SPECIFICATION NO. RDSO/2008/EL/SPEC/0072 (Rev. '0') dt. 30.07.2008

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GOVERNMENT OF INDIA

MINISTRY OF RAILWAYS

TECHNICAL SPECIFICATION

FOR

6670 KVA TRANSFORMER with HOTEL LOAD

FOR WAP4, 25 KV AC LOCOMOTIVE

SPECIFICATION NO. RDSO/2008/EL/SPEC/0072 (Rev. '0')

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ISSUED BY

RESEARCH DESIGNS AND STANDARDS ORGANISATION

MANAK NAGAR, LUCKNOW-226 011

Index

Specification for 5400 KVA Transformer with 1000 KVA Hotel Load for WAP4 Locomotive

1.0 Background

IR have been using 5400 kVA Traction Transformer for WAP4/WAG7 electric locomotives over the past several years for hauling prestigious passenger/freight trains. In the present system, WAP4 locos hauling passenger trains utilize the traction power solely for the hauling purposes whereas the power requirement for the coaches of the train are met either through Self Generating (SG) System with alternators/battery in individual coaches or the End-on-Generator (EOG) System with the help of power cars at either end of the train as in the case of Rajdhani/ Shatabdi Express trains. With the advancement of technology and with the objective of modernizing its coaching trains requirement in line with the trend world over, Indian Railways have planned to switchover to Head on Generation (HOG) System of passenger train operation where the power and air conditioning requirements of different types of coaches in passenger trains is to be met from the power of the locomotive hauling the train. This has necessitated the development of a traction transformer with capacity suitable for traction as well as power for the coaches henceforth termed as "hotel load" requirements.

2.0 Scope

The scope of this specification is to design, develop, manufacture and supply traction transformer with hotel load power of 1000 kVA in addition to its present capacity of (5400 + 270) kVA transformer used on WAP4 locomotives within the same dimensional envelops of the existing transformer in view of the limitations of space. The new transformer shall be designed using the modern insulation scheme/materials and core design techniques to ensure the availability of desired power in the specified space.

3.0 Climate & Environment Conditions

➢ Atmospheric temperature	Metallic surface temperature under Sun: 75^{o} C max. and in shade: 55^{o} C max. Minimum temperature: - 10 ℃ (Also snow fall in certain areas during winter season)
➢ Humidity	100% saturation during rainy season.
➢ Reference site conditions	i) Ambient Temp.: 50^{o} C ii) Humidity: 100% iii) Altitude: 1776 m above mean sea level.
➢ Rain fall	Very heavy in certain areas. The locomotive shall be designed to permit its running at 10 kmph in flood water

	level of 102 mm above rail level.
➢ Atmosphere during hot weather	Extremely dusty and desert terrain in certain areas. The dust concentration in air may reach a high value of 1.6 mg/m^3. In many iron ore and coalmine areas, the dust concentration is very high affecting the filter and air ventilation system.
➢ Coastal area	Locomotive and equipment shall be designed to work in coastal areas in humid and salt laden atmosphere with maximum pH value of 8.5, sulphate of 7 mg per litre, max. concentration of chlorine 6 mg per liters and maximum conductivity of 130 micro siemens /cm
➢ Vibration	The equipment sub-system and their mounting arrangement will be designed to withstand vibrations and shocks encountered in service as per IEC : 61373 unless otherwise prescribed.
➢ Electromagnetic Pollution	High degree of electromagnetic pollution is anticipated in locomotive machine room, where the equipment will be mounted. Necessary precaution should be taken in this regard.
➢ Wind speed	High wind speed in certain areas, with wind pressure reaching 150 kg/m^2

4.0 Standards

The following specifications shall generally be followed for manufacture and testing of the transformer:-

- IEC-60310 - Rules for traction transformers and reactors
- IEC-60076 - Recommendations for power transformers
- IEC-60077 - Rules for Electrical Traction Devices
- IEC-61373 - Vibration & shock
- IEC-60038 - Standard voltages
- IEC-60296 - Transformer Oil
  IS- 12463

5.0 TECHNICAL DATA

(i) Rated Primary Current:

-	Nominal	-	25 KV
-	Maximum	-	27.5 KV
-	Minimum	-	19 KV
-	Short Time-		
	Minimum	-	17.5 KV
	Maximum	-	30 KV for short duration

(ii) Minimum Primary voltage for guaranteed traction - 22.5 KV

(iii) Minimum voltage for functioning of auxiliaries - 17.5 KV

(iv) Frequency - 50 Hz ± 3%

(v) No. of traction winding - Two

(vi) System of connection of traction windings - One winding for each rectifier bridges.

