Amendments in Technical Specification No.

- **GETCO/E/TS - 2XMER01power/R13 Jun'22 for 220/66kV, 50, 100 & 160 MVA and 220/33KV, 125MVA and 132/33kV, 50MVA TRANSFORMER**

Sr	Clause No.	Instead of	Read as
01	**SECTION: I** **Cl. 1.6 (DESIGN)** **Cl. 1.6.6**	The transformer and all its accessories including CTs etc shall be designed to withstand without any injury, the thermal and mechanical effects of any external short circuit to earth and of short circuits at the terminals of any winding for a period of 3 secs. The short circuit level of the HV and LV system to which the subject transformer will be connected is 40 kA (sym, rms, 3 phase fault on 400, 220 and 132 kV) & 25 kA (sym, rms, 3 phase fault on 66, 33, 22 and 11 kV).	**OPTION 1:** The transformer and all its accessories including CTs etc shall be designed to withstand without any injury, the thermal and mechanical effects of any external short circuit to earth and of short circuits at the terminals of any winding for a period of 3 secs. The short circuit level of the HV and LV system to which the subject transformer will be connected is 40 kA (sym, rms, 3 phase fault on 66, 33, 22 and 11 kV). **OPTION 2:** The transformer and all its accessories including bushing /built in CTs etc. shall be designed to withstand the thermal and mechanical effects of any external short circuit to earth and of short circuits at the terminals of any winding without damage. **The transformer shall be designed to withstand the thermal stress due to short circuit for a duration of 2 seconds** and the same shall be verified during design review. However, **generator transformer and associated auxiliary transformer shall be designed to withstand the thermal stress due to short circuit for a duration of 3 seconds**. The following short circuit level shall be considered for the HV & IV System to which the transformers will be connected: 765kV system - 63 kA for 1 sec (sym, rms, 3 phase fault) 400kV system - 63 kA for 1 sec (sym, rms, 3 phase fault 220kV system - 50 kA for 1 sec (sym, rms, 3 phase fault) 132kV system - 40 kA for 1 sec (sym, rms, 3 phase fault) 66kV system - 31.5 kA for 1 sec (sym, rms, 3 phase fault) However, for transformer design purpose, the through fault current shall be considered limited by the transformer self-impedance only **(i.e. Zs = 0)**.

Sr	Clause No.	Instead of	Read as
02	**SECTION: I** **Cl. 1.6 (DESIGN)** **Cl. 1.6.7**	Transformer shall be capable of withstanding thermal and mechanical stresses caused by symmetrical or asymmetrical faults on any winding.	If **OPTION 1** is chosen in amended Cl. No. 1.6.6 in 1.6 DESIGN in SECTION: I DETAIL SPECIFICATION: Transformer shall be capable of withstanding thermal and mechanical stresses caused by symmetrical or asymmetrical faults on any winding. If **OPTION 2** is chosen in amended Cl. No. 1.6.6 in 1.6 DESIGN in SECTION: I DETAIL SPECIFICATION: Transformer shall be capable of withstanding thermal and mechanical stresses due to symmetrical and asymmetrical faults on any terminals. Mechanical strength of the transformer shall be such that it can withstand 3-phase and 1-phase through fault with rated voltage applied to HV and/or IV terminals of transformer. The short circuit shall alternatively be considered to be applied to each of the HV, IV and tertiary (LV) transformer terminals as applicable. The tertiary terminals shall be considered not connected to system source. For short circuit on the tertiary terminals, the in-feed from both HV & IV system shall be limited by the transformer self-impedance only and the rated voltage of HV and IV terminals shall be considered.
03	**SECTION: I** **Cl. 1.10 (Winding)** **Cl. 1.10.8**	Transformer shall be designed and constructed to withstand, without damage, the thermal effects on external short circuits (SC) for 3 seconds under conditions specified in IS: 2026 (Part-I, amended up to date).	If **OPTION 1** is chosen in amended Cl. No. 1.6.6 in 1.6 DESIGN in SECTION: I DETAIL SPECIFICATION: Transformer shall be designed and constructed to withstand, without damage, the thermal effects on external short circuits (SC) for 3 seconds under conditions specified in IS: 2026 (Part-I, amended up to date). If **OPTION 2** is chosen in amended Cl. No. 1.6.6 in 1.6 DESIGN in SECTION: I DETAIL SPECIFICATION: The transformer and all its accessories including bushing/built in CTs etc. shall be designed to withstand the thermal and mechanical effects of any external short circuit to earth and of short circuits at the terminals of any winding without damage. **The transformer shall be designed to withstand the thermal stress due to short circuit for a duration of 2 seconds** and the same shall be verified during design review. However, **generator transformer and associated auxiliary transformer shall be designed to withstand the thermal stress due to short circuit for a duration of 3 seconds**.

<table>
<tr><th>Sr</th><th>Clause No.</th><th>Instead of</th><th>Read as</th></tr>
<tr><td>04</td><td>SECTION: I
Cl. 1.12 (Insulation)
Cl. 1.12.2</td><td>
<table>
<tr><th>System Voltage</th><th>Impulse Test Voltage</th><th>Power Freq. Voltage</th></tr>
<tr><td>220</td><td>1050 kVp</td><td>460 kV rms</td></tr>
<tr><td>66</td><td>350 kVp</td><td>140 kV rms</td></tr>
<tr><td>LV 33</td><td>170 kVp</td><td>70 kV rms</td></tr>
<tr><td>N 36</td><td>170 kVp</td><td>75 kV rms</td></tr>
</table>
</td><td>
<table>
<tr><th>System Voltage</th><th>Lightning Impulse withstand Voltage</th><th>Switching Impulse withstand Voltage</th><th>One Minute Power Freq. Withstand Voltage.</th></tr>
<tr><td>220kV</td><td>950 kVp</td><td>750 kVp</td><td>395 kV rms</td></tr>
<tr><td>132kV</td><td>650 kVp</td><td>540 kVp</td><td>275 kV rms</td></tr>
<tr><td>66kV</td><td>350 kVp</td><td>-</td><td>140 kV rms</td></tr>
</table>
</td></tr>
<tr><td>05</td><td>SECTION: I
Cl. 1.19 (Bushings)
Cl. 1.19.2</td><td>
<table>
<tr><th colspan="2">Winding Details</th><th colspan="4">Bushing Details</th></tr>
<tr><th>Highest System Voltage (kV)</th><th>BIL</th><th>Class (kV)</th><th>Insulation Level LI / SI / AC(Kv)</th><th>STC 3S</th><th>Min. creepage 25/31 mm/kV</th></tr>
<tr><td>420</td><td>1300/1050 /570</td><td>420</td><td>1425/1050 /695</td><td>40</td><td>-- /13020</td></tr>
<tr><td>245</td><td>1050/850/ 460</td><td>220</td><td>1050/850/ 505</td><td>40</td><td>6125/7595</td></tr>
<tr><td>145</td><td>650/540/ 275</td><td>132</td><td>650/ 540/ 305</td><td>40</td><td>3625/4495</td></tr>
<tr><td>72.5</td><td>350/NA/ 140</td><td>66</td><td>350/ NA/ 155</td><td>25</td><td>1815/2250</td></tr>
<tr><td>33 (LV)</td><td>200/NA/70</td><td>66</td><td>350/ NA/ 155</td><td>25</td><td>1815/2250</td></tr>
<tr><td>36 (Neutral)</td><td>170/NA/70</td><td>36</td><td>170/NA/75</td><td>25</td><td>900/1120</td></tr>
</table>
</td><td>
<table>
<tr><th colspan="2">Winding Details</th><th colspan="4">Bushing Details</th></tr>
<tr><th>Highest System Voltage (kV)</th><th>BIL</th><th>Rated Volt (kV)</th><th>Insulation Level LI / SI / AC(kV)</th><th>STC (KA)</th><th>(Specific creepage distance: 31mm/kV corr. to line to line highest sys. volt)</th></tr>
<tr><td>420</td><td>1300/1050/ 570</td><td>420</td><td>1425/1050/ 695</td><td rowspan="6">As per Option - I OR Option - II</td><td>13020</td></tr>
<tr><td>245</td><td>950/750/ 395</td><td>245</td><td>1050/850/ 505</td><td>7595</td></tr>
<tr><td>145</td><td>650/540/ 275</td><td>132</td><td>650/ 540/ 305</td><td>4495</td></tr>
<tr><td>72.5</td><td>350/NA/ 140</td><td>66</td><td>350/ NA/ 155</td><td>2250</td></tr>
<tr><td>33 (LV)</td><td>200/NA/70</td><td>66</td><td>350/ NA/ 155</td><td>2250</td></tr>
<tr><td>36 (Neutral)</td><td>170/NA/70</td><td>36</td><td>170/NA/75</td><td>1120</td></tr>
</table>
</td></tr>
</table>

Sr	Clause No.	Instead of	Read as
06	**SECTION: I** **Cl. 1.19 (Bushings)** **Cl. 1.19.12**	The STC rating shall be 40 kA for 3 sec for 132 kV & above class and 25 kA for 3 sec for 66 kV and below class.	If **OPTION 1** is chosen in amended Cl. No. 1.6.6 in 1.6 DESIGN in SECTION: I DETAIL SPECIFICATION: The STC rating shall be 40 kA for 3 sec for 132 kV & above class and 25 kA for 3 sec for 66 kV and below class. If **OPTION 2** is chosen in amended Cl. No. 1.6.6 in 1.6 DESIGN in SECTION: I DETAIL SPECIFICATION: The transformer and all its accessories including bushing/built in CTs etc. shall be designed to withstand the thermal and mechanical effects of any external short circuit to earth and of short circuits at the terminals of any winding without damage. **The transformer shall be designed to withstand the thermal stress due to short circuit for a duration of 2 seconds**. However, **generator transformer and associated auxiliary transformer shall be designed to withstand the thermal stress due to short circuit for a duration of 3 seconds**. The following short circuit level shall be considered for the HV & IV System to which the transformers will be connected: 765kV system - 63 kA for 1 sec (sym, rms, 3 phase fault) 400kV system - 63 kA for 1 sec (sym, rms, 3 phase fault 220kV system - 50 kA for 1 sec (sym, rms, 3 phase fault) 132kV system - 40 kA for 1 sec (sym, rms, 3 phase fault) 66kV system - 31.5 kA for 1 sec (sym, rms, 3 phase fault) However, for transformer design purpose, the through fault current shall be considered limited by the transformer self-impedance only **(i.e. Zs = 0)**.

<table>
<tr><th>Sr</th><th>Clause No.</th><th>Instead of</th><th>Read as</th></tr>
<tr><td>07</td><td>SECTION: I
Cl. 1.38 (TRF losses & evaluation of bids)</td><td>
The transformers are to be designed with maximum permissible losses as indicated in below.
<table>
<tr><th>Transformer Rating</th><th>No Load Loss at Rated Volt. in kW</th><th>Full load losses (Copper + stray loss) at 75 oC, in kW</th><th>Auxiliary Loss in kW</th></tr>
<tr><td>160MVA (220/66KV)</td><td>64</td><td>365</td><td>11</td></tr>
<tr><td>100MVA (220/66KV)</td><td>37</td><td>234</td><td>4.5</td></tr>
<tr><td>50MVA (220/66KV)</td><td>26</td><td>160</td><td>0</td></tr>
<tr><td>125MVA (220/33KV)</td><td>55</td><td>300</td><td>8</td></tr>
<tr><td>50MVA (132/33KV)</td><td>25</td><td>160</td><td>0</td></tr>
</table>
As we have specified fixed loss figures of maximum losses, manufacturers have to adhere to these figures by designing transformer suitably. Bidder will not be ask to give any loss figure in GTP. Therefore, there will be no capitalization at tender stage. The order will be placed to lowest price bidder as per GETCO policy and actual losses measured during acceptance. It will be at discretion of GETCO to accept/reject the unit whenever there is positive variation in the losses measured at actual. However, the unit shall not be accepted in the event measured losses are beyond the following limits against the fixed loss figures specified in the tender.
1) No Load losses : 5%
2) Full Load losses : 2%
3) Aux losses : 5%
Penalty towards the higher losses within above limits shall be recovered as follow:
1) No Load losses: 3 times capitalization cost of 3,33,000/- per kW
2) Full Load losses: 3 times capitalization cost of 1,36,000/- per kW
</td><td>
The maximum permissible losses (No load loss, I2R loss, auxiliary loss and load loss) at rated voltage/current (at 75 deg C) have been specified as under.
<table>
<tr><th>Transformer Rating</th><th>No Load Loss at Rated Voltage, in kW</th><th>Full load losses (Copper + stray loss) at 75 oC, in kW</th><th>Auxiliary Loss in kW</th></tr>
<tr><td>160MVA (220/66KV)</td><td>60</td><td>320</td><td>8</td></tr>
<tr><td>100MVA (220/66KV)</td><td>37</td><td>234</td><td>4.5</td></tr>
<tr><td>50MVA (220/66KV)</td><td>26</td><td>160</td><td>0</td></tr>
<tr><td>125MVA (220/33KV)</td><td>55</td><td>300</td><td>8</td></tr>
<tr><td>50MVA (132/33KV)</td><td>25</td><td>125</td><td>3</td></tr>
</table>
As we have specified fixed loss figures of maximum losses, manufacturers have to adhere to these figures by designing transformer suitably. Bidder will not be asked to give any loss figure in GTP. Therefore, there will be no capitalization at tender stage.

The order will be placed to lowest price bidder as per GETCO policy and actual losses measured during acceptance, it will be at discretion of GETCO to accept/reject the unit whenever there is positive variation in the losses measured at actual.
However, the unit shall not be accepted in the event measured losses are beyond the following limits against the fixed loss figures specified above:
1) No Load losses: 2%
2) Full Load losses: 2%
3) Aux losses: 2 %

Penalty towards the higher losses within above limits shall be recovered as follow:
<table>
<tr><th>S.N.</th><th>Differential of specified losses vs Measured losses</th><th>RATE (in INR per KW)</th></tr>
<tr><td>1</td><td>No load Loss</td><td>Rs. 10,00,000/KW</td></tr>
<tr><td>2</td><td>I²R Losses/Load Losses (Differential of whichever loss is higher shall be considered for penalty)</td><td>Rs. 8,00,000/KW</td></tr>
<tr><td>3</td><td>Auxiliary Losses</td><td>Rs. 8,00,000/KW</td></tr>
<tr><td colspan="3">Note: For a fraction of a kW, the penalty shall be applied on pro rata basis.</td></tr>
</table>
It is also proposed that testing of unit will be carried out in presence and witness of third party selected by GETCO at the discretion of GETCO.
</td></tr>
</table>

		3) Aux losses: 3 times capitalization cost of 1,33,000/- per kW It is also proposed that testing of unit will be carried out in presence and witness of third party selected by GETCO at the discretion of GETCO. In case of any order, **the losses of successful bidder will be measured during acceptance testing and if the figures of loses are found equal to or lesser than specified above, the transformer shall be accepted. However, if any of the loss figure measured during acceptance test is found more than specified above, the transformer will not be accepted. There shall be no provision for penalty for acceptance of transformer with losses higher than specified above. Bidder shall submit undertaking separately for the same, with the technical bid**. The measurement of losses shall be carried out with digital 3 (Three) Watt meter method only and CTs, PTs and meters used for these measurements shall be of class of accuracy of 0.2. However, no weightage shall be given for supply of transformer, with losses (measured during routine tests) less than the guaranteed losses.	In case of any order, **the losses of successful bidder will be measured during acceptance testing and if the figures of loses are found equal to or lesser than specified above, the transformer shall be accepted. However, if any of the loss figure measured during acceptance test is found more than specified above, the transformer will not be accepted. There shall be no provision for penalty for acceptance of transformer with losses higher than specified above. Bidder shall submit undertaking separately for the same, with the technical bid**. The measurement of losses shall be carried out with digital 3 (Three) Watt meter method only and CTs, PTs and meters used for these measurements shall be of class of accuracy of 0.2. However, no weightage shall be given for supply of transformer, with losses (measured during routine tests) less than the guaranteed losses**.**

<table>
<tr><th>Sr</th><th>Clause No.</th><th>Instead of</th><th>Read as</th></tr>
<tr><td>08</td><td>SECTION: II
Cl. 2.3 (Type & Rating)
Cl. 2.3.1 (j & k)</td><td>
<table>
<tr><th>SN</th><th>Parameters</th><th>TRF</th></tr>
<tr><td>j)</td><td>Insulation Level of winding: LI/ SI/ AC kV</td><td></td></tr>
<tr><td></td><td>220KV</td><td>1050/850/460</td></tr>
<tr><td></td><td>132KV</td><td>650/540/275</td></tr>
<tr><td></td><td>66KV</td><td>350/NA/140</td></tr>
<tr><td></td><td>33KV LV</td><td>200/NA/70</td></tr>
<tr><td>k)</td><td>Chopped Lightning impulse</td><td></td></tr>
<tr><td></td><td>220KV</td><td>1155</td></tr>
<tr><td></td><td>132KV</td><td>715</td></tr>
<tr><td></td><td>66KV</td><td>385</td></tr>
</table>
</td><td>
<table>
<tr><th>SN</th><th>Parameters</th><th>TRF</th></tr>
<tr><td>j)</td><td>Insulation Level of winding: LI/ SI/ AC kV</td><td></td></tr>
<tr><td></td><td>220KV</td><td>950/750/395</td></tr>
<tr><td></td><td>132KV</td><td>650/540/275</td></tr>
<tr><td></td><td>66KV</td><td>350/NA/140</td></tr>
<tr><td></td><td>33KV LV</td><td>200/NA/70</td></tr>
<tr><td>k)</td><td>Chopped Lightning impulse</td><td></td></tr>
<tr><td></td><td>220KV</td><td>1045</td></tr>
<tr><td></td><td>132KV</td><td>715</td></tr>
<tr><td></td><td>66KV</td><td>385</td></tr>
</table>
</td></tr>
<tr><td>09</td><td>SECTION: II
Cl. 2.3 (Type & Rating)
Cl. 2.3.1 (q & r)</td><td>
<table>
<tr><th>SN</th><th>Parameter</th><th colspan="3">TRF</th></tr>
<tr><td>q)
r)</td><td>Short circuit level for the system</td><td>Voltage, kV
220
66
33</td><td>S C MVA
15300
4573
1500</td><td>S C current, Ka
40 for 3 Sec
25 for 3 Sec.
25 for 3 Sec.</td></tr>
</table>
</td><td>
<u>If OPTION 1 is chosen in amended Cl. No. 1.6.6 in 1.6 DESIGN in SECTION: I DETAIL SPECIFICATION:</u>
<table>
<tr><th>SN</th><th>Parameters</th><th colspan="3">TRF</th></tr>
<tr><td>q)
r)</td><td>Short circuit level for the system</td><td>Voltage, kV
220
66
33</td><td>S C MVA
15300
4573
1500</td><td>S C current, Ka
40 for 3 Sec
25 for 3 Sec.
25 for 3 Sec.</td></tr>
</table>
<u>If OPTION 2 is chosen in amended Cl. No. 1.6.6 in 1.6 DESIGN in SECTION: I DETAIL SPECIFICATION:</u>
The following short circuit level shall be considered for the HV & IV System to which the transformers will be connected:

765kV system - 63 kA for 1 sec (sym, rms, 3 phase fault)
400kV system - 63 kA for 1 sec (sym, rms, 3 phase fault
220kV system - 50 kA for 1 sec (sym, rms, 3 phase fault)
132kV system - 40 kA for 1 sec (sym, rms, 3 phase fault)
66kV system - 31.5 kA for 1 sec (sym, rms, 3 phase fault)
</td></tr>
</table>

<table>
<tr><th>Sr</th><th>Clause No.</th><th>Instead of</th><th>Read as</th></tr>
<tr><td>10</td><td>SECTION: III
(Bidding Schedule-A)
GTP to be filled by bidder</td><td>
<table>
<tr><th>SN</th><th>Description</th><th>Unit</th><th>Specified by buyer</th></tr>
<tr><td>14</td><td>Impedance & Losses</td><td></td><td></td></tr>
<tr><td>(iv)</td><td>Guaranteed Load Losses at rated tap and 75 deg c
(a) 50MVA, 220/66
(b) 100MVA, 220/66
(c) 160MVA, 220/66
(d) 125MVA, 220/33
(e) 50MVA, 132/33</td><td>kW</td><td>
160
234
365
300
160</td></tr>
<tr><td>(viii)</td><td>Guaranteed No load losses
(a) 50MVA, 220/66
(b) 100MVA, 220/66
(c) 160MVA, 220/66
(d) 125MVA, 220/33
(e) 50MVA, 132/33</td><td>kW</td><td>
26
37
64
55
25</td></tr>
<tr><td>(xi)</td><td>Guaranteed aux loss
(a) 50MVA, 220/66
(b) 100MVA, 220/66
(c) 160MVA, 220/66
(d) 125MVA, 220/33
(e) 50MVA, 132/33</td><td>kW</td><td>
0.0
4.5
11.0
8.0
0.0</td></tr>
</table>
</td><td>
<table>
<tr><th>SN</th><th>Description</th><th>Unit</th><th>Specified by buyer</th></tr>
<tr><td>14</td><td>Impedance & Losses</td><td></td><td></td></tr>
<tr><td>(iv)</td><td>Guaranteed Load Losses at rated tap and 75 deg c
(f) 50MVA, 220/66
(g) 100MVA, 220/66
(h) 160MVA, 220/66
(i) 125MVA, 220/33
(j) 50MVA, 132/33</td><td>kW</td><td>
160
234
320
300
125</td></tr>
<tr><td>(viii)</td><td>Guaranteed No load losses
(f) 50MVA, 220/66
(g) 100MVA, 220/66
(h) 160MVA, 220/66
(i) 125MVA, 220/33
(j) 50MVA, 132/33</td><td>kW</td><td>
26
37
60
55
25</td></tr>
<tr><td>(xi)</td><td>Guaranteed aux loss
(f) 50MVA, 220/66
(g) 100MVA, 220/66
(h) 160MVA, 220/66
(i) 125MVA, 220/33
(j) 50MVA, 132/33</td><td>kW</td><td>
0.0
4.5
8.0
8.0
3.0</td></tr>
</table>
</td></tr>
</table>

Note : The vacuum and pressure test on Transformer/Reactor tank is revised as per CEA guidelines.

Further, following clause are added & incorporated in Technical Specification.

<table>
<tr><th>Sr</th><th>Description</th><th>To be added</th></tr>
<tr><td>01</td><td>Core</td><td>

Manufacturers of Stampings / Laminations / Cores of transformers (with or without winding) from CRGO/Amorphous material have to get Certificate of Conformity (CoC) from Bureau of Indian Standard (BIS).
Essential Requirements (As per Ministry of Steel, GOI Steel and Steel Products (Quality Control) Order, 2020 dated 27.05.2020: Table 2)

<table>
<tr><th>Sl. No.</th><th>Goods & Articles</th><th>Essential Requirements</th><th>ITC (HS) Code</th><th>Date of Implementation</th></tr>
<tr><td>1</td><td>Stampings / Laminations / Cores of transformers (with or without winding)</td><td>Made from BIS standard marked Grain Oriented Electrical Steel Sheet and Strip confirming to IS 3024:2015 or Cold rolled non-oriented electrical steel sheet and strip confirming to IS 648:2006 or Magnetic materials – specification for individual material – Fe based amorphous strip delivered in the semi-processed state confirming to IS 16585:2016.</td><td>85049010
85049090</td><td>With immediate effects</td></tr>
</table>
</td></tr>
<tr><td>02</td><td>Rail arrangement</td><td>

The rail arrangement for civil foundation plinth drawings for Transformers are standardized as per drawing No : GETCO/E/2S-STD/TRFRAIL-02 (R0) and same is attached herewith for reference.

</td></tr>
<tr><td>03</td><td>NIFPS specification</td><td>

The revised specification No: GETCO/E/TS-FF/2903/R3 June’2020 for the “Work of design, supply, erection and commissioning including civil work of nitrogen injection system for protection against the fire & explosion for transformer” is incorporated in Transformer / Reactor technical specification.

