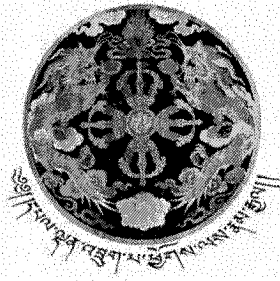




འབྲུག་གློག་མེ་ལས་འཛིན།

**Bhutan Power Corporation Limited**  
(An ISO 9001:2015, ISO 14001:2015 & ISO 45001: 2018 Certified Company)  
Registered Office, Thimphu  
Procurement Services Department  
Thimphu: Bhutan



BPC/PSD/2023 Materials/2022/11/

August 29, 2022

**Subject:** **Addendum No. 1**

**Reference:** BPC/PSD/2023 Materials/2022/11 dated August 13, 2022

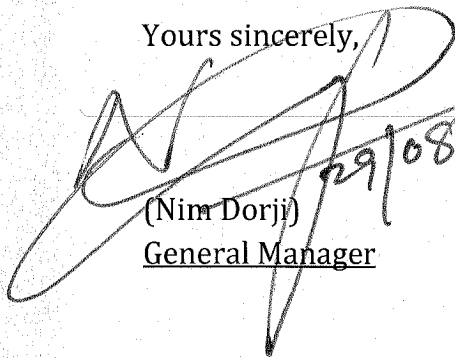
Dear Sir(s),

This is in reference to the above-mentioned tender whereby PSD, BPC would like to notify the prospective Bidders that the Technical Specifications of **item 4.12: Power Transformer 33/11kV, 2.5 MVA** and **item 4.13: Power Transformer 33/11kV, 5 MVA** are attached as **Annexure-I** and **Annexure-II** respectively.

This addendum shall form a part of the bidding document and shall be binding. However, due to the above inclusion and additional information, no time extension shall be granted and the submission date and time shall remain unaltered.

Thanking you,

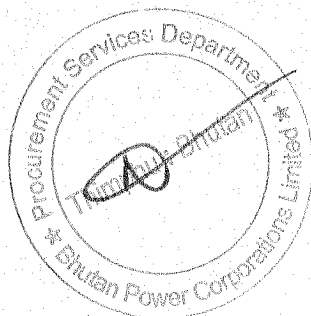
Yours sincerely,

  
(Nim Dorji)  
General Manager

29/08/2022

## **TECHNICAL SPECIFICATIONS**

### **Item 4.12: Power Transformer 33/11kV, 2.5 MVA**



ANNEXURE - I

## 1.0 POWER TRANSFORMER

1.1.1 Applicable standards : IEC 60076, 60214, 60296  
(Part I to IV) or IS 2026 (Part I to IV)

### 1.1.2 Parameters

Refer Table 1 for parameters of transformers.

### 1.1.3 Capitalisation of losses for bid evaluation

1.1.3.1 Transformer losses indicated by the Bidder will be capitalised considering tolerances as applicable for the purpose of bid evaluation at the following rates:

- |    |                  |   |                |
|----|------------------|---|----------------|
| a) | No load losses   | : | Nu. 132,000/kW |
| b) | Load Losses      | : | Nu. 70,000/kW  |
| c) | Auxiliary losses | : | Nu. 53,000/kW  |

### 1.1.4 Penalty for Losses

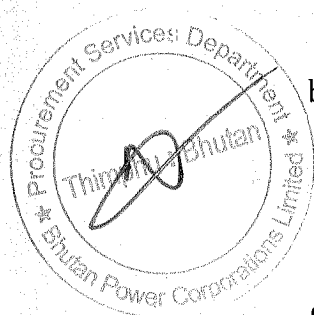
1.1.4.1 If measured losses exceed the guaranteed figures; penalties will be levied to the Contractor at the rates given in Clause 1.1.3.1 above, within tolerable limits.

### 1.1.5 Accessories and Fittings

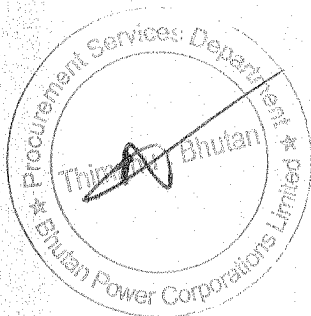
1.1.5.1 The transformer shall have the following accessories including but not limited to:

1.1.5.2 Each 2.5 MVA transformers shall have the following fittings and accessories, including but not limited to:

- a) A conservator of sufficient volume with
  - i. oil level gauge with provision of potential free contacts for initiating alarm for low oil level
  - ii. weather-proof dehydrating breathers -
  - iii. shut off valves
  - iv. filling plug and drain valves
- b) Gas and oil actuated Buchholz relay with
  - i. necessary shut off valves
  - ii. test cock with pipe connections for sampling
  - iii. potential free contacts for initiation of alarm in case of slow gas formation and trip in case of fast oil and gas surges
- c) Dial type thermometer with