(vii)

(a) Traction Winding rating - Rated no load voltage of each traction winding at 32nd tap and 22.5 KV shall be 1000 Vrms (approx. to suit rated traction motor voltage of 750 V on full load).

(b) Rated continuous current of each Traction winding at 22.5 KV Corresponding to traction motor Current of 3 x 900 Amps (DC) - 2700 A(approx.)

(c) Apparent continuous power Of each winding - $\frac{2700 \times 1000}{1000}$

= 2700 KVA

(d) Total continuous apparent traction power at 22.5 KV - 2 x 2700 KVA

= 5400 KVA

(e) Percentage Impedance - 10% ± variation as per IEC: 60310

(f) The No load voltages at different taps from 0 to 32 notch corresponding to 22.5KV shall be as under:

Tap Position	Secondary voltage at traction Winding at no load corresponding to 22.5 KV
0	0
1	31
2	62
3	94

4	125
5	146
6	166
7	187
8	208
9	239
10	271
11	302
12	333
13	364
14	397
15	428
16	459
17	490
18	521
19	552
20	584
21	615
22	645
23	687
24	728
25	771
26	813
27	844
28	875
29	906
30	938
31	969
32	1000

(viii) Emergency Operation - In the event of failure of cooling system i.e. oil circulating pumps and radiator blower with the transformer shall be able to deliver 50% of traction current for ½ hr after having worked at 90% of the full load before failure.

(ix) Percentage overload Rating after running continuously at 90% full load - 60% for two minutes followed by 50% for 10 minutes

(x) Special duty

After continuous working at 90% full load, 1.7 times the rated current of traction motors(900A) for 15 seconds repeated four times at 5 minutes

interval to match with the requirement of traction motor as per clause 37.2 of IEC 60349.

(xi) Auxiliary Winding

a)	No. of windings	-	One
b)	Rated voltage at 22.5 KV	-	830 V
c)	Continuous rated apparent power of aux. windings.	-	270 KVA
d)	% age Impedance	-	3 to 5 %
e)	Type of Loads	-	Single phase to three phase static converter and single phase loads like battery charger, head light, heaters etc.

(xii) Hotel Load Winding

a)	No. of windings	-	One
b)	Rated voltage at 22.5 KV	-	750 V
c)	Continuous rated apparent power of windings.	-	1000 KVA
d)	% age Impedance	-	3 to 5 %
e)	Type of Loads	-	Single phase to three phase static converter.

(xiii) Alternatively in place of (xi) & (xii) above and as described at clause 6.2, the KVA rating of auxiliary winding as well as hotel load winding may be merged as single winding termed as Tertiary winding as per details given below:

a)	No. of windings	-	One
b)	Rated voltage at 22.5 KV	-	750 V

	c)	Continuous rated apparent power of windings.	-	1270 KVA
	d)	% age Impedance	-	3 to 5 %
	e)	Type of Loads	-	Single phase to three phase arno convertor, Single phase to three phase static converter.
(xiv)	Rated primary power of The transformer		- =	(5400 + 270 + 1000) KVA 6670 KVA
(xv)	Cooling		-	Oil forced air forced
(xvi)	Temperature rise limits		-	For class 'H' insulation for copper conductor and mineral insulating oil as cooling medium (IEC 60310-20 ºC) Winding - 55 ºC Mineral oil - 45 ºC
(xvii)	Insulation		-	Class 'H' with mineral insulating oil alternatively any superior insulation scheme may be adopted. However for the same, firm should indicate it's service experience, advantages, size, weight and cost implication etc
(xviii)	Core		-	Latest core design with minimum core loss
(xix)	Cooling medium		-	Inhibited Transformer Oil to IEC- 60296 / IS 12463(latest)