</td></tr>
</table>

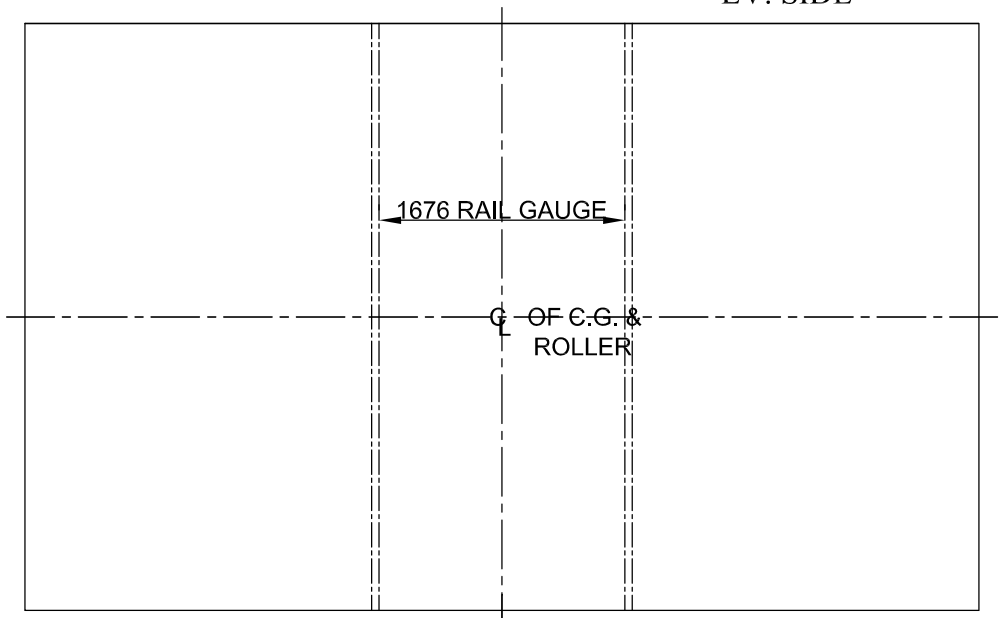
Further, following clause are revised & incorporated in Technical Specification as per CEA (April-2021).

<table>
<tr><th>Sr</th><th>Description</th><th>To be added/revised</th></tr>
<tr><td>04</td><td>Insulation Resistance</td><td>➢ The minimum satisfactory values for insulation Resistance at 30°C (one minute measurements) at the time of commissioning is as under,

<table>
<tr><th>Rated Voltage class of winding</th><th>Minimum desired IR value at 1 minute (Mega ohm)</th></tr>
<tr><td>11kV</td><td>500 MΩ</td></tr>
<tr><td>33kV</td><td>1000 MΩ</td></tr>
<tr><td>66kV & above</td><td>1500 MΩ</td></tr>
</table>
</td></tr>
<tr><td>05</td><td>Polarization Index Test</td><td>➢ The Polarization Index (PI) is the ratio of the 10 min to the 1 min mega-ohm readings.

<table>
<tr><th>Polarization Index</th><th>Insulation Condition</th></tr>
<tr><td>Less than 1</td><td>Dangerous</td></tr>
<tr><td>1.0 - 1.1</td><td>Poor</td></tr>
<tr><td>1.1 - 1.25</td><td>Questionable</td></tr>
<tr><td>1.25 - 2.0</td><td>Fair</td></tr>
<tr><td>2.0 – 4.0</td><td>Good</td></tr>
<tr><td>Above 4.0</td><td>Excellent</td></tr>
</table>
</td></tr>
<tr><td>06</td><td>Tan Delta of Windings and bushings</td><td>➢ For Winding and bushings, the tan delta value shall not exceed 0.005 i.e. 0.5 % (during first charging).</td></tr>
</table>

LV. SIDE



HV. SIDE

DIRECTION OF WITHDRAWAL

PLAN VIEW OF TR. PLINTH

SR NO.	REFERENCE	REV:	DESCRIPTION
1	RAIL ARRANGEMENT STANDARDIZED VIDE OFFICE NOTE OF STD TR FDN DRGS NO. GETCO/CE(ENGG)/VI/B/O-007901 DATE:25.11.2021	R0	FIRST PREPARATION

GUJARAT ENERGY TRANSMISSION CORPN.LTD.
S.P.VIDYUT BHAVAN, RACE COURSE,
VADODARA - 390 007

RAIL ARRANGEMENT FOR (50MVA, 100MVA, 150MVA & 160 MVA) TRANSFORMER AT 132KV & 220KV YARD

CHECKED: DE (CIVIL)	EE (CIVIL)	APPD: SE (ENGG.)	SIZE: A4
SCALE: N.T.S.	DATE: 10.12.21	DRG. NO: GETCO / E / 2S-STD /TRFRAIL-02	SHEET: 2 OF 2 / REV: R0

Dated: 08.09.2020

TTR validity amendment-1

(Addendum to Technical Specification for validity of type test reports for *major electrical equipments*)

Sr. No.	Name of test/ Equipment	Type test reports validity (In Years)
i.	On Line Tap Changer (OLTC)	10
ii.	Power Transf. Bushing/ Reactor Bushing	7
iii.	Transformer/reactor fittings and accessories.	10
iv.	Circuit Breaker	10
v.	Isolators	10
vi.	Lightning Arrestors	10
vii.	Wave Trap	10
viii.	Instrument Transformer	7
ix.	Low Voltage (LV) & Medium Voltage (MV) Switchgear	10
x.	Cable & associated joints	10
xi.	Capacitors	10
xii.	Energy Meters [including smart meters & Availability Based Tariff (ABT) meters]	5
xiii.	Conductors & earth wire	10
xiv.	Insulators(Porcelain/ Glass)	10
xv.	Composite Insulators	5
xvi.	Power Line Carrier Communication (PLCC)/Fibre Optic (FO) cable/Optical Ground Wire (OPGW)	5
xvii.	Terminal connectors of all major equipments including transformers	10

Note: Type test reports shall be valid as on the last date of submission of bid.

GUJARAT ENERGY TRANSMISSION CORPORATION LTD.

SARDAR PATEL VIDYUT BHAVAN,
RACE COURSE, BARODA – 390 007

TECHNICAL SPECIFICATIONS FOR

1) 220/66 KV – 50, 100, 160 MVA Power Transformer
2) 220/33 KV – 125 MVA Power Transformer
3) 132/33 KV – 50 MVA Power Transformer

(Without Capitalization)

GETCO/E/TS – 2XMER01power/ *R13 Jun'22*

SPECIAL INSTRUCTIONS TO BIDDER

Please read following instructions carefully before submitting your bid.

1. All the drawings, i.e. elevation, side view, plan, cross sectional view etc., in AutoCAD format and manuals in PDF format, for offered item shall be submitted. Also the hard copies as per specification shall be submitted.

2. The bidder shall submit Quality Assurance Plan with the technical bid.

3. Bidder shall have to submit type test report as mentioned in clause No. 1.30.3.1(b).

4. The bidder must fill up all the points of GTP for offered item/s. Instead of indicating "refer drawing, or as per IS/IEC", the exact value/s must be filled in.

5. All the points other than GTP, which are asked to confirm in technical specifications must be submitted separately with the bid.

6. The bidder is required to impart training in view of manufacture, assembly, erection, operation and maintenance for offered item, at his works, to the person/s identified by GETCO, in the event of an order, free of cost. The cost of logistics will be bear by GETCO.

7. Please note that the evaluation will be carried out on the strength of content of bid only. No further correspondence will be made.

8. The bidder shall bring out all the technical deviation/s only at the specified annexure.

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Note for RIP/ RIF/ RIS bushings :

If offered RIP/ RIF/ RIS bushings are to be supplied from Indian manufacturing unit under technical collaboration with foreign OEM, then type test reports & satisfactory performance certificate from their offered country works of foreign OEM shall be considered valid for BID evaluation. However, in event of order, following type test reports to be submitted by Indian manufacturing unit having technical collaboration of foreign OEM, before commencement of supply, without affective delivery schedule, free of cost to GETCO.

a. Dielectric Test as per IEC 60137 (Latest Edition)
b. Temperature Rise Test as per IEC 60137 (Latest Edition)

INDEX

SECTION: I

DETAIL SPECIFICATION OF 50, 100 & *160* MVA, 220/66 kV, 125 MVA 220/33 kV, 50 MVA 132/33KV POWER TRANSFORMERS

GENERAL TECHNICAL REQUIREMENTS

1.1 SCOPE

1.1.1 This section covers the design, manufacture, assembly, testing at manufacturer's works, supply and delivery include loading, transportation & unloading on plinth at site, of the ***oil filled,*** Power transformers as detailed in the Schedule of requirements, complete with all accessories required for ***safe, efficient,*** satisfactory and trouble free operation of the equipment.

1.1.2 The scope of work shall also include **EITHER** complete erection, testing and commissioning of all the equipments/accessories furnished under this specification **OR** only supervision of erection, testing and commissioning of all the equipment furnished under this Specification, as indicated in **Schedule – A** of the commercial bid.

*1.1.2.1 Each transformer shall be supplied with (i) Oil storage tank (Steel Tank) as per cl. no. 2.8, (ii) 3 nos. of oil sampling bottles as per cl. no. 2.9, (iii) Fiber optic sensors (iv) On Line Moisture and Gas In Oil Analyser, (v) Nitrogen Injection System For Protection Against The Fire & Explosion, (vi) On line PD measurement, (vii) GPS/GRPS/GSM based on line transformer movement tracking system on returnable basis (viii) Condition controlled maintenance free on line breather as per specification (ix) on line tan delta of bushing (x) SFRA Kit (xi) Tan delta kit (xii) Air Dryer(xiii)Fiber Optic Sensor**, ***if indicated in Schedule – A of respective tender****.*

However, Bidder has to quote for the accessories equipments/ Material, indicated in Schedule-A of commercial Bid.

1.1.3 **GUARANTEE:**
The bidder shall among other things guarantee the following:

i) Quality and strength of materials used.
ii) The bidder shall give the guarantee as satisfactory working of the complete transformer for 36 months from the date of commissioning of equipment or 42 months from the date of receipt of transformer at site, whichever is earlier.
Guarantee period will be reckoned from the date of receipt of 100 % accessories and not from the date of receipt of main tank only.

It may be noted that the service guarantee would be applicable even when the transformers are erected and operated through any other agency appointed by the GETCO.

1.2 TRANSPORT:

The equipment to be furnished under this specification shall be packed for transportation in such a manner as may facilitate easy handling and avoiding any damage during transit.

1.3 STANDARDS:

The power transformers covered under this specification shall comply with the requirements of the latest edition of IS:2026 (amended upto date) except specified herein. However, in the event the offered equipment conforms to any other standards, the salient points of difference between the standard adopted and the specified standard shall be clearly brought out in the bid.

1.4 DRAWINGS:

1.4.1 Drawings in AutoCAD format and in hard copy, incorporating the following particulars shall be submitted by each bidder with the bid.

i) General outline drawing showing dimensions, wheel loading, net weight of transformer, tap change gear, marshalling box, **control cubicles required for all the monitoring devices,** etc.
ii) General arrangements of foundations and structural mounting.
iii) Sectional views showing the general constructional features and disposition of various fittings and sectional view of Core Coil assembly clearly indicating boltless construction and other necessary specific details.
iv) Dimensions of the largest packages to be transported.
v) Drawing showing the complete details of all class condenser bushing and other relevant data.
vi) Drawings showing details of Buchholz relay, winding temperature indicator, oil temperature indicator, air cell, cooling systems, tap changer, ***all the monitoring devices and NIFPS, AVR relay, maintenance free breather,*** etc.

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

i) General out line 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.
ii) Detailed foundation drawings along with structural drawings showing design criteria & loadings.
iii) Drawings of each type of bushings, lifting dimensions, clearance between HT and LT terminals and ground, quantity of insulating oil, name plate details etc. showing various weights and ratio of WT-CT, OT-CT, all bushing CT and details of OLTC & RTCC. *The rating / name plate and erection sequence diagram plate shall be as per IEEMA transformer manual no. 25 - 2014.*
iv) Large scale drawings of high, medium and low-tension windings of the transformers showing the nature and arrangement of insulators and terminal connections.

v) Control and annunciation wiring diagram and drawings showing temperature indicator, alarm circuits, Buchholz relay, oil surge relay, PRV, MOG, WTI, OTI, AVR relay, OLTC, cooling control, ***all the monitoring devices and NIFPS, AVR relay, maintenance free breather,*** etc.
vi) Drawing showing construction and mounting details of marshalling boxes.
vii) Operation and maintenance guide for transformer and OLTC.
vii) Detailed drawing showing wheel loadings and its center of gravity.
viii) ***Any other drawing/document required during design review, which will be conducted during detail engineering, shall be submitted.***

1.4.3 The bidder may submit any other drawings found necessary in addition to the drawings mentioned above or as asked during detailed engineering.

1.5 TYPE OF TRANSFORMER:

1.5.1 The transformers shall be oil-immersed, conventional type, suitable for outdoor installation. The type of cooling shall be as specified in specific Technical requirements given in Section-II of this Specification.

1.5.2 ***Transformer size including radiator width has to be accommodated as mentioned below on either sides from the center line of transformer gantry.***

220/66 KV – 50, 100, 160 MVA Power Transformer	:	7 Meters
220/33 KV – 125 MVA Power Transformer	:	7 Meters
132/33 KV – 50 MVA Power Transformer	:	5 Meters

1.6 DESIGN:

1.6.1 The transformer shall be used for bi-directional flow of rated power. The transformers and accessories shall be designed to facilitate inspection cleaning, repairs and for operation where continuity of supply is the primary consideration. All apparatus shall be designed to ensure satisfactory operation under sudden variations of load and voltage as may be met with under working conditions of the systems, including those due to short circuits.

1.6.2 All materials used shall be of the best quality and of the class most suitable for working under the conditions specified and shall withstand the variations of temperature and atmospheric conditions arising under working conditions without undue distortion or deterioration or setting up of undue stresses in any part & also without affecting the strength and suitability of the various parts for the work which they have to perform.

1.6.3 All outdoor apparatus, including bushing insulators with their mountings, shall be so designed as to avoid pockets in which water can collect. All connections and contacts shall be of ample cross-sections and surfaces for carrying continuously the specified current without undue heating and fixed connections shall be secured by bolts or set

screws of ample size, adequately locked, lock-nuts shall be used on stud connection carrying current.

1.6.4 Radio Interference and Noise level:

The transformer shall be designed with particular attention to the suppression of maximum harmonic voltage, especially the third and fifth so as to minimize interference with communication circuits.

The noise level of transformer, when energized at normal voltage and frequency with fans and pumps running shall not exceed, when measured under standard conditions, ***the values shall not be more than 75 dB, measured as per*** NEMA standard publication TR-I.

1.6.5 The transformer shall be capable of being loading in accordance with IS: 6600/IEC-354. There shall be no limitation imposed by bushings, tap changers etc. or any other associated equipments.

1.6.6 The transformer and all its accessories including CTs etc shall be designed to withstand without any injury, the thermal and mechanical effects of any external short circuit to earth and of short circuits at the terminals of any winding for a period of 3 sec. The short circuit level of the HV and LV system to which the subject transformer will be connected is 40 kA (sym, rms, 3 phase fault on 400, 220 and 132 kV) & 25 kA (sym, rms, 3 phase fault on 66, 33, 22 and 11 kV).

1.6.7 Transformer shall be capable of withstanding thermal and mechanical stresses caused by symmetrical or asymmetrical faults on any winding.

1.6.8 In the event of an order, design review will be conducted in line with CIGRE broacher no. 629, April 2013.

1.7 TANK

1.7.1 The transformer tank and cover ***or BELL type tank*** shall be fabricated from good commercial grade low carbon steel suitable for welding and of adequate thickness. The tank and the cover shall be of welded construction. All seams shall be welded and where practicable they shall be double welded. The tank wall shall be reinforced by stiffener of structural steel for general rigidity. The tank shall have sufficient strength to withstand without permanent distortion (i) filling by vacuum (ii) continuous internal gas pressure of 0.35 atmospheres with oil at operating level, and (iii) mechanical shock during transportation. The tank cover shall be bolted to the tank and the transformer design shall be such that the tank will not be split between the lower and upper cooler connection for Untanking. ***The tank covers shall be fitted with pockets at the position of maximum oil temperature corresponding to MCR (Maximum Continuous Rating) for RTD sensors and bulbs of oil and winding temperature indicators. It shall be possible to remove these sensors bulbs without lowering the oil in the tank. The tank wall penetrations shall be leak proof, suitably marked with respective sensor identification.***

1.7.2 A manhole 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.

1.7.3 All bolted connections to tank shall be fitted with suitable oil-tight gasket, which shall give satisfactory service under the operating conditions. Special attention shall be given to the methods of making the hot oil-tight joints between the tank and cover as also between the core and the bushings and all other to ensure that the joints can be remade satisfactorily and with ease, with the help of semi-skilled labors. Where compressible gaskets are used, steps shall be provided to prevent over compression. Bushings, turrets, cover of accessories, holes and other devices shall be designed to prevent any leakage of water into or oil from the tank. There should not be any leakage for three year and this should be guaranteed. **All the gaskets to be provided shall be of RC70C or RC80C grade. Necessary tests certificates from manufacturer shall be submitted along with acceptance test report. The gasket to be used shall not be older than One year.**

1.7.4 Suitable guides shall be provided for positioning the various parts during assembly or dismantling. Adequate space shall be provided between the covers and windings and the bottom of the tank for collection of any sediment.

1.7.5 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.

1.7.6 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.

1.7.7 The tank shall be provided with two suitable copper alloy or any other suitable material lugs for the purpose of grounding.

1.7.8 The tank shall be equipped with the following valves with standard screw connection for external piping. All valves up to and including 100 mm shall be of GM and larger valves shall be of Cast Iron bodies with GM fittings. They shall be of full way type with internal screw and shall open when turned counter clock wise when facing the hand wheel, along with suitable locking in open and close positions.

(i) One drain valve of adequate size with eccentric reducer and flange, located on the low voltage side of the transformer. This valve shall be equipped with a

small sampling cock. The draining valve must be at bottommost location of the tank.

(ii) One filter valve of adequate size with eccentric reducer and flange, located at the top of tank on the high voltage side. The opening of this valve shall be baffled to prevent aeration of oil.

(iii) One filter valve of adequate size with eccentric reducer and flange, located on the high voltage side the transformer above the bottom of the tank.

(iv) Suitable valves shall be provided to take sample of oil from the OLTC chamber during operation of transformer.

(v) A valve of other suitable means shall be providing to fix the on line dissolved Gas monitoring system to facilitate continuous dissolved gas analysis. Location and size of the same shall be finalized during detailed engineering.

(vi) Pressure relief valve of adequate size & number/s shall be provided on main tank as well as for OLTC.

(vii) All hardware used shall be ***hot dip galvanised.***

(viii) ***Necessary provision for installation of On Line moisture and gas in oil monitoring system shall be made for satisfactory performance through out the life of transformer.*** **Location and size of the same shall be finalized during detailed engineering.**

(ix) ***Necessary provision shall be made for installation of Nitrogen Injection Fire Prevention cum Extinguishing System. Location and size of the same shall be finalized during detailed engineering.***

1.8 UNDER CARRIAGE

1.8.1 The transformer tank shall be supported on a structure steel base equipped with forged steel single flanged wheels suitable for moving the transformer completely with oil.

1.8.2 Jacking pads shall be provided. It shall be possible to change the direction of the wheels through 90^0 when the transformer is lifted on jacks to permit movement of the transformer both in longitudinal and transverse direction. A standard track gauge 1676 mm in both longitudinal and transverse directional shall be provided.

1.8.3 Pulling eyes shall be provided to facilitate movement of transformer and they shall be suitable brazed in a vertical direction so that bonding does not occur when the pull has a vertical component.

1.9 CORE:

1.9.1 The transformer may be of core or shell type. The core shall be built up with high-grade non-ageing cold-rolled grain oriented silicon steel laminations having high permeability and low hysteresis loss. The core material shall be prime CRGO, which shall be procured directly from manufacturer or through accredited marketing organization of reputation.

1.9.1(a) The thickness of lamination shall be 0.27 mm or less. Surface insulation of laminations shall be rust resistant and have high inter laminar resistance. Insulation shall withstand annealing temperature as high as 850 ^{0}C. Insulation shall be resistant to hot cooling medium. Laminations are not to be punched.

1.9.1(b) Bidder should have in house core cutting facility for proper monitoring & control on quality & also to avoid any possibility of mixing if prime material with defective/second grade material. This should be indicated in variably in the QAP. The purchaser may witness the core-cutting process. In case the in-house core cutting facility is not available, then the same shall be carried out in the presence of the representative of GETCO.

1.9.1(c) The bidder will offer the core for stage inspection and get approval from GETCO during manufacturing stage. The bidder has to produce following documents at the time of inspection for confirmation of use of prime core materials at the time of stage inspection for confirmation of use of prime core materials.

i) Invoice of supplier
ii) Mills of approved test certificates
iii) Packing list
iv) Bill of lading
v) Bill of entry certificate by custom.

To avoid any possibility of mixing of 'Prime material' with any other second grade/ defective material, the imported packed slit coils of CRGO materials shall be opened in the presence of the GETCO representative. Only after the inspection and approval from purchaser, the core material will be cut in-house OR sent to external agency for cutting individual laminations. In case the core is sent to external agency for cutting, the GETCO representative will have full access to visit such agency for the inspection of the cutting of core.

1.9.2 After being sheared, the laminations shall be treated to remove all burrs and shall be re-annealed to remove all residual stresses. The insulation of the lamination shall be inserted to the action of hot transformer oil. Paper and varnish insulation will not be accepted. The nature of insulation should be specified in the bid.

1.9.3 The core shall be rigidly clamped to ensure adequate mechanical strength and to prevent vibration during operation. The clamping structure shall be so constructed that eddy currents will be minimum.

1.9.4 The core shall be provided with lugs suitable for lifting the complete core and coil assembly of the transformer.

1.9.5 The core and the coil assembly shall be so fixed in the tank that shifting will not occur when the transformer is moved or during a short circuit.

1.9.6 The transformer shall be designed in such a way that the flux density in the steel core corresponding to the *Rated* voltage and the rated frequency shall be not exceeding **1.727 tesla**.

1.9.7 Core and frame terminal should be brought out on transformer top so as to enable meggering.

1.9.8 The core and the coil assembly shall be so fixed in the tank that shifting will not occur and cause any damage when the transformer is moved shifted, or during a short circuit. **The maximum flux density in any part of core or yoke at 10% continuous over voltage condition shall not exceed 1.9 tesla.**

1.9.9 The complete core and core coil assembly of bolt less core type transformer shall be so assembled that the axis and the plate of outer surface of the coil stack shall not deviate from the vertical plane by more than 25 mm.

1.9.10 In case transformer with variable flux, the voltage variation which would affect flux density at every tap shall be kept in view while designing the transformer.
Transformers shall be designed to withstand the following over fluxing conditions:

a)	110 % of maximum density corresponding to rated voltage	Continuous for all transformers
b)	125 % & 140 % of max. flux density corresponding to rated voltage	for 1 minute and 5 sec. respectively

1.10 **WINDING:**

1.10.1 The conductor for winding shall be of electrolytic grade copper. 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 Pv and the necessary test certificate shall be submitted along with the stage 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.**

1.10.2 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.

1.10.3 All threaded connections shall be provided with locking facilities. All leads from the winding to the terminal board and bushings shall be rigidly supported to prevent injury from vibration. Guide tubes shall be used where practicable.

1.10.4 The windings shall be clamped securely in place so that they will not be displaced or deformed during short circuits. The assembled core and windings shall be vacuum dried and suitably impregnated before removal from the treating tank. The copper conductors used in the coil structure shall be best suited to the requirements and all permanent current carrying joints in the windings and the leads shall be welded or brazed.