- i. maximum temperature indicator and its resetting device
- ii. potential free contacts for initiating alarm on high temperature and trip on very high temperature
- iii. top oil temperature transducer and other necessary devices to provide two sets of 4-20mA signals for transmitting to remote control panel and SCADA.
- d) Winding temperature indicator with
  - i. necessary sensing, compensating and calibrating devices
  - ii. potential free contacts for initiating alarm on high temperature and trip on very high temperature
  - iii. WTI transmitter for remote indication
  - iv. winding temperature transducer and other necessary devices to provide two sets of 4-20mA signals for transmitting to remote control panel.
- e) Pressure relief devices and relays for transformer tank
- f) Weather-proof marshalling box mounted on transformer tank
- g) Name plate, rating and diagram plate and valve schedule plate
- h) All Valves with locking arrangement (covers) and plugs as below:
- i) Earthing pads of copper or non-corrodible material for transformer tank (2 places) and radiator banks
- j) Inspection manholes as required
- k) Lifting arrangement for lifting
  - i. fully assembled transformer
  - ii. core and coil
  - iii. tank
- l) Hauling eyes on each face of the transformer
- m) Bi-directional flanged wheels suitable for 1676 mm rail gauge
- n) Anti-earthquake clamping devices with locking arrangement
- o) Ladder with anticlimbing device
- p) Jacking pads
- q) All the wires and cables shall be securely fastned in the body through GI pipes and other places through flexible pipe.
- r) Bi-directional flanged wheels of 1000mm rail guage.



1.1.6 The technical parameters of the transformers shall be as below.

1.1.6.1 Table 1

a)	Designation of Transformer	<b>Power transformer</b>
	Rating	33 kV/11 kV
		<b>2.5 MVA</b>
b)	Quantity	As per BOQ
c)	Installation	Outdoor
d)	No. of phases	3

	And Frequency	50Hz
e)	Type of cooling	ONAN
f)	No. load Ratio	33kV/ 11 kV
g)	Tap changer	Off-Circuit Tap Changer
	i. Range	±5%
	ii. Step	1.25%
h)	Tap changing operations	Local/Remote
i)	Impedance at principal tap	6% (Latest amendment of international standard)
j)	Vector group	Dyn11
	System earthing	Solidly earthed
k)	Design ambient	40°C
l)	Temp.Rise	
	i. Winding	As per relevant standards
	ii. Top Oil	
m)	Insulation	Uniform Insulation
n)	Terminations	
	i. HV	Cable box type suitable for 33 kV, E grade
		3 Cx 150 sq.mm Al cond. XLPE armoured cable
	ii. LV	Cable box type suitable for 11 kV, E grade
		3Cx300 sq.mm Al cond. XLPE armoured cable
o)	Current Transformer	
	i. HV & LV side	As per requirements. Ratings to be decided during detail engineering.
p)	Paint shade	RAL 7032
r)	Maximum loss limit	
s)	Maximum Noise level at 1 m	62dB
t)	NCT provided/Rating	Yes/DDE

*Note# (a) For transformer protection, refer relays and protection for details.*

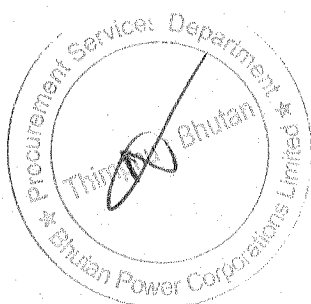


Table 2: Station Transformer

a)	Description	Unit	Particular	
1	Type		Oil filled	
2	Transformer Installation		Outdoor	
3	Rated output	kVA	63	
4	No load voltage ratio	kV	11/0.400	
5	No. of phases	Ph	3	
6	Rated Frequency	Hz	50	
7	Impedance at principal tap	%	As per IS recommendation	
8	Material of conductor		Electrical grade copper	
9	Type of cooling		ONAN	
10	Vector group		Dyn11	
11	Design ambient temperature	Deg. C	40	
12	Winding temperature rise measured over designed ambient temperature by resistance method	Deg. C	55	
13	Type of tap changer link	-	Off-Circuit Tap Changer	
14	Tap range	%	±5	
15	Tap step	%	± 2.5	
16	Type of terminal connection			
a)	HV side		Cable box	
b)	LV side		Cable box - open able	
17	<b>Cable sizes:</b>			
a)	Primary		3Cx300 sq.mm Al cond. XLPE armoured cable	
b)	Secondary		2 x 4C x 95 sq. mm, 1.1 kV, Aluminum XLPE armoured cable	
c)	Secondary neutral end		One busting each inside and outside cable box	
18	Windings		HV	LV
a)	One minute power frequency withstand voltage (Dry & wet)	kV (rms)	28	3
b)	1.2/50 micro second full wave impulse withstand voltage	kV (peak)	75	-
19	Bushing			
	Rate voltage - Primary	kV	11	
	- secondary	kV	0.400	

a)	Description	Unit	Particular
	One minute power frequency withstand voltage (Dry & wet) - Primary	kV(rms)	28
	-secondary (line & Neutral	kV(rms)	3
	Rated lighting impulse withstand voltage	kV (peak)	75
20	Painting		Power coated
21	Colour		RAL 7032

**Note#** Transformer selection will be based on loss evaluation formula by CBIP, India. The transformer shall be designed taking into consideration the altitude correction factor and the power frequency & rated values shall be corrected accordingly.