6.0 General Design and Constructional aspects:

6.1 The transformer block cell consists of following equipment.

i) Main transformer consisting of

a) An auto transformer winding.

b) A fixed ratio transformer with twin secondary winding for feeding power to traction motors.

c) A tertiary winding for power supply to auxiliary machines.

d) Hotel load winding for meeting hotel load power requirements.

e) A tank filled with mineral oil as coolant provided with conservator.

ii) L.V. and H.V. bushings including 25 KV vertical take off type cable Head Termination assembly.

iii) Cooling equipment comprising of a oil pump, a radiator and a motor blower set.

iv) The tenderer shall give a detailed list of accessories required to make the equipment offered including any other equipment not indicated in the specification but considered necessary by the tenderer for improving the performance of the transformer.

6.2 In order to accommodate the desired power of hotel load within the same dimension of existing 5400 KVA transformer, the tenderer shall explore the possibility of merging the auxiliary load(270 KVA) and hotel load(1000 KVA) in the same winding giving 1270 KVA power at 750 V as indicated at Clause 5(Xiii)

6.3 The space available in the locomotive for accommodating transformer and the associated equipment is given in the Drg. No. CLW/ES/SK-2/T22. The design of the equipment shall be such as to ensure that the limiting dimensions are not infringed. The mounting arrangement of the transformer shall be same as shown in the drawing. The size of the opening in the under frame is 1400 x 2130 mm. The size of the tank should be 1375 x 2080 mm so as to ensure a total clearance of 25 mm widthwise and 50 mm lengthwise. The top cover of the tank should be so designed as to have the same configuration, for bushings as per existing 5400 KVA transformer with separated provision for hotel load winding bushings.

6.4 The equipment (including components and accessories and their mounting arrangement shall generally conform to IEC 60076, IEC 60077-1&2 and IEC 60310. It shall be of robust design suitable for traction duty and shall withstand satisfactorily the vibration & shock as stipulated in the IEC:60310.

6.5 The auto transformer shall have 32 tapings for connection to the tap changer. The transformer tank shall have provision for fitting an N-32 tap changer of BT/Ganz type (mounting details of the tap changer to the transformer shall be furnished to the successful tenderer).

6.6 The tenderer may offer class H Insulation or modern insulation scheme for copper conductors and modified core dimension having minimum core loss with mineral insulating oil as the cooling medium.

6.7 The transformer shall be forced oil cooled by means of circulating oil pump and radiator. The cooler (radiator) shall be air cooled by means of a motor blower set.

The pump, the radiator and the cooler blower shall be mounted on the transformer body. The ratings of these equipment should be adequate to ensure cooling of the transformer to the desired standards. The exhaust of the cooler blower shall preferably be arranged through the roof of the locomotive. There is a depression of 12 mm (WG) inside the loco. The design of cooling equipment should take this into account.

6.8 The transformer tank shall be provided with drain plug and filling valves, filtering valves, sampling valve, oil flow relay, conservator tank with Silica gel breather, oil temperature indicator with contacts for operating in a audible alarm in the drivers cabs, oil level gauge and explosion vent. Necessary valves in between the transformer tanks and cooler shall be provided.

6.9 The transformer shall also be supplied and provided with necessary accessories for its protection like current transformer along with over current relay for over current protection and air flow & oil flow relays for detecting the failure of ventilation & oil circulation.

6.10 Various terminals from the traction winding shall be so located as to enable shortest interconnections between the transformer and the rectifier cubicles.

6.11 The construction of the transformer shall be such as to keep the weight of the transformer as low as possible while meeting adequately the severe requirements of traction duty such as rapid load variation, vibration, short circuits etc. Tenderer shall also furnish the design calculation of MPH as well as radiator with motor blower set in view of higher thermal losses due to provision of hotel load winding. Tenderer shall also adopt Aluminium tubes & fins design radiator in place of conventional design to keep the total weight of the transformer with cooling equipments similar to the existing 5400 KVA transformer.

