Draft

Specifications

for

Main Transformer of 7775 kVA for 3-Phase drive locomotives

Type WAP-5 / WAP-7 with increased Hotel Load Capacity of 1245 kVA 960V

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Main Transformer of 7775 kVA for 3-Ph drive locomotives type WAP-5 / WAP-7 with increased Hotel Load Capacity of 1245 kVA 960V	PREP.BY.	CHECKED .BY	CENTRE FOR DESIGN & DEVELOPMENT CHITTARANJAN LOCOMOTIVE WORKS WEST BENGAL, INDIA NO: CLW/ES/3/ 0542/D&D					
	APPROVED BY.		ALT.					

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Abbreviations

The following abbreviations are used in this specification:

Abbreviations	Full Name
CLW	Chittaranjan Locomotive Works.
OEM	Original Equipment Manufacturer.
RDSO	Research Design and Standards Organisation.
Bidder	Shall mean firm or company participating in the tender to manufacture of the item.
Contractor	Shall mean firm or company with whom the order to manufacture the item has been placed.
Supplier	The successful tenderer for supply of the equipment.

1.0 Foreword

This specification covers broad features, requirement and testing of the main transformer for 3-phase drive locomotives type WAP5/WAP7. These locomotives are presently being manufactured by CLW with 7475 KVA capacity transformers as per their original design.

The main transformer type LOT 7500 for WAP5 locomotive was originally supplied by M/s. ABB Secheron/Switzerland and now is to be manufactured to the same design in terms of ToT document available with CLW but with slightly increased hotel load winding capacity and voltage. In this regard, approved manufacturers of transformers for 3-ph drive locomotives which have TOT documents of OEM's will be considered for development of LOT 7775 KVA transformer with revised hotel load rating as 1245 KVA, 960V.

2.0 Climate & Environment Conditions

Max. Atmospheric Temp.	:	Under Sun -	70°C
		In Shade -	50°C
Humidity	:	100% saturation during rainy season	
Reference site conditions	:		
(i) Ambient Temp.	:	Max. 55°C, Min. 0°C	
(ii) Humidity	:	60%	
(iii) Altitude	:	160 m above mean sea level	
(iv) Rainfall	:	Very heavy in certain areas. The locomotive will be designed to permit its running at 10 kmph in flood water level of 102mm above rail level.	
Atmosphere during hot weather	:	Extremely dusty and desert terrain in certain areas.	
Coastal area	:	Locomotive and equipment will be designed to work in coastal areas in humid and salt laden atmosphere.	
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.	

3.0 Standards

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

- **ToT design documents to be obtained under MOU with CLW.**
- IEC-60310 - Rules for traction transformers and reactors
- IEC-60076 - Recommendations for power transformers
- IEC-61373 - Rules for Electrical Traction Devices
- IEC-38 - Standard voltages
- IEC-60296 - Transformer Oil

4.0 Description

4.1 Each loco requires one transformer for feeding supply to traction converters/ traction motors, to auxiliary converter for supplying to auxiliary machines and to supply Hotel load of train. This transformer will consist of Primary winding, 04 Traction windings, Auxiliary winding (BUR) and Hotel Load winding. In addition, it has a FILTER winding which is connected on locomotive to passive filter.

4.2 The transformer tank also contains 02 series resonant chokes (one for each converter) & 03 Auxiliary Converter double chokes (one for each of the 03 auxiliary converters).

4.3 Transformer is oil cooled and external cooling of the oil is designed with two independent oil circuits with cooling units located within the machine room of locomotives. However, the cooling units / circuit component do not form part of transformer supply.