#### 1.1.7 Windings

1.1.7.1 The windings shall be of electrical grade copper.

1.1.7.2 Materials used in insulation and assembly shall be insoluble, non-catalytic and chemically inactive in the hot transformer oil and shall not soften or otherwise be affected under operating conditions.

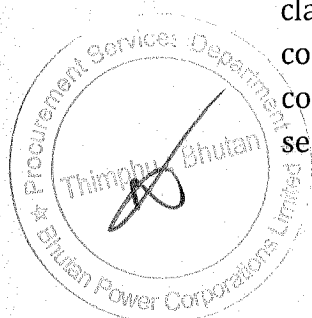
1.1.7.3 Leads from winding to the terminal board and bushings shall be rigidly supported to prevent injury from vibration.

1.1.7.4 HV windings shall be suitably braced to withstand short circuit stresses.

#### 1.1.8 Core

1.1.8.1 The magnetic circuit shall be constructed from high grade, cold rolled, non-ageing, grain oriented silicon steel laminations. Each sheet shall have an insulating coating resistant to the action of hot oil.

1.1.8.2 The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand a voltage of 2000 V for one minute. The framework and clamping arrangements of core and coil shall be securely earthed inside the tank by a copper strap connected to the tank. The core clamping structure shall be designed to minimise eddy current loss. The core shall be provided with lugs suitable for lifting the complete core and coil assembly. The framework and clamping arrangements shall be securely earthed.



### 1.1.9 Tank

1.1.9.1 The transformer tank shall be made from high-grade sheet steel, suitably reinforced by stiffeners made of structural steel sections. All seams, flanges, lifting lugs, braces, and other parts attached to the tank shall be welded. The interior of the tank shall be cleaned by shot blasting and painted with two coats of heat resistant, oil insoluble paint. Adequately sized manholes shall be provided for ease of inspection and maintenance. Steel bolts and nuts exposed to atmosphere, shall be galvanised.

1.1.9.2 Tank together with radiators, conservator, bushings and other fittings shall be designed to withstand without permanent distortion the following conditions:

- a) Full vacuum of 760 mm of Hg for filling with oil under vacuum.
- b) Internal gas pressure of 0.35 kg/cm<sup>2</sup> with oil at operating level.

1.1.9.3 Tank shall be provided with a pressure release device, which shall operate at a pressure below the test pressure for the tank and radiators. The device shall be rainproof after blowing and shall be provided with a device visible from ground to indicate operation. An equaliser pipe connecting the pressure relief device to the conservator shall be supplied. The device shall be provided with potential free contacts for alarm and tripping. Alternatively, a separate pressure relay shall be provided for this purpose.

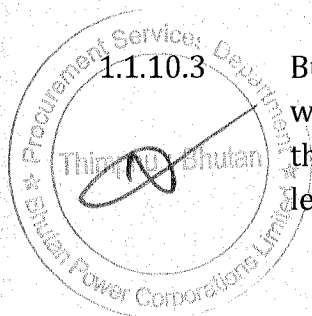
1.1.9.4 The tank cover shall be bolted type and not welded, sealed type. The tank cover shall be removable and shall be suitably sloped so that it does not retain rainwater.

### 1.1.10 Bushings

1.1.10.1 Bushings shall be of porcelain. Stresses due to expansion and contraction in any part of the bushing shall not lead to deterioration.

1.1.10.2 The angle of inclination of oil filled bushing to vertical shall not exceed 30°.

1.1.10.3 Bushings rated 72.5 kV and above shall be of the oil-filled condenser type with a central tube and draw-in conductor, which shall be connected to the connector, housed in the helmet of the bushings. The pull through lead shall be fitted with a gas bubble deflector.





1.1.10.4 Bushings shall be equipped with oil level indicators and means for sampling and draining the oil. Condenser type bushings shall be equipped with the following additional features:

- a) Provision for power factor testing without disconnecting main leads; and
- b) Bushing turrets with vent pipes so connected as to route any gas collection through the Buchholz relay

1.1.10.5 All applicable routine and type tests as stated and specified in the applicable standards shall be carried out.

#### 1.1.11 Radiators

1.1.11.1 Radiators shall be designed to withstand the vacuum pressure conditions specified for the tank. They shall be so designed as to completely drain oil into the soak pit and to prevent formation of gas pockets when the tank is being filled.