6.12 Technical data to be furnished by the tenderer with the offer is given in Annexure-A.

6.13 Additional technical data to be furnished by the successful tenderer is given in Annexure-B.

6.14 The technical data of the smoothing reactor, rectifier, tap changer & traction motor in use are given in Annexure-C.

7.0 Tests

7.1 Transformer Including Hotel Load Winding

The Type and Routine Tests shall be carried out on the transformer as per Table-1 below which also stipulates the category of the tests and the clause to which the reference is to be made.

TABLE-1

TESTS	Clause or sub-clause		
	Type	**Routine**	**Investigation**
Preliminary checks	7.1.1	7.1.1	-
Measurement of winding resistance	7.1.2	7.1.2	-
Measurement of voltage ratios	7.1.3	7.1.3	-
Measurement of no-load primary current and losses	7.1.4	7.1.4	-
Measurement of impedance voltages	7.1.5	7.1.5	-
Measurement of load losses	7.1.6	7.1.6	-
Determination of total losses	7.17	-	-
Temperature Rise	7.1.8	-	-
Dielectric : - full wave impulse voltage withstand - induced voltage withstand - separate source voltage withstand	 7.1.9 7.1.10 7.1.11	 - 7.1.10 7.1.11	 - - -
Measurement of IR of windings	7.1.12	7.1.12	-
Pressure and Leakage test on Tank	7.1.13	7.1.13	-
Measurement of weight	7.1.14	-	-
Vibration & Shock	7.1.15	-	
Short circuit test	7.1.16	-	

7.1.1 **Preliminary Checks (IEC 60310- Clause 18)**

Visual inspection and identification of the circuit diagram, terminal meetings, polarities & particulars on the rating plate shall be carried out.

7.1.2 **Measurement of Winding Resistance (IEC 60310- Clause 19)**

Resistance of each winding shall be measured with direct current at ambient temperature and the values thus obtained corrected to 75 deg.C.

7.1.3 **Measurement of Voltage Ratio (IEC 60310- Clause 20)**

Voltage ratio shall be measured between Auto windings at different taps and both secondary windings. Voltage ratio shall also be measured between HV winding & Auxiliary winding, & Hotel load winding .

The measured values shall be with-in ± 0.5% of the design values.

7.1.4 **Measurement of No load primary current & losses (IEC 60310 - Clause 21)**

No load primary current and losses shall be measured with 50 Hz sinusoidal voltage applied to high voltage winding. However, this measurement can also be carried out by energising Auxiliary/hotel load winding. No load current and losses for the primary winding shall be measured at 17.5 KV – 27.5 KV in steps of 2.5 KV.

7.1.5 Measurement of Impedance Voltage (IEC 60310- Clause 22)

Impedance voltage between each pair of the windings shall be measured at rated frequency using approximately sinusoidal voltage supply.

The short circuit impedance between primary winding and the traction windings shall be with-in ± 15% of the design value.

7.1.6 **Measurement of Load Losses (IEC 60310- Clause 23)**

Load losses between HV winding and traction windings, Auxiliary winding and Hotel load winding shall be measured and corrected to 75 deg.C. The corrected losses shall not exceed the guaranteed values specified by manufacturer.

7.1.7 **Determination of total losses of transformer (IEC 60310 -Clause 24)**

The total losses of the transformer at reference temperature of 75 deg. C shall be computed as under:-

(a) Load losses of HV to all Traction windings
(b) Load losses of HV to Auxiliary winding
(c) Load losses of HV to Hotel load winding
(d) No load losses

The total transformer losses will be the sum of (a), (b), (c) & (d) above.

The total transformer losses shall not exceed the limit specified by the manufacturer.

