete set of bi-metallic connectors for both HV & LV bushings.

7.2.1.30 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 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

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 to the office of Director, Design & Inspection-II, BPDB, 9/B, Motijheel C/A, Dhaka, Bangladesh, Telephone # 88-02-9550404.

7.2.1.31 TESTS AT MANUFACTURERS WORKS:

7.2.1.30.1 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.

7.2.1.30.2 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.

7.2.1.30.3 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.

7.2.1.30.4. 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.

7.2.1.32 TECHNICAL ORIENTATION AND QUALITY TEST WITNESS :

The Purchaser shall have the right to inspect/test the goods/materials to confirm their conformity to the specification. The purchaser shall be entitled at all reasonable time during manufacture to inspect, examine and test of goods/materials at the manufacturers' premises, workmanship and performance.

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.

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.

The Supplier shall, after consulting the purchaser, give the Purchaser reasonable notice in writing of the date on and the place at which any material or equipment will be ready for testing as provided in the contract and unless the purchaser shall attend at the place so named on date, which the supplier has stated in his notice, the supplier may proceed with the tests, which shall be deemed to have been made in the purchaser's presence, and shall forth with forward to the purchaser duly certified copies of test readings.

When the purchaser intends to attend the test he shall promptly inform the supplier accordingly in writing, so that he can take action. The purchaser shall give the supplier timely notice in writing of his intention to attend the test.

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.

7.2.1.33 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.

7.2.2 Technical Specification of 33/11 KV, 20/26.66 MVA Power Transformer

7.2.2.1 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.

7.2.2.2 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.

7.2.2.3 SYSTEM PARTICULARS

SL. NO.	SYSTEM CHARACTERISTICS	VOLTAGE LEVEL			
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	1500	500
8.	Basic Insulation Level, kV	750	650	170	75

7.2.2.4 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.

7.2.2.5 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	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	Mineral Oil as per IEC-60296
18.	Type of System Earthing	Effectively Earthed
19.	Bushing Material	Porcelain

20.	Type of Base	On Wheels 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 insulation and 100% loading capacity
26.	Maximum Temperature rise over 40^0C ambient at full load & tap change is at normal position : a) Winding by Resistance (^{0}C) b) Oil by Thermometer (^{0}C)	 65^0C 60 ^{0}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 75^0C, 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.
	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	600/5A on HV, 1800/5A on LV of accuracy class

		5P20, burden 20 VA.
32.	Neutral Bushing CT for Standby Earth Fault (SEF) & Restricted Earth Fault (REF) protection	1800/5-5Aon LV neutral of accuracy class 5P20, burden 20 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	Class-1
	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:**
	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) One inspection hole with cover. m) Facilities for lifting cover and coil assembly from tank. n) Lifting lugs for lifting complete Transformer. o) Base designed for rollers with bi-directional flanged rollers parallel to either Centre line. p) Tank oil sampling, draining valve and oil centrifuging outlets. q) Tank earthing points. r) Fans for forced cooling (ONAF). s) All mounting accessories including rails (2 Nos. rails each 10 Meter long). t) All equipment should be fully tropicalized. u) Painting to approved colour and shade. v) Rating nameplate and diagram plate of stainless steel having engraved letters filled with black enamel paint. w) The oil shall be supplied/ delivered in non-returnable sealed containers/ drums. x) The oil shall be fresh, unused, cleaned and free from suspended matter or sediment. y) The test shall be carried out on the oil as to be supplied without drying and degassing. z) Uninhibited oils must not contain anti-oxidant additives. aa) Laminated, detailed Schematic Diagram of Control Circuit of Transformer & Tap changer inside Marshalling kiosk. bb) Maintenance free dehydrating Silica-gel breather with self regulating heating element. cc) Air release plug. dd) Earthing terminals with lugs. ee) Thermometer pockets. ff) Winding temperature indicator with two contacts gg) Bottom mounting channel for 10/13.33MVA hh) Operation and maintenance manual along with troubleshooting procedure and installation guideline/manual shall be supplied with each transformer.
36	**Following instructions to be followed for Submission of Test reports & Calculation:**

	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).

7.2.2.6 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 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_{FL} = Full Load losses at rated voltage, normal ratio and rated frequency in ONAF condition at 75^0C in KW + Auxiliary loss in KW
- P_0 = 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%).

7.2.2.7 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.

7.2.2.8 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.

7.2.2.9.1 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 ACSR Gross Beak (636 MCM) conductor.

7.2.2.9.2 LT BUSHING:

Provide 4 porcelain outdoor type bushing with bolted type connectors, suitable for connection to outgoing leads of one numbers of 500 Sq.mm XLPE, single core copper conductors per phase and suitable for head shrink termination.

7.2.2.10 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 1500 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.

7.2.2.11 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.

7.2.2.12 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.

7.2.2.13 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.

7.2.2.14 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.

7.2.2.15 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 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).