1.1.11.2 Radiators shall be of detachable with bolted and gasket flange connections.

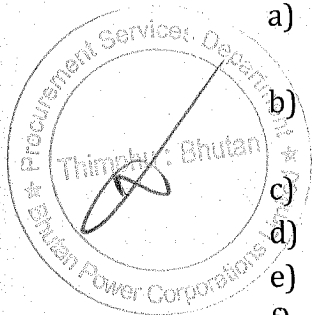
- a) Shut-off valves and blanking plates on transformer tank at each point of connection of inlet and outlet header
- b) Top and bottom shut-off valves and blanking plate on each radiator
- c) Lifting lugs
- d) Top oil filling plug
- e) Air release plug at top
- f) Oil drain plug at bottom
- g) Earthing terminals.

#### 1.1.12 Tap changing gear

1.1.12.1 OFF CIRCUIT Tap Changer (OCTC) shall be provided. An external handle shall be provided for local manual operation. This handle shall be suitable for operation by a man standing at ground level.

#### 1.1.13 Marshalling box

1.1.13.1 The marshalling box shall be tank mounted /free standing, weather proof, sheet steel (2.5 mm thick minimum), enclosed and with hinged door having padlocking facility. Door and gland plate shall be fitted with



neoprene gaskets. Bottom shall be atleast 600 mm from grade level. Top surface shall be sloped. The degree of protection shall be atleast IP55.

1.1.13.2 Contacts/terminals of electrical devices/relays, etc. mounted on the transformer shall be wired to the marshalling box. Interconnecting wires between the marshalling box and the accessories/devices shall be XLPE insulated armoured cables together with provision of compression type, brass cable glands at the marshalling box. The above mentioned cables as well as terminating the cables shall be the Contractor's responsibility.

1.1.13.3 All contacts for alarm, trip and indication circuits shall each be electrically free, designed for the auxiliary DC supply of 110/48 V (as available at the site) and brought out to separate terminals in the marshalling box. Terminals shall be rated for 10 A. Disconnecting/ shorting type terminal block shall be used for CT circuits.

1.1.13.4 Transformer digital outputs for remote annunciation/control shall be provided with two changeover contacts for alarm condition and two changeover contacts for trip condition for each of the following conditions including but not limited to: alarm and trip of Buchholz relay, oil and winding temperature high and very high, pressure relief device, oil level low in tank and conservator, auto changeover of control supply etc.

#### 1.1.14 Cable Terminations

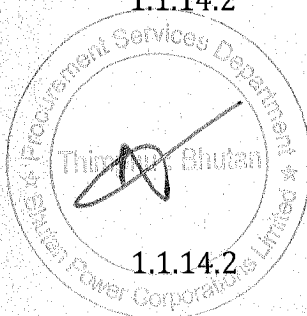
1.1.14.1 Primary and Secondary side cable boxes shall have sufficient space for segregating the cable cores and for adequate clearance in air between bare conductors at the terminals. Cable boxes shall be complete with necessary glands, lugs and armour grips.

1.1.14.2 Air filled cable boxes shall be of adequate dimensions and designed in such a manner that they can be opened for inspection without disturbing the gland plate or incoming cable. Disconnecting chamber shall be provided for disconnecting and moving away the main transformer, without removing the cables or the cable box.

1.1.14.2 Provision shall be made for earthing the body of each cable box.

#### 1.1.15 Tests

1.1.15.1 All auxiliaries and accessories such as bushing CTs, Temperature Indicators, Buchholz and pressure relays shall be tested as per the applicable standards and test certificates shall be furnished to the Engineer for approval.



1.1.15.2 Bends, pressure test for leakage, noise level and heatrun for 1 transformer of each rating shall be carried out without any additional cost implication and shall be included in the transformer cost.

1.1.15.3 Type test for each transformer rating carried out within 5 years shall be submitted during the detail engineering.

1.1.16 Rejection

1.1.16.1 The Employer may reject the transformer if anyone of the following conditions arises:

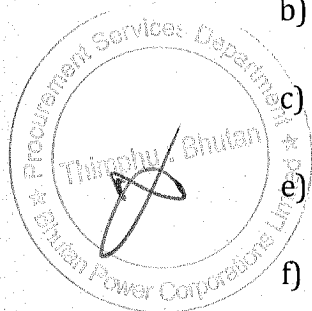
- a) Any of the quantities/parameters of transformers subject to tolerances are outside the tolerances given in the applicable standards or such tolerance guaranteed in the Contractor's bid.
- b) Winding and/or top oil temperature rise exceeds the specified/guaranteed value; and
- c) Transformer fails to withstand any of the dielectric tests.
- d) If the transformer losses are beyond the maximum losses specified in the specification of the bidder.