1.10.5 Windings shall be subjected to a shrinkage treatment before final assembly, so that no further shrinkage occurs during service. Adjustable device shall be provided for taking up any possible shrinkage of coils in service if required.

1.10.6 The conductor shall be transposed at sufficient intervals in order to minimize eddy currents and equalize the distribution of currents and temperature along the windings.

1.10.7 The tapping winding shall be provided separately from main winding to minimise the out of balance forces in the transformer at all voltage ratios.

1.10.8 Transformer shall be designed and constructed to withstand, without damage, the thermal effects on external short circuits (SC) for 3 seconds under conditions specified in IS:2026 (Part-I, amended up to date).

1.10.9 Bidder shall invariably indicate in the GTP, the cross sectional area of all windings with respect to the current density adopted.

1.10.10 Bidder shall have to submit the calculations for thermal & dynamic ability to withstand short circuits.

1.10.11 The cooling calculations will have to be submitted ***with technical bid.***

1.10.12 Fiber optic sensors shall be embedded in each phase of the winding located at hot spot. The location and details shall be derived & indicated in the respective drawings along with Justification.

1.11 INSULATING OIL

1.11.1 The oil for first filling together with 10% extra shall be supplied with each transformer. The oil shall comply in all respects with ***Appendix – A of the specification.*** Particular attention shall be paid to deliver the total oil free from moisture having uniform quality throughout. ***The oil may be supplied either in sealed tanker, or*** in non-returnable steel drums, ***which will be opened at site in presence of***

GETCO representative. The quantity of oil for first filling ***& 10% extra*** of each transformer shall be stated in the bid, ***separately***.

1.11.2 The supplier of transformer shall furnish test certificates of the insulating power oil supplied against their acceptance norms, prior to dispatch. Subsequently oil samples shall be drawn

i) At manufacturer's works before and after heat run test and shall be tested for following:
   a) BDV in kVrms
   b) Moisture content
   c) Dissolved Gas Analysis – samples for DGA shall be taken from sampling device within 24 hrs prior to commencement of heat run test and immediately after this test. The acceptance norms shall be as per IS:10593 (based on IEC-599)

ii) prior to filling in main tank at site and shall it be tested for BDV and moisture content **and Corrosive sulphur detection test as per IEC 62353 subjecting oil for 150 ^{0}C for 72 hrs** for acceptance norms as per Appendix – A.

iii) prior to energisation at site and shall be tested for the following:
   a) BDV in kVrms
   b) Moisture content
   c) Tan Delta at 90 ^{0}C
   d) Resistivity at 90 ^{0}C.
   e) Interfacial Tension

1.11.2.1 **On Line Moisture and Gas In Oil Analyser For New Transformer With Model Analysis Software And Remote Data Transfer/Communications through internet shall be provided as per Technical Specifications attached, if indicated in Schedule – A of the commercial bid.**

1.12 INSULATION

1.12.1 The dielectric strength of winding in insulation and of the bushings shall conform to the values given in IS:2026-1962 (as amended up to date).

1.12.1.1 **The partial discharges in the transformer at the time of dispatch shall not be more than *100* pC *at 1.5 p.u*.**

1.12.1.2 The Maximum Limit of value of tan delta *at 20 ^{0}C* shall be *0.5%* for windings, *0.4%* for bushings and 0.2 % for oil.

1.12.2 For rated system voltage of 220,66 kV & 33KV, the following impulse test voltage ***shall*** be offered

System Voltage	Impulse Test Voltage	Power frequency voltage
HV 220 kV	1050 kV	460 kVrms
LV 66 kV	350 kV	140 kVrms
LV33 kV	170 KVp	70 KVrms
N 36	***170 kVp***	***75 kV rms***

1.12.3 The H.V. winding of the transformer shall have graded insulation. ***The LV winding of transformer shall have full insulation.***

1.13 **TEMPERATURE RISE:**

1.13.1 The transformer shall be installed out-door without any protection from sun and rain. The maximum hot spot temperature shall be limited to **98**^{0}C ***considering annual weighted ambient temperature of 32 ^{0}C*** with Class-A insulation***. However, the hot spot temperature rise shall be uniform for all the units of the order. In any case, the hot spot temperature should not be more than 116 ^{0}C.*** F O sensors shall be placed at hot spot location only and Maximum temperature measured by FO sensor shall be considered as hot spot temperature. Each transformer shall be capable of operating continuously at its normal rating without exceeding the temperature rise limits specified as under

	220/66KV, 100MVA 220/66KV, 160MVA 220/33KV, 125MVA	220/66KV,50 MVA 132/33KV, 50MVA Cooling with tank mounted radiators only
Winding (measured by resistance)		
ONAN	*45*	*50*
ONAF / OFAF	*50*	*Not Applicable*
Top oil (measured by thermometer).		
ONAN	*40*	45
ONAF / OFAF	*45*	*Not Applicable*
Cores	Not to exceed that permitted for the adjacent part of the winding.	

Note: ***The maximum ambient temperature for the purpose of design shall be considered as 50^{0}C, i.e. even at this temperature, the rise mentioned above shall not exceed. The gradient in temperature between phases shall not be more than 10 ^{o}C. Heat flow diagram shall be submitted by successful bidder.***

1.13.2 The transformer shall be free from abnormal noise (other than humming) and vibration. Maximum noise level shall not be more than 75 db.

1.13.3 The transformer will deliver rated current without exceeding temperature rise when operating on 105% of the rated voltages. The transformer shall be capable of being operated without danger on any tapping at the rated MVA with voltage of ±10% corresponding to the voltage of that tapping.

1.14 **FREQUENCY:**

1.14.1 The transformer shall be suitable for continuous operation with a frequency variation of ±3% from normal of 50 Hz. without exceeding the specified temperature rise.

1.15 **PARALLEL OPERATION:**

1.15.1 The similar ratio transformers shall operate satisfactorily in parallel with each other if connected between high voltage and low voltage bus bars. Also wherever specified, the transformers shall suitable for parallel operation with existing transformers. The details of existing transformer shall be ***considered same as per this specification.***

1.16 **IMPEDANCES:**

1.16.1 Supplier shall indicate the guaranteed impedance and tolerances and also the upper and lower limits of impedances which can be offered without an increase in the quoted price. Impedance shall include positive and zero sequence and shall be expressed in terms of the branches of the star connected equivalent diagrams, all on the same KVA base and the range shall be for each branch of the equivalent circuit in turn. The transformer impedance shall be as specified in Section-II of this Specification.

1.17 **TAP CAHANGING MECHANISM:**

1.17.1 ON LOAD TAP CHANGER:

1.17.1.1 Each transformer shall be provided with on- load tap changing mechanism. This shall be designed for remote control operation from switchboards in the control room. In addition, the tap changer shall include the following:

a. An oil-immersed tap selector – arcing switch for arc suppressing tap selector, provided with reactor or resistor for reduction of make & break arcing voltage and short circuits.
b. Motor driven mechanism.
c. Control and protection devices
d. Local & remote tap changer position indicator
e. Manual operating devices
f. Pressure relief device.

1.17.1.2 The on-load tap changer shall be so designed that the contacts do not interrupt arc within the main tank of the transformer. The tap selector and arcing switch or arc suppressing selector switch shall be located in one or more oil filled compartments. The compartment shall be provided with a means of releasing the gas produced by the arcing. It shall be designed so as to prevent oil in the tap selector compartment from

mixing with the oil in the transformer tank. An ***oil surge*** relay shall be provided to indicate accumulation of gas and alarm thereof.

1.17.1.3 The tap changer shall be capable of permitting parallel operation with other transformer of the same type.

1.17.1.4 The transformer shall give full load out-put on all taps. The manual operating device shall be so located on the transformer that it can be operated by an operator standing at the level of the transformer track. It shall be strong and robust in construction.

1.17.1.5 The control scheme for the tap changer shall be provided for independent control of the tap changers, when the transformers are in independent service. In addition, provision shall be made to enable parallel control also at times so that the tap changers will be operated. Simultaneously, when one unit is in parallel with another so that under normal conditions the tap changer will not become out of step and this will eliminate circulating currents. Additional features like master followers and visual indication during the operation of motor shall also be incorporated.

1.17.1.6 Necessary interlock, blocking independent, control, must be provided when the units are in parallel shall be provided.

1.17.1.7 Under abnormal conditions such as may occur, if the contactor controlling one tap changer sticks, the arrangement must be such as to switch off supply, to the motor so that an out of step condition is limited to one tap difference between the units. Details of out of step protection provided for the taps should be furnished in the bid.

1.17.1.8 The contactors and associated gear for the tap change driving motors shall be housed in a local kiosk mounted adjacent to or on the transformer. The motor shall be suitable for operation with 3 phase, 415 Volts, 50 Cycles external power supply with MCB / fuse and single phasing prevention.

1.17.1.9 In addition to the above equipment, the supplier shall supply a separate panel for installation in purchaser's control room for remote operation with the following accessories.

- ❖ Raise and lower function.
- ❖ Remote tap position indication of digital type, device for indicating 'ON' & 'OFF' position of fan / motor / pump of cooler control.
- ❖ Microprocessor based Annunciation
- ❖ Out of step relay and indication.
- ❖ Name-plate for each component. An alarm indication lamps showing tap changing in progress.

- ***RTCC panel shall be compatible to SCADA operation with IEC 61850 protocol.***
- Any other accessory required for satisfactory operation or required during detail engineering.
- ***RTCC panel shall be either front or rear door opening. The requirement shall be informed during detailed engineering.***

- The intended transformer shall be suitable for operation under SCADA system in all respect. The minimum analog & digital input / output requirement for the same shall be as follow:

Typical I/O List for SCADA Compatibility (RTCC)				
Sr. No.	**PARAMETERS**	**DI Hard wired**	**DO**	**AI (4-20mA)**
1	OLTC Control Supply ON	√		
2	OLTC Control Supply OFF	√		
3	OLTC on LOCAL	√		
4	OLTC on REMOTE	√		
5	Tap Changer Raise		√	
6	Tap Changer Lower		√	
7	Tap Changer Out of Step	√		
8	Tap Changer in progress	√		
9	Tap Position Indication			√
10	OLTC Motor O/L Trip	√		
11	OLTC Upper limit reached	√		
12	OLTC Lower Limit reached	√		
13	AC Mains Cooler Supply Fail	√		
14	AC Standby Cooler Supply Fail	√		
15	Cooler Control Supply Fail	√		
16	Cooler fan ON (Each)	√		
17	Cooler Pump ON (Each)	√		
18	Fan Fail – Group A	√		
19	Fan Fail – Group B	√		
20	Common Thermal O/L Trip (Pump)	√		

1.17.1.10 complete particulars of the tap changing gear including the capacity of the motor shall be stated in the bid.

1.17.1.11 Tap changer shall be suitable for bidirectional power flow. **The tap changer rating shall be *more than* maximum rated current of transformer.**

1.17.1.12 Manual control

The cranking device for manual operation of the OLTC gear shall be removable and suitable for operation by a man standing at ground level. The mechanism shall be complete with following:

a) Mechanical tap position indicator which shall be clearly visible
b) A mechanical operation counter
c) Mechanical stops to prevent over-cranking of the mechanism beyond the extreme tap position
d) The manual control considered as back up to the motor operated load tap changer control shall be interlocked with the motor to block motor start-up during manual operation. The manual operation mechanism shall be labeled to show the direction of operation for raising the HV terminal voltage and vice-versa

1.17.1 Automatic Voltage Regulating Relays:

1.17.2.1 The AVR relay shall be provided, as per specification indicted in Annexure – I, The scheme shall detect (i) failure of auxiliary supply, (ii) failure of PT supply and (iii) failure of mechanism to complete the tap changing operation. The relay shall have necessary contacts to be connected to the alarm & / or to the Annunciator available in the panel for visual and audible indication of the failure of trip circuit. The AVR relay shall be compatible to SCADA operation of any make. ***However, the RTCC panel shall be fully operable even in case of non utilization of AVR relay.***

1.17.2.2 All the necessary wiring shall be carried out in RTCC panel and schematic drawings shall be submitted with the technical bid and during detailed engineering for approval in duplicate.

1.18 OIL PRESERVING EQUIPMENT:

1.18.1 Air cell type conservator tank is to be provided for oil conservator system, ***as per specification given in Annexure – II attached here with.***

1.18.2 Bidder shall offer diaphragm type oil sealing in the conservator to prevent oxidation and contamination of oil due to contact with water. In this type of oil preservation system, conservator shall be fitted with a dehydrating filter breather.

1.18.3 In this system, using a flexible Diaphragm shall prohibit contact of oil with atmosphere.

(a) Diaphragm used shall be suitable for continuous operation in an atmosphere of 100 ^{0}C to which transformer oil is likely to rise.

(b) The connection of the air cell to the top of the reservoir shall be by an air proof seal permitting entrance of air into the cell only.

(c) The diaphragm of the conservator shall withstand the vacuum during installation and maintenance. Otherwise provision shall be made to isolate the conservator from main tank during vacuum by providing vacuum sealing valve in the pipe connecting the main tank with the conservator.

(d) Conservator with air cell shall be provided with Air Cell Rupture Relay Suitable arrangement to be made to extend alarm signal to control room.

1.19 **BUSHINGS:** The following bushing shall be supplied as mention in Schedule 'A' of respective tender:

1.19.1 Bushing for 52 KV & above shall be OIP condenser type with porcelain insulator & 36KV or lower voltage (Neutral or Tertiary) Bushings shall be solid porcelain or oil communicating type. This is applicable even if nothing is mentioned in schedule A.

1.19.2 Technical Requirement of Bushings

Winding Details		Bushing Details			
Class (kV)	BIL	Class (kV)	Insulation Level LI/ SI/ AC (kV)	STC, 3S (KA)	Minimum Creepage 25/31 mm/ kV
400	1300/1050/570	420	1425/1050/695	40	--/ 13020
220	1050/850/460	220	1050/850/505	40	6125/7595
132	650/540/275	132	650/ 540/ 305	40	3625/4495
66	350/NA/140	66	350/ NA/ 155	25	1815/2250
33 (LV)	200/NA/70	66	350/ NA/ 155	25	1815/2250
36 (Neutral)	170/NA/70	36	170/NA/75	25	900/1120

1.19.3 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.

1.19.4 Each bushing shall be so coordinated with the transformer insulation so that all flash over will occur outside the tank.

1.19.5 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 realize.

1.19.6 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.

1.19.7 The bushings for 66 kV and above shall be of the oil filled condenser type (hermetically sealed) and shall conform to the latest edition of IS: 2099 & IS: 3347. 36 kV bushings for neutral shall be solid porcelain or oil communicating type. Dimensions shall confirm to IS: 2099 & IS: 3347 (Part – V). The characteristics of the oil used in the bushings shall be the same as that of the oil in the transformer. Oil filled condenser type bushing shall be provided with fittings viz. oil level gauge, oil filling plug, Tap for capacitance and Tan delta test, etc.

1.19.8 All bushings shall have puncture strength greater than the dry flashover value.

1.19.9 Main terminals shall be soldering-less terminals and shall be suitable for ***TWIN*** 'ACSR MOOSE' conductor ***or as specified in Schedule – A of respective tender***. The spacing between the bushings must be adequate to prevent flash over between phases under all conditions of operation.

1.19.9 The bidder shall give the guaranteed withstand voltage for the above and also furnish a calibration curve with different settings of the coordination gap to the GETCO to decide the actual gap setting. Bidder's recommendations are also invited in this respect.

1.19.10 Bushing CTs shall be provided for REF protection as specified in Section – II Cl. 2.5. The bushing shall be removable without disturbing the CTs.

1.19.11 Bushings of identical rating shall be interchangeable.

1.19.11a The tan delta and capacitor measurement tap shall be provided. Test taps relying on pressure contacts against outer earth layer of the bushing is not acceptable.

1.19.12 The STC rating shall be 40 kA for 3 secs for 132 kV & above class and 25 kA for 3 secs for 66 kV and below class.

1.19.13 The height of live part shall be so arranged that minimum clearance up to plinth shall be maintained as per following safety clearances.

400 kV Live Part to ground clearance up to plinth – 8000 mm
220 kV Live part to ground clearance up to plinth – 5500 mm
33 kV Live part to ground clearance up to plinth – 3600 mm

1.19.14 Mounting dimensions of bushings shall be matched with other makes also.

1.19.15 Polymer / composite insulator shall be seamless sheath of a silicon rubber compound. The housing & weather sheds should have silicon content of minimum of 30% by weight. It should protect the bushing against environment influences, external pollution and humidity. It shall be extruded or directly moulded on the core. The interface between the housing and the core must be uniform and without voids. The strength of the bond shall be greater than tearing strength of polymer. The manufacturer shall follow non destructive technique (NDT) to check the quality of jointing of the housing interface with the core. The technique being followed with detailed procedure and sampling shall be decided during finalization of MQP.

The weather sheds of the insulators shall be of alternate of shed profile as per IEC 60815-3. The weather sheds shall be vulcanized to the sheath (extrusion process) or moulded as part of the sheath (Injection moulding process) and free from

imperfections. The vulcanization for extrusion process shall be at high temperature and high pressure. Any seams / burrs protruding axially along the insulator, resulting from the injection moulding process shall be removed completely without causing any damage to the housing. The track resistance of housing and shed material shall be class 1A4.5 according to IEC 60587. The strength of the weather shed to sheath interface shall be greater than the tearing strength of the polymer. The composite insulator shall be capable of high pressure washing.

End fittings shall be free from cracks, seams, shrinks, air holes and rough edges. End fittings should be effectively, sealed to prevent moisture ingress, effectiveness of sealing system must be supported by test documents. All surfaces of the metal parts shall be perfectly smooth with the projecting points or irregularities which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly.

The hollow silicon composite insulators shall comply with the requirements of the IEC publications. IEC 61462 and the relevant parts of IEC 62217.The design of the composite insulators shall be tested and verified according to IEC 61462 (type and routine test).

All type test & routine test as per applicable standards for OIP Porcelain or Composite Insulator bushing shall be submitted for approval.

Spare bushings (draw lead / draw rod) shall be supplied with lead / rod.

1.20 COOLING:

1.20.1 AIR BLAST, FORCED COOLED OIL TRANFORMERS:

1.20.1.1 Each cooler unit shall consist of a totally enclosed, oil immersed motor pump and a forced air cooled ***radiators***. Motor and pump shall be placed in an oil tight container with motor leads brought through hermetically sealed bushings. Each cooler unit shall be detachable from the transformers without disturbing the oil in the transformer tank. Moving parts of motor and pump shall be readily removable without dismantling of cooler and with minimum spillage of oil. Fans shall be located so that they are readily accessible for inspection and repair. Heat exchangers, fans and oil pumps shall be completely interchangeable.

1.20.1.2 All coolers shall be attached to and mounted on the transformer tank or provided separately. The separate cooler banks shall be provided on right side of transformer looking from 220 kV side.

1.20.1.3 Cooler shall be so designed as to be accessible for cleaning and painting to prevent accumulation of water on the outer surfaces completely, drain oil in the tank and to ensure against formation of gas pockets when the tank is being filled.

1.20.1.4 ONAN/ONAF/OFAF cooled transformers shall be provided with requisite number of radiator banks. Besides the requisite number of oil pumps and fans required for normal operation, each radiator bank shall be provided with one standby fan and oil pump as applicable.

1.20.1.5 Cooler units shall be connected to the tank by machined steel flanges welded to cooler units and to the tank and provided with gaskets. Each cooler unit shall be provided with an indicting shut-off valve, which can be fastened in either open or closed position. A separate oil-tight black flange shall be provided for each tank connection for use when the cooler unit is detached. Each cooler unit shall have two lifting eye at top & one lifting eye at bottom with, an oil drain at the bottom and a vent at the top.

1.20.1.6 An oil flow indicator with alarm contacts shall be furnished with each pump assembly to indicate normal pump operation and direction of oil flow.

1.20.1.7 Fans or blowers for air blast cooling shall be mounted so as to ensure that no damage to the coolers can arise from vibration of the fans. Wire mesh screens shall be fitted to prevent accidental contact with the blades, the mesh being not greater than 2.5 cm.

1.20.1.7(a) The fan or blowers wiring shall be in such a way that any fan can be operated as of group II or standby.

1.20.1.8 In cases of ONAN/ONAF/OFAF type cooling, the transformer shall be capable of giving a continuous output of at least 50% of rated full output with all the artificial cooling out of service and without exceeding the temperature rise. In case of ONAN/ONAF type of cooling the transformer shall be capable of giving continuous output of at least 75% of the rated full output with the artificial oil force cooling out of service and without exceeding temperature rise. In case of ONAN or ONAF type of cooling the transformer shall have two sets of radiators.

1.20.1.9 For OFAF cooled transformers with ONAN rating, piping system shall permit bypassing of oil pump and operation of the transformer at its ONAN rating, in case forced oil system develop any troubles.

1.20.1.10 ONAN/ONAF/OFAF cooled transformers shall be designed to operate at no load for 4 hours without any cooler unit in service. ONAN/ONAF cooled transformers shall also be capable of delivering its rated MVA for **20** minutes with the loss of all cooling equipment while the transformer is carrying full load.

1.20.1.11 The cooling calculation shall be furnished with radiator drawing for specified temperature rise along with the technical bid.

1.20.1.12 The cooling fan shall be operated by OTI & FOS at 2 sets of temperatures for fan GR I & GR II. The oil pump shall be also operated by WTI & FOS.

1.20.1.13 In case of ONAN /ONAF / OFAF cooled transformers, provision of automatic changeover from main supply to stand by auxiliary supply should be available in case of failure of main supply. Necessary alarm etc. for this may also be included.

1.20.2 NATURAL OIL COOLED TRANSFORMER

1.20.2.1 The radiating sections/tubes provided shall have sufficient cooling surface to limit the temperature rise to the values specified under clause – 1.13 of this specification. The radiating sections/tubes shall be connected to the tank cooler assembly headers by machined steel flanges with adequate gaskets to avoid oil leakage. Each radiator unit shall be provided with positive operated butterfly and lockable – non interchangeable type oil leak proof shut-off valve, which can be fastened in either closed or open position. A separate oil tight flange shall be provided for each tank connections for use when the radiator unit or cooler assembly is detached. It shall be possible to take out any of the radiating tubes without disturbing the transformer. Each radiator unit shall have a lifting arrangement and oil drain at the bottom and a vent at the top.

1.20.2.2 The radiators shall be so designed as to prevent any accumulation of water on the outer surface or formation of gas pockets when the tank is being filled.

1.20.2.3 220/66KV, 50MVA Transformer & 132/33KV, 50MVA Power Transformer cooling allowed with Tank Mounted Radiators only.

1.20.3 **COOLER CONTROL:**

1.20.3.1 Cooler units shall be suitable for operation with 415 Volts, 3 phase, 50 Hz external power supply.

1.20.3.2 Control equipment for oil pump and for motors shall be mounted in a marshalling cabinet adjacent to the transformer and it shall include the necessary contactors with automatic control and annunciation equipment and provision for manual control.
The cabinet shall be 3 mm thick steel sheets having rain shed and it should be tested for IP 55 degree of protection. The separate indicating must be provided for main & stand by 3 phase supply. The cabinet shall have two-illumination circuit to be operated from both the side. The cable tray shall be provided from ground for aesthetic cable entry. The heater with thermostat of suitable rating shall be provided line the cabinet. The bottom of the cabinet shall have enough cable entry with gland and it shall include the necessary contractors with automatic control and equipment and provision for manual control & remote indication.

1.20.3.3 A single metal enclosed main isolating switch with Miniature Circuit Breakers shall be provided for the cooling plant contractor group.

1.20.3.4 The switching in or out of the cooling equipment shall be controlled by winding temperature and there shall be provision for automatic switching in or out at predetermined temperature levels which should be capable of adjustment and setting at will. Hunting of the cooling equipment should be avoided by suitable auxiliary timer relay. *The arrangement of winding temperature and oil temperature indicator shall be at such height that it is easy to read by naked eye by an operator from ground.*

1.20.3.5 The bidder shall specify the loading of the transformers in case of failure of one or more set of fans or pumps.