7.1.8 **Temperature rise test (IEC 60310- Clause 25)**

This test on the transformer shall be carried out by short circuit method to determine temperature rise of oil, average temperature of air at the blower entrance, average temperature of air at cooler exit, average temperature of oil at transformer exit, average temperature of oil at cooler exit. For this, Thermocouples shall be provided at locations as under:

- Top oil pocket - One
- Air entrance to the blower – One
- Air exit under the cooler – one
- Oil exit from the transformer – One
- Oil inlet to the transformer - One
- Oil containers – Three, located at about 3 m from the transformer

7.1.8.1 **Oil Temperature Rise**

For this test, with the auxiliary winding and hotel load winding left open circuited, the Secondary windings shall be short circuited and primary windings energized such as to feed losses in the transformer determined in clause 7.1.7 above. These losses fed in the transformer shall be maintained till oil temperature stabilizes. The oil temperature measured and temperature rise calculated.

The temperature rise of oil shall not exceed 45 deg.C.

7.1.8.2 **Winding Temperature Rise**

- **HV Winding**

For this test, the Secondary windings shall be short circuited and supply given to HV winding so as to feed 240 Amps. in HV winding for a duration of 60 min. At the end of 60 min., blowers shall be switched off and hot resistance of the HV winding measured.

- **Traction Windings**

For this test, with blowers on, series connected traction winding shall be short circuited and supply given to HV winding to feed 5400 Amps. in traction windings for a duration of 60 min. The blowers shall be switched off and hot resistance of the traction windings measured.

- **Auxiliary Winding**

For this test, with blowers switched off, the auxiliary winding shall be short circuited and supply applied to HV winding with 325.3 Amps in Aux. winding for a duration of 60 minute at the end of which hot resistance of the winding shall be measured.

- **Hotel Load Winding**

For this test with blowers switched off, the hotel load winding shall be short circuited and supply applied to HV winding with 1333.3 Amps. in hotel load winding for a duration of 60 minutes, at the end of which hot resistance of the hotel load winding shall be measured.

7.1.8.3 Overloading Temperature Rise Test:

Overloading test as per para 4(viii),(ix) & (x) shall be carried out on the winding with maximum temperature rise.

7.1.9 **Impulse voltage withstand test (IEC 60310- Clause 26.3)**

The HV winding shall be subjected to impulse voltage test of 150 KVp, 1.2/50 micro second wave.

The winding shall withstand the test voltage.

7.1.10 **Induced Voltage Withstand Test (IEC 60310- Clause 26.1)**

All traction and hotel load windings shall be shorted & connected to tank and earth. Auxiliary winding shall be energised such as to induce 60 KV voltage in HV winding.

The winding shall withstand the test voltage.

7.1.11 **Separate source voltage withstand test (IEC 60310-Clause 26.2)**

Single phase 50 Hz, separate source voltage of amplitude as given below shall be applied for 1 minute between each winding to be tested and all other windings connected together to tank and earth:-

(i)	primary winding and all other windings to earth	10 KV
(ii)	Traction winding to all other windings and earth	10 KV
(iii)	Auxiliary winding to all other windings and earth	6 KV
(iv)	Hotel load winding to all other windings and earth	6 KV

The windings shall with stand the test voltage.

7.1.12 Measurement of IR value (IEC 60310 -Clause -)

Measurement of IR value of individual windings to Tank and Earth and between windings shall be carried out at room temperature. The values obtained after 60 seconds shall be corrected to 30 deg. C. For HV winding & all other windings 5/2.5 kV megger shall be used.

7.1.13 Pressure & Leakage Test on Tank (IEC 60310 -Clause -)

Pressure test on the transformer tank shall be carried out at a pressure of 14.2 PSI over the normal head of oil for a period of 24 hours. There shall be no oil leakage from the tank.

There shall not be any leakage during or at the end of the test.

7.1.14 Measurement of weight (IEC 60310 -Clause -)

The weight of the Transformer filled with mineral oil shall be measured.

7.1.15 Vibration & Shock

Vibration & Shock test on the transformer shall be carried out as per IEC:61373(latest).

7.1.16 Short Circuit Test

Short Circuit test shall be carried out as per IEC:60310. The test voltage shall be 27.5 KV and both the secondary traction windings are to be subjected to short circuit test with two shots each out of which first short is to be applied at the highest voltage tap No. 32 and the second shot on 18^{th} tap.