7.2.2.16 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 Electro-statically 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.

g) Coil clamping rings shall be of the on on-magnetic steel or insulating materials built up from flat laminations. Auxiliary laminated material other then 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 sports 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.

7.2.2.17 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 insolating 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.

7.2.2.18 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.

7.2.2.19 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. 20/26 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.

7.2,2.20.1 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.

7.2.2.20.2 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.

7.2.2.20.3 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 material of the gasket is mounted on a textile backing. Exterior gaskets shall be weatherproof and shall not be affected by strong sunlight.

7.21 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.

7.2.2.22 ACCESSORIES

72.2.22.1 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 badditional 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.

7.2.2.22.2 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 aperature of adequate size, fitted with clear, reinforced glass.

7.2.2.22.3 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.

7.2.2.22.4 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.

7.22.5 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.

7.2.2.22.5 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.

7.2.2.23 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.

7.24 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 phsphated 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 colour followed ba 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 micons shall be maintained throughout.
h) Exterior steel work and metalwork, after preparation and priming shall be painted with one coat od xinc 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.

7.2.2.25 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 o impurities in the zinc or additivies 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 staed 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..2.226 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..2.2.27 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.**

7.2.2.28 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 ±10% of the specified value. If the value exceeds the tolerance (±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
= Contract Price x {(Measured loss - Specified loss /declared loss) ÷ Specified loss/declared loss} X %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)x100=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

7.29 Mandatory SPARE PARTS
The Supplier shall provide for every five transformers the following mandatory spares:
•One HV Bushing
•One LV Bushing
•One complete set of bi-metallic connectors for both HV & LV bushings.
7.30 Approval of Drawings

Design, Drawing diagrams, Specification and Technical Particulars & Guarantees etc, shall be submitted to the Engineer, Director, Design & Inspection–II, BPDB by the Supplier for approval, prior to the manufacturing of the goods. The Supplier shall have to submit 3 (three) sets of the same for approval within 15 (fifteen) days from the date of signing Contract.

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

Full Technical Specification and Guaranteed Technical Particulars
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

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.
Drawings of each type of bushings, lifting dimensions, clearance between HT and LT terminals and ground, quantity of insulating oil, name plate details etc.
Large scale drawings of high and low-tension windings of the transformers showing the nature and arrangement of insulators and terminal connections.
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
Drawing/ Wiring diagram showing construction and mounting details of marshalling boxes.
Operation and maintenance guide for transformer and OLTC.
Detailed loading drawing to enable the Purchaser to design and construct foundations for the transformer.
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 to the office of Director, Design & Inspection-II, BPDB, 9/B, Motijheel C/A, Dhaka, Bangladesh, Telephone # 88-02-9550404.

7.2.2.31 Tests at Manufacturers Works:

7.30.1 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.

7.30.2 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.

7.30.3 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.

7.30.4. 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.

7.2.2.32 TECHNICAL ORIENTATION AND QUALITY TEST WITNESS :

The Purchaser shall have the right to inspect/test the goods/materials to confirm their conformity to the specification. The purchaser shall be entitled at all reasonable time during manufacture to inspect, examine and test of goods/materials at the manufacturers' premises, workmanship and performance.

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.

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.

The Supplier shall, after consulting the purchaser, give the Purchaser reasonable notice in writing of the date on and the place at which any material or equipment will be ready for testing as provided in the contract and unless the purchaser shall attend at the place so named on date, which the supplier has stated in his notice, the supplier may proceed with the tests, which shall be deemed to have been made in the purchaser's presence, and shall forth with forward to the purchaser duly certified copies of test readings.

When the purchaser intends to attend the test he shall promptly inform the supplier accordingly in writing, so that he can take action. The purchaser shall give the supplier timely notice in writing of his intention to attend the test.

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.

7.2.2.33 **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.

7.2.3 Technical Specification of 33/.415KVA, 200KVA Transformer

7.2.3.1 GENERAL SPECIFICATION:

1.	Installation	Outdoor, Tropical, High Rainfall & Humidity
2.	Type	Core
3.	Coolant	Mineral oil
4.	Method of Cooling	ONAN
5.	Phases	3 (Three)
6.	Frequency	50 Hz.
7.	Winding	Two windings of high conductivity copper
8.	KVA Rating	200 KVA
9.	Rated Voltage at no-load	33/0.415 kV
10.	Vector Group	Dyn11
11.	Percentage Impedance at 75^0C, %	4 %
12.	No Load Loss	Max430 Watts
13.	Load loss at 75^0 C	Max 2800 Watts
14.	Maximum Temperature Rise at full load Over 40^0C ambient temperature with tap changer in principal position.	a) 65^0C for Winding measured by Resistance Method.
		b) 60^0C for Top Oil measured by Thermometer Method.