1.1.16.2 Employer reserves the right to have the transformer replaced or repaired by the Contractor within reasonable period to Employer's satisfaction at no extra cost to the Employer. The Contractor shall also bear the costs, including but not limited to, incurred by the Employer in re-inspection/re-testing such as travel and incidental expense, etc. The Contractor shall note that any delay in completion time due to such repair/replacement shall be subject to liquidated damages as specified in the Conditions of Contract.

1.1.17 Inclusions

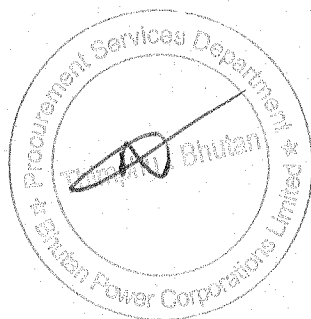
1.1.17.1 The following items shall also be included in the Contractor's scope:

- a) Supply, installation and commissioning of interconnecting cables between transformers mounted accessories, marshalling box, in the control room along with associated compression type brass cable glands, lugs, etc.
- b) Ten percent extra oil, in addition to that required for first filling of complete transformer, in non-returnable drums,
- c) A 10 liter can of paint for touching up the external surface after erection, and
- e) Terminal clamps/ connectors suitable for connecting to specified sizes of conductor/ tube/ cable.
- f) Tools and tackles as required for the normal operation shall be supplied with the transformer.



## **TECHNICAL SPECIFICATIONS**

### **ITEM 4.13: Power Transformer 33/11kV, 5 MVA**



ANNEXURE - II

## 1.0 POWER TRANSFORMER

1.1.1 Applicable standards : IEC 60076, 60214, 60296  
(Part I to IV) or IS 2026 (Part I to IV)

### 1.1.2 Parameters

Refer Table 1 for parameters of transformers.

### 1.1.3 Capitalisation of losses for bid evaluation

1.1.3.1 Transformer losses indicated by the Bidder will be capitalised considering tolerances as applicable for the purpose of bid evaluation at the following rates:

- |    |                  |   |                |
|----|------------------|---|----------------|
| a) | No load losses   | : | Rs. 132,000/kW |
| b) | Load Losses      | : | Rs. 70,000/kW  |
| c) | Auxiliary losses | : | Rs. 53,000/kW  |

### 1.1.4 Penalty for Losses

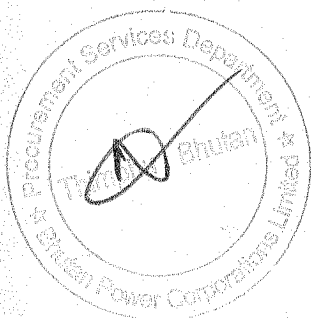
1.1.4.1 If measured losses exceed the guaranteed figures; penalties will be levied on the Contractor at the rates given in Clause 1.1.3.1 above, within tolerable limits.

### 1.1.5 Accessories and Fittings

1.1.5.1 The transformer shall have the following accessories including but not limited to:

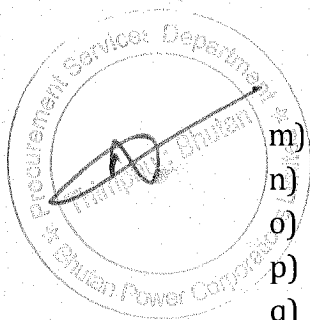
1.1.5.2 Each 5 MVA transformers shall have the following fittings and accessories, including but not limited to:

- a) A conservator of sufficient volume with
  - i. separate compartment for OLTC
  - ii. oil level gauge with provision of potential free contacts for initiating alarm for low oil level
  - iii. weather-proof dehydrating breathers for both compartments
  - iv. shut off valves
  - v. filling plug and drain valves(Alternatively a separate conservator with all the accessories shall be provided for OLTC)



Conservator shall be designed to maintain an oil seal upto a temperature of 100° C.

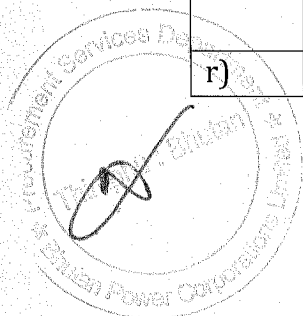
- b) Gas and oil actuated Buchholz relay with
  - i. necessary shut off valves
  - ii. test cock with pipe connections for sampling
  - iii. potential free contacts for initiation of alarm in case of slow gas formation and trip in case of fast oil and gas surges
- c) Separate Buchholz relay as in b) above for OLTC chamber
- d) Dial type thermometer with
  - i. maximum temperature indicator and its resetting device
  - ii. potential free contacts for initiating alarm on high temperature and trip on very high temperature
  - iii. top oil temperature transducer and other necessary devices to provide two sets of 4-20mA signals for transmitting to remote control panel and SCADA.
- e) Winding temperature indicator with
  - i. necessary sensing, compensating and calibrating devices
  - ii. potential free contacts for initiating alarm on high temperature and trip on very high temperature
  - iii. WTI transmitter for remote indication
  - iv. winding temperature transducer and other necessary devices to provide two sets of 4-20mA signals for transmitting to remote control panel.
- f) Pressure relief devices and relays for transformer tank and OLTC chamber
- g) Weather-proof marshalling box mounted on transformer tank
- h) Name plate, rating and diagram plate and valve schedule plate
- i) All Valves with locking arrangement (covers) and plugs as below:
- j) Earthing pads of copper or non-corrodible material for transformer tank (2 places) and radiator banks
- k) Inspection manholes as required
- l) Lifting arrangement for lifting
  - i. fully assembled transformer
  - ii. core and coil
  - iii. tank
- m) Hauling eyes on each face of the transformer
- n) Bi-directional flanged wheels suitable for 1676 mm rail gauge
- o) Anti-earthquake clamping devices with locking arrangement
- p) Ladder with anticlimbing device
- q) Jacking pads
- r) All the wires and cables shall be securely fastned in the body through GI pipes and other places through flexible pipe.