Variation in % impedance before & after the short-circuit test shall not differ more than ±1%. After the test, the transformer to be removed from the tank and no observable deformation, movement or slackening of any winding, insulation over clamping devices should be revealed.

8.0 Technical Documents to be supplied by the Supplier :

The following documents shall be supplied by the supplier as a part of the contract :

i) Type test reports – 5 copies

ii) Routine test reports along with each set – 5 copies

iii) Maintenance manual – 1 copy per unit

iv) Detailed drawings – 6 copies

v) Supplier should submit detailed drawings and technical source of sub-supplier for approval before manufacturing of prototype sample.

vi) Design data calculation and drawings of transformer submitted by the supplier during design approval

9.0 Quality Assurance

Quality assurance should be as per ISO:9000 quality management system.

NOTE:- 1. The firm should emboss following data in their product :

- Make
- Year and month of manufacturing
- Sl. No.
- Trade mark, if any
- Drg. No.
- Order No.

2. Standard fasteners shall be used from CLW approved sources.

3. Quality Assurance Plan for the Transformer shall be prepared covering various aspects given below & submit to RDSO :

3.1 The QAP to be submitted by the vendor in duplicate (along with the application form for registration) shall cover the following aspects –

a) Organisational Chart, clearly indicating the Quality Control Set- up.

b) Qualification of key personnel and the officials deployed in Quality Control Cell.

c) Process Flow Chart indicating process of manufacture for an individual product or for a family of products if the process is same.

d) Quality Assurance System – Inspection & Testing Plan. This shall cover the following :-

- Incoming material
- Process control
- Product control
- System control
- Gauging scheme – in the format for each operation gauges should be mentioned, if used.

e) Stage inspection detailing inspection procedure, inspection parameters, method of testing/test procedure including sample sizes for destructive and non- destructive testing etc

f) Calibration scheme and status of calibration of test equipment.

The generalized format for covering the information under (d & e) should be as below :-

Subject/ Product/ Process	Sample Size & its Frequency of inspection	Parameters for inspection	Mode of inspection/ equipment . used	Acceptance limits/ Criteria /specified Value	Rejection details Repro-cessed/ Scraped

g) QAP covering all the information as asked above under item 'a' to 'f' must be given in the form of single document indicating name of the firm and page no. 'x' of 'y' on each page. Each page should be signed by QC in-

charge. The approved QAP must be a controlled document and a quality record of ISO:9000 quality control system of the vendor. A certificate to this effect shall be provided along with the QAP by the vendor.

3.2 The QAP shall be provisionally approved by the officer nominated for capability assessment and final approval shall be given by concerned Director/ Jt. Director

3.3 The QAP shall be submitted in duplicate. One copy, after final approval will be given back to the vendor.

Annexure-A

TECTNICAL DATA TO BE SUPPLIED WITH THE OFFER

TRANSFORMER

1. Make
2. Type
3. Standard
4. Primary Voltage (kV)
   - i) Nominal
   - ii) Maximum
   - iii) Minimum

5. Continuous rating at 22.5 kV

Winding	Primary	Traction (secondary)	Auxiliary	Hotel load	or Auxiliary + Hotel load
No. of windings					
No load voltage (V)					
Current (A)					
Capacity (kVA)					

6. Percentage impedance voltage at rated traction winding current of 2700 A each at all tap positions from 1 to 32 tap with

   - i) One winding shorted
   - ii) Both windings shorted

7. Percentage impedance voltage of

   - Auxilliary winding (%)
   - Hotel load winding (%)

   or

   - Tertiary Winding(Auxiliary + Hotel load)

8. No load magnetization current

   - i) at 22.5 kV (A)
   - ii) at 27.5 kV (A)

9. Flux density in the core

i) at 22.5 kV (Wb/m²)
ii) at 27.5 kV (Wb/m²)

10. Current density at rated current

i) Primary (A/mm²)
ii) Traction (Secondary) (A/mm²)
iii) Auxiliary (A/mm²)
iv) Hotel load (A/mm²)
or
v) Auxiliary + Hotel load (A/mm²)

11. Transformer losses At 22.5kV At 27.5kV

Core (kW)
Copper (kW)
Total (kW)

12. Transformer overall efficiency

i) at 22.5 kV (%)
ii) at 27.5 kV (%)

13. Permissible and designed temperature rise separately

(i) Oil (℃)
(ii) Winding (℃)
(By resistance method)

14. Type of cooling and cooling medium

15. Class of insulation

a) On conductors
b) Cooling medium

16. (i) Material of insulation on the conductor

(ii) Material of the cooling medium (Mineral oil/Silicons fluid)

(iii) Thermal and electrical characteristics of conductor insulation.

