SPECIFICATION FOR MAIN TRANSFORMER FOR WAG-9 (Co-Co),ELECTRIC LOCOMOTIVES

.

Specification No : CLW/ES/3/0456/K

ISSUED BY
DY.CHIEF ELECTRICAL ENGINEER/D-II
CHITTARANJAN LOCOMOTIVE WORKS
CHITTARANJAN – 713331
Dist: BARDHAMAN(WEST)
WEST BENGAL (INDIA)

ALTERATION RECORD SHEET

Amendment Number	Date of Amendment	Page number	Alteration	Descriptions	Authority
1.	28-02-2002	14	A	Addition of Set Transformer Fixing Bolts and Nut in the scope of supply in Sheet no-16	Sd/-
2.	26-08-2002	17	B	To Improve the Visibility of Oil level of the expansion tank, the surface of the expansion tank behind the oil level gauge has to be painted white paint e.g RAL 9010 or similar vide modification release no-420, dt-21-02-1997	Sd/-
3.	15-01-2003		C	i) Flame Resistance marking should be provide in the Hose Pipe for conservator connection supplying along with Transformer. ii) Assembly of Electrical Termination of Bushing for Traction & SOD Windings should be provided as per RDSO SMI No-228 vide letter no-EL/3.2.1-3Ph, dt-13-08-2002. iii) To Arrest the Oil leakage from Bushing and Covers, all Gaskets / ”O” Ring should be used as per RDSO Technical Circular No-ELRS/TC/0076 vide letter no: EL/3.2.1-3Ph, dt-17-09-2002. iv) Firm Should amboss their name plate on all transformer accessories including Hose pipe, Quick-coupling etc.	Sd/-
4.	16-04-2003	16	D	Firm Should provide Min/Max. Oil level Scale in Conservator Tanks.	Sd/-

5.	29-12-2003		E	A) Corrections of specification as per ABB Doc. has been done as following i) Voltage , Rated Current, Max. Current for Traction Per Winding at sheet No-7, clause no-4.3.3 ii) Inrush current : Max. Inrush Peak Load I peak at Sheet No-7 clause no-4.3.2 iii) Auxiliary Converter Choke unit (3-Double Choke) type at sheet nos-(9& 12 clause no-4.6.1 & 7.1) iv) Current for Inductance per BUR choke at Sheet no-9 clause no-4.6.1 v) Operational time within 40 years at sheet no-11 clause no-6.1 vi) Type Test Procedure & Routine Test Procedure at Sheet no-11 clause no-7.1. B) i) Line " The Test results of the first transformer from ABB are recorded in the table annexure-2" is deleted from Sheet No-8 clause no-4.3.2 because annexure-2 is not included in the specification. ii) Line " According to 3EHE428048 (see annexure-3)" is deleted from sheet no-9, clause no-4.6.1because annexure-3 is not included in the specification. iii) Clause no-8.10 Annexure-1is deleted from sheet no-14 because Annexure-1, Annexure -2 are not included in specification.	Sd/-
6.	21-11-2011		F	Standardized Traction Bushing Height as per Drg No-CLW/ES/3/ SK-6/0456	Sd/-