7.2.3.2 Major Components

H.T WINDING :	
Nominal rated voltage	33 kV
Maximum system voltage	36 kV
Basic insulation level (minimum)	170 kV

Tap Changer	+1x2.5%, 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	2.5 kV
Transformer Oil :	
Application	Insulating mineral oil for Transformer. It will be free from PCB (Poly Chlorinated Biphenyl)
Grade of oil	Class-1
a) Physical Properties	
Appearance	Liquid and free from suspended matter or sediment
Density at 20^0 C	0.895 g/cm^3 (Max^m.)
Flash point (Closed cup)	140^0 C (Min^m.)
Kinematics Viscosity at -15^0 C	800 cSt. (Max^m.)
Kinematics Viscosity at 20^0 C	40 cSt. (Max^m.)
Pour point	-30^0 C (Max^m.)
b) 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 oils are introduced into the apparatus or equipment. The break down voltage of this oil shall be more than 50 kV.
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 (Max^m.)
c) Chemical Properties	
Neutralization value	0.03 mg KOH/g (Max^m.)
Neutralization value after oxidation	0.40 mg KOH/g (Max^m.)
Total sludge after oxidation	0.10% weight (Max^m.)
PCB Content	Free from PCB (Poly Chlorinated Biphenyl)
d) 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.

7.2.3.3 **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) First filling of new oil shall comply to the latest revision of IEC-60296 standard or other equivalent standards.
f) Each H.T. bushing shall have bolted type bimetallic connector suitable for accommodating ACSR conductor having Dia. range from 9mm to 14.5mm.
g) Each L.T. bushing shall have bolted type bimetallic connector for accommodating copper/AAC of area range 2x70mm^2 to 2x120mm^2 .
h) 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.
i) Dial thermometer for oil temperature mounted on L.T. side of the tank.
j) Earthing terminals at the bottom corners of Tank.
k) Name plate with transformer rating & winding diagram made of stainless steel shall have engraved letters filled with black enamel.
l) The tank & radiator or flanged radiator shall be painted with two coats of gray finishing paint on suitable prime coats.
m) 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.
n) HT and LT bushing shall be outdoor porcelain type
o) 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.

For Conservator Type :

a) Transformer tank completes with covers, necessary openings & gaskets.
b) Complete oil preservation system consisting of an oil conservator with shut-off valve oil level gauge. The system shall have valve for filter press inlet & oil drain. The oil sampling valve & dehydrating breather shall be provided.

7.2.3.4 **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, 200KVA, 3-Phase, Dyn11 distribution transformer.
b) Detail dimensional drawings of offered 33/0.415KV, 200KVA, 3-Phase, Dyn11 distribution transformer.
c) Manufacturer's valid ISO 9001 Certificate;

7.2.3.5 **DOCUMENTATION**

The following documents are to be submitted along with the Tender for the similar or higher KVA rating of same voltage class of offered 33/0.415KV Distribution Transformer:

1) Guaranteed Technical Particulars (GTP) shall be properly filled up and signed by both Manufacturer & Tenderer;
2) Letter of authorization from the Manufacturers, in case, the Bidder is not the manufacturer, in prescribed Form;
3) 2 nos. of Manufacturer's Supply Record for similar or higher KVA rating of same voltage class of offered type Distribution Transformer within the last 5 (five) years from the date of opening in the following format (The supply record covering 25% of the tendered quantity in a single Contract will be considered only);

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

4) At least 2 (two) Satisfactory Performance Certificate from for similar or higher KVA rating of same voltage class of offered type Distribution Transformer within the last 5 (five) years from the date of opening;
5) Type Test report for similar or higher KVA rating of same voltage class of offered type Distribution Transformer from an independent testing laboratory/Institute as per relevant standard (unless otherwise specified).

7.2.3.6 **Test Reports**

Tenderer's shall include in their offer the following routine tests, type tests and Short circuit withstands tests (or details calculations on the basis of design data) as prescribed in IEC-60076/ BS-171 for 33/0.415KV, 200KVA , 3-Phase, Dyn11 Distribution Transformer or higher capcity.

ROUTINE 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 tests.

TYPE TESTS

1) Impulse Voltage withstands test.
2) Temperature rise test.

SPECIAL TESTS

1) Short circuit withstands tests or details calculations along with thermal & mechanical calculations on the basis of design data.

7.2.3.7 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 ± 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 3 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±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 specifiec 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

= Contract Price x {(Measured Loss - specified Loss) ÷ specified Loss} x %MT

Where,

Contract Price	=	Total Contract 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 Monetized Transformer) = % of the Monetized 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)x100=20%

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

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

7.2.3.8 APPROVAL OF DRAWINGS

Calculation for the Max. Temp. Rise of Winding & Oil over 40^0C 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.

7.2.3.9 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.

7.2.3.10 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.

7.2.3.11 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 filling with oil 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 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.

7.2.3.12 RATING PLATE

A brass or stainless steel rating plate shall be fitted to each transformer. The information shall 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
* Manufacture'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. .....of .....KVA ..... 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**.**

7.2.3.13 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.

7.2.3.14 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.

7.2.3.15 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.

7.2.3.16 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.

7.2.3.17 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.

7.2.3.18 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.

7.2.3.19 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 looking 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