(iv) Thermal and electrical characteristics of cooling medium.

17. Dielectric levels Primary Traction Auxiliary Hotel load or Aux.+hotel load

(a) Induced voltage withstand (kV)

(b) Separate source

voltage withstand (kV)

(c) Impulse voltage withstand (Kvp)

18. Construction

i) Type of core : Core type/Shell type
ii) Type of winding : Concentric coils/sandwich coils
iii) type of winding construction (single coil or more coils in series/parallel)

- Primary
- Secondary
- Auxiliary
- Hotel load

19. Weight of transformer and oil

i) Without cooling equipment
ii) 'with cooling equipment

20. Overall dimensions of the transformer

i) Without cooling equipment

ii) With cooling equipment (Attach drawings)

21. Oil
i) Weight
ii) Volume

22. Data on additional equipment

i) oil circulating pump

a) Motor
- Make
- Type
- Rating
- Insulation class
- Weight

b) Pump
- Make
- Type
- Speed
- Quantity & head
- Weight

ii) Fluid circulating blower

a) Motor - Make

- Type
- Rating (kW)
- Voltage (V)
- Current (A)
- Speed (RPM)
- Insulation class
- Weight

b) Pump
- Make
- Type
- Speed (RPM) (Max)
- Air Quantity (m3/hr) & head (mm WG)
- Weight (kg)

iii) Radiator
- Make
- Type
- Rating (kW)

iv) Current transformer

- Type
- Make
- Ratio
- Burden (VA)
- Accuracy class
- Insulation class

v) Overload relay

- Type
- Make
- Ratio
- Burden
- Accuracy class
- Setting value

vi) Oil flow relay

- Type
- Make
- Range
- Setting

vii) Oil temperature indicator

- Type
- Make
- Range
- Setting

viii) Silicagel

- Type
- Make

23. The following drawings/curves/calculations shall be submitted by the tenderer along with the offer :

    Outline and general arrangement drawing of the transformer,

24. The contractor shall also furnish detailed drawings showing core arrangement, winding/coil arrangement, insulation arrangement, cross sectional drawings, rating plate etc. for transformer.

25. Overload Vs. duration curve of the transformer with sample calculations for the same.

ANNEXURE-B

ADDITIONAL DATA TO BE SUBMITTED BY THE CONTRACTOR

TECHNICAL DATA OF MAIN TRANSFORMER

1. Rating:

1.1	Primary	Volts	Amps.	kVA
1.2	Traction (Secondary)	Volts	Amps.	kVA
1.3	Auxiliary	Volts	Amps.	kVA
1.4	Hotel load	Volts	Amps.	kVA
1.5	Magnetising current(%)			
1.6	Core losses:			
	- 22.5 kV			
	- 27.5 kV			

		Primary	Traction (Secondary)	Auxiliary	Hotel load	or Aux. hotel load
1.7	Copper losses					
1.8	Total losses					
1.9	Resistance (%)					
1.10	Reactance (%)					
1.11	Current density					

		Primary	Traction (Secondary)	Auxiliary load	Hotel or	Aux. + hotel load
2.	Winding details					
2.1	Total No. of turns					
2.2	No. of windings					
2.3	No. of coils					
2.4	Sections per coil					
2.5	Turns per coil					
2.6	Turns per layer					
2.7	No. of layers					
2.8	Size of conductor					
2.9	Total sectional area					
2.10	No. of parallel conductors.					
2.11	Mean length of winding (mm)					
2.12	Weight of copper wire(kg)					
2.13	Coil dia (inner)					
2.14	Coil dia (outer)					
2.15	Depth of winding (radial)					