1.20.3.6 In case of ONAN/OFAF cooled transformers, provision of automatic changeover from main supply to stand by auxiliary supply should be available in case of a failure of main supply. Necessary alarm and indication etc. for this may also be included.

1.20.3.7 The bidder shall provide for fan & pump indicator in the cooling circuit in the remote control panel.

Following lamp indications with annunciation shall be provided in cooler control cabinet

a) Control supply failure
b) Cooling fan failure for each bank
c) Cooling pump failure for each pump
d) No oil flow or Reverse flow for pumps
e) Common thermal overload trip

One potential free initiation contact for all the above conditions shall be wired independently to the terminal blocks of cooler control cabinet.

1.20.3.8 The fan circuit shall be operated at different temperatures for group **I** fans and group **II** fan from OTI ***& FOS***. The pump circuit shall be also operated from same WTI ***& FOS*** contacts at different temperatures.

1.20.3.9 The connection shall be bolted type having CB – 30 and CT connector shall be of ***disconnecting*** link type, which can be shorted for testing or checking circuit.

1.21 CENTRE OF GRAVITY:

1.21.1 The center of gravity of the assembled transformer shall be low and as near the vertical center line as possible. The transformer shall be stable with or without oil.

1.22 ACCESSORIES:

1.22.1 Each transformer shall be provided with the following accessories

(i) Dial Image sensing type ***mercury free*** thermometers for oil;
   (a) For ONAN/ONAF and ONAN/OFAF Transformer
   The dial Image sensing type indicting thermometers of robust batten mounted on the side of the transformer at a convenient height to read the temperature in the hottest part of the oil and fitted with alarm and trip contacts and contacts for switching in and switching out the cooling system at pre-determined temperatures.

The OTI shall be compatible for remote SCADA operation, for which separate ROTI shall be provided***.***

(b) For ONAN Transformers

A dial Image sensing type ***mercury free*** thermometer for indicating oil temperature fitted with maximum pointer and adjustable alarm and trip contacts.

(c) The switch contacts shall have adequate AC and DC rating.

(ii) One winding hot spot winding temperature detector in LT winding of each phase ***having 4 sets of contacts,*** as under:

(a) For ONAN/ONAF and ONAF/OFAF Transformer

It shall be indicating type, responsive to the combination of top temperature and winding current, calibrated to follow the hottest spot temperature of the transformer winding. The winding temperature detector shall operate a remote alarm and trip at predetermined independent temperature in the even the hottest spot temperature approaches a dangerous value.

(b) For ONAN/ONAF and ONAN/OFAF Transformer

In the case of ONAN/ONAF/OFAF type transformers it shall automatically actuate the fans/pumps also.

c) ***Accuracy class of WTI shall be +/- 1.5% or better.***

d) Any special cable required for shielding purpose, for connection between cooler control cabinet and remote WTI control circuit, shall be in the scope of supplier. Only one RWTI with a four-point selector switch shall be provided for all the windings.

The WTI shall be compatible for remote SCADA operation, for which separate ROTI shall be provided***.***

(e) The switch contacts shall have adequate AC and DC rating.

ii-A) Separate PT 100 resistance temperature detector (RTD) for ROTI & RWTI shall be provided.

RTD shall be provided with PT100 temperature sensor having nominal resistance of 100 ohms at zero degrees centigrade. The PT100 temperature sensor shall have three wire ungrounded system. The calibration shall be per IEC 60751-2 or equivalent. The PT100 temperature sensor may be placed in the pocket containing temperature sensing element.

RTD shall include image coil for OTI system and shall provide dual output 4-20 mA for remote OTI & SCADA system individually.

RTD shall include image coil, Auxiliary CTs, if required, for WTI system and shall provide dual output 4-20 mA for remote OTI & SCADA system individually.

The transducer shall be installed in the individual marshalling box.

(ii) One magnetic type oil level gauge with low alarm contacts and dial showing minimum, maximum and normal oil levels. The gauge shall be readable from the transformer base level for main tank conservator over and above the prismatic type oil level gauge.

(iv) One oil filling valve (inlet).

(v) One oil drain valve

(vi) One filter valve located at the top of tank on the H.V. Side.

(vii) One filter valve located near the bottom of tank of the H.V. side of the transformer.

(viii) Oil sampling devices.

(ix) Pressure relief device ***and Sudden/Rapid pressure rise release relay***
A safety valve of the chimney type shall be provided to ***detect pressure*** rise ***inside the transformer and shall operate to prevent tank rupture. Suitable pipe with bend shall be provided on opening to suitably direct sudden splash of oil to suitable location to prevent damage or any injury. Necessary tripping contacts shall be provided in terminal box having ingress protection of IP55 with connecting cable up to marshaling cubical. Termination shall be push and plug type. It shall have 2 switch 4 terminal arrangements for tripping contact.***

(x) 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. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation & taking gas sample. A copper or Stainless Steel tube shall be connected from the gas collector to a valve located at 1200 mm above ground level. ***Necessary alarm & tripping contacts shall be provided in terminal box having ingress protection of IP55 with connecting cable up to marshaling cubical. Termination shall be push and plug type. The switch shall be mercury free. It shall have 2 switch 4 terminal arrangement for tripping contact.***

(xi) Radiators complete with pumps, motors, fans etc. as described in clause 1.20.

(xii) (a) An oil conservator
(b) Oil preserving equipment complete in all respects as described in cl. 1.18.

(xiii) Eye bolts and lugs on all parts for ease of handling.

(xiv) Four grounding terminals ***one on each side of transformer.***

(xv) Diagram and rating plate

(xvi) One set of equipment for control, protection, indication and annunciation for each transformer comprising motor contractors, detecting elements or devices, indicating apparatus, instruments relays, annunciates etc.

(xvii) Suitable weather proof cubicle for housing the control equipment, terminal blocks etc. (one for each transformer) and one indoor cubicle for each transformer for remote control of radiators, on load tap changer alarm and indicating devices.

(xviii) ***[A]*** Dehydrating Filter Breather ***for Main/ OLTC conservator.***
Silica gel breather to be fitted with conservator shall be designed such that:

a) It is of clear view type design so that moisture absorption indication by change in colour of silica gel is visible from a distance
b) Passage of air is possible through silica gel only
c) Height of breather mounting shall not be less than 1200 mm from rail top level
d) Size of breather shall be such that it contents 5 kg of silica gel in it
e) The nos. of breathers shall be Three or more as required for main conservator and shall be Two for OLTC conservator
f) Silica gel is isolated from atmosphere by an oil seal.

xviii) [B] Condition controlled maintenance free dehydrating breather for main conservator (if indicated in the Schedule – A of respective tender):

The main Transformer tank conservator shall be fitted with a silica gel Breather of the Maintenance-Free type at a height of 1200 mm from rail top level. Each Silica gel breather shall be equipped with a humidity sensor, a condition based microprocessor control unit and LED status indication. The function shall be tested via a test button. A stainless steel filter at the bottom shall protect the silica gel chamber against external environment influences. This condition controlled application should be environmental friendly.

Dehydrating breathers work according to the following principle. When the oil conservator suctions in air (e.g., due to the reduced load), the air flows through a filter made of high-grade steel wire mesh to the inside of the device. This filter & the dust cap, filters the dust, sand and other dirt particles from the air. The filtered air flows through the desiccant chamber filled with colorless, moisture adsorbing pellets and are dehydrated. The dehydrated air rises further via the pipe in the oil conservator. The dehydrating breather is mounted on the pipe to the oil conservator. A suitable counter-flange must be installed on the pipe to mount the dehydrating breather. The desiccant contained in the drying assembly is dehydrated using sensor which is controlled by the built-in heating unit, thus obviating the need for periodic desiccant replacement.

The Maintenance Free Type of Breather shall fulfill the objectives like reduced site inspections, no storage or replacement of the desiccant no pollution and disposal problem of the used up desiccant.

Technical requirements:

1. *Material & External Construction of the Breather shall be such that all external parts are suitable for outdoor use & resistive to transformer oil, ultraviolet rays, pollution & salt water.*

2. *The equipment shall work without any trouble for ambient temperature between 0^{o} C to +80 ^{o}C.*
3. *Degree of Protection shall be at least IP55.*
4. *The control unit shall be provided on the breather equipped with suitable heater to prevent moisture condensation.*
5. *Status LEDs for local display shall be provided on breather along with suitable contacts to take the signal to remote control room.*
6. *The moisture and temperature measurement system (sensor) installed should be modular making it easy to replace the same if at all the same is necessary during the service of breather. A self diagnostic system shall be provided with LED indication and remote signal through a relay shall be provided.*
7. *Micro fuse and an additional built in line filter shall be provided to protect against over voltages & to avoid failures caused by high-frequency interference.*
8. *The control unit in the breather shall provide analogue output signal of 4-20mA and also shall be equipped with a RS 485 port for data logging.*
9. *Suitable Data Logger shall also be provided in the control unit.*
10. *The size and type of* ***Condition controlled maintenance free dehydrating breather*** *to be provided shall be selected on the basis of volume of oil of the offered transformer.*
11. *The Breather shall also be equipped with integrated test button which should allow to carry out a self-test and to check the functions like relay circuits, heating or the signal transmission in the control room, etc. at any time.*
12. *Rated supply Voltages shall be 230 V AC or DC.*
    Rated insulation level - 500VAC 50 Hz, 1 min withstand voltage
    500VAC 50 Hz, 1min. withstand, analog output against ground;
    2.5kVAC 50 Hz, 1 min. withstand, relay contact against ground
13. *Type Test report for Degree of protection for control unit shall be submitted.*
14. *Successful bidder shall offer all acceptance tests on Condition controlled maintenance free dehydrating breather and submit routine test report during acceptance of transformer for each supply. List of acceptance / routine tests shall be submitted with the tender.*

All applicable clauses for breather shall be treated accordingly.

(xix) Conservator and Buchholz (Surge) relay for on load tap changer.

(xx) Suitable *compression* type terminal connectors for HV, LV & Neutral bushings

(xxi) Suitable ladder or climbing devices.

(xxii) Tap changer remote control panel complete with all accessories with SCADA compatibility, suitable for IEC 61850 communications, front/rear door, to be installed in the Purchaser's control room.

(xxiii) A **twin** tinned copper strip grounding conductor of 50 x 6 mm size shall be provided from the neutral terminal to transformer base for connection to the sub-station grounding grid. Necessary pin insulator clamps, bolts etc. shall be supplied for this grounding purpose. **Neutral bushing to grounding**

conductor shall be made through twin copper flexible strip of size 50 x 10 mm.

xxiv) Man hole opening and Inspection covers

xxv) Protected type mercury or alcohol in glass thermometer

xxvi) Bottom and top filter valves with threaded male adaptors, bottom

xxvii) Rating and diagram plates on transformer and auxiliary apparatus

xxviii) Flanged bi-directional wheel with anti earth quake clamps

xxix) Cooler control cabinet

xxx) Bushing CTs

xxxi) Oil flow Indicator ***with alarm contacts***

xxxii) On Load Tap Changing Gear

xxxiii) Drain valves/plugs shall be provided in order that each section pipe work can be drained independently

xxxiv) Terminal Marking plates of Stainless Steel sheet having minimum thickness of 2 MM

xxxv) Valves Schedule plates of Stainless Steel sheet having minimum thickness of 2 MM

xxxvi) Skids at the base of transformer.

xxxvii) Stranded Copper double PVC, control cable of 1100 V grade.

xxxviii) ***Fiber Optic sensor temperature indicator system (To be Provided if indicated in Schedule – A of respective tender): Temperature measurement of Oil and winding shall also be done using Fiber Optic Sensors, meeting following criteria:***

1. ***System shall be fiber optic rugged, proven technology. The probes shall be directly installed in each phase of transformer to measure the winding hotspot and top oil temperature. There will be total eight probes inside the transformer, out of which two probes shall be installed for top & bottom Oil temperature measurement of the transformer.***

2. ***Out of remaining six (6) Fiber Optic probes, one each should be installed in each phase at the hottest spots of*** *HV &* ***LV winding. The hottest spot location shall be justified by suitable software. The locations of the probe shall be proposed by the Manufacturer and finalized by agreement with the purchaser.***

3. ***Probes shall be able to be completely immersed in hot transformer oil & they shall withstand exposures to hot kerosene vapor during the transformer installation drying process.***

4. ***Temperature range of the system should be -30ºC to +200 ºC & accuracy of ±1% with no recalibration required.***

5. ***Probes shall be*** *200 µm* ***all silica double PFA Teflon jacketed, Kevlar cabled*** */ PTFE (Teflon) jacketed cable* ***fiber with perforated outer jacket to allow complete oil filling and white Teflon protective Helix wrap for improved visibility and mechanical strength.***

6. ***System should include analog outputs for each measurement channel. Temperature resolution of the analog outputs shall be ±0.1 ºC and the systems shall offer a user programmable temperature alarm outputs with 6 relays, alarm lights and controller system status indicators. All inputs and outputs of the system shall meet the requirements of surge test of IEEE C37.90.1-1989 in which a 3000V surge is applied to all the inputs and outputs without permanent damage to the instrument.***

7. ***The system shall be capable of retaining temperature data of 90 or more days at rate of One reading per minute and should retain maximum temperature of each channel until reset.***

8. ***The manufacturer should submit data showing that the probes are located in the hottest point of the winding.***

9. ***The Fiber Optic cable should be brought out of the main tank through tank wall penetrator feed through plate. The feed through plate shall be welded on the tank. The external fiber optic extension cable shall then be run to main control cabinet, routed inside the conduits with large bend radiuses.***

10. ***The controller shall be housed in cooler control cabinet. Temperature rise test measurements shall be made with FO thermometers. The equipment shall be operational during temperature tests and demonstrated during these tests. During probe verification, the hottest probes for each phase shall be identified, and temperature data for all probes recorded and reported in the test report.***

11. ***Transformer manufacturer shall confirm for full guaranteed performance of transformer with provision of FO sensors system. FO system shall cover all required accessories to indicate temperatures at local, remote and shall be SCADA compatible. Suitable change over facility of alarm & control contacts shall be provided for conventional thermal image type temperature indicators and fiber optic temperature indicators.***

12. ***The FO system shall have suitable length of FO cable, sensor and probes.***

13. ***The output of FO system shall be suitable for PC interface with USB port. All required software shall be provided.***

14. ***Any other accessories required for satisfactory operation of fiber optic sensor temperature measurement system shall be provided.***

15. ***All the type tests reports as per IEC 60076-7 table E1 Annexure – E3 shall be submitted with the technical bid. Acceptance tests shall be performed as per relevant standard.***

16. ***Services of FO system supplier during manufacturing, testing, commissioning and after sales even beyond guarantee period shall have to be arranged and provided by the bidder.***

17. ***All the data shall be recorded with time stamping and shall be retrieved & recorded easily.***

Any other fitting / accessories other than listed above, required for satisfactory operation of the transformer are deemed to be included

1.22.2 The equipment and accessories furnished with the transformer shall be suitably mounted on the transformer, for satisfactory operation, inspection and maintenance and the mounting details shall be subject to the approval of the purchaser. All valves shall be provided either with blind companion flanges or with pipe plugs for protection.

1.22.3 Indication, alarm and relay equipment shall have contacts suitable for operation with 110 V/220 V D.C. Supply.

1.22.4 All cables from all equipment/device shall be arranged by manufacturer with proper clamping arrangement ***in galvanised perforated tray.***

Any other accessories or appliances recommended by the manufacturer for the satisfactory operation of the transformer shall be given and indicated in the bid.

1.23 **TERMINALS:**

1.23.1 The bushing shall be equipped with terminals suitable for connection with ACSR Moose/Zebra/Panther **TWIN or Single** conductor. ***However, the requirement shall be***

decided during detailed engineering. The short time current rating of connector shall be of 40 kA /3sec for HV and 25 kA / 3sec for LV & neutral.

1.24 CURRENT TRANSFORMERS:

1.24.1 The bidder shall include in the scope of supply the multi ratio type turret mounted current transformer on all phases of HV, LV & neutral leads of the power transformers for restricted earth fault protection, as well as for standby earth fault protection. ***Also winding CT of required ratio shall be provided in each phase.***

1.25 TERMINAL MARKING:

1.25.1 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.

1.26 CLEANING AND PAINTING:

1.26.1 **Painting:** External surface of Tank, Radiator & Fittings shall be of shade no. 631 IS .5. Any fabricated accessories should be either galvanized or outer side PU. Powder coating may be accepted provided it should be sun light /outdoor/UV ray resistant. Being not Eco friendly, Zinc Chromate is not to be used. Bottom plate of tank will also be accepted with coal tar based paint.

1.26.2 Hot dip galvanized with a minimum thickness of 70 µm and painting as per the following specification.

ITEM	Surface preparation	Primer coat	Intermediate undercoat	Finish coat	Total dry film thickness (DFT)	Colour shade
Main tank, pipes, conservator tank, oil storage tank etc. (external surfaces)	Shot Blast cleaning Sa 2½*	Epoxy base Zinc primer (30-40µm)	Epoxy high build Micaceous iron oxide (HB MIO) (75µm)	Aliphatic polyurethane (PU) (Minimum 50µm)	Minimum 155µm	Shade no. 631 of IS: 5
Main tank, pipes (above 80 NB), conservator tank, oil storage tank etc. (internal surfaces)	Shot Blast cleaning Sa 2½*	Hot oil resistant, non-corrosive varnish or paint or epoxy	-	-	Minimum 30µm ***Max 40µm***	Glossy white for paint
Radiator (external surfaces)	Chemical/ Shot Blast cleaning Sa 2½*	Epoxy base Zinc primer (30-40µm)	Epoxy base Zinc primer (30-40µm)	PU paint (minimum 50µm)	Minimum 100µm	Shade no. 631 of IS: 5
Radiator and	Chemical	Hot oil proof,	-	-	-	-

pipes up to 80NB (internal surfaces)	cleaning, if required	low viscosity varnish				
Control cabinet/ marshalling box	Seven tank process as per IS:3618 & IS:6005	Zinc chromate primer (two coats)	-	EPOXY paint with PU top coat	Minimum 80µm	Shade no. 631 of IS: 5

Sa 2 ½ - Swedish standard SIS 055900 of ISO 8501 Part -1

All the necessary certificates for above stages shall be provided during stage inspection to GETCO representative.

1.26.1 Before painting or filling with oil or compound all ungalvanised parts shall be completely cleaned and free from dust, scales and grosses and all external rough surfaces on castings shall be filled by metal deposition. The interior of oil transformer tanks and other filled chambers and internal structural steel work shall be cleaned of all scale and rust by sandblasting or other approved method.

1.26.2 Deleted

1.26.3 All internal surfaces of mechanism chambers and Kiosks except those, which have received anticorrosion treatment, shall receive three coats of paints applied to the thoroughly cleaned metal surfaces. The final coat shall be of light colored anti-condensation mixture. Any damage to paint work incurred during transport and erection shall be made good by thoroughly cleaning the damaged portion and by applying full member of coats of paints.

1.26.4 All paint shall be carefully selected to withstand heat & extremes of weather. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling. The minimum thickness of outside painting of tank ***& total thickness shall as indicated in table above.***

1.27 PACKING AND TRANSPORT:

1.27.1 Transportation:

The bidder shall dispatch the transformer filled with oil or in an atmosphere of Nitrogen or dry air. In the former case the bidder shall take care of the weight limitation on transport and handling facility at site. In the latter case, necessary arrangement shall be ensured by the bidder to take care of pressure drop of Nitrogen or dry air during transit and storage till completion of oil filling during erection. A gas pressure testing valve with necessary pressure gauge and adaptor valve shall be provided. The transformer shall be fitted with sufficient number of impact recorders during transportation to measure the movement due to impact in all three directions. ***The impact recorder shall be provided with suitable communication port (USB port) to down load data at any time. The impact recorder shall be returned after submission of all the data in hard and soft copy.***

1.27.2 All parts shall be adequately marked to facilitate field erection.

1.27.3 In case of synthetic resin bonded paper type bushing is offered; special attention shall be paid in packing so as to avoid moisture ingress. The details of the bushing and the method of packing shall be stated in the bid.

1.27.4 Loose Material e.g. bolt-nuts etc. shall be packed in gunny bags and sealed in polyethylene bags with proper tagging. Component containing glass shall be carefully covered with shock absorbing protective material. All flanges etc. which are prone to scratches shall be provided with wooden caps bolted in place. Fragile Material shall be securely braced within the containers or otherwise amply fastened and packed to prevent shifting or rattling. Soft non-hydroscopic packing materials shall be placed between hard packing Materials and fragile equipment. Articles which do not completely filled the selected container must be cushioned, braced, fastened or blocked to prevent damage to the article itself of destruction of container. Inner bracing or blocking must be such that content's weight is distributed over entire interior surface rather than concentrate on one or two critical points. All opening in the equipment / accessories shall be tightly covered, plugged or capped to prevent foreign material to enter in.

1.27.5 Any material found short / damaged inside the intact packing shall be supplied at no extra cost to the purchaser.

1.28 LABELS:

1.28.1 Labels shall be provided for all apparatus such as relays, switches, fuses contained in cubicles or marshalling kiosk.

1.28.2 Labeling shall be clear, concise and adequate and shall be of standard size.

1.28.3 Descriptive labels for mounting indoor or inside cubicles and kiosk shall be of material that will ensure permanence of the lettering. Danger notices shall have red lettering on a white background. All plates shall be of material, which will not be corroded.

1.28.4 Labels shall be attached to panels with brass screws or with steel screws, which have received rust preventive treatment.

1.29 **INSPECTION:**

(a) The bidder shall carry out a detailed inspection and testing program for manufacturing activities of the various components. An indicative program of inspection of as envisaged by the Engineer is given below. This is not, however, intended to form a comprehensive program as it is bidder's responsibility to draw up and carry out such a program duly approved by the Engineer.

(b) Cost of inspection/tests is to be borne by the bidder.

(c) Additional tests, if required, are to be deemed as included in scope of work.

(d) Stages of inspection and owners' participation would be defined and *shall be as per purchaser requirement.* Photographs shall be taken jointly and submitted with inspection report.

(e) The bidder shall guarantee that the goods are new and of high quality and the goods will be free from defects in design.

TANK AND CONSERVATOR:

(a) Certificates of chemical analysis and material tests of plates.
(b) Welder's and weld procedure qualification.
(c) Testing of electrodes for quality of base material.
(d) Inspections of major weld preparation.
(e) Crack detection of major strength weld seam by dye penetration test.
(f) Measurement of film thickness of
  i) Oil insoluble varnish.
  ii) Total paint thickness
  iii) Light gray paint.

(g) Check correct dimensions between wheels, demonstrate twining of wheels through 90^0 and further dimensional check.
(h) Check for physical properties of materials for lifting lugs jacking pad etc. All load bearing welds including lifting lug welds shall be subjected to NDT.
(i) Leakage test of the conservator.
(j) Certification of all test results.

CORE:

(a) Samples testing of core material for checking specific loss, bend properties magnetization characteristics and thickness.
(b) Check on the quality of varnish if used on the stampings.
(c) (i) Measurement of thickness & hardness of varnish on the stampings.
  (ii) Solvent resistance test to check that varnish does not react in hot oil.
  (iii) Check over all quality of varnish on stamping to ensure uniform shining colour, no bars spots, no over burnt varnish layer and no bubbles on varnished surface.
(d) Check on the amount of burrs.
(e) Bow check on stampings.
(f) Check for the overlapping stampings, Corners of the sheets are to be apart.
(g) Visual and dimensional check during assembly stage.
(h) Check for inter laminar insulation between core sections before & after pressing.
(i) Check on completed core for measurement of iron loss and check for any hot spot by exciting the core so as to induce the designed value of flux density in the core. *The losses shall be actually measured on built up core with*

dummy turns or can be demonstrated through suitable software to GETCO representative and the report for the same shall be submitted. However, during final inspection the losses shall be actually measured & the same shall be within guaranteed losses.

(j) Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps.

(k) High voltage test (2 KV for one minute) between core and clamps.

(l) Certification of all test results.

INSULATING MATERIAL:

(a) Sample check for physical properties of material.