7.	22-08-12		G	The Transformer and Conservator tank should be complete filled with Oil. Two Barrel Oil (Instead of One Barrel) separately provided for filling in Oil Pipes and Other accessories.	Sd/-
8.	08-07-2016	14,19	H	800mm Connecting Hose deleted as per approval of C.A vide this office note no-ELDD/3254/part, dt-09-06-2016.	Sd/-
9.	21-08-2017	16	I	Method of SL. No-marking added this office note no-ELDD/3254, dt-04-08-2017 with the approval of C.A.	Sd/-
10.	01-07-2021	14	J	Self Gripping Sealing Rubber Gasket 09mtrs (4.5 x 2) as per drawing no: 1209.18.406-089 Alt-5 added in scope of supply.	Sd/-
11.			K	i) The Specification has been issued on 03.02.2001. Alteration "A" was done on 23.02.2002 and last Alteration "J" was done on 01-07-2021. This specification has been issued incorporating all the addition/ deletion/ modification from Alt-A to Alt-J. In addition, specification for transformer fixing bolts and nuts, drawing for self gripping sealing rubber and specification for Transformer Tank& cover and Specification for conservator tank has been included as Annexures. ii) In Page 16 of 17, Cl.no.9.0, Sl.no.11 at Qty/Loco "Two barrel (209 liters x 2) Oil should be separately provided for filling in Oil Pipes and other Accessories " is deleted and 350 liters oil separately provided for filling up oil pipes and other accessories is included. iii) In Page 10 of 17 at Cl.no. 4.3.8 Minimum insulation resistance between windings and between winding and the earth at 20ºC shall be150 MΩ. The insulation resistance shall be measured by a megohmmeter applying at least 1000 V d.c is included.	

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SPECIFICATION FOR MAIN TRANSFORMERfor 3-Phase, 6000 HP WAG-9 class locomotive.

1.0 SCOPE

This specification applies to MAIN TRANSFORMER for 3-Phase, 6000 HP WAG-9 class locomotive for 25 kV AC 50 Hz system.

2.0 Climatic and Environmental Condition

- Maximum atmospheric temperatures: Under Sun : 70°C.
  In shade : 50°C.
- Maximum Humidity : 100% saturation during rainy season.
- Reference site condition :
  i) Ambient Temperature : max. 55°C , min-10^{0}C
  ii) Normal Humidity : 60%.
  iii) Altitude condition. : 1776 m above mean sea level against USBRL project condition.
  iv) Rainfall. : Very heavy in certain areas. The locomotive will be designed to permit it's running at 10 kilometer per hour in flood water level of 200millimeter above rail level.
- Atmosphere during hot weather : Extremely dusty and desert terrain in certain areas.
- Coastal areas : Locomotive and equipment will be designed to work in coastal areas in humid and salt laden atmosphere.
- Vibration.: The equipment , subsystem and their mounting arrangement will be designed to withstand vibrations and shocks encountered in service as specified in corresponding IEC:61373publications unless otherwise prescribed.

3. DESCRIPTION

3.1 SUBJECT

3.1 .1 SHORT DESCRIPTION

Transformer for supply of the bogie related Traction Converters and Auxiliary Converters from the catenary (25 kV/50Hz). In order to connect a passive filter, the transformer includes an additional filter winding.

3.1.2 NUMBER OF ITEMS (Within the Transformer)

Each loco requires one transformer, which consists of the following components:

- 4 Traction windings

- 1 Primary Winding
- 1 BUR Winding
- 1 Filter Winding
- Series Resonant Choke Unit (02 Chokes)
- BUR Choke Units (3 Double Chokes)
- Transformer Oil.

3.2 FUNCTION / PRINCIPLE

The transformer tank contains main transformer, the series resonant & auxiliary converter chokes. External cooling of the oil is designed with two independent oil circuits. Note, that there is no separation wall in the tank. The cooling units are located within the machine room.

4. TECHNICAL DATA

4.1 GENERAL DESIGN

4.1.1 ASSEMBLY

The transformer should be mounted at the middle of the underframe (underfloor transformer). The HV-supply connected through a HV cable with CHT Plug.

4.1.2 COOLING

Type : Forced oil cooling with two circuits.
Oil flow rate (nom) : 2 x 1000 Lt./min.
Pressure drop, transformer tank (max.) : 1000 mbar at 1000 Lt./min.
Pump type : Plumettaz TA08-2174/15 or similar
Oil temperature, tank drainage (max.) : 80 °C at Pverl Lt. max = 240kW.
Oil temperature, tank drainage (max.) : 84 °C
Oil temperature rise (max) : 4 °K at 1000 Lt./min
Maximum temperature of the winding and oil according to standard IEC 60310 minus 20°C.