#### 1.1.6

The technical parameters of the transformers shall be as below.

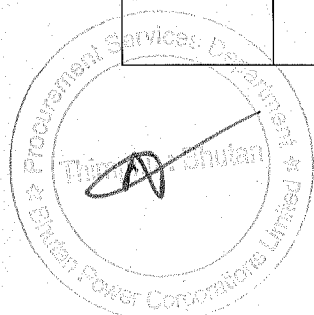
a)	Designation of Transformer	<b>Power transformer</b>
	Rating	33 kV/11 kV
		<b>5 MVA</b>
b)	Quantity	As per BOQ
c)	Installation	Outdoor
d)	No. of phases	3
	And Frequency	50Hz
e)	Type of cooling	ONAN
f)	No. load Ratio	33kV/ 11 kV
g)	Tap changer	On load on HV winding
	i. Range	±5%
	ii. Step	1.25%
h)	Tap changing operations	Manual / Local
i)	Impedance at principal tap	7.15%
j)	Vector group	Dyn11
	System earthing	Solidly earthed
k)	Design ambient	40°C
l)	Temp.Rise	
	i. Winding	As per relevant standards
	ii. Top Oil	
m)	Insulation	Uniform Insulation
n)	Terminations	
	i. HV	Cable box type suitable for 33 kV, E grade
		3 Cx 185 sq.mm Al cond. XLPE armoured cable
	ii. LV	Cable box type suitable for 11 kV, E grade
		3Cx300 sq.mm Al cond. XLPE armoured cable
o)	Current Transformer	As per requirements
	i. HV & LV side	To be decided during detail engineering.
p)	Paint shade	RAL 7032
q)	Altitude correction	The transformer shall be designed taking into altitude consideration for different places as given in the bid.
r)	Maximum loss limit	



s)	Maximum Noise level at 1 m	60 db
t)	NCT	

Table 2: Station Transformer

a)	Description	Unit	Particular
1	Type		Oil filled
2	Transformer Installation		Outdoor
3	Rated output	kVA	63
4	No load voltage ratio	kV	11/0.400
5	No. of phases	Ph	3
6	Rated Frequency	Hz	50
7	Impedance at principal tap	%	As per IS recommendation
8	Material of conductor		Electrical grade copper
9	Type of cooling		ONAN
10	Vector group		Dyn11
11	Design ambient temperature	Deg. C	40
12	Winding temperature rise measured over designed ambient temperature by resistance method	Deg. C	55
13	Type of tap changer link	-	Off-Circuit Tap Changer
14	Tap range	%	$\pm 2\frac{1}{2}\%$
15	Tap step	%	$\pm 2.5$
16	Type of terminal connection		
a)	HV side		Cable box
b)	LV side		Cable box - open able
17	<b>Cable sizes:</b>		
a)	Primary		3Cx300 sq.mm Al cond. XLPE armoured cable





b)	Secondary		2 x 4C x 95 sq. mm, 1.1 kV, Aluminum XLPE armoured cable	
c)	Secondary neutral end		One busting each inside and outside cable box	
18	Windings		HV	LV
a)	One minute power frequency withstand voltage (Dry & wet)	kV (rms)	28	3
b)	1.2/50 micro second full wave impulse withstand voltage	kV (peak)	75	-
19	Bushing			
	Rate voltage - Primary	kV	11	
	- secondary	kV	0.400	
	One minute power frequency withstand voltage (Dry & wet) - Primary	kV(rms)	28	
	-secondary (line & Neutral	kV(rms)	3	
	Rated lightning impulse withstand voltage	kV (peak)	75	
20	Painting		Power coated	
21	Colour		RAL 7032	

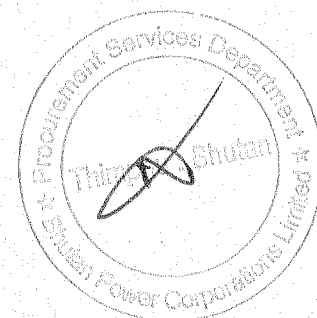
**Note#** Transformer selection will be based on loss evaluation formula by CBIP, India. The transformer shall be designed taking into consideration the altitude correction factor and the power frequency & rated values shall be corrected accordingly.