(b) Check for dielectric strength.

(c) Visual & dimensional checks.

(d) Sample check on insulating paper for pH Value, electric strength.

(e) Check for the reaction of hot oil on insulating materials.

(f) Certification of all tests results.

WINDING:

(a) Sample check on winding conductor for mechanical properties and electrical conductivity.

(b) Visual dimensional checks on conductor for scratches, dent marks etc.

(c) Sample check on insulating paper for pH Value, electric strength.

(d) Check for the reaction of hot oil on insulating paper.

(e) Check for the bonding of the insulating paper on conductor.

(f) Check for absence of short circuit between parallel strands.

(g) Check and ensure that physical condition of all materials taken for winding is satisfactory and free of dust.

(h) Check for brazed joints wherever applicable.

(i) Measurement of voltage to be carried out when core/yoke is completely restacked and all connections ready.

(j) Conductor enamel test for checking of cracks, leakage and pin holes

(k) Conductor flexibility test

(l) Heat Shrinkable test for enameled wire

(m) Certification of all test results

CHECK BEFORE DRYING PROCESS:

(a) Cheek conditions of insulation in the conductor and between the windings.

(b) Cheek insulation resistance between high voltage connection cable and earth others live parts.

(c) Check insulation resistance between low voltage connection and earth & other parts.

(d) Insulation test of core earthing.

(e) Check for proper clean lines and absence of dust etc.

(f) Certification of all test results.

CHECK DURING DRYING PROCESS:

a) Measurement and recording of temperature and drying time during vacuum treatment.
b) Check for completeness of drying.
c) Certification of all test results.

ASSEMBLED TRANSFORMER:

(a) Check completed transformer against approved outline drawing: provision for all fitting, finish level etc.
(b) Taking test on all the assembled transformer
The bidder shall also prepare a comprehensive inspection and testing program for all bought out / sub-contracted items and shall submit the same to the Engineer for approval. Such program shall include the following.
(i) Buchholz relay
(ii) Sudden/rapid pressure rise relay/ PRV
(iii) Axles and wheels.
(iv) Winding temperature indicator for local and remote mounting.
(v) Oil temperature indicators
(vi) Bushing
(vii) Bushing Current Transformer
(viii) Terminal connectors
(ix) Radiators, cooler control and any other item, as desired by purchaser.
c) Test to check effective shielding of the tank
d) Jacking test with oil on all the assembled transformers
e) Dye penetration test shall be carried out after the jacking test

PRE-SHIPMENT CHECKS AT MANUFACTURER'S WORKS:

(a) Check for interchangeability of components of similar transformer for mounting dimensions.
(b) Check for proper packing and preservation of accessories like radiators, bushings, PRV, dehydrating breather, rollers, Buchholz relay, control cubicle, connecting pipes, conservator tank.
(c) Check for proper provision of bracings to arrest the movement of core and winding assembly inside the tank.
(d) Gas tightness test to conform tightness.
(e) Derivation of leakage rate and ensure adequate reserve gas capacity.

INSPECTION AND TESTING AT SITE:

The successful bidder shall carry out a detailed inspection and testing program for field activities, namely covering area right from the receipt of material stage up to commissioning stage. An indicative program of inspection as envisaged by the Engineer is given below.

This is however not intended to form a comprehensive program as it is bidder's responsibility to draw up and carry out such a program duly approved by the Engineer.

1.30 RECEIPT AND STORAGE CHECKS:

(a) Check and record condition of each package, visible part of the transformer etc. for any damage.
(b) Check and record the gas pressure in the transformer tank as well as in the cylinder.
(c) Visual check for welding of core and coils before filling up with oil and also check condition of core and winding in general.

1.30.1 **INSTALLATION CHECKS:**

Test on oil samples taken from main tank top and bottom and cooling system as per IS:335. Sample should be taken only after the oil has been allowed to settle for 24 hours.

1.30.1.1 Check the whole assembly for tightness, general appearance, etc.
1.30.1.2 Oil leakage tests.
1.30.1.3 The bidder shall warrant that oil furnished is in accordance will the specifications given in this specification.
1.30.1.4 Capacitance and tan delta measurement of bushings before fixing / connecting to the winding. Bidder shall furnish these values for site reference.
1.30.1.5 Sweep Frequency Response Analysis (SFRA) test

1.30.2 **COMMISSIONING CHECKS:**

(a) Check the color of silica gel breather.
(b) Check the oil level in the breather housing conservator tank, cooling system, condenser bushing etc.
(c) Check the bushings for conformity of connection to the line etc.
(d) Check for correct operation of all protections and alarms :
  (i) Buchholz relay
  (ii) Excessive winding temperature
  (iii) Low oil flow
  (iv) Excessive oil temperature
  (v) Low oil level indication
(e) Check for adequate protection on electronic circuit supplying the accessories.
(f) Insulation Resistance measurement for
  (i) Control wiring
  (ii) Main winding
(g) Check for cleanliness of the transformer and the surrounding.

1.30.3 **TESTING:**

1.30.3.1 The transformer shall be tested in the presence of GETCO's representative; all tests (routine and type tests) shall be witnesses by him. All the tests shall be performed in compliance of IS:2026-1962 (as amended up to date). **All the instruments, meters,** ***instrument transformers*** **etc., used for testing shall be duly calibrated at NABL laboratory and necessary calibration certificate shall be made available during inspection.** ***The instrument transformers shall have ≤0.2 accuracy class. The measurement of losses shall be carried out with 3 (Three) Watt meter method only through digital power analyzer and CTs, PTs and meters used for these measurements shall be of class of accuracy of 0.2.*** The following tests shall be carried out on the transformer.

1.30.3.1(a) ROUTINE TESTS:

All the tests shall be performed in compliance of IS:2026 (as amended up to date) with dielectric tests corresponding to Method 2 shall be carried out on each transformer:

(a) Resistance of each winding.
(b) Turns ratio for all sets of windings on each tap, with percentage error.
(c) Polarity and phase relation-ship.
(d) Impedance between each pair of winding.
(e) Excitation losses at 90, 100 and 110 % rated voltage measured by the average voltmeter method.
(f) Positive phase sequence impedance measurement on three phase transformers.
(g) Regulation at rated load and unity, 0.9, 0.8 lagging P.F.
(h) Load losses, measured at rated frequency, by applying a primary voltage sufficient to produce rated current in the windings with the secondary windings short-circuited.
(i) Separate source voltage withstand test.
(j) ACLD test
(k) Auxiliary losses (fans, pump, etc)
(l) SFRA test *(at factory and at site)*
(m) Zero Sequence impedance test
(n) Tests on tap-changer (IEC:60214)
(o) Tan delta & capacitance test for bushings and windings
(p) Tests on transformer oil including DGA on selected sample as per IS:9434/IEC: 567, before and after temp rise test and at final stage before dispatch. Corrosive sulphur detection test as per *IEC 62535* subjecting oil for 150^{o}C for *72* hrs, as specified in Appendix – A (Revised).
(q) Magnetic Circuit test:
After assembly of each core shall be tested at 2 kV between side plates, structural steel works etc. for 1 Minute
(r) Tank leak test at 5 psi (35 kN/m^2) for 12 hrs with oil & 1 hr with air.
(s) Magnetic Balance & current test on all winding
(t) HV withstand test on auxiliary equipments and wiring
(u) Measurement of Insulation Resistance
(v) Measurement of acoustic noise level
(w) Measurement of harmonics of no load current
(x) Measurement of Partial Discharges of transformer
(y) Vacuum test for tank at 25 bar for 1 hr.
(z) Measurement of no load current with 415 V AC supply on LV side.
(aa) Tests on air cell
(bb) Temperature rise as per cl. 1.30.3.1(b)(i) with DGA at initial, after Temp rise test and at final stage before dispatch.
(cc) Lightning impulse with chopped on tail test on all windings
(dd) Water content in transformer measurement test (limit – 0.5% - 0.7% of total insulation weight) – By Karl Fischer method. Sample shall be decided jointly.
(ee) Measurement of transferred surge in LV due to Lighting impulse on HV
(ff) Tests on Fiber Optic system viz. (i) Calibration (ii) functionality and conformance tests along with test report for Probe dielectric test"
(gg) Calibration of temperature indicators and relays.
(hh) CT testing viz. IR, ratio, polarity, excitation etc.
(ii) OLTC Motor current signature

(jj) Switching Impulse test

All the routine/acceptance tests shall be carried out on transformer filled with oil and fitted with all accessories to be supplied with transformer.

1.30.3.1(b) **TYPE TEST:**

Following type test reports as mentioned below and as specified in IS: 2026 (amended up to date) shall be submitted for the offered class and rating of transformer, invariably with the technical bid. If bidder is unable to comply this requirement, following is acceptable:

(1) Bidder shall submit at least one out of (a) Impulse Voltage Withstand Test (b) Heat run test for offered class/ rating transformer along with confirmation for balance test/s to carry out before commencement of supply, without affecting delivery schedule, free of cost, duly witnessed by NABL accredited laboratory representatives, in the event of order;

OR

(2) Submit full type test report for the higher class/ rating transformer along with confirmation for tests to be carried out on offered transformer, before commencement of supply, without affecting delivery schedule, free of cost, duly witness by NABL accredited laboratory representative, in the event of order.

The type test reports shall not be older than FIVE years and shall be valid as on the last date of submission of bid.

i) Temperature rise test

The temperature rise test shall be conducted at a tap for the worst combination of loading ***i.e. Load losses measured at minimum voltage tap and no load losses measured at rated voltage. The thermometers used during test shall be digital having calibrated in NABL lab. Calibration certificate shall not be older than one year.***

Gas chromatographic analysis on oil shall also be conducted before and after this test and the values shall be recorded in the test report. The sampling shall be in accordance with IEC 60567. For the evaluation of the gas analysis in temperature rise test the procedure shall be as per IS: 9434 (based on IEC 60567) and results will be interpreted as per IS: 10593 (based on IEC: 60599). *The temperature rise measurements shall be made with the Fiber Optic Thermometers & conventional OTI/WTI. The FOS shall also be operational during temperature tests and demonstrated during these tests. During probe verification, the hottest probes for each phase shall be identified, and temperature data for all probes recorded and reported in the test report. Data obtained from FOS and conventional OTI/WTI shall be compared however, both values should satisfy the commitment.*

ii) Impulse test shall be made on three limbs of transformer. The test sequence shall be with chopped wave.

iii) Vacuum and pressure test

iv) Tests on OLTC

1.30.3.1(c) **SPECIAL TESTS:**

Following test reports shall be submitted for the offered type rating of transformer & bought outs, invariably with the technical bid.

i) Zero phase sequence impedance measurement.
ii) Degree of protection (IP55) for control cabinets, OLTC driving mechanism, terminal boxes of PRV, MOG, Buchholz Relay, pump motors, fans, control cubicles for monitoring and NIFPS, etc. RTCC panel shall have IP 54 degree protection
iii) Short Time Current withstand test on offered HV and LV terminal connectors for 40 kA 3 sec.
iv) Measurement of acoustic noise level
v) Measurement of power taken by all auxiliaries
vi) Measurement of harmonic level in no load current
vii) Measurement of transferred surge in LV due to Lighting impulse on HV & IV
viii) **ACLD test**

If the above tests are carried out at bidder works, then the bidder shall have to repeat these tests again on any one unit without affecting delivery schedule at no extra cost to GETCO. The necessary confirmation shall invariably be submitted with the technical bid otherwise the offer shall be evaluated accordingly.

1.30.3.1(d) **CALCULATIONS:**

i) Thermal and Dynamic ability to withstand terminal short circuits
ii) Cooling calculations for ONAN, ONAF & OFAF.
iii) Calculation of offered losses with respect to offered winding and core materials.

1.30.3.2 Radiator, valves and other parts necessary for complete transformer shall be tested for leaks and strength applying to the complete tank filled with oil by air pressure not less than 0.7 atmospheres for a period of 24 hours or not less than 1.0 atmosphere for a period of 6 hours.

1.30.3 **TESTS ON TRANSFORMERS TANK:**

In addition to the routine tests on welds in the tank, the following type tests shall be carried out on all the transformer tanks **in presence of GETCO representative.**

1.30.3.1 **VACUUM TEST:**

The transformer tanks without oil shall be subjected to a vacuum of 760 mm. of mercury at sea level. It shall be tested at internal pressure of 3.33 KN/Sq.mm. absolute (25 torr) for 01 hour. The permanent deflection of the flat plates after removal of vacuum shall not exceed the values specified below.

Horizontal length of plate (mm)	Permanent deflection (mm)
Up to & Including 750	5
751 to 1250	6.5
1251 to 1750	8

1751 to 2000	9.5
2001 to 2250	11
2251 to 2500	12.5
2501 to 3000	16
3001 and above	19

1.30.3.2 **PRESSURE TEST**

The transformer tank along with radiators conservator and other fittings shall be subject to a pressure corresponding to twice the normal head of oil in the transformer or normal pressure plus 0.36 Kg/sq.cm, whichever is lower. The permanent deflection of flat plates after release of excess pressure shall not exceed the figures specified under vacuum test.

During vacuum and pressure test the Sr. no. of transformer punched on jacking pad since fabrication shall be got verified from inspector and recorded in report.

1.30.3.3 **PRESSURE RELIEF TEST**

Pressure Relief Device with its diaphragm in position shall be subject to an increasing oil pressure. This device shall operate before reaching the pressure specified in the pressure test above. Following routine tests shall be performed on PRD

i) Air pressure test
ii) Liquid pressure test
iii) Contact test
iv) Leakage test
v) Dielectric test

1.30.4 **TEST AT SITE**

After erection at site, the transformer shall be subject to the following test

(i) Insulation resistance test
(iii) Ratio and polarity test
(iii) Dielectric test of oil
(iv) Temperature rise test with maximum possible load.
(v) SFRA test

1.30.5 TYPE TESTS ON BOUGHT OUT ITEMS:

1. Bushing (Type test as per IS:2099/IEC:60137) ***Thermal stability, measurement of PD, PF, switching Impulse voltage withstand test, Thermal short time current withstand test etc.***
2. OLTC (Temp Rise of contact, Short circuit current test, Mechanical test & Dielectric test as per IEC:60214 and IP:55 test on driving mechanism box)
3. Buchholz relay (as per IS:3637) & IP-55 on terminal box
4. Air cell (Flexible air separator) – Oil side coating, Air side under coating, Air side outer coating and coated fabric as per IS:3400/BS:903/IS:7016.
5. Oil pump – vacuum test, oil pressure test at 1 kg/cm2 for 24 hrs., Temperature rise test by resistance method, IP-55 for terminal box.
6. Cooling fan and motor assembly – Free air delivery, Temperature rise, sound level, running at reduced voltage, IP-55 for terminal box.
7. MOG & terminal box for IP-55 degree of protection

8. ***Tests on fiber optic system- (i) Full wave negative impulse & Negative switching surge tests as per ASTM D-3426 and (ii)PD as per ASTM D-149 tests on fiber optic cable along with EMC testing: Surge testing 4000V (IEEE C37.90.1-2002) on measuring instrument "***
9. ***For any other item required during detailed engineering.***
10. ***Tests on AVR relay – Electrical, Environmental & Mechanical test as per relevant IEC and compatibility with IEC 61850.***

1.31 **TESTS ON OLTC:**

1.31.1 The various tests (routine and type) as stipulated in the IEC:60214 (as amended up to-date) ***including vacuum helium and gas leak tests*** shall be carried out.

1.31.2 Type test certificate copies of oscillograms as called for in IEC:60214 (as amended up to-date) shall be furnished by the supplier.

1.32 **TEST REPORTS:**

1.32.1 On completion of all the tests have been completed 3 copies of each test report shall be furnished to the GETCO for his approval prior to the dispatch of equipment. ***Soft copy of test reports for tests results obtained from software shall be submitted for approval and record.***

1.32.2 All the reports of inspections like stage, acceptance, routine & type tests carried out on each transformer including test certificates for bought out items, in bound volume, shall be submitted before dispatch. Also one copy shall be sent along with transformer.

1.33 **FURTHER TESTS:**

The GETCO reserves the right of having any other reasonable test carried out at his own expense to ensure that the transformer compiled with requirements of this specification.

1.34 LOSS/DAMAGES:

1.34.1 The Purchaser shall not be responsible for any damage to the equipment during commissioning if such damage results from faulty or inadequate action.

1.34.2 Purchaser shall not be liable for any loss, damage or injury to property or persons at the installation site unless such damages or injuries are caused by any and or negligence of the supervising erector.

1.35 **TECHNICAL AND GUARANTEED PARTICULARS:**

The bidder shall furnish all guaranteed technical particulars as called for in, **Section – III** of this specification. Particulars, which are subject to guarantee, shall be clearly marked. Bidder not containing this information is likely to be rejected.

1.36 INSTRUCTION MANUALS:

1.36.1 Six copies of operation, maintenance and erection manuals in English language for each transformer shall be supplied with the dispatch of the equipment. The manuals shall be bound volumes and shall contain all the drawings and information required for erection, operation and maintenance of the transformer. The manuals shall include amongst other the following particulars

(a) Marked erection prints identifying the component parts of the transformer as dispatched with the assembly drawings.

(b) Detailed dimensions, assembly and description of all the components.

(c) Detailed view of core & winding assembly, winding connections and tap changer construction, etc.

(d) List of spare parts.

1.37 DEVIATION FROM SPECIFICATION:

All deviations from this specification shall be separately and specifically listed ***in specified Schedule only***, in absence of which, it will be presumed that the provisions of the specification are compiled with by the bidder.

1.38 TRANSFORMER LOSSES & EVALUATION OF BID **& acceptance/ rejection**:

The transformers are to be designed with ***maximum*** permissible losses ***as indicated below.***

Transformer Rating	*No Load Loss at Rated Voltage, in kW*	*Full load losses (Copper + stray loss) at 75 °C, in kW*	*Auxiliary Loss in kW*
220/66KV, 160 MVA	***64***	***365***	***11***
220/66KV 100 MVA	***37***	***234***	***4.5***
220/66KV 50 MVA	***26***	***160***	***0***
220/33 KV 125 MVA	***55***	***300***	***8***
132/33KV 50 MVA	***25***	***160***	***0***

As we have specified fixed loss figures of maximum losses, manufacturers have to adhere to these figures by designing transformer

suitably. Bidder will not be ask to give any loss figure in GTP. Therefore there will be no capitalization at tender stage.

The order will be placed to lowest price bidder as per GETCO policy and actual losses measured during acceptance. It will be at discretion of GETCO to accept/reject the unit whenever there is positive variation in the losses measured at actual.

However, the unit shall not be accepted in the event measured losses are beyond the following limits against the fixed loss figures specified in the tender.

1) No Load losses : 5%

2) Full Load losses : 2%

3) Aux losses : 5%

Penalty towards the higher losses within above limits shall be recovered as follow:

1) No Load losses: 3 times capitalization cost of ₹3,33,000/- per kW

2) Full Load losses: 3 times capitalization cost of ₹1,36,000/- per kW

3) Aux losses: 3 times capitalization cost of ₹1,33,000/- per kW

It is also proposed that testing of unit will be carried out in presence and witness of third party selected by GETCO at the discretion of GETCO.

In case of any order, ***the losses of successful bidder will be measured during acceptance testing and if the figures of looses are found equal to or lesser than specified above, the transformer shall be accepted. However, if any of the loss figure measured during acceptance test is found more than specified above, the transformer will not be accepted. There shall be no provision for penalty for acceptance of transformer with losses higher than specified above. Bidder shall submit undertaking separately for the same, with the technical bid.*** The measurement of losses shall be carried out with 3 (Three) Watt meter method only and CTs, PTs and meters used for these measurements shall be of class of accuracy of 0.2.

However, no weightage shall be given for supply of transformer, with losses (measured during routine tests) less than the *above specified* losses.

1.40 REJECTION:

1.40.1 The Purchaser ***shall*** reject transformer, if any of the following conditions during or service arises:

i) No load losses or load losses ***or Auxiliary losses*** exceed the ~~d~~ ***specified*** value.

ii) Impedance value ***deviates*** the guaranteed value by ± 10% or more.

iii) Oil or winding temperature rise exceeds the specified value.

iv) Transformer fails ***to withstand any of the dielectric tests.***

v) Transformer fails ***to pass any of acceptance*** test.

vi) Transformer is proved to have been manufactured not in accordance with agreed specification.

1.40.2 The Purchaser reserves the right to retain the rejected transformer and use it until the bidder replaces the defective transformer by a new transformer, **as a stop gap arrangement**, within a reasonable period, at no extra costs to the GETCO. **Defective transformer may be replaced by new acceptable transformer.** In such case the transportation, loading, unloading on plinth, inspection, erection, testing & commissioning charges shall be bourn by the bidder.

1.41 **TRAINING TO ENGINEERS:**

1.41.1 The successful bidder will be required to grant facilities for training to minimum two Engineers to be nominated by the GETCO, for accessories indicated in this specification. Training in respect of Fiber Optic system, On line moisture and multi gas in oil analyzer, Nitrogen injection system for protection, AVR relay, On line PD measurement, GPS/GRPS/GSM based on line transformer movement tracking system on returnable basis, Condition controlled maintenance free on line breather, etc., as applicable shall be arranged.

The bidder shall state the general condition of training and number of Man days (minimum 15) for training for which such training will be arranged by him. GETCO may nominate different Engineers for different items.

1.41.2 Bidder shall at his cost arrange for the above training facilities and in addition shall bear all living expenses **excluding** to and fro passage of the trainees. Bidder shall indicate following in the prices schedule.

a) The lump sum amount of training for the above training facilities.
b) Price reduction / addition for number of trainees specified herein.

1.42 Guarantee period will be reckoned from the date of receipt of 100 % accessories and not from the date of receipt of main tank only.

1.43 If GETCO Engineer **happens to return** without inspection of offered equipments due to non-readiness of materials at their works then financial loss to the GETCO for deputing their representative will be recovered from the concerned supplier.

1.44 TRANSFORMER OIL:

1.44.1 (1) Manufacturers / Suppliers will have to supply the transformer oil as per GETCO's Specification of Transformer oil attached herewith at Annexure - A.

(2) At the time of inspection of transformer, bidder has to furnish the certificate / test reports of transformer oil purchased. Same should be meeting to GETCO's transformer oil specification. At the time of inspection of the each power transformer, the supplier of the transformer shall arrange to take a sample of the transformer oil from the power transformer under testing in presence of GETCO's representative and the supplier shall arrange at their cost the testing of the transformer oil sample as per Cl. 5.3 of IS: 1866 - 1994 with latest amendments thereof at M/s. ERDA or any other Govt. recognized laboratory to confirm the quality of the transformer oil. The result of the same shall be submitted for approval.

(3) After commissioning the transformer at site, in presence of representative, commissioning Engineer of Supplier of transformer, 2 nos. of joint samples may be collected and sealed. One sample will be sent for testing as per Cl. 5.3 of IS: 1866 - 1994 with latest amendments thereof to M/s. ERDA, Baroda or Government approved Laboratory to confirm the quality of transformer oil and second sample will be preserved. In case of dispute for results of first sample, 2nd sample should be got tested through any other approved test house by GETCO and results shall be binding to suppliers.

1.45 QUALITY ASSURANCE PLAN:

The bidder shall invariably furnish following information's along with his offer, failing which his offer shall be liable for rejection. Information shall be separately given for individual type of equipments offered.

1. QAP for incoming material, in process and final checks and testing.
2. Statement giving list of important raw materials, names of sub suppliers for the raw materials, list of standard according to which the raw materials are tested. List of tests normally carried out on raw materials in presence of bidder's representatives, copies of test certificates.
3. Information and copies of test certificates as in (i) above in respect of bought out accessories.
4. List of manufacturing facilities available.
5. Level of automation achieved and list of areas where manual processing exists.
6. List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
7. Special features provided in the equipment to make it maintenance free.
8. List of testing equipments available with the supplier for final testing of transformer specified and test plant limitation, if any, for the special acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in 'The schedule of divinations' for specified test requirements.
9. Field Quality Plan shall be submitted with the technical bid.