4.1.3 COOLANT

Type : Mineral Oil confirming to IEC- 60296 Class II
Oil weight : 1850 Kg.

4.1.4 FIXED ELECTRICAL CONNECTIONS

- Preferably pressed - on
- Not soldered (brazed)

4.1.5 SHOCK AND VIBRATIONAL STRESS

Suitably for railway stock, according to IEC61373 or latest.

4.1.6 INFLAMMABILITY AND TOXICITY OF THE MATERIALS

- No PCB
- Non-toxic
- Avoid any inflammable prone materials.

4.2 TRANSFORMER UNIT

Assembly : Dimensions according to HSTN003359P0001or CLW/ES/3/SK-1/0456/K
Estimated total weight, oil included : 9500KG ± 3 %

4.2.1 Transformer tank

Material, transformer tank : Aluminium
Cover, Transformer tank : Bolt-on, oil proof
Shock resistance : According toIEC 61373 or latest
Colour : RAL 7009
Finish : Silky
Specification No: : CLW/ES/3/0507

4.2.2 Electrical Connections:

Connection for winding and chokes according to outline drawing HSTN003359P0001.

4.2.3 Additional apparatus of the transformer

-Overflow valve (Incase of over pressure the tank must not be damaged and overflowing oil shall be drained off the transformer cover).
- Oil drain tap, Oil level screw.
- Slide for oil intake and drainage.
- Transformer tank fastening
- 2 Expansion tanks, **RAL 7030**.specification no-CLW/ES/3/0508
- Earthing

4.2.4 Additional apparatus of the Expansion tank

- Air dehumidifier including valve
- Oil level gauge
- Connection to the transformer including rapid action coupling
- Oil filler tap
- Oil drainage screw.

4.3 MAIN TRANSFORMER

Scheme Position : 7
Type : LOT 6500
Required Number : 1
Outline drawing: HSTN003359P0001(Necessary part drawing shall be provide to successful tenderer).
Application:

Supply from	**Number of windings**
2 Traction converter ~~(NSC)~~	4
3 Auxiliary Converter	1
1 Filter winding	1

The traction converters (2 per loco) use IGBT technology with a 2-point circuit and a link circuit. In order to reduce harmonic, the traction converters are phase shifted (frequency: 250 Hz, k = 5). On the other hand, the auxiliary converters are controlled according to requirements and they are independent of each other.

4.3.1 Catenary

Frequency: f_{nom}: 50 Hz.±3%
Voltages: max. : 30 kV
min. : 17.5 kV.

4.3.2 Power Data

Ratios:

U = U_{lnom}: Ux, Tolerance +0.5% (according to IEC:60310)

Secondary no-load voltage at U_1 = 25 kV

Winding	**Des.**	**Voltage**	**Ratio**
Traction (4x)	U_T	1269 V	19.7
Auxiliary winding	U_B	1000V	25
Filter winding	U_F	1154V	21.7

4.3.3 Thermal Design:

Calculated at U1min=22.5 kV

Winding	**Power (kVA)**	**Voltage (V)**	**Rated current , (A_{eff})**	**Maximum current (A_{eff})**
Primary	5878	22500	261	261
Traction (per winding)	1304	1142	1142	1142
Auxiliary winding	301	900	333	333
Filter winding	361	1039	347	347

4.3.4 Inrush current

- Maximum inrush peak load: I_{lpeak} (25kV) = 1400A (line impedance not taken into account)
- Peak load 35 periods after turn on : I_{lpeak} (25kV) = 400 A

4.3.5 Rated power:

At U_{lnom} (25 KV) and I_{lnom} (261A) : 6531 kVA

4.3.6 Power loss:
At U_{ldef} (22.5 KV): 195 kW + 15%

4.3.7 Magnetizing current
Magnetizing current at U1nom (25 kV) : 0.7 A
at U1min (22.5 kV) : 0.5 A
at U1max, (27.5 kV) : 1.3 A
at U1min, (17.5 kV) : 0.3 A
at U1max, (30 kV) : 3.5 A

