TENDER SPECIFICATION

ALT	A					
SHEETS						

ENCLOSURES:

1. DRG. NOS.:- CLW/ES/3/SK-1 to SK-6/0456except SK-3

SPECIFICATION FOR

MAIN TRANSFORMER WITH STEEL TANK for 3-Phase ,6000HP WAG-9 class Electric Locomotives for 25 KV AC 50Hz system.

ISSUED BY:
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INDEX

ALTERATION RECORD SHEET

Amendt. Number	Date of Amendment	Page number	Alteration	Descriptions	Authority
1			A	**i) In clause no 5.4, remarks added that arrangement and design of windings inside the transformer shall be decided by manufacturer.** **ii) In clause no. 5.3.2 remarks added that resistance data of the transformer windings shall be declared by manufacturers as per best suited CRGO.** **iii) In clause no. 5.1 remarks that manufacturers may declare weight of oil, if any variation then same shall be indicated.** **iv) In clause no. 5.2 Weight of the transformer has been modified.** **v) Latest version of IECs are incorporated wherever applicable.** **vi) In clause no 7.0 test program has been added** **vii) In clause no. 9.0 scope of supply has been modified.**	Sd/-

1.0 GENERAL DESCRIPTION

SPECIFICATION FOR MAIN TRANSFORMER WITH STEEL TANK FOR 3-Phase ,6000HP WAG-9 class Electric Locomotives for 25 KV AC 50Hz system

2.0 SCOPE:

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

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3.0 CLIMATIC AND ENVIRONMENTAL CONDITION

SL.No	Description	Remarks
3.1	Maximum atmospheric temperatures :	• Under sun: 70^{o}C • Minimum Temperature -10 °C (Also. Snow Fall in certain areas during winter season).
3.2	Humidity:	100% saturation during rainy season
3.3	Reference site conditions	• Ambiant Température max 55°C • Min -10^{o}c • Humidity : 100%. • Altitude : 160m above mean sea level
3.4	Rainfall	Very heavy in certain areas. The locomotive shall be designed to permit it's running at 10 Km per hour in flood water level of 102 millimeter above Rail level.
3.5	Atmosphere during hot weather	Extremely dusty and desert terrain in certain areas.
3.6	Coastal areas	Locomotive and equipment shall be designed to work in coastal areas in humid and salt laden atmosphere
3.7	Vibration	The equipment and subsystem and their mounting arrangement will be designed to withstand vibrations and shocks encountered in service as per IEC 61373 or latest unless otherwise prescribed.

4. DESCRIPTION

4.1 SUBJECT

SHORT DESCRIPTION

Transformer for supply of the bogie related traction converters and the auxiliary converters from the centenary (25kV/50Hz). In order to connect a passive filter, the transformer includes an additional filter winding.

NUMBER OF ITEMS (within transformer)

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

- 1 Ttransformer
- 4 Traction winding
- 1 Primary winding
- 1 BUR winding
- 1 Filter winding
- Series resonance choke unit (2 chokes)
- BUR choke unit (3 double chokes)
- Transformer oil

4.2 FUNCTION/PRINCIPLE

The transformer tank contains main transformer, the series resonant & auxiliary converter chokes. External cooling of 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.

5. TECHNICAL DATA

5.1: GENERAL DESIGN

The Transformer shall generally confirm to specification No: CLW/ES/3/0456 (latest Version) for main Transformer for WAG-9 (Co-Co) Electric Locomotives unless otherwise specified.

ASSEMBLY

The transformer tank should be suspended horizontally at the middle of the under frame (under floor transformer). The HV – supply connected through a High Voltage cable with Plug.

COOLING

Type	: Forced oil cooling with two circuits
Oil flow rate (nom)	: 2 X1000Lt/min
Pressure drop, transformer tank (max)	: 1000 mbar at 1000 Lt/min
Pump type	: Plumettaz TA08-2174/15 or equivalent
Oil temperature, tank drainage(max)	: 80°C at Pverl max = 240 kW
Oil temperature, tank drainage (max)	: 84°C
Oil temperature rise (max)	: 4°K at 1000Lt/min

Maximum temperature of the winding and oil according to standard IEC 60310 minus 20°C.

Air inlet temperature for Transformer to be 68.2°C considering preheating of air due to converters for an overall maximum Oil temperature 84.5°C

COOLANT

Type : Mineral oil
Make : Shell Diala DX or equivalent Oil confirming to IEC60296 class -II
Oil weight : 1850kg or to be declared by manufacturer .

FIXED ELECTRICAL CONNECTIONS

- Preferably pressed –on
- Not soldered (brazed)

SHOCK AND VIBRATIONAL STRESS

Transformer shall confirm to class-A , Category-1of the latest version of IEC61373

INFLAMMABILITY AND TOXICITY OF THE MATERIALS

-NO PCB
-Non Toxic
Avoid any flammable prone materials.