SECTION – II

TECHNICAL SPECIFICATION
FOR 220 kV CLASS POWER TRANSFORMERS

SPECIFIC REQUIREMENTS

2.1 **SCOPE:**

2.1.1 This section covers the specific technical requirements, climatic and isokeraunic conditions and system particulars for which the power transformer shall be offered as per the general technical requirements given in Section – I of this specification and the Schedule of requirements specified herein for the various sub-stations.

2.2 CLIMATIC AND ISOCERANIC CONDITIONS:

2.2.1 The climatic conditions under which the equipments shall operate satisfactorily.

(a)	Maximum ambient temperature of air in Shade (^{O}C)	50
(b)	Minimum ambient temperature of air in shade. (^{O}C)	3.5
(c)	Maximum relative humidity (%)	95
(d)	Average number of thunder storm (days/annum).	15
(e)	Average number rain fail (cm)	150
(f)	Maximum wind pressure (kg / m^2)	150
(g)	Height above monsoon level (mtr)	Not exceeding 1000
(h)	*Climate: Moderately hot & humid tropical, conducive to rust & fungus growth.*	
(i)	*Isokeraunic level*	*30*
(j)	*Earth quake acceleration (g)*	*0.08X2*

2.2.2 All equipments offered shall be suitable for continuous satisfactory operation at the full rated capacity under the climatic conditions.

2.2.3 Since the sub-station may be near seashore or industrial area, the equipment offered shall be suitable for heavily polluted atmosphere.

2.3 **TYPE AND RATING:**

2.3.1 The transformers shall be core or shell type construction, 3 phase, oil immersed, ONAN/ONAF/OFAF with external radiators and shall be suitable for outdoor services. The rating and the electrical characteristics of the transformers shall be as under:

SN	Technical Particulars	132/33KV 50MVA	220/33KV 125MVA	220/66KV 50 MVA	220/66KV 100 MVA	220/66KV 160 MVA
(a)	Type	3 phase two winding *Power* transformer				
(b)	Rated Capacity (MVA)	50	62.5/ 93.75/ 125	50	50/ 70/ 100	80/ 120/ 160
(c)	Rated Voltage (kV)	132/33	220/33	220/66	220/66	220/66
(d)	Highest System Voltage (kV)	145/36	245/36	245/72.5	245/72.5	245/72.5
(e)	System frequency (Hz)	50	50	50	50	50
(f)	Rated current in Amp (HV)	131.21	164/ 246/ 328	131.21	131.21/ 183.68/ 262.41	209.92/ 314.89/ 419.85
	Rated current in Amp (LV)	874.77	1093.5/ 1640.3/ 2187	437.38	437.38/ 612.339/ 874.77	699.81/ 1049.72/ 1399.63
(g)	Type of cooling	ONAN	ONAN/ ONAF/ OFAF	ONAN	ONAN/ ONAF/ OFAF	ONAN/ ONAF/ OFAF
(h)	Vector Group	YNyn0	YNyn0	YNyn0	YNyn0	YNyn0
(i)	System of grounding	Solidly Grounded	Solidly Grounded	Solidly Grounded	Solidly Grounded	Solidly Grounded
(j)	Basic Insulation Level (Winding) LI/SI/ AC (kV)					
	HV	650/ 540/ 275	1050/ 850/ 460	1050/ 850/ 460	1050/ 850/ 460	1050/ 850/ 460
	LV	200/NA/70	170/NA/75	350/NA/160	350/NA/160	350/NA/160
(k)	Chopped Lightning Impulse					
	HV	715	1155	1155	1155	1155
	LV	--	--	385	385	385
	Neutral (HV)	--	--	--	--	--
(l)	% Impedance	12.5%	15%	15%	15%	15%
(m)	Tapping range	-10% to +10% in equal 16 steps each 1.25% on HV winding for LV variation.	-10% to +10% in equal 16 steps each 1.25% on HV winding for LV variation.	- 5 to + 15% in equal 16 steps each 1.25% on LV neutral end for LV variation	- 5 to + 15% in equal 16 steps each 1.25% on LV neutral end for LV variation	- 5 to + 15% in equal 16 steps each 1.25% on LV neutral end for LV variation.
(n)	Type of tap changers	On Load Tap Changer (Resistance transition type)	On Load Tap Changer (Resistance transition type)	On Load Tap Changer (Resistance transition type)	On Load Tap Changer (Resistance transition type)	On Load Tap Changer (Resistance transition type)
(o)	Bushing Current Capacity – HV/LV/LV-N	800/ 1250/ 1250	1250/ 3150/ 3150	1250/ 800/ 800	1250/ 1250/ 1250	1250/ 2000/ 2000
(p)	Type of bushing lead HV/LV//LV-N	Draw Lead/ Solid Stem/ Sold Stem	Draw Rod/ Solid Stem/ Solid Stem	Draw Rod/ Solid Stem/ Solid Stem	Draw Rod/ Solid Stem/ Solid Stem	Draw Rod/ Solid Stem/ Solid Stem

SN	Technical Particulars	132/33KV 50MVA	220/33KV 125MVA	220/66KV 50 MVA	220/66KV 100 MVA	220/66KV 160 MVA
(q)	Short circuit level for the system	KV MVA 220 15300 66 4573 33 1500				
(r)	System Fault level	HV: 40 kA 3 sec LV: 25 kA 3 sec				
(s)	Service	Outdoor				
(t)	Duty	Continuous				
(u)	Overload capacity	As per IS:6600 – 1972 / IEC354				
(v)	Partial Discharge level	*100 Pico-coulomb, Max*				

2.3.2 The equipment offered shall be suitable for continuous operation under the above conditions at the full rated capacity.

2.3.4 The power transformers shall in general have constant ohmic impedance between HV and LV on all taps. However, in case of parallel operation with the existing transformer,

i) The impedance, vector group, OLTC connection & range etc. of the transformer is to be matched with that of the existing transformer
ii) Necessary provision is to be kept in the transformer control scheme for parallel operation with the existing Master/Follower/Independent/Off type OLTC control system.
iii) Matching of physical dimension, orientation etc. to facilitate interchangeability with the existing transformer, if necessary.

2.3.4 External or internal reactors shall not be used to achieve the HV/LV impedance specified

2.4 EARTHQUAKE & WIND DESIGN LOADS:

2.4.1 The equipment offered shall be designed to withstand repeated earthquake acceleration of 0.08 x 2 g. and wind loads of 150 kg/m^2 on the projected area non-simultaneous without damage to component parts and without impairment or operation.

2.5 HV, LV AND NEUTRAL BUSHING CT:

2.5.1 One multi ratio, turret mounted type, current transformer shall be provided on all line as well as common neutral lead in case of 2 winding transformer, neutral CT each for H.V. & L.V with following technical details.

Voltage Class	corresponding line voltage rating for line bushing CT and corresponding neutral voltage rating of neutral bushing CT

		132/33 kV 50 MVA	220/33 kV 125MVA	220/66 kV 160MVA	220/66 kV 100MVA	220/66 kV 50MVA
(A) HV Side (Line As well as Neutral)						
No of Cores	:	Two or as indicated in schedule A	Two or as indicated in schedule A	Two or as indicated in schedule A	Two or as indicated in schedule A	Two or as indicated in schedule A
Ratio	:	900-1200/1 A	900-1200/1 A	900-1200/1 A	900-1200/1 A	600-900/1 A
Accuracy Class	:	PS (As per IS: 2705)	PS (As per IS: 2705)			
V_k		≥ 1400 V @1200A	≥ 1400 V @1200A	≥ 1400 V @1200A	≥ 1400 V @1200A	900V @ 900A
I_0 at $V_k/2$		≤ 30 mA	≤ 30 mA	≤ 30 mA	≤ 30 mA	≤ 30 mA
Application		REF	REF	REF	REF	REF
(B) LV Side (Line As well as Neutral)						
No of Cores		Two or as indicated in schedule	Two or as indicated in schedule	Two or as indicated in schedule	Two or as indicated in schedule	Two or as indicated in schedule
Ratio		900-1200/1A	2000-2500/1A	1200-1500/1A	900-1200/1A	600-900/1A
Accuracy Class		PS (As per IS: 2705)	PS (As per IS: 2705)	PS (As per IS: 2705)	PS (As per IS: 2705)	PS (As per IS: 2705)
V_k		≥ 1400 V, at 1200A	≥ 1200 V, at 2500A	≥ 1400 V, at 1500A	≥ 1400 V, at 1200A	≥ 900 V @ 900/1A
I_0 at $V_k/2$		≤ 30 mA	≤ 30 mA	≤ 30 mA	≤ 30 mA	≤ 30 mA
Application		REF	REF	REF	REF	REF

2.5.2 Any change in the parameters of CT required at the time of detailed engineering will have to be incorporated without any extra cost. ***Turret mounted type, current transformer shall be provided for each winding for WTI.***

2.6 **POWER SUPPLY FOR CONTROLS:**

2.6.1 The AC power supply for auxiliaries will be available at 240 volts, 1 phase and 415V. 3 phase, 50 Hz. The frequency can vary between ± 3% of normal frequency of 50 Hz and voltage can very from 85% to 110% of the normal value.

2.6.2 The D.C. supply at either 220 V or 110 Volts will be available from station battery. The D.C. supply is subject to variation of ± 10%.

2.6.3 Each of the foregoing supplies will be made available by the purchaser at one terminal for each transformer for operation of accessories & auxiliary equipments. Bidder's scope shall include distribution this point.

2.7 OIL STORAGE TANK:

2.7.1 General

This specification covers supply of oil storage tank of 15 cubic meter capacity along with complete accessories. **Number of tanks, if required, will be as indicated in Schedule – A of respective tender.**

2.7.2 Standard

The oil storage tank shall be designed and fabricated as per relevant Indian Standards e.g. IS: 803 or other internationally acceptable standards.

2.7.3 Specifications

Transformer oil storage tanks shall be towable & rested on pneumatic types of adequate quality & size. The tank shall be to cylindrical shape & mounted horizontally and made of mild steel plate of adequate thickness. Size of the storage tank shall be follows:

Diameter : 2.5 meter */ suitable*
Capacity : 15 cubic meters

The tank shall be designed for storage of oil at a temperature of 100ºC.

2.7.3.1 The Bidder may further note that maximum height of any part of the complete assembly of the storage tank shall not exceed 4.0 meters above road top.

2.7.3.2 The tank shall have adequate number of jacking pad so that it can be kept on jack while completely filled with oil. The tank shall be provided with suitable saddles so that tank can be rested on ground after removing the pneumatic tyres. **Sr. no. of transformer shall be punched on jacking pad since fabrication.**

2.7.3.3 The tank shall be also fitted with manhole, outside & inside access ladder, silica gel breather assembly, inlet & outlet valve, oil sampling valve with suitable adopter, oil drainage valve, air vent etc. Pulling hook on both ends of the tank shall be provided so that the tank can be pulled from either end while completely filled with oil. Bidder shall indicate the engine capacity in horse power to pull one tank completely fitted with oil. Oil level indicator shall be provided with calibration in terms of litre so that at any time operator can have an idea of oil in the tank. Four nos. suitable rubber hoses with couplers and unions each not less than 10 meter long shall also be provided.

2.7.3.4 The internal & external surfaces to be painted shall be short or sand blasted to remove all rust and scale of foreign adhering matter or grease. All steel surfaces in contact with insulating oil shall have painted with two coats of heat & oil resistant anti-corrosive paint after one coat of red oxide as per IS:104 and one each coat of finishing coats of glossy white shade.

All steel surfaces exposed to weather shall be given primary coat zinc chromate, second coat of oil & weather resistant paint of a colour distinct from primary and final two coats of glossy oil & weather resistant light grey paint in accordance with shade no. 631 of IS: 5. All paint shall be carefully selected to withstand heat & extremes of weather. The paint shall not scale off or crinkle or be removed by abrasion due to

normal handling. The minimum thickness of outside painting of tank shall be 20 microns per coat the total thickness shall be within 70 to 100 microns.

2.7.3.5 The tank shall contain a self-mounted centrifugal oil pump with inlet and outlet valves, with couplers suitable for rubber houses and necessary switchgear for its control. There shall be no rigid connection to the pump. The pump shall be electrical motor driven and shall have a discharge of not less than 6 klph with a discharge head of 8 Mtr. The pump motor and the control cabinet shall be enclosed in cubicle with IP55 enclosure.

2.8 OIL SAMPLING BOTTLE:

2.8.1 Oil sampling bottle shall be suitable for collecting oil sample from transformer and shunt reactors for dissolved gas analysis. Bottles shall be robust enough so that no damage occurs during frequent transportation of samples.

2.8.2 Oil sampling bottle shall be made of Stainless Steel having capacity of ONE litre.

2.8.3 Oil sampling bottle shall be capable of being sealed gas tight and shall be fitted with cocks on both ends.

2.8.4 The design of bottle & seal shall be such that loss of hydrogen shall not exceed 5% per week.

2.8.5 An impermeable oil proof transparent plastic or rubber tube of about 5 mm diameter and of sufficient length shall also be provide with each bottle along with suitable connectors to fit the tube on to the oil sampling valves of the equipment and the oil collecting bottle respectively.

SECTION – III

BIDDING SCHEDULE - 'A'

Guaranteed Technical Particulars for Power Transformers to be filled by Bidder where ever not specified by buyer.

(Important note: Bidder is not liable to indicate any change in parameters specified by buyer.)

Item	Description	Unit	Specified (by Buyer)	Offered (by manufacturer)
1	**General Information** i) Name of Manufacturer ii) Place of Manufacturing iii) Type of transformer (Core/Shell)		 - - **Core**	 -
2	**Applications** i) Indoor/Outdoor ii) 2Wdg/3Wdg/Auto		 Outdoor 2 wdg	 - -
3	**Corrosion Level at Site**			
	i) Light ii) Medium iii) Heavy iv) Very Heavy		*Heavy*	-
4	**Applicable Standards** i) IEC: 60076 ii) IS : 2026 iii) ANSI C57.12.00		 *IEC 60076* *IS 2026* *(Latest)* --	 - - -
5	Type : Liquid immersed		*Liquid oil immersed*	-
6	**Full load rating** (HV/IV/LV)	**MVA**		-
7	**3Phase/Bank of Three Phase/Single Phase (A,B,C)**		*Three phase*	-
8	**Rated No Load Voltages** (HV/LV)	kV		-
a	**Rated Currents** (HV/LV) at normal tap	Amp		-
b	**Short time thermal rating**		-	
9	**Rated Frequency**	Hz	*50*	
10	**Connections and phase displacement (Vector group)**		*YNynO (Star/star)*	
11	**Weight Schedules (Maximum) (Minimum with no negative tol.)**			
	i) Active part	kg	-	
	ii) Oil	kg	-	
	Iii) Tank and Fittings	kg	-	

	iii) Total Weight	kg	-	
	iv) Overall dimensions L X B X H	mm	-	
	v) Size of heaviest package L X B X H vi) Weight of heaviest package	mm kg	- -	
12	**LV Winding**			
	i) Stabilizing tertiary (Yes/No) ii) Loaded (Yes/No)			- -
13	Tappings			
	i) OLTC/OCTC		*OLTC*	-
	ii) Tapping on			-
	iii) Variation on		*LV*	-
	iv) Range of variation			-
	v) No of Steps vi) Parallel Operation Requirements		*16 steps* *Yes*	- -
14	**Impedance and Losses**			
	i) Calculated I^2R Loss at rated tap and 75 ^{0}C	kW	-	
	ii) Eddy current and stray loss at rated tap and 75 ^{0}C (indicative)	kW	-	
	iii) Calculated Load Loss(I^2R+Eddy and Stray)at rated tap and 75 ^{0}C	kW	-	
	iv) Guaranteed Load Losses at rated tap and 75 deg c 220/66KV, 50 MVA Transformer 220/66KV, 100 MVA Transformer 220/66KV, 160 MVA Transformer 220/33KV, 125 MVA Transformer 132/33KV, 50 MVA Transformer	kW	 *160* *234* *365* *300* *160*	Bidder is not allowed to enter any figures.)
	v) Guaranteed Impedance (Base MVA at Principle tap) 220/66KV, 50 MVA Transformer 220/66KV, 100 MVA Transformer 220/66KV, 160 MVA Transformer 220/33KV, 125 MVA Transformer 132/33KV, 50 MVA Transformer	%	 *15%* *15%* *15%* *15%* *12.5%*	(Bidder is not allowed to enter any figures.)
	vi) Impedance at extreme tappings a) Max. Voltage tap b) Min. Voltage tap c) Tolerance	% %	 - - -	
	vi-a) Zero sequence impedance at rated current and frequency at 75 ^{0}C vi-b) Impedance voltage drop at normal ratio at 75 ^{0}C expressed as a percentage of normal voltage on full load (%)	%	- -	
	vii) Regulation at full load 0.8 pf at 75 ^{0}C winding temperature	%	-	

	viii) Guaranteed No load losses 220/66KV, 50 MVA Transformer 220/66KV, 100 MVA Transformer 220/66KV, 160 MVA Transformer 220/33KV, 125MVA Transformer 132/33KV, 50MVA Transformer	kW	 26 37 64 55 25	(Bidder is not allowed to enter any figures.)
	ix) Calculated Fan Loss	kW	-	
	x) Calculated Pump Loss	kW	-	
	xi) Guaranteed aux loss 220/66KV, 50 MVA Transformer 220/66KV, 100 MVA Transformer 220/66KV, 160 MVA Transformer 220/33KV, 125MVA Transformer 132/33KV, 50 MVA Transformer	kW	 0.0 4.5 11.0 8.0 0.0	Bidder is not allowed to enter any figures.)
	xii-a) Guaranteed maximum Magnetizing Current at rated Voltage & frequency (b) Guaranteed maximum Magnetizing Current at maximum voltage and rated frequency	%	- -	
	xiii) (a) Efficiency at 100 % load , unity PF (b) Efficiency at 75 % load , unity PF (c) Efficiency at 50% load , unity PF (d) Efficiency at 25 % load , unity PF (e) Efficiency at 100 % load , 0.8 PF (f) Efficiency at 75 % load , 0.8 PF (g) Efficiency at 50% load , 0.8 PF (h) Efficiency at 25 % load , 0.8 PF	%	- - - - - - - - -	
	xiv) Load for Maximum efficiency xv) Maximum efficiency	% %	- -	
	(xvi) Percentage reactance at rated current and Frequency : (xvii) Percentage resistance at 75 deg C in ohm		- -	
15	Over load capacity (as per IS:6600) starting from: Full load and with Temp. as specified in the Specification (MVA)		-	
16	PD level at 1.5 Um/√3 between phase & ground PC (max)	PC	**100**	Bidder is not allowed to enter any figures.)
17	RIV at 1.05 Um/√3 between phase and ground		-	
18	Max continuous ratings a) At 50 deg. c ambient air temperature at site b) At 40 deg. c ambient air temperature at site c) At 30 deg. c ambient air temperature at site d) At 20 deg. c ambient air temperature at site	MVA	 - - - -	
19	Net weight of core (kg)(CRGO only) Minimum(No -ve tolerance is allowed)	Kg	-	

20	Weight of complete core and windings	Kg	-	
21	Weight of fittings	Kg	-	
22	Net untanking weight	Kg	-	
23	Weight of tank and covers	Kg	-	
24	Weight of oil in transformer including bushing,, conservator, cooling systems	Ltrs	-	
25	Weight of oil in transformer (including bushings)	Kg	-	
26	Weight of complete transformer with oil and all fittings	Kg	-	
27	Weight of transformer with all fittings but without oil	Kg	-	
28	Weight of the package to be transported and dimensions	Kg	-	
29	Transformer -Overall dimensions (LxBXH)	mtr	-	
30	Main Tank Conservator (a) Size – Length and diameter (b) Capacity	 Mm Ltr		
31	OLTC Conservator (a) Size – Length and diameter (b) Capacity	 Mm Ltr		
30	Minimum clear height for lifting core and windings from tank in meters	mtr	-	
31	Guarantee against leakage	Yrs	*3*	

A. MAGNETIC SYSTEM

Item	Description	Unit	Specified (Buyer)	Offered (by manufacturer)
1	**Core Type**			
	i) 3Phase 3 Limb(3 wound limbs)		-	
	ii) 3Phase 5 Limb(3 wound limbs)		-	
	iii) 1Phase 2 Limb(2 wound limbs)		-	
	iv) 1Phase 3 Limb(1 wound limb)		-	
	v) 1Phase 4Limb(2 wound limbs) vi) 1Phase 5Limb(3wound Limbs)		-	
2	**Type of Core Joint**			
	i) Mitred		-	
	ii) Step Lap		-	
3	**Core material** a)Thickness b) Grade (As per IS) c) Max. Specific loss at 1.7 T, 50Hz. d) Net weight of core (kg)	 mm Watts	CRGO - - - -	

	e) Insulation of core clamping plates f) Prime quality grade g) Insulation of core lamination	/kg	- - -	
4	**Core bolts in Limb /Yoke**	Yes/ No	No	Bidder is not allowed to enter any figures.)
5	**Minimum Gross Area** of Core/Limb/Yoke/Unwound limb (May be verified during manufacturing stage)	cm^2	-	
6	**Stacking Factor**	%	-	
7	**Voltage per turn**	V	-	
8	**Apparent Core Density** for Weight Calculation		-	
9	Minimum Net Weight of Silicon Steel Lamination CRGO (may be verified during manufacturing stage by calculation using input from item -5)	kg	-	
10	Max Flux density at rated voltage and frequency, (may be verified during manufacturing stage by calculation)		-	
11	W/kg at working flux density		-	
12	**Building Factor considered**		-	
13	**Maximum Sound Level**	dB	-	
14	**Core Isolation test**	kV	-	

B. CONDUCTING SYSTEM

Item	Description	Unit	Specified (Buyer)	Offered (by manufacturer)			
				HV	IV	LV	Reg
1	**Type of Winding**						
	Helical/Disc/Layer/interwound		-				
2	**Type of Conductor**						
	PICC/CTC/CTCE/CTCEN/BPICC		-				
3	**Minimum Yield Strength of Conductor**						
	0.2% elongation	N/mm 2	-				
4	**(a) Maximum Current density at any tap** **(b) Winding cross sectional area**	A/mm 2	- -				
5	**(a)Bare Weight of copper without paper insulation and lead (Minimum) (-2%)** **(b) Copper weight with insulation**	Kg Kg	- -				
6	Per Phase Maximum resistance of winding at rated tap at 75 ^{O}C	Ohm	-				
7	Insulation of winding		-				
8	Number of Turns/Phase		-				
9	**Dielectric Shielding used**						
	i) Interleaved winding ii) Wound in Shield iii) Others		- -				

10	Magnetic Shielding Used						
	i) Yoke Shunt on core clamp		-				
	ii) Magnetic shunt on tank		-				
	iii) Electromagnetic (Copper/Aluminum) shield on tank		-				
	iv) Others		-				