4.3.8 Winding data:
- Values, secondary side related
- Values, measured on the terminal
- Values, at an operational temperature T_{cu}= 75^{0}C

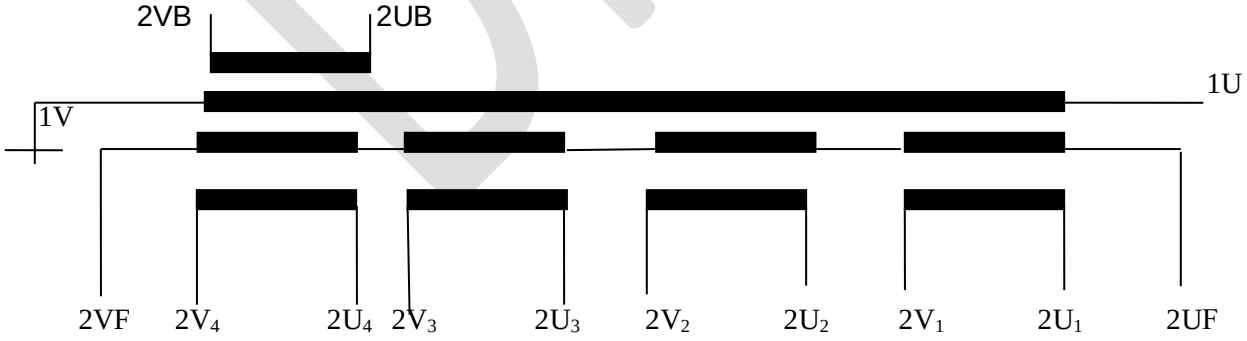
Winding	Resistance		Inductance	
	Value (m_Ω)	Tol. %	Value(mH)	Tol. (%)
Primary winding				
Traction winding	37		2.1	+15%
Auxiliary winding (HB)	60		0.43	
Filter winding	19		0.29	

With the exception of the traction inductance, the above given values are for information only. All winding shall be inductance-decoupled as far as possible.
Measures against eventual over voltage transformer (e.g. systems resonance):
- Appropriate arrangement of the disk winding.
- No capacitive screening.

Preventive measures against blow-outs (e.g. contamination of the coil circuit with metallic particles).
- Insulated bus bar within the transformer.
- Short circuit Resistance: According to IEC:60310 or latest.

Minimum insulation resistance between windings and between winding and the earth at 20ºC shall be150 MΩ. The insulation resistance shall be measured by a megohmmeter applying at least 1000 V d.c.

4.4 ARRANGEMENT OF THE WINDINGS, TERMINAL DESIGNATION



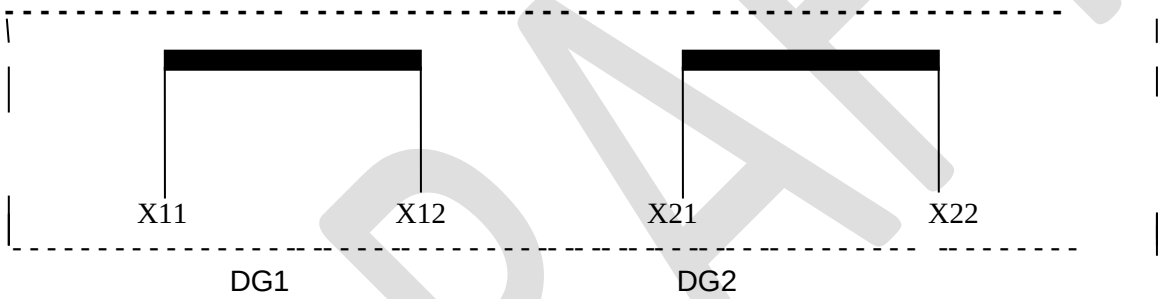
4.5.1 Series Resonant Inductor Unit–

SchemePosition	15.3
Type	2 SOD 240
Required number	2

Electrical data

Inductance	2 x 0.551 mH (±15%) (UntilI_{Peak} = 1391A)
Thermal current I_{Th}	2 x 984A_{eff}
Resonant frequency	100 Hz
Voltage Stress	
Between terminals max	482 V_{AC}(Maximum)
Against earthmax	3471 V
Dissipation Power loss at I_{nom}	12.5 kW+15%