2.16 Height of section
2.17 Conductor insulation
2.18 Winding method
2.19 Inter connection of sections
2.20 Inter connection of coils
2.21 Clearance between HV&LV

	Primary Traction (Secondary)	Auxiliary	Hotel or Aux. + load	hotel load

3. Magnetic Circuit Details

3.1 Grade (silicon sheet steel)

3.2 Thickness (mm)

3.3 Space Factor (%)

3.4 Core constructional arrangement (2 or 3 limb)

3.5 Sectional area
- Gross (cm^2)
- Nett (cm^2)

3.6 Flux density at :
- 22.5 kV (wb/m^2)
- 27.5 kV (wb/m^2)

3.7 Volt/turn at :
- 22.5 Kv
- 25.5 kV

3.8 Mean core length (mm)

3.9 Dimensions of windows (mm)

3.10 Outer dimensions

4. Ancillary Data

4.1 Operating pressure of explosion vent

4.2 HV and LV bushing Specification

4.3 Weight (kg)
i) Core and coils
ii) Tank and fittings

iii) Fluid (lit.)
iv) Cooler and pump
v) Fluid
vi) Total weight of Transformer block

5. Calculations

5.1 Temperature rise calculations for rated load and overloads.

5.2 Reactance calculations for different windings for arriving at designed value.

5.3 Calculations for thermal and mechanical effects under 3 second short circuit.

5.4 Calculations for arriving at the regulation characteristics of the transformer alongwith the regulation curve (dc voltage vs dc current)

ANNEXURE-C

TECHNICAL DATA OF EXISTING EQUIPMENT IN USE

1. Tap Changer

(i)	Type	:	No-32
(ii)	No. of taps	:	32
(iii)	Rated Voltage	:	25 KV 50 Hz
(iv)	Rated current	:	400 A
(v)	Weight of the tap changer without oil	:	481 Kg
(vi)	Oil capacity	:	75 Lit.

2. RECTIFIER

(i)	Input nominal voltage	: 1000 V rms
(II)	System of connections of diodes	: Bridge
(iii)	Surge voltage protection level	: 3.7 KV
(iv)	Direct current rating of rectifier with all Bridges healthy with blower	: 4050 A - 5 min. : 3300 A - 10 min. : 3150 A – Cont.
(v)	DC rating of rectifier bridge with all Bridges healthy without blower motor for minimum period of 30 min.	: 2700 Amps.
(vi)	Design short circuit capacity corresponding to traction motor flashover. 2700 A with asymmetric factor of 1.6	:36.65 KA(Asymmetric) for 100 ms during Continuous loading of
(vii)	Design short circuit capacity Corresponding to short circuit Within rectifier before smoothing reactor	: 60 KA for 10 ms continuous loading of 2700 A.

2. **SMOOTHING REACTOR**

(I)	Make	:	CLW
(ii)	Type	:	SL-30
(iii)	Number	:	2
(iv)	Circuit rated voltage	:	1270 V
(v)	Continuous rating	:	1350 A per limb
(vii)	One hour rating	:	1640 A per limb
(vii)	Inductance	:	3.35 ± 0.3 mH across each coil
(viii)	Insulation	:	180 ºC temp. index

(ix) Ripple factor : 28.1%

3. TRACTION MOTOR

(i) Continuous rating : 750 V, 900 A, 895 rpm, 850 h.p.

(ii) One hour rating : 750V, 960 A, 877 rpm, 905 h.p.

(iii) Permanent shunting : 5%

(iv) Field strength
- Max. : 95%
- Min. : 40%
- Intermediate : Three field shunting

(v) Max. Starting current of the Motor : 1350 A for 2 minutes

(vi) Short time rating : 1200 A for 10 minutes

(viii) Motor Resistance 115ºC and inductance value:

-	Armature	: 0.01283 Ohms	1.2 mH
-	Main Field	: 0.0122 Ohms	2.2 mH
-	Interpole	: 0.0093 Ohms	0.6 mH