5.2 TRANFORMER UNIT

Assembly : Dimension according to HSTN003359P0001(CLW/ES/3/SK-1/0456/K) Interface Dimensions (Elecrical+ Mechanical) shall be matched according to HSTN003359. the new transformer should be 100% interchangeble with the existing transformer without any changes at car body level.

Estimated total weight including Oil : **9450kg ± 3%**

Transformer tank

Material, transformer tank : Steel (Grade S355) as per EN 10025.or equivalent Indian standard
Cover, transformer tank : Bolt - on Oil Proof
Shock resistance : According to latest version of IEC 61373
Color : RAL 7009
Finish : Silky

Electrical Connections: Connection for winding and chokes according to outline drawing HSTN003359P0001.

ADDITIONAL APPARATUS OF THE TRANSFORMER

- Overflow valve (in case 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 drainage and intake
- Transformer tank fastening
- 2 Expansion tanks, RAL 7030
- Earthing

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

5.3 : MAIN TRANSFORMER

- Type : LOT 6500
- Required number : 1
- Outline drawing : HSTN003359 P0001

APPLICATION:

SUPPLY FROM	Number of windings
2 traction converters	4
3 Auxiliary converter	1
1 filter winding	1

The traction converters (02 per loco) use GTO-IGBT technology with a two potnt circuit and a link circuit. In order to reduce harmonic, traction converters are phase shifted (frequency 250Hz, K=5). On the other hand auxiliary converters are controls according to requirements and they are indipendent of each other.

5.3.1 Catenary

Frequency : f_{nom}: 50 Hz ± 3%
Voltage : max: 30KV;
Min : 17.5 KV

5.3.2 Power Data

Ratios:

U = UInom : Ux Tolerance +0.5% (accordance to IEC 60310)

Secondary no load voltage U1 = 25 kV

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

Thermal Design:

Calculated at U_{Imin} = 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

Inrush current

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

Rated Power

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

Power Loss

At U_{1def} (22.5kV): 195 KW + 15%

Magnetizing current:

At U_{Inom} (25 KV) : 0.7 A
U_{Imin} (22.5 KV) : 0.5 A
U_{Imax} (27.5 KV) : 1.3 A
U_{Imax} (17.5 KV) : 0.3 A
U_{Imax} (30 KV) : 3.5 A

Winding data:

- Values, secondary side related
- Values, measured on the terminal
- Values, at an operational temperature T cu= 75C

Winding	Resistance value mΩ	Resistance tol	Inductance value MH	Inductance tol
Primary winding				
Traction winding	37		2.1	+15%
Auxiliary winding HB	60		0.43	
Filter winding	19		0.29	

Note: Resistance to be delared by the Manufacturers considering best suited CRGO.

With the exception of the traction inductance, the above given values are for information only
All winding should be inductance decoupled as far as possible.

Measures against eventual over voltage transformer (e.g. system resonance)

- Appropriate arrangement of the winding
- **capacitive screeing if required can be provided based on transformer design topology with appropriate reasoning.**

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 latest version

5.4 ARRANGEMENT OF THE WINDING, TERMINAL DESIGN

As per manufacturers design keeping the same bushing location as per existing arrangement. However, prior approval of vendor approving agency shall be taken for design and schemetic connection diagram.

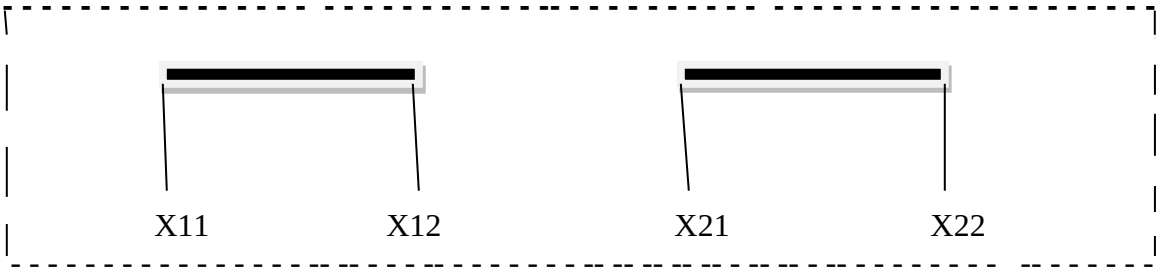
5.5 Series Resonant Inductor Unit :

- Scheme position : 15.3
- Type : 2 SOD 240
- Required Number : 1

5.5.1 **Electrical Data**

Inductance : 2x0.551 mH (± 15%) (until I_{peak} = 1391Amp)
Thermal Current : 2x 984 A_{eff}
Resonanse frequency :100HZ
Voltage Stress
Between terminals Max : 482 V AC (maximum)
Against Earth Max : 3471 V
Power Loss : 12.5 KW + 15%