4.5.2 TERMINAL ARRANGEMENT and DESIGNATION



4.6.1. - Auxiliary Converter choke unit (3 double chokes)

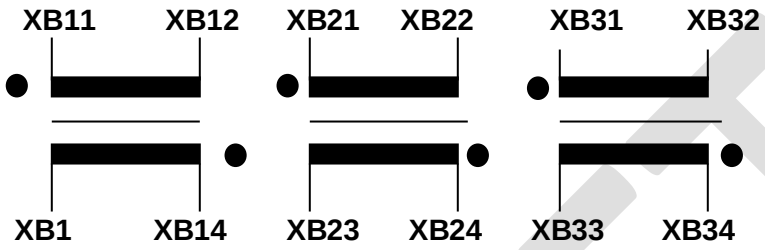
Scheme. Position	51.3
Type	6 GOD 120

Electrical Data

Inductance per BUR - choke	
0A	30mH
120A	30mH
155A	26mH
190A	20mH
Tolerances	- 0% + free
Frequency	100 Hz
CurrentRated	155A
Current Max	190 A
Ripple nom	38.6 %
RippleMax.	50.2 %

Voltage stress against -Earth Rated	1153 V
Voltage stress against Earth -max.	2000V
Dissipation power at I_{nom}	12 kW + 15%

4.6.2 ARRANGEMENT and DESIGNATION



BUR-1 BUR-2 BUR-3

Each choke consists of a magnetic frame, which contains a part choke. Due to asymmetrical voltages all chokes shall be completely decoupled from each other.

5. STANDARDS / QUALITY

5.1. Standards

IEC 60038 : Standard Voltage
IEC60077 : Electrical Traction devices
IEC60310 : Rules for traction transformers and reactors.
IEC: 60296 : Transformer Oil
IEC 61133 : Complete Loco

5.2. Quality

QS- Qualification (According to Quality Management Manual 3EHQ600002 Rev. C)
Transformer complete: Q-Klasse 3
Main transformer : Q-Klasse 3
Series resonant choke : Q-Klasse 3
BUR - choke : Q-Klasse 4
Transformer tank : Q-Klasse 4
Execution : An ISO 9001 or similar QS System must be used at least.

6.0 RELIABILITY REQUIREMENT:

6.1 Life Time:

Operational Time

Daily : Approx 16 Hrs (at approx 330 days per Year)

Yearly : 5280 Hrs

Within 40 Years : 211200 Hrs.

6.2 Reliability:

Under operational condition as defined in chapter 6.1 (Life time) and MTBF of$11x10^6$ h is expected.

7.0 <u>TEST PROGRAMME</u>:

7.1Type Test: A Type Test according to IEC: 60310or latest version is required. The type test procedure according to HSTN 612192 has to be submitted to the project management for approval**.**

7.2 Routine Test : A Routine Test according to IEC: 60310 or latest version is required. The routine test procedure according to HSTN 612193 has to be submitted to the project management for approval

7.3 Special Test : The first serial transformer must be tested fully. The measurement includes the short circuit impedance of all windings and cross-couplings.

7.4 **Time Schedule:** The Type and Routine test take place in the presence of the inspecting officer of Indian Railways. In order to inform the client, a schedule must be submitted to the project management for approval at least 7 weeks before start of the test.