#### 1.1.7 Windings

1.1.7.1 The windings shall be of electrical grade copper.

1.1.7.2 Materials used in insulation and assembly shall be insoluble, non-catalytic and chemically inactive in the hot transformer oil and shall not soften or otherwise be affected under operating conditions.

1.1.7.3 Leads from winding to the terminal board and bushings shall be rigidly



supported to prevent injury from vibration.

1.1.7.4 HV windings shall be suitably braced to withstand short circuit stresses.

1.1.8 Core

1.1.8.1 The magnetic circuit shall be constructed from high grade, cold rolled, non-ageing, grain oriented silicon steel laminations. Each sheet shall have an insulating coating resistant to the action of hot oil.

1.1.8.2 The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand a voltage of 2000 V for one minute. The framework and clamping arrangements of core and coil shall be securely earthed inside the tank by a copper strap connected to the tank. The core clamping structure shall be designed to minimise eddy current loss. The core shall be provided with lugs suitable for lifting the complete core and coil assembly. The framework and clamping arrangements shall be securely earthed.

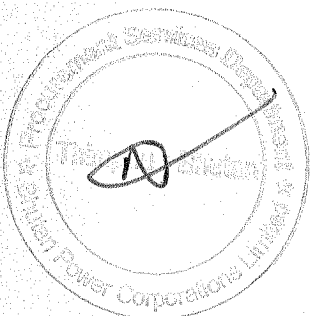
1.1.9 Tank

1.1.9.1 The transformer tank shall be made from high-grade sheet steel, suitably reinforced by stiffeners made of structural steel sections. All seams, flanges, lifting lugs, braces, and other parts attached to the tank shall be welded. The interior of the tank shall be cleaned by shot blasting and painted with two coats of heat resistant, oil insoluble paint. Adequately sized manholes shall be provided for ease of inspection and maintenance. Steel bolts and nuts exposed to atmosphere, shall be galvanised.

1.1.9.2 Tank together with radiators, conservator, bushings and other fittings shall be designed to withstand without permanent distortion the following conditions:

- a) Full vacuum of 760 mm of Hg for filling with oil under vacuum.
- b) Internal gas pressure of  $0.35 \text{ kg/cm}^2$  with oil at operating level.

1.1.9.3 Tank shall be provided with a pressure release device, which shall operate at a pressure below the test pressure for the tank and radiators. The device shall be rainproof after blowing and shall be provided with a device visible from ground to indicate operation. An equaliser pipe connecting the pressure relief device to the conservator shall be supplied. The device shall be provided with potential free contacts for alarm and tripping. Alternatively, a separate pressure relay shall be provided for this purpose.



1.1.9.4 The tank cover shall be bolted type and not welded, sealed type. The tank cover shall be removable and shall be suitably sloped so that it does not retain rainwater.

1.1.10 Bushings

1.1.10.1 Bushings shall be of porcelain. Stresses due to expansion and contraction in any part of the bushing shall not lead to deterioration.

1.1.10.2 The angle of inclination of oil filled bushing to vertical shall not exceed 30°.

1.1.10.3 Bushings rated 72.5 kV and above shall be of the oil-filled condenser type with a central tube and draw-in conductor, which shall be connected to the connector, housed in the helmet of the bushings. The pull through lead shall be fitted with a gas bubble deflector.

1.1.10.4 Bushings shall be equipped with oil level indicators and means for sampling and draining the oil. Condenser type bushings shall be equipped with the following additional features:

- a) Provision for power factor testing without disconnecting main leads; and
- b) Bushing turrets with vent pipes so connected as to route any gas collection through the Buchholz relay

1.1.10.5 All applicable routine and type tests as stated and specified in the applicable standards shall be carried out.

1.1.11 Radiators

1.1.11.1 Radiators shall be designed to withstand the vacuum pressure conditions specified for the tank. They shall be so designed as to completely drain oil into the soak pit and to prevent formation of gas pockets when the tank is being filled.

1.1.11.2 Radiators shall be of detachable with bolted and gasket flange connections.

- a) Shut-off valves and blanking plates on transformer tank at each point of connection of inlet and outlet header
- b) Top and bottom shut-off valves and blanking plate on each radiator



- c) Lifting lugs
- d) Top oil filling plug
- e) Air release plug at top
- f) Oil drain plug at bottom
- g) Earthing terminals.

#### 1.1.12 Tap changing gear

1.1.12.1 ON LOAD Tap Changer (OLTC) shall be provided for 5 MVA, 33/11 kV transformer and shall comply with the relevant standards.