5.5.2 TERMINAL ARRANGEMENT and DESIGNATION



5.6. AUXILIARY CONVERTER CHOKE UNIT : (3 Double Choke)

- Scheme position : 51.3
- Type : 6 GOD 120

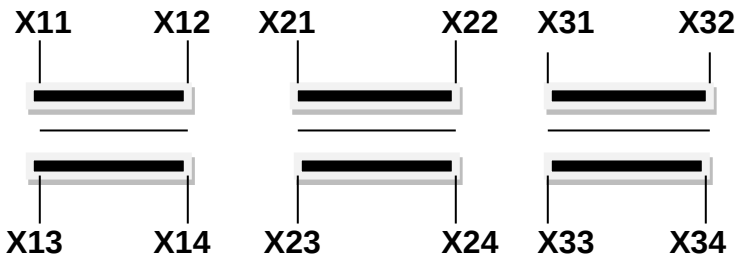
5.6.1 Electrical Data

Inductance per BUR – Choke
0 A : 30mH
120 A : 30mH
155 A : 26mH
190 A : 20 mH
Tolerance : - 0% + free
Frequency : 100HZ
Current Rated : 155 A
Maximum : 190 A
Ripple Nom : 38.6%
Max : 50.2%

Voltage Stress
Rated : 1153 V AC (maximum)
Against Earth Max : 200 V

Dissipation Power at I_{nom} : 12 KW + 15%

5.6.2 **TERMINAL 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.

6. **STANDARDS/ QUALITY**

6.1 **Standards**

IEC 60038	: Standard voltage
IEC 60077	: Electrical traction devices
IEC 60310	: Rules for traction transformers and reactors
IEC 60296	: Transformer Oil
IEC 61373	: Shock and Vibration
ISO 9606	: For welder certification

6.2 **Quality**

QS-qualification (according to quality management manual 3EHQ600002 Rev. C)

Transformer complete	: Q-class 3
Main transformer	: Q-class 3
Series resonant choke	: Q-class 3
BUR-Choke	: Q-class 4
Transformer tank	: Q-class 4

Execution : An ISO: 9001 similar QS system must be used at least.

6.3 Reliability requirement

6.3.1 Life Time:

Operational Time

Daily : Approx 16 Hrs. (at approx. 330 days per year)
Yearly : 5280 Hrs
Within 40 years : 211200 Hrs

6.3.2 Reliability:

Under operational condition given in clause 5.3.1 MTBF of $11x10^6$ is expected.

7.0 Test Programme:

7.1 Type Test: A type test according to IEC60310 latest version is required. the type test procedure according to HSTN1612192 has to be submitted to the project management for approval.

7.2 Routine Test: Routine test according to IEC60310 latest version is required. the type test procedure according to HSTN1612192 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 cuircuit impedence of all windings and cross coupling.

7.4 Time Schedule: Type and routine test takes place in ppresence of inspecting officers 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	Weight Measurement 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 inspection will be carried out by the authorized representatives of Indian .Railways

8. DOCUMENTATION

- QAP
- Design Data sheet
- Technical data sheet
- GA drawing
- Bill of material (sorted by indent no-)
- .Maintance manual
- Installation and commissioning manual

8.1 All drawings and description which are necessary 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.

8.2 **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.

8.3 **Manual**

The manual includes all necessary information for correct operation, maintenance, fault-finding and repair of the transformer, including spare part catalogue and instructions for assembly, dismantling and replacement of the individual components. An overview of function and work order has to be given. The chapters of the manual must belong to the individual sub-assembly components. All drawing and documents, which are used as reference documents, have to be given as annexure to the manual.

8.4 REFERENCE DOCUMENTS

Main power circuit : 3 EHP281141
Auxiliary Scheme : 3 EHP281142
Cooling system : 3 EHP510077
Specification for Main Transformer for WAG-9 (Co-Co) Electric locomotives : CLW/ES/3/0456 latest version.

9.0 SCOPE OF SUPPLY

SL. No	Item Description	Qty/Loco

1	Transformer winding inside the Tank	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	Quick -Coupling as per drawing no CLW/ES/3/SK-4/0456/K	6 Sets (one set consists of one male and one female)
9	Elbow Union as per drawing no CLW/ES/3/SK-5/ 0456/K.	2 Nos
10	Transformer Oil : Confirming to IEC- 60296 Class II.	The Transformer tank sould be completely filled with Oil. 350 liters Oil should be separately provided for filling in conservator tank and Oil pipe s and other accessories
11	Set of Transformer fixing bolts and plates as per Spec. No. CLW/ES/3/0069 Alt-D.	01 Set
12	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-6/0456 latest version.

10.0 Label and Marking :

10.1 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.

10.2 * 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.

Note : Standard Hardware and fasteners of CLW/BLW/RDSO approved source only to be used.