7.5 Following tests to be carried out on Transformer:

Sl. No	**Test Description**	**Type Test**	**Routine Test**
7.5.1	Dimensions & preliminary check.	Y	Y
7.5.2	Measurement of insulation Resistance	Y	Y
7.5.3	Measurement of winding Resistance.	Y	Y
7.5.4	Measure of voltage Ratio	Y	Y
7.5.5	Measurement of no-load current and no- load losses.	Y	Y
7.5.6	Measurement of impedance voltage and load losses	Y	Y
7.5.7	Measurement of short circuit reactance	Y	Y
7.5.8	Induced voltage withstand test.	Y	Y
7.5.9	Separate source voltage withstand test.	Y	Y
7.5.10	Oil BDV measurement test	Y	Y
7.5.11	DGA analysis of Oil	Y	Y
7.5.12	Impulse test.	Y	No
7.5.13	Temperature rise test.	Y	No
7.5.14	Weightment test	Y	No

7.5.15	Oil leakage test.	Y	Y

7.6 TEST ON REACTORS: 2 SOD 240

7.6.1	Preliminary checks	Y	Y
7.6.2.	Measurement of insulation resistance	Y	Y
7.6.3.	Measurement of winding resistance.	Y	Y
7.6.4	Measurement of winding inductance and losses	Y	Y
7.6.5.	Separate source voltage withstand test.	Y	Y
7.6.6.	Temperature rise test.	Y	No

7.7 TEST ON REACTORS: 6 GOD 120

7.7.1	Preliminary checks	Y	Y
7.7.2	Measurement of Insulation resistance	Y	Y
7.7.3	Measurement of winding resistance.	Y	Y
7.7.4	Measurement of winding inductance and losses	Y	Y
7.7.5.	Separate source voltage withstand lest.	Y	Y
7.7.6.	Temperature rise test.	Y	No

7.8 (a) Prototype and routine inspection will be carried out by the authorized representatives of Indian Railways

(b) All type test and routine test will be carried out as per the tender specification.

8.0 DOCUMENTATION

8.1. -General

Project Designation : Main Transformer for WAG-9 Locomotive of Indian Railways.

8.2- Contents

8.2.1- Drawings, Tracing and description:

All drawings and description, which are necessary for design, assembly and commissioning of the transformer. A part list / composition list of each drawing has to be given. Within the individual lists all parts of the corresponding drawing have to be mentioned, including consumable items.

A family tree has to be given,including all drawings, part listsand other relevant documentswhich are part of thedocumentation. Also a completelist of all documents and acomplete list of all components(“Bill of Materials”)formspart of the documentation.

8.2.2. Manual

The manual Hindi & English language includes all necessaryinformation for correctoperation, maintenance,faultfinding and repair of thetransformer, including spareparts catalogue and instructionsfor assembly, dismantling andreplacement of the individualcomponents. An overview offunction and work order has tobe given. The chapters of themanual must belong to theindividual sub-assemblycomponents. All drawings anddocuments, which are used asreference documents have to begiven asannexure to the Manual.

8.3. **- Structure**

8.3.1- Drawing, Tracings and descriptions

The documentation shall be structured by the following order:

1. Family tree
2. List of drawings
3. Bill of materials
4. Drawings, etc. (sorted by subassembly components, corresponding to the family tree).

All documents insoft as well as hard copies haveto be given in proper folders.Loosen documents will notbe accepted.

8.4 **- Standards / Units**

Only IEC - Standards will be accepted. Internally used BBC / ABB / ADtranz - Standards may only be mentioned together with correspondence IEC -Standard. Only SI-Units will be accepted.

8.6 - No. of Documents.