#### 1.1.14 Marshalling box

1.1.14.1 The marshalling box shall be tank mounted /free standing, weather proof, sheet steel (2.5 mm thick minimum), enclosed and with hinged door having padlocking facility. Door and gland plate shall be fitted with neoprene gaskets. Bottom shall be atleast 600 mm from grade level. Top surface shall be sloped. The degree of protection shall be atleast IP55.

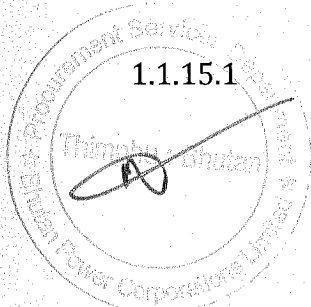
1.1.14.2 Contacts/terminals of electrical devices/relays, etc. mounted on the transformer shall be wired to the marshalling box. Interconnecting wires between the marshalling box and the accessories/devices shall be XLPE insulated armoured cables together with provision of compression type, brass cable glands at the marshalling box. The above mentioned cables as well as terminating the cables shall be the Contractor's responsibility.

1.1.14.3 All contacts for alarm, trip and indication circuits shall each be electrically free, designed for the auxiliary DC supply of 110/48 V (as available at the site) and brought out to separate terminals in the marshalling box. Terminals shall be rated for 10 A. Disconnecting/ shorting type terminal block shall be used for CT circuits.

1.1.14.4 Transformer digital outputs for remote annunciation/control shall be provided with two changeover contacts for alarm condition and two changeover contacts for trip condition for each of the following conditions including but not limited to: alarm and trip of Buchholz relay, oil and winding temperature high and very high, pressure relief device, oil level low in tank and conservator, auto changeover of control supply etc.

#### 1.1.15 Cable Terminations

1.1.15.1 Primary and Secondary side cable boxes shall have sufficient space for segregating the cable cores and for adequate clearance in air between bare conductors at the terminals. Cable boxes shall be complete with necessary glands, lugs and armour grips.



1.1.15.2 Air filled cable boxes shall be of adequate dimensions and designed in such a manner that they can be opened for inspection without disturbing the gland plate or incoming cable. Disconnecting chamber shall be provided for disconnecting and moving away the main transformer, without removing the cables or the cable box.

1.1.15.2 Provision shall be made for earthing the body of each cable box.

1.1.16 Tests

1.1.16.1 All auxiliaries and accessories such as bushing CTs, Temperature Indicators, Buchholz and pressure relays shall be tested as per the applicable standards and test certificates shall be furnished to the Engineer for approval.

1.1.16.2 Bends, pressure test for leakage, noise level and heatrun for 1 transformer of each rating shall be carried out without any additional cost implication and shall be included in the transformer cost.

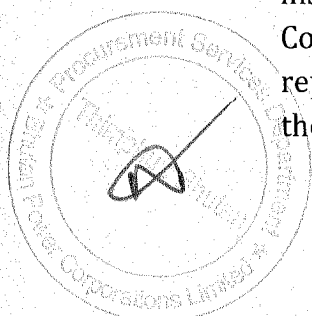
1.1.16.3 Type test for each transformer rating carried out within 5 years shall be submitted during the detail engineering.

1.1.17 Rejection

1.1.17.1 The Employer may reject the transformer if anyone of the following conditions arises:

- a) Any of the quantities/parameters of transformers subject to tolerances are outside the tolerances given in the applicable standards or such tolerance guaranteed in the Contractor's bid.
- b) Winding and/or top oil temperature rise exceeds the specified/guaranteed value; and
- c) Transformer fails to withstand any of the dielectric tests.
- d) If the transformer losses are beyond the maximum losses specified in the specification of the bidder.

1.1.17.2 Employer reserves the right to have the transformer replaced or repaired by the Contractor within reasonable period to Employer's satisfaction at no extra cost to the Employer. The Contractor shall also bear the costs, including but not limited to, incurred by the Employer in re-inspection/re-testing such as travel and incidental expense, etc. The Contractor shall note that any delay in completion time due to such repair/replacement shall be subject to liquidated damages as specified in the Conditions of Contract.



### 1.1.18 Inclusions

1.1.18.1 The following items shall also be included in the Contractor's scope:

- a) Supply, installation and commissioning of interconnecting cables between transformers mounted accessories, marshalling box, in the control room along with associated compression type brass cable glands, lugs, etc.
- b) Ten percent extra oil, in addition to that required for first filling of complete transformer, in non-returnable drums,
- c) A 10 liter can of paint for touching up the external surface after erection, and
- e) Terminal clamps/ connectors suitable for connecting to specified sizes of conductor/ tube/ cable.
- f) Tools and tackles as required for the normal operation shall be supplied with the transformer.

### 1.1.19 Parallel Operation

The similar rating transformer shall operate in parallel with each other.