C. COOLING SYSTEM

Item	Description	Unit	Specified (By buyer)	Offered (by manufacturer)
1	**Type of Cooling**			
	i) ONAN ii) ONAN/ONAF iii) ONAN/ONAF/OFAF		- - ONAN/ONAF/OFAF	
2	Percentage Rating Corresponding to Cooling Stages (HV/IV/LV)		50/75/100	
3	**Guaranteed Maximum Temperature rise at 1000Mtr. altitude**			
	i) Top Oil by thermometer			Bidder is not allowed to enter any figures.)
	220/66KV, 50MVA Transformer		45	
	220/66KV, 100MVA Transformer	^{0}C	40/45	
	220/66KV, 160MVA Transformer	^{0}C	40/45	
	220/33KV, 125MVA Transformer	^{0}C	40/45	
	132/33KV, 50MVA Transformer	^{0}C	45	
	ii) Average Winding by resistance			Bidder is not allowed to enter any figures.)
	220/66KV, 50MVA Transformer		50	
	220/66KV, 100MVA Transformer		45/50/50	
	220/66KV, 160MVA Transformer	^{0}C	45/50/50	
	220/33KV, 125 MVA Transformer	^{0}C	45/50/50	
	132/33KV, 50MVA Transformer	^{0}C	50	
	iii) Winding hot spot (max)	^{0}C	116	
	iv) Limit of hot spot for which transformer is designed	^{0}C	-	
4	**Type of Cooler**			
	i) Radiator Bank ii) Oil to Air Heat Exchanger		- -	-
	iii) Tank Mounted		-	
	iv) Header Mounted		-	
	v) Separately Mounted		-	
5	**Cooling Fans**			

	i)Type		-	
	ii)Size		-	
	iii)Rating(kW)		-	
	iv)Supply voltage, AC		-	
	v)Quantity(Running + Standby)		-	
6	**Oil Pumps**			
	i)Type		-	
	ii)Size		-	
	iii)Rating a) LPM b) kW		-	
	iv)Supply voltage, AC		440 V	
	v)Quantity(Running + Standby)		-	
	Radiators: i) Numbers per transformer ii) Width of elements (mm)	 Nos mm	- -	
8	iii) Thickness of sheet (mm) iv) Length (mm) v) Numbers of flutes / section vi) Nos. of Sections / radiator	Mm Mm Nos Nos	- - - -	
9	Cooling calculations submitted		-	

D. DIELECTRIC SYSTEM

Item	Description	Unit	Specified (By buyer)	Offered (by manufacturer)			
1	**Geometric Arrangement of winding with respect to core**						
	Eg: Core-LV-IV-HV-Reg Coarse-Reg Fine		-				
2	**Regulating Winding**						
	i) Body Tap ii) Separate		- -				
3	**HV Line Exit point in winding**						
	i) Top ii) Center		- -				
4	**Varistors used across Windings**	Yes/ No	No	-			
	If yes, Details						
5	**Insulation Levels**			**HV**	**LV**	**HVN**	**IVN**
	i)1.2/50 µs lightning Impulsewithstand voltage	kVp	-				
	ii)Chopped Impulsewithstand voltage	kVp	-				
	iii)Switching Impulse withstand voltage	kVp	-				
	iv)AC (Short duration/ long duration) withstand voltage	kV	-				

		rms					
	v)Max PD level at 1.5 PU	PC	-				
6	Design value of surges transferred on LV a) For 1050 kVp, 1.2/50 μs surge striking on each of HV terminals		- -				
7	Clearances						
	a) Minimum clearance between phase i) In oil : ii) Out of oil : b) Minimum clearance of high voltage to earth : in oil c) Minimum clearance of high voltage to tank : in oil (d) Phase to phase & phase to earth in air of live parts: at the top of bushings	mm mm mm mm mm	- - - - -				
6	**Press Board** i) Make and type		-				
7	**Conductor Insulating Paper** -Kraft paper, thermally upgraded Kraft paper, nomex		-				
8	**Type of axial support (HV, IV & Tertiary)**		-				
9	**Type of radial support (HV, IV & Tertiary)**		-				
10	**Insulation details (HV, IV & Tertiary)**		-				

E. ACCESSORIES / PARTS

Item	Description	Unit	Specified (By buyer)	Offered (by manufacturer)
1	**Tap Changers**			
	i)Control			
	a-Manual b-Automatic c-Remote d-Local		Manual, Automatic, Remote & Local	
	ii)Voltage Class and Current Rating of Tap Changers		-	
	iii) Step Voltage		-	
	iv) STC rating		-	
	iii) Make and Model		-	
	iv) Time to complete tap change	Sec	-	
	v) Diverter selector switch transition time	c/s	-	
	vi) Protection device		-	
	vii) Maxi. Impulse withstand test voltage value with: 1.2/50 μs full wave between switch and ground (viii) Maxi. Impulse withstand test voltage value with:		- -	

	1.2/50 μs. Full wave between the remote terminal and ground with the selector terminal at one end of the range (ix) Maxi. Power frequency test voltage between: switch assembly and range (x) Maxi. Impulse withstand test voltage with: 1.2/50 μs across the tapping range (xi) Maxi. Temp. of the tap changer which must not be exceeded during operation (xii) Approximate overall weight (xiii) Approximate overall dimensions (xiv) Compatibility of SCADA remote operation (xv) Line drop compensator provided. (xvi) No of operations after which the change of oil is necessary (xvii) Time to complete one tap change		- - - - - - - - -				
	iv) Make and Type of AVR		-				
	v) Power Supply for control motor		-				
	vi) No of Phase/Voltage/Frequency		-				
	vii) Rated Voltage for control circuit		-				
	viii) Phase/Voltage/Frequency		-				
	ix) Quantity of Oil in OLTC	Ltr	-				
2	**Tank**						
	i)Tank Cover: Conventional/Bell II) Tank cover: Bolted iii) Plate thickness : side, bottom, cover	mm	- **Bolted** -				
	iv) Rail Gauge	mm	1676 mm	-			
	v)Minimum Clearance height from rail for lifting Active Part	mm	-				
	vi) Wheels: a) Numbers b) Plane c) Flanged d) Uni- Directional e) Bi-Directional f) Locking Details	Nos	- - - - - -				
	vii)Vacuum withstand Capability	mm of Hg	-				
	viii) Make a) Tank b) Radiators c) Conservator ix) a) Radiator fins thickness b) conservator plate thickness	 mm mm	- - - - - -				
3	**Bushings (HV/IV/LV/HVN/IVN)** **As applicable**			**HV**	**IV**	**LV**	**HVN/ LVN**
	i) Termination Type		Outdoor				

	ii)Type of Bushing: OIP/RIP iii) Bushing housing - Porcelain /polymer		-				
	iii)Rated Voltage Class	kV					
	iv) Rated Current iv-a) STC rating for 3 sec	A kA					
	v)Rated 1.2/50 us Impulse Withstand	kVp					
	vi) Rated One minute AC withstand, Dry	kV rms					
	vii)Minimum Creepage Distance	**mm**					
	viii)Make and Model ix)Terminal Pad /(Stud) details x) BCT Requirements	Dia/ **mm**					
4	**Fiber Optic system** ***a. Make :*** ***b. Address of FO system supplier :*** ***c. Nos. of channels :*** ***d. Sensors per channel :*** ***e. Channel switching frequency :*** ***f. Sampling sensor rate :*** ***g. Switching reliability :*** ***h. Wave length operational length :*** ***i. PC output interface :*** ***j. Data display :*** ***k. Self Diagnostic*** ***l. Temp range & resolution :*** ***m. Accuracy :*** ***n. Response time :*** ***o. Front panel display :*** ***p. Probe signal strength readout :*** ***q. Input power :***		-					

	r. ***Serial Output :***			
	s. ***Fiber type :***			
	t. ***Nos. of relays :***			
	u. ***Temperature Data storage :***			
	v. ***LED alarm indicators :***			
	w. ***System fault relay :***			
	x. ***System fault status indicator :***			
	y. ***Surge protection :***			
	z. ***Connectors :***			
	aa. ***Operating temperature range :***			
	bb. ***Storage temperature :***			
	cc. ***Probes material & dimensions :***			
	dd. ***Analog output :***			
	ee. ***SCADA compatibility :***			
	ff. ***Nos. of probes :***			
	gg. ***Tank wall adaptor plate with cover:***			
	hh. ***EMI/RMI susceptibility:***			
	ii. ***Signal conditioner compatibility :***			
	jj. ***Connector for tank wall feed through:***			
4	**Indicative**		-	
	i) Winding temperature thermometer (a) Dial size (b) Sensing (c) Mercury (d) Nos/phase		150 mm Image Free One	
	ii) oil temperature thermometer (a) Dial size (b) Sensing (c) Mercury (d) Nos/phase		150 mm Image Free One	

	iii) oil actuated/gas operated relay (a) Make (b) Size		- -	
	iv) Pressure Relief Device (a) Make (b) Size (c) Operating pressure		- - -	
	v) Sudden Pressure relief Device /RPRRV (a) Make (b) Size (c) Operating pressure		- - -	
	vi) Dehydrating Breathers (a) Make (b) Type (c)Size and Quantity		- -	
	vii) Conservator Bag (air cell) (a) Make (b) Type		- -	
	viii) Oil level Indicators – Main conservator (a) Dial type - make (b) Prismatic Make		- -	
	ix) Oil level Indicators – OLTC conservator (a) Prismatic (b) Make		-	
	x) Oil Sight Window Main Tank Main Conservator xi) OLTC Conservator xii) Tap Changer protective device (a) PRD – make & Size (b) OSR – make & Size xiii) Bushing CTs		- - - - -	
5	**Transformer Oil**			
1	i) Grade as per ii) Spare oil as percentage of first filling		GETCO specification 10%	- -
2	Name of supplier		-	

F. CONTROL CABINET

	Description	Unit	Specified (By buyer)	Offered (by manufacturer)

1	Manufacturer's name and Country		-	
2	Indoor/ outdoor application		Both	
3	Design ambient air temperature (C^0)		50	
4	Thickness of sheet steel for outdoor & indoor panels	(mm)	3 & 2.6	
5	Degree of protection		IP 55 outdoor IP 54 indoor	
6	Colour of finish paint Outside Inside		 631 of IS:5 Glossy white	
7	Maximum Temperature rise at rated current over specified ambient temp of 50^0C	C^0	-	
8	Continuous current rating	Amp	-	
9	Three second short time current rating	kA	-	
10	Control wiring			
a	Material of conductor for various circuits		-	
B	Size of conductor For various circuits	mm^2	2.5 - control 4 - power	
c	Conductor – Solid / Stranded		stranded	
11	Terminal Blocks		-	
	i) Make		-	
	ii) Current rating	Amp	-	
12	Space heater rating	W	-	
13	Thermostate Make Temperature range	 ^OC	 - 0 - 90	

G. TERMINAL CONNECTORS

	Description	Unit	Specified (By buyer)	Offered (by manufacturer)
1	BIDDER's name and address		-	
	Manufacturer's name and address		-	
	Applicable standards		IS:5561	
	Application		outdoor	
	Type		compression	
	For connection to Conductor size and arrangement Equipment terminal size and arrangement		-	
	Material a) Clamp body b) Bolts and nuts c) Spring washers d) Liners if any		-	
	Rated current		-	
	STC rating for 3 sec		-	
	Maximum Temperature rise at rated current over specified ambient temp of 50^0C	C^0	-	
	Rated terminal load	kG	-	
	Factor of Safety		-	
	Minimum thickness of any part	mm	10	

	Weight of connector complete with Hardware	kG	-	

APPENDIX – A (Revised)
SPECIFICATION FOR TRANSFORMER OIL (uninhibited)
(for 132 kV & ABOVE CLASS UP TO 400 kV Transformers and 400 kV Reactors)

Sr. No.	Characteristics of Transformer Oil	Requirement	Method of test
1	Appearance	The oil shall be clear transparent & free from suspended matter of sediments.	Visual. *(A representative sample of the oil shall be examined in a 100 mm thick layer, at ambient temperature.)*
2	Density, gm/Cm^3 - at 29.5 ^{0}C Max. - at 20 ^{0}C	 0.89 0.895	 IS: 1448 P16 ISO 3675 / ISO 12185
3	Kinematic Viscosity, in CST (sqmm/sec) - at 40 ^{0}C, Max - at (-20) ^{0}C, Max	 *12* *1800*	*ISO 3104*
4	Flash point, ^{0}C Min. Penskey-Marten (Closed)	135	*ISO 2719*
5	Interfacial tension at 27 ^{0}C Newton/M, Min.	0.04	*ISO 6295*
6	Pour point, Max	*- 30 ^{0}C*	IS: 1448 P:10 / ISO 3016
7	Neutralization value Total acidity mg KOH/gm, Max	 *0.01*	IEC:62021-1 or 2
8	Corrosive Sulphur (In terms of classification of copper strip+paper)	*Not corrosive*	IEC 62535 (150^{0}C for 72 hrs)
9	Total Sulphur content % w/w	*<0.15*	BS 2000 Part 373 or ISO 14596
10	Electric Strength (Break down voltage) a) New Untreated Oil b) After treatment	 *30* KV Min. (rms) *70* KV Min. (rms)	IEC 60156
11	Dielectric Dissipation Factor (Tan delta) at 90 ^{0}C	0.002 Max.	IEC:60247
12	Oxidation Stability after 164 Hrs. @ 120 ^{0}C, Max a) Total Acidity in mg	 *1.2*	IEC 61125 (method C)

	KOH/gm Max. b) Total sludge % by weight max. c) DDF at 90 ^{0}C	 0.8 0.05	
13	Presence of Anti Oxidation inhibitor (Additive)	Absent	IEC:60666
14	Water content PPM (Max) As Delivered After treatment at site by transformer manufacturer.	*<30 (in bulk);* *< 40 (in drum)* 05	IEC 60814
15	Poly Chlorinated Biphenyls (PCB) Content	Not detectable (< 2 PPM)	IEC 61619
16	Poly Cyclic (PCA) content, Max	3%	BS 2000 part 346
17	2 FAL/ Furans, ppm	< 0.1	IEC 61198
18	Impulse Breakdown voltage test	>145 kVp	ASTM method D 3300

Note:

1) P N A content shall be taken as finger print value by oil supplier and shown in acceptance test report.

2) When pour point (max) has been decided as (-30 ^{o}C), Lowest Cold Start Energizing Temperature shall be (-20 ^{o}C).

APPENDIX – B

1.0 QUALIFICATION REQUIREMENTS FOR ERECTION, TESTING & COMMISSIONING

1.1 The bidder should have carried out erection, testing, commissioning of and test charging of at least two nos. of 220 kV or above class transformers at 220 kV &/or 400 kV switch yard of sub stations satisfactory during last five years before date of submission of the bid.

1.2 The bidder should arrange requisite tools and tackles including adequate capacity hydraulic crane having suitable adjustable boom length for erection of bushing, radiators, conservator, and other associated costly equipments.

1.3 The bidder should have team of trained personnel and skilled labour force and supervising engineers to carry out erection, commissioning, testing and test charging work including laying of control cables and wiring of OLTC gear scheme and inter connection of RTCC panel with D.M., of OLTC., wiring of cooler control scheme and cooling fans including automatic operation of cooler control etc.

2.0 ERECTION OF POWER TRANSFORMER

2.1 Erection includes entire vacuum by proper capacity of vacuum pump, for not less than 48 hours, or more if required as per the instruction of engineer in charge.

2.2 ***Oil may be supplied in tanker/steel drums, which should be properly sealed during transportation and storage. Seal shall be verified and opened by GETCO representative before filling in transformer. Contractor should have enough storage capacity for handling oil.*** Filling the oil from tank/drums to the transformer through 6000 liters capacity of high quality filter machine and filtration of the same to get desired BDV &PPM as specified by engineer in charge and transformer manual.

2.3 Contractor has to replace all the gaskets by new ones if required by engineer –in –charge.

2.4 Erection shall include wiring of cooling fans, RTCC panels, terminations of alarm and trip contacts from buchholz relay, WTI, OTI, PRD to M.K. box and in turn to remote relay panel and RTCC panel in control room. Required cabling on the transformer as well as from transformer to control room shall also be included in scope of work. The testing and commissioning of OLTC as well as cooler control scheme shall be carried out as per instruction of engineer in charge.

2.5 The contractor shall arrange nitrogen cylinder required at site for above work.

2.6 In case of any breakage of any item, contractor has to follow up with insurance for the claims and amount for damage /breakage will be with

held from contractor's bill till the time claim is finalized by insurance company.

2.7 Minimum 15 Nos. of good skilled fitters, with 2 Nos. qualified supervisors and senior engineer having sufficient experience should be posted at site during the above work.

2.8 Contractor has to repaint the transformer tank with two coat of anti rusting good finish LTBS grey shade 632 of IS:5 by spray painting as per the direction of engineer in charge.

2.9 Contractor is required to carry out all minor/major fabrication work of pipes and hangers if required at site as per direction of engineer in charge.

2.10 All tools and tackles, testing equipments listed here under are to be arranged by the contractor.

2.11 Contractor shall arrange required capacity of oil tanker at site.

2.12 Any other items not mentioned above but required for successful completion of erection shall have to be arranged by the contractor.

3.0 TOOLS REQUIRD FOR ERECTION

1. One or two mobile crane hydraulic of adequate capacity with long boom of 30 ft. bearing free vertical lifts suitable for lifting HV bushing.
2. Steel/Manila/Nylon ropes and D shackle for lifting of 3-ton weight.
3. 4000 or 6000 liters. / hr. capacity filter machine in excellent working condition. It must be capable of heating transformer oil up to 80^0 C and must be equipped with built in high vacuum pump and chamber filter elements.
4. Following accessories should also be made available.

a) Non-collapsible hose piping of size 40 mm to 80 mm with nipple and flange.

b) Hosepipe should be of oil resistant 2□□ to 3□□ BSP suitably threaded for connecting hose pipes & provided with holes for fastening.

c) 2 Nos. storage tanks for insulating oil of adequate capacity provided with 2 bottom drain cum filter valve and another 2□□ top valve.

d) Two complete sets of ring and flat spanners of metric size up to 4 to 36.

e) One complete set of Allen keys.

f) One complete set of screw derivers.

g) ¼" shackle 3-ply nylon rope of 15 mtr. Length.

h) 4 nos. of flange each of 1", 2" to 3" BSP suitably threaded for connecting hose pipe & provided with holes for fastening.

i) Multi stage vacuum pumping system capacity 250-500 mm cu/hr. & should be able to create absolute vacuum of 1 tor or 1.3 m bar or less having following accessories.

j) Non return valve at inlet.

k) GI pipe/non-collapsible pipes with flange for connecting vacuum pump to transformer main tank.

l) Vacuum gauge for reading 0 to 50 mm along with flange for fitting at top of transformer of any suitable size 3/16" and 3/8" set in good quality.

m) Oil testing kit in good working condition having 2.5mm and 4 mm gauge for adjusting the gap, 2.5/5 KV megger motor driven and capable of reading up to 50000 M-OHM.

n) Hot air blower for drying out of bushing.

o) Required nitrogen cylinder.

p) Stainless steel bottles for samples.

q) Gas cylinder with nozzle torch for gas cutting etc.

r) Any other item required for successful completion of work.

s) ***Tools required for erection are on returnable basis.***

ANNEXURE - I
AUTOMATIC VOLTAGE REGULATING RELAY

1. Automatic voltage control shall be initiated by a voltage regulating relay of an approved make and suitable for flush and/or wall mounting / DIN-rail ***/ rack*** mounting.
2. The relay shall operate from the nominal reference voltage derived form a circuit mounted 1 phase / 3 phase Voltage transformer (VT).
3. The AVR relay shall be Microprocessor based Numerical relay having large LCD display 128x128 ***or higher.***
4. The relay shall have 4 selectable set point voltages.
5. The AVR relay shall have the following methods as option for the compensation of voltage.

    - Apparent Current (Z-Comp.)
    - Line drop compensation (LDC)
    - Active Current
    - Reactive current

6. The relay bandwidth shall be adjustable ~~between –5 to +15~~ of set point voltage ***to suit per step voltage of 1.25%.***
7. The relay shall have following options regarding time behavior with Time factor selectable from 0.1 to 30.

    - Linear
    - Integral
    - Fast integral

8. The relay shall incorporate an under voltage / over voltage blocking facility which shall make the control inoperative if voltage falls / rises by percentage value of set point value (as mentioned in Guaranteed technical particulars) with automatic restoration of control when nominal voltage rises / falls to value as mentioned in the Guaranteed technical particulars.
9. The AVR relay shall have integrated features for the display of following parameters

    - Integrated tap changer position display
    - Nominal Voltage
    - Load current
    - Bandwidth
    - Measuring values V. I. Active power, Reactive power, Apparent power, phase angle, Power factor, Reactive current and frequency

10. The AVR relay shall have facility to compensate the VT and CT-errors.
11. The AVR relay shall have facility to register the tap changer statistics. In the statistics mode, the relay shall display the no. of tap changing operations occurred on each tap.
12. The AVR relay shall have facility to recode the voltage and current with respect to time. Each of voltage value shall be measured for 100ms and averaged for 1 second. The recorded values shall be presented in graphical format on the device.
13. The AVR relay shall have integrated feature to make the parallel operation of 10 transformers working in parallel. The relay shall be self sufficient and shall not require any additional devices like parallel balancing module etc. ***At least*** following principal shall be available in the relay as standard.
    - Master Follower / Master Slave
    - Circulating current

14. The AVR relay shall have facility to monitor or control the following parameters

- Monitoring of life time consumption of transformer
- Monitoring of operating hours of Tap changer, Fans and Pump
- Control of cooling levels of transformer
- Recording of Hot spot temperature

15. The AVR relay shall have facility to record specific events (Event-Recorder) like under voltage, over voltage, over current, Auto/Manual, local/remote etc. with date and time stamping.
16. The AVR relay shall have facility to make selection of Auto/Manual and Local/Remote.
17. The AVR relay shall have different LEDs to indicate Service and Blocked condition.
18. It is preferred that 12 nos of freely programmable LEDs ***duly tagged or stickered*** shall be available to indicate different Operations / Alarm / Faults condition. ***If stickers are provided, then 5 sets of such stickers shall be supplied free of cost for future replacement.***
19. The AVR relay shall have freely programmable Binary Inputs, Binary outputs, Analog Inputs and Analog Outputs.
20. The AVR relay shall have software to make the parameter settings of the device and it shall also be possible to do the parameter setting through keyboard of relay.
21. The AVR relay shall have suitable interface to make communication with higher level SCADA system. The following minimum ports shall be available on the device.

    a. RS 232 port (COM 1) for doing the parameter setting and local communication with device.
    b. RS 485, Fiber optic ports for communication with higher level SCADA with protocols like MODBUS & IEC 61850.

22. It shall be possible to communicate via bus with all similar devices located at different location by making communication link with any one device through its RS 485 - port ***or Fiber Optic port meant for SCADA*** communication.
23. It shall have facility by which a customer specific software programme can be written and incorporated as feature in the relay.

ANNEXURE C

List of documents attached with technical bid:

Bidder shall invariably attach the following documents and clearly marked and duly flagged in technical bid. In absence of these documents offer will be evaluated as a non submission.

Sr. No.	Particulars of document	Whether attached with tech bid
1	Drawings in AutoCAD format	
2	Drawings hard copies as indicated in specification	
3	Manual in PDF format	
4	QAP for manufacturing process in SOFT format	
5	QAP for manufacturing process in Hard format	
6	FQP in SOFT format	
7	FQP in Hard copy	
8	Type test Reports in hard copies	
a	for transformer	
b	for OLTC	
c	for control cabinet	
d	for clamps & connectors	
e	for Air cell	
9	Confirmation regarding type tests as per clause no. Cl. 1.30.3.1(b) page no. 32 – "IMPORTANT NOTE"	
10	Calculation of Thermal stability to withstand short circuits	
11	Calculation of Dynamic ability to withstand short circuits	
12	Cooling calculation	
13	Guaranteed Technical Particulars, completely filled in	
a	for transformer	
b	for OLTC	
c	for control cabinet	
d	for clamps & connectors	
e	for Air cell	
14	Any other essential documents	

SIGNATURE OF BIDDER **COMPANY'S ROUND SEAL**

DATE:
PLACE:

ANNEXURE – II

SECTION: I

DETAIL SPECIFICATION OF FLEXIBLE SEPARATOR (AIR CELL)

GENERAL TECHNICAL REQUIREMENTS

1.1 SCOPE:

1.1.1 This section covers the design, manufacture, assembly, testing at manufacturer's works, supply and delivery of the Flexible Separator (Air cell) as detailed in the Schedule – A of the commercial bid, complete with all accessories required for satisfactory and trouble free operation of the equipment.

1.1.2 When it is an item purchase or supply with transformer, the scope of work shall be design, manufacture, assembly, testing at manufacturer's works, supply and delivery of Flexible Separator (Air cell) & it's all required accessories.

OR

when it is job work of providing and fixing, then the scope of work shall be design, manufacture, assembly, testing at manufacturer's works, supply, delivery, including all required fabrication, fittings, valves, gauges, pipes etc., and complete erection, testing and successful commissioning for a given transformer conservator indicated in Schedule – A of the commercial bid.