8.6.1 - Drawings, Tracing and Descriptions

1 Sets ofcopies in soft as well as hard(According to 8.2.1)

8.6.2 Manuals: "1 Sets ofcopies in soft as well as hard(according to 8.2.2)

8.7- REFERENCE DOCUMENTS

Main power circuit Co' Co : 3 EHP281141
Auxiliary Scheme Co' Co' : 3 EHP281142
Cooling system Co' Co' : 3 EHP510077

9.0 SCOPE OF SUPPLY

SL. No	Item Description	Qty/Loco

1	TransformerTankas per specification no-CLW/ES/3/0507	1 No.
2	Series Resonant Choke (SOD)	2 Nos. Within the Transformer Tank
3	D.C. Link circuit choke aux. Converter (GOD)	6 Nos. Within the Transformer Tank
4	High voltage bushing mounted on transformer	1 Set
5	RTD - PT 100 mounted on transformer	1 No
6	Conservator Tank with Breather and Min./ Max. Oil level scale in conservator tanks.	2 Nos
7	Hose with nipple as per CLW/ES/3/SK-2/0456/K)	2 Nos
8	Connecting Hose complete with nippleas per CLW/ES/3/SK-2/0456/K	1 No.
9	Quick -Coupling as per drawing no.CLW/ES/3/~~SK-4~~SK-3/0456/K	6 Sets (one set consists of one male and one female)
10	Elbow Union as per drawing no CLW/ES/3/~~SK-5~~SK-4/0456/K.	2 Nos
11	Transformer Oil : Confirming to IEC- 60296 Class II.	The Transformer tank should be completely filled with Oil. ~~Two barrel (209 liters x 2) Oil should be separately provided for filling in Oil Pipes and other Accessories.~~ 350 liters oil is to be separately provided for filling in oil pipes and other accessories .
12	Set of Transformer fixing bolts and plates as per Spec. No. CLW/ES/3/0069Alt-D.	01 Set
13	Self Gripping sealing Rubber Gasket as drawing no-1209-18.406-089 Alt-5.	09 mtrs (4.5mtrs x 2)

Note: Supply should also confirm to drawing number CLW/ES/3/SK-1/0456 to CLW/ES/3/SK-5/0456

10.0 TECHNICAL DOCUMENTS TO SUPPLIED BY THE SUPPLIER:

The following documents shall be supplied by the supplier as a part of thecontract.

i) Routine test reports along with each set
ii) Maintenance manual - 3 copies (in soft andhard) with Prototype Unit & 1copy with subsequent units.
iii) Supplier should submit detailed drawings and technical source of sub supplier for approval before manufacturing of prototype sample.
iv) Design data calculation and drawings of transformer is to be submitted by the supplier during design approval.

11.0 Design Data: -

Make and type
Type of construction
Particular of winding with their continuous rating
Permissible duty cycle

Percentage impedance voltage of each winding with other winding opened no - load magnetization current.
Transformer losses and efficiency
Permissible temperature rise.
Details of insulation of winding
Dielectric levels
Overall dimensions and weight of the transformer without conservator and cooling equipment, details of devices associated with the transformer.
Design calculations
Reliability predictions for transformer
Drawings
List of materials used in construction of the transformer general arrangement of transformer, windings and core and connected auxiliaries.

12.0 Note:

12.1 The firm should emboss following data in their products.

(i) Make
(ii) Year and month of manufacturing
(iii) ***SI. No.
(iv) Trade mark, if any
(v) Specification No.
(vi) Order No.

12.2- Standard Hardware and fasteners of **CLW/BLW/RDSO** approved source only to be used.

12.3* SL. No as per format "**XXXX-65-MM-YY-ZZZ**" where **XXXX**-Firm's Name in three or Four letters, **65**-capacity of TFP for LOT6500kVA transformer, **MM**-02 digit for Month of Dispatch, **YY**- last 02 digit of Year of Manufacturing and **ZZZ**- Serial Number of Transformer.

12.4 For completeness of this specification, other CLW specifications/Drawing which is related to this item has been included in the specification. List of such specifications /Drawing are given below:

Annexures	**Item Description**	**Specification no**
Annexure-A	Transformer Fixing bolts and Plates.	CLW/ES/3/0069 Alt.D
Annexure-B	Self Gripping Rubber Gasket	1209-18.406-089 Alt-5.
Annexure-C	Transformer Tank& Cover	CLW/ES/3/0507
Annexure-D	Conservator Tank	CLW/ES/3/0508