1.1.3 GUARANTEE:

The bidder shall among other things guarantee the following:

i) Quality and strength of materials used.

ii) The bidder shall give the guarantee as satisfactory working of the complete transformer for 36 months from the date of commissioning of Flexible Separator (Air cell) or 42 months from the date of receipt of at site, whichever is earlier.

It may be noted that the service guarantee would be applicable even when the Flexible Separator (Air cell) is erected and operated through any other agency appointed by the GETCO.

2.0 CONSTRUCTION:

The construction of Flexible Separator (Air cell) shall be of Polymide/nylon fabric coated on both side with synthetic rubber and meeting the complete requirement of this specification.

Adhesives used shall be compatible with air and transformer oil at 100°C. All the joints shall be properly designed & suitably vulcanized. Further, Flexible Separator (Air cell) shall be reinforced at bottom face to avoid damage due to contact with magnetic oil gauge float. There shall not be any patch work in Flexible Separator (Air cell). Adaptor used shall be made from structural steel confirming to Fe-410-S to IS:226. Adaptor and bolts shall be cadmium plated and passivated (CD-8 of IS:1572) or Zinc plated and passivated.(Fe Zn 12.5 of IS:1573). The width of the overlap at the joints shall be such that there is no possibility of joint opening and leakage. Minimum width shall be 75 mm.

3.0 FUNCTIONAL REQUIREMENTS:

i) The function of Flexible Separator (Air cell) is to line the inside of the conservator tank in transformer, allowing for changes in volume, while protecting the oil from any type of contamination or external corrosive agents like ozone, nitrogen, humidity etc.
ii) Flexible Separator (Air cell) shall be suitable for continuous use in transformer oil at -20°C to 100° C.
iii) Inside coating shall be very good enough to resist weather and ozone. Outside coating shall be transformer oil resistant. Compounds used for coating shall not deteriorate during service.
iv) Flexible Separator (Air cell) shall be suitable for inflation and deflation due to change in oil volume in the conservator. Further, Flexible Separator (Air cell) shall be designed to collapse slowly as oil level rises in the conservator.
v) Flexible Separator (Air cell) shall not develop cracks even at -20°C.
vi) Fixation lugs and adaptor shall be provided on the Flexible Separator (Air cell).
vii) Flexible Separator (Air cell) shall have excellent impermeability to oil, gases and water vapor.
viii) Flexible Separator (Air cell) shall have high mechanical resistance.
ix) Flanges provided shall meet any of our requirements indicated.

4.0 GENERAL:

The Flexible Separator (Air cell) shall be suitable for conservator of diameter, length & shape indicated in schedule – B, attached separately, with the tender. The suitability & size of Flexible Separator (Air cell) to be provided shall be supported by necessary calculation for given size and shape of conservator.

The Flexible Separator (Air cell) conform to relevant IS or international standards shall be indicated in the bid. The type tests and routine/acceptance tests shall be carried out accordingly and report shall be submitted with the bid.

The work of providing and fixing shall be carried out as per availability of shut down of particular transformer at site. Necessary tools tackles, accessories, manpower, etc required shall be managed by contractor.

The guaranteed technical particulars as listed in Section II, but not limited to shall be invariably submitted with the technical bid.

GUARANTEED TECHNICAL PERTICULARS
Flexible Separator (Air cell)

Sr. No.	Particulars		
1	Item description		:
2	Name of manufacturer		:
3	Type & designation		:
4	Shape		:
5	Size of conservator	Diameter	:
		Length	:
6	Size of Flexible Separator (Air cell)		:
	a. Length (mm)	Fully inflated	:
	b. Length (mm)	Fully deflated:	
	c. Width (mm)	Fully inflated:	
	d. Width (mm)	Fully deflated	
	e. Distance between axes i.e. pitch distance of lugs (mm)		:
	f. Expansion volume (litre)		:
	g. Occupation rate (%)		
7	Material of Flexible Separator (Air cell)		:
	a. Basic fabric		:
	b. Coating compound		:
	c. Oil side coating		:
8	Inside coating Material		:
9	Outside coating Material		:
10	Thickness		:
11	Resistance to perforation		:
12	Warp breaking strength		:
13	Weft breaking strength		:
14	Warp elongation breaking		:
15	Weft elongation breaking		:
16	Seam resistance		:
17	Perforation		:
18	Permeability to Oxygen		:

19	Permeability to water vapor	:
20	Resistance to Ozone gas for 96 hrs at 40^{o}C:	
21	Attachment details	:
22	Flange details	:
23	Lugs	:
24	vulcanizing process	:
25	Reinforcement at bottom	:
26	Suitable for maximum temperature	:
27	Minimum width of over lap (mm)	:
28	Material of adaptor and bolts	:
29	Guarantee period	:
30	Accessories and fittings (Give list with details)	:
31	Any other information	:

ANNEXURE – III

GUJARAT ENERGY TRANSMISSION CORPORATION LTD.

SARDAR PATEL VIDYUT BHAVAN,
RACE COURSE, BARODA – 390 007.

TECHNICAL SPECIFICATION

FOR

THE WORK OF DESIGN, SUPPLY, ERECTION AND COMMISSIONING INCLUDING CIVIL WORK OF NITROGEN INJECTION SYSTEM FOR PROTECTION AGAINST THE FIRE & EXPLOSION FOR TRANSFORMER.

TECHNICAL SPECIFICATION NO.
GETCO/E/TS-FF/2903/R3 June'2020

SPECIAL INSTRUCTIONS TO BIDDER

Please read following instructions carefully before submitting your bid.

1. All the drawings, i.e. elevation, side view, plan, cross sectional view etc., in AutoCAD format and manuals in PDF format, for offered item shall be submitted. Also the hard copies as per specification shall be submitted.

2. The bidder shall submit Quality Assurance Plan for manufacturing process and Field Quality Plan with the technical bid.

3. The bidder shall have to submit all the required type test reports for the offered item. However, in the event of partial submission or reports older than specified limit, bidder must submit his confirmation for those type test report/s to be submitted in the event of an order, without affecting delivery schedule, before commencement of supply, free of cost. In absence of this confirmation, the evaluation shall be carried out accordingly as non-submission of type test reports.

4. The bidder must fill up all the point of GTP for offered item/s. Instead of indicating "refer drawing, or as per IS/IEC", the exact value/s must be filled in.

5. All the points other than GTP, which are asked to confirm in technical specifications must be submitted separately with the bid.

6. The bidder is required to impart training in view of manufacture, assembly, erection, operation and maintenance for offered item, at his works, to the person/s identified by GETCO, in the event of an order, free of cost. The cost of logistics will be bear by GETCO.

7. Please note that the evaluation will be carried out on the strength of content of bid only. No further correspondence will be made.

8. The bidder shall bring out all the technical deviation/s only at the specified annexure.
9. The bidder should indicate manufacturing capacity by submitting latest updated certificate of a Chartered Engineer (CE).

TECHNICAL SPECIFICATIONS

1) **Scope of work:**

I) Turnkey contract for the work of design, supply, erection and commissioning of Nitrogen Injection system for protection against the transformer explosion up to 400 KV Transformers and Shunt Reactors as indicated in Schedule – A ***including all required civil works of oil sump, foundations, any other required for satisfactory working of system.***

II) **NIFPS supplier shall be Original Manufacturer (OEM) of system. The offered system has to be designed, manufactured and tested as per relevant IS/IEC/ANSI standard with latest amendments.**

III) Each oil filled transformer / reactor shall be provided with a dedicated Nitrogen Injection system for prevention against the transformer explosion, which shall use nitrogen as quenching medium. The system shall prevent transformer / Reactor oil tank explosion and possible fire in case of internal / external cause. In the event of fire by external causes such as bushing fire. OLTC fires, fire from surrounding equipment etc., it shall act as a fast and effective fire fighter. It shall accomplish its role as fire preventer and extinguisher without employing water or carbon dioxide. Fire shall be extinguished within reasonable with time (not more than 3 minutes so as not to harm the transformer) of system activation and within 30 seconds (maximum) of commencement of nitrogen injection.

IV) The system shall have been in successful operation / commissioned in Indian / Abroad installations for at least last five years for protection of transformers of 220 KV and higher voltage class. The list of past supplies in India / Abroad along with performance certificate from users of the system shall be submitted for approval of purchaser.

2) **Activation of the system**

I) Mal-functioning of the Nitrogen injection system could lead to interruption in power supply. The supplier shall ensure that the probabilities of chances of malfunctioning of the Nitrogen injection system are practically zero. To achieve this objective, the supplier shall plan out scheme of activating signals which should not be too complicated to make the system inoperative in case of actual need.

II) The system shall be provided with automatic controls to prevent the explosion of transformers. Besides automatic control, remote electrical push button control at Control box and local manual control in the cubicle shall also be provided. The following electrical-signals shall be used for activating the system under prevention mode/fire extinguishing mode.

a) **Auto Mode**

- **For prevention:**
  - *Arc sensor input (if any)*
  - Differential relay operation.
  - Buchholz relay paralleled with pressure relief valve or RPRR (Rapid Pressure Rise Relay)
  - Tripping of all circuit breakers (on HV & LV/IV side) associated transformer / reactor is the pre-requisite for activation of system.
- **For extinguishing**
  - Fire Detector *(quartz bulb / Linear Heat Detector)*
  - Buchholz relay paralleled with pressure relief valve or RPRR (Rapid Pressure Rise Relay).
- Tripping of all circuit breakers (on HV & LV/IV side) associated with transformer / reactor is the pre-requisite for activation of system.

b) **Manual Mode (Local / Remote)**

- Tripping of all circuit breakers (on HV & LV / IV side) associated with transformer / reactor is the pre-requisite for activation of system.

c) **Manual Mode (Mechanical)**

- Tripping of all circuit breakers (on HV & LV / IV side) associated with transformer / reactor is the pre-requisite for activation of system.
- The system shall be designed to be operated manually in case of failure of power supply to the system.

3) **General description**

I) Nitrogen Injection system should be a dedicated system for each oil filled transformer / reactor.

II) It should have a Fire Extinguishing Cubicle (FEC) placed on a plinth at a distance of 5-10 m away from transformer / reactor or placed next to the firewall (if fire fighting wall exists).

III) The FEC shall be connected to the top of transformer / reactor oil tank for depressurization of tank and to the oil pit **(Steel Tank)** (capacity is approximately equal to 10% of total volume of oil in transformer / reactor tank / oil to be drained or existing oil pit) from its bottom through oil pipes.

IV) The FEC should house a pressurized nitrogen cylinder (s) which is connected to the oil tank of transformer /reactor oil tank at bottom. The Transformer Conservator Isolation Valve (TCIV) is fitted between the conservator tank and Buchholz relay.

V) Cable connections are to be provided from signal box to the control box in the control room, from control box to FEC and from TCIV to signal box. Detectors placed on the top of transformer / reactor tank are to be connected in parallel to the signal box by Fire survival cables.

VI) Control box is also to be connected to relay panel in control room for receiving system activation signals.

VII) System shall have facility for inspection of oil leakages from oil drain valves when system is in service.

VIII) It shall be ensured that Nitrogen gas shall not enter the energized transformer/ reactor tank through valve even in case of leakage.

IX) Steel Tank shall be grouted & to be earthed with existing substation earth pit.

4) **<u>Operation</u>**

I) On receipt of all activating signals, the system shall drain - pre-determined volume of hot oil from the top of tank (i.e. top oil layer), through outlet valve, to reduce tank pressure by removing top oil and simultaneously injecting

nitrogen gas at high pressure for stirring the oil at pre-fixed rate and thus bringing the temperature of top oil layer down.

II) Transformer conservator isolation valve blocks the flow of oil from conservator tank in case of tank rupture / explosion or bushing bursting.

III) Nitrogen occupies the space created by oil drained out and acts as an insulating layer over oil in the tank and thus preventing aggravation of fire.

5) **System components**

I) Nitrogen Injection system shall broadly consist of the following components. However, all other components which are necessary for fast reliable and effective working of the system shall deemed to be included in the scope of supply.

a) **CUBICLE (FEC)**

- The Cubicle Frame shall be made of CRCA sheet of 3 mm (minimum) thick complete with the base frame, painted inside and outside with post office red colour (shade 538 of IS -5).
- It shall have hugged / hinged split doors fitted with high quality tamper proof lock. The doors, removable covers and panels shall be gasketted all round with neoprene gaskets.
- The degree of protection shall be IP55. The following items shall be provided in the Cubicle.
- Nitrogen gas cylinder with regulator and falling pressure electrical contact manometer.
- Oil drain pipe with mechanical quick drain valve.
- Electro mechanical control equipment for draining of oil of pre-determined volume and injecting regulated volume of nitrogen gas.
- Pressure monitoring switch for back-up protection for nitrogen release.
- Limit switches for monitoring of the system.

- *Solenoid /* Butterfly valve with flanges on the top of panel for connecting oil drain pipe and nitrogen injection pipes for transformer / reactors.
- Panel lighting (CFL Type)
- Oil drain pipe extension of suitable sizes for connecting pipes to oil pit.
- Space heater.

b) **Control box**

- Control box is to be placed in the control room for monitoring system operation, automatic control and remote operation. The following alarms, indications, switches, push buttons, audio signal etc. shall be provided.
  - ♦ System *ON.*
  - ♦ TCIV open.
  - ♦ Oil drain valve closed.
  - ♦ Gas inlet valve closed
  - ♦ TCIV closed
  - ♦ Detector trip
  - ♦ Buchholz relay trip
  - ♦ Oil drain valve open
  - ♦ Extinction in progress
  - ♦ Cylinder pressure low
  - ♦ Differential relay trip
  - ♦ PRV / RPRR trip
  - ♦ Transformer / reactor trip

- ♦ System out of service
- ♦ Fault in cable connecting fault detector
- ♦ Fault in cable connecting differential relay
- ♦ Fault in cable connecting Buchholz relay
- ♦ Fault in cable connecting PRV / RPRR
- ♦ Fault in cable connecting transformer reactor trip
- ♦ Fault in cable connecting TCIV
- ♦ Auto / Manual / Off
- ♦ Extinction release on / off
- ♦ Lamp test
- ♦ Visual / Audio alarm for AC supply fail
- ♦ Visual / Audio alarm for DC supply fail

- As far as possible the control box should be such devised that all the transformers and reactors or group thereof should be controlled from single spot.
- Potential free contacts shall be available for alarm troubles for input to SCADA system.
- Also, separate hooter & emergency trip provision shall be provided in control room over & above provided in control box (as control box is to be provided in respective yard kiosk).
- Control Box shall have DC Source-1 & DC Source-2 auto changeover facility. Potential free contact shall be provided to monitor DC Source healthiness in SCADA.

c) **<u>Transformer Conservator Isolation Valve.</u>**

- Transformer conservator isolation valve (TCIV) to be fitted in the conservator pipe line, between conservator and buchholz relay which

shall operate for isolating the conservator during abnormal flow of oil due to rupture / explosion of tank or bursting of bushing.

- The valve shall not isolate conservator during normal flow of oil during filtration or filling or refilling, locking plates to be provided with handle for pad locking. It shall have proximity switch for remote alarm, indication with visual position indicator.

- The TCIV should be of the best quality as malfunctioning of TCIV could lead to serious consequence. The closing of TCIV means stoppage of breathing of transformer / reactor.

- Locking plates shall be provided for pad locking.

d) **Detectors**

- The system shall be complete with adequate number of detectors (quartz bulb) *OR Linear Heat Detector cables with Arc sensors* fitted on the top cover of the transformer / reactor oil tank.

e) **Signal box**

- It shall be mounted away from transformer / reactor main tank, preferably near the transformer marshalling box, for terminating cable connections from TCIV & detectors and for further connection to be control box.

- The degree of protection shall be IP55.

f) **Cables**

- Fire survival cables (capable to withstand 750º C.) of 4 core x 1.5 sq. mm size for connection of detectors in parallel shall be used. The fire survival cable shall conform to BS 7629-1, BS 8434-1, BS 7629-1 and BS 5839-1, BS EN 50267-2-1 or relevant Indian standards.

- Fire Retardant Low Smoke (FRLS) armoured cable of adequate size shall be used for connection of signal box / marshalling box near transformer / reactor and FEC mounted near transformer/ reactor with control box mounted in control room.

- Fire Retardant Low Smoke (FRLS) armoured cable of 4 core x 2.5 sq. mm size shall be used for connection between control box to DC & AC supply source, FEC to AC supply source, signal box / marshalling box to transformer conservator isolation valve connection on transformer / reactor. Separate cables for AC supply & DC supply shall be used.

g) **Pipes**

- Pipes complete with connections, flanges, bends and tees etc. shall be supplied along with the system.

h) **Other items to be supplied.**

- Oil drain and nitrogen injection openings with gate valves on transformer / reactor tank at suitable locations.
- Flanges between Buchholz relay and conservator tank for fixing TCIV.
- Detector brackets *or Linear Heat Detector cable with Arc sensors mounting arrangement* on transformer / reactor tank top cover.
- Spare potential free contacts activating the system i.e. in differential relay, Buchholz relay. Pressure Relief Device / RPRR, Circuit breaker of transformer / reactor.
- Pipe connections between transformer / reactor and FEC and between FEC and oil pit required for collecting top oil.
- Cabling for detectors mounted on transformer / reactor top cover.
- Inter cabling between signal box, control box and FEC.
- *Solenoid /* Butterfly valves / Gate valves on oil drain pipe and nitrogen injection pipe which should be able to withstand full vacuum.
- Supports, signal box etc. which are to be painted with enameled paint.
- Any other item required for satisfactory operation of system.

II) **Power supply**

a) For Control Box 220 V / 110 V DC

b) For FEC Auxiliary 230 V AC

6) **Spares for three (3) years Operation & Maintenance**

I) The bidder apart from the below mentioned spares shall submit a list of recommendation spares for three years trouble free operation of the equipments and also furnish unit rates. The owners will scrutinize the said list and decide on the items on spares to be ordered and the quantities. These spares shall be supplied by the contractor before end of guarantee period. The owner reserves right to order the spares with twelve (12) months from the date of order for main equipments and the rate shall be kept valid till this date. The prices of these spares shall not be considered for evaluation of the bid.

II) **Mandatory Spares**

a) Cylinder filled with Nitrogen of required capacity per system 1 No.

b) Detectors */ Arc sensors* per transformer
3 No.

c) Regulator assembly per sub-station
1 No.

d) Linear Heat Sensing cable of required length (if any)

7) **Modification on the transformer**

I) No modification on the transformer shall be allowed which affects its performance (i.e. efficiency, losses, heat dissipation ability etc.) Safety, life etc. or it's any other useful parameter. This requirement shall be paramount importance and shall form the essence of the contract.

II) However, in any case, performance of transformer should not be affected in any manner by having Nitrogen Injection Fire Prevention Cum Extinguishing System (NIFPES) and the Contractor / Sub-Contractor shall give an undertaking to this effect.

III) All pipes should be washed / rinsed with transformer oil. If any damage is done to the transformer and / or any connected equipment during installation & commissioning full recovery therefore shall be effected from the Contractor / Sub-Contractor, of NIFPES system.

IV) It shall be solely the responsibility of Contractor / Sub-Contractor to install, carry out pre-commissioning tests & commission NIFPES at the mentioned Sub-Station in this specification, to the entire satisfaction of the GETCO.

8) **Interlocks**: It shall be ensured that once the NIFPES gets activated manually or in auto mode, all the connected breakers shall not close until the system is actually put in OFF mode. Also PRV shall get closed only if all the connected breakers are open.

9) **Tests**

I) Contractor has to **submit valid** type test **reports** as per relevant IS/IEC, i**ncluding** IP 55 on FEC, Control box, Signal Box i.e. all enclosure utilized in system., from NABL approved Laboratory **or any other reputed authority nationally or internationally not older than 5 years & must be valid as on the last date of submission of bid.**

II) Acceptance Test

a) The Supplier Shall demonstrate the entire functional tests as mentioned**==** in specification associated with:

- FEC
- Control Box
- Fire Detector
- Transformer Conservator Isolation Valve

b) The Auxiliary wiring including terminal block excluding electronic circuit if any shall be tested for High Voltage Test i.e. 2 KV (RMS) at 50 Hz for One Minute between all live parts connected together and the body.

c) The steel tank shall be tested for leak test at pressure of 35 KN/M^2 for 12 Hrs with transformer oil.

III) The performance test of the complete system shall be carried out after erection of the system with transformer at site.

10) Detailed layout drawings, equipment drawing along with 4 sets of Operation and Maintenance manual along with soft copies (In pen drives) shall be submitted by the supplier along with the consignment.

11) The guaranteed and other technical particulars for the offered system are indicated in **Section - "Guaranteed and Other Technical Particulars".** Any other particulars considered necessary in addition to those listed in that Section may be furnished by the Bidder.

GUARANTEED TECHNICAL PARTICULARS

NITROGEN INJECSTION SYSTEM FOR PREVENTION OF FIRE/ EXPLOSION FOR TRANSFORMERS/REACTORS.

Sr. No.	Description	Guaranteed Particulars
1	Name of Manufacture and country of origin	
2	Reference standards	
3	Details of system equipments	
4	**FEC (Fire Extinguishing Cubicle)**	
4.1	Dimensions (LXBXH) mm	
4.2	Weight	
4.3	Capacity of Nitrogen cylinder	
4.4	Number of cylinders	
4.5	Pressure of Nitrogen filing	
4.6	Minimum distance of FE cubicle from the transformer	
4.7	Method of mounting	
4.8	Whether the following items are provided in FE cubicle. If so furnish make, type & other details	
4.9	Contact Manometer	
4.10	Pressure Regulator	
4.11	Oil Release Unit	
4.12	Gas release unit	
4.13	Oil drain assembly	
4.14	Pressure / limit switches	
4.15	No. of contacts & spare contacts (NO & NC)	
4.16	Oil drain Valve (ABOVE FEC)	
4.17	Make	
4.18	Type	
4.19	Size	
4.20	Type of metal	
4.21	Nitrogen Injection Valve (Above FEC)	
4.22	Make	
4.23	Type	
4.24	Size	

4.25	Oil drain pipe	
4.26	Size	
4.27	Length	
4.28	Number of openings in the transformer tank	
4.29	Material	
5	**Control Box**	
5.1	Dimensions (LXBXH) mm	
5.2	mm	
5.3	Type & Thickness of sheet steel	
5.4	Details of components provided in the control box	
5.5	Control voltage	
5.6	Method of mounting	
5.7	Whether audio and visual alarm provided?	
6.	**Transformer Conservator Isolation Valve**	
6.1	Make	
6.2	Type	
6.3	Location	
6.4	Whether suitable for pipe of size 80 mm dia	
6.5	No. of contacts & spare contacts (NO & NC)	
6.6	Padlocking provision	
7	**Detectors**	
7.1	Make	
7.2	Type	
7.3	Quantity required	
7.4	Method of fixing	
7.5	Effective heat sensing area	
7.6	Temperature recommended for effective heat sensing	
7.7	Number of contacts NO / NC	
7.8	Necessity and condition of Refilling	
8	Whether approved by Tariff Advisory Committee of India	
9	**TECHNICAL PARTICULARS FOR NITROGEN INJECTION SYSTEM FOR PREVENTION OF TRANSFORMER EXPLOSION**	
10	**Power Supply**	

10.1	Control box	
10.2	FEC (lighting)	
10.3	Extinction period	
10.4	On system activation	
10.5	On commencement of Nitrogen injection	
11	FEC Suitable for capacity	
11.1	Dimensions (LXBXH) mm	
11.2	Weight	
11.3	Nitrogen cylinder capacity	
12	**Control Box**	
12.1	Dimensions (LXBXH) mm	
12.2	Weight	
13	**Detectors**	
13.1	Heat sensing temperature	
14.0	Time of Operation	

		Transformer Tank Explosion Prevention	Fire Extinction
a	For system activation		
b	For reduction of pressure in tank by Nitrogen release.		

15	Any other technical details not covered above	