4.4 <u>The special features of the transformer are</u>

- Transformer is mounted under slung on under frame
- Transformer is designed for feeding GTO/IGBT based Power and Auxiliary converter load.
- Very high impedance between primary & traction windings
- 100% de-couplings between windings
- Use of continuous transposed conductor for windings
- Use of disc construction of windings
- Transformer and conservator tank of Alluminium Alloy
- Rapid action coupling between transformer and conservators in oil circuit

4.5 <u>Additional apparatus of the transformer</u>

- 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 of oil intake and drainage
- Transformer tank fastening
- Two conservator tanks including
  - Air dehumidifier including valve
  - Oil level gauge

-Connection to the transformer including rapid action coupling
-Oil filler tap
-Oil drainage screw

- Earthing

4.6 For general arrangement of transformer- refer CLW Drawing No.CLW/ES/3/SK-1/0315 of WAP7/WAP5 loco transformer.

5.0 Technical Details

Salient / Technical details of the transformer are given below. For other details of design/ manufacture, refer to ToT documents. Note that any deviation from ToT document/ design will require specific approval of purchaser.

5.1 Transformer

Catenary Voltage: Max: 30 KV
Nominal: 25 KV
Min: 17.5 KV

Frequency: 50 Hz ±6%

Ratings for WAP5 / WAP7 Loco Transformer

WINDING	POWER (KVA)	VOLTAGE (V)	CURRENT (A)
HV	7775	25000	311
TRACTION	4x1449	4x1269	4x1142
BUR	334	1000	334
FILTER	400	1154	347
HOTEL LOAD	1245	960	1296

Percentage impedance voltage at rated traction winding , 1449 KVA

Impedance HV to all traction windings shorted: 60%

5.3 Series resonant choke type 2 SOD 240

i) Inductance per choke : 2 x 0.551 mH (±15%)
Linear to I_{peak} = 1391A

ii) Thermal current I_{Th} : 2 x 984A_{eff}

iii) Resonant frequency : 100 Hz

iv) Voltage stress between

a. terminals max. : 482 VAC
b. to earth max. : 3471 V

v) Separate voltage withstand capability : 10 KV

5.4 Auxiliary converter choke type 6 GOD 120

(i) Inductance per BUR-choke :

0A		:	30 mH
120A		:	30 mH
155A		:	26 mH
190A		:	20 mH
(ii)Tolerances		:	-0%, +free
(iii) Frequency		:	100 Hz
(iv)Current	rated	:	155 A
	max.	:	190 A
(v)Ripple	nom.	:	38.6%
	max.	:	50.2%
(vi)Voltage to earth	rated	:	1153 V
	max.	:	2000 V
(vii)Separate voltage withstand capability		:	10 KV

5.5 No load magnetization current (A)

(i) at 25 KV : 0.7%(approx.)

(ii) at 22.5 KV :0.5%(approx.)

(iii) at 27.5 KV : 1.3%(approx.)

5.6 Transformer losses at 25 KV

(i) Core(kw) : 3.5 + IEC Tol.

(ii) Copper(kw) :206.5 + IEC Tol.

(iii) Total :210 + IEC Tol.

5.7 Transformer overall efficiency

At 25 KV : ≥ 97 %(approx.)

5.8 Permissible and designed temperature rise

(i) Oil (°C) : 45 °C [IEC 60310-20 °C]

(ii)Winding (°C) :55 °C [IEC 60310-20 °C]

5.9 Type of Cooling and cooling medium

OFAF. Inhibited mineral Transformer Oil as per IEC: 60296

5.10 Class of Insulation

(i) on conductors : Enamel of class H and nomex insulation of class H

(ii)Cooling medium : Class A(Mineral inhibited insulation oil)

5.11 Dielectric levels

	Primary Traction Aux.	Filter	Hotel load
(i) Induced voltage withstand (KV)	60 -	-	- -
(ii) Separate source withstand (KV)	5 8.3 5	5	5

(iii) Impulse voltage withstand (KVp) 150 - - - -

6.0 Total Weight : WAP5/WAP7- 10,000 ± 3% kg

7.0 Tests

Type tests on the prototype unit as per IEC:60310

8.0 Quality Assurance Plan

Existing approved Quality Assurance Plan for manufacturing of 3-ph locomotive transformers will be followed.

9.0 Bill of Material (BoM)

Existing approved Bill of Material (BOM) for manufacturing of 3-ph locomotive transformers will be followed.

10.0 Documentation

10.1 Contents

10.1.1 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 mentioned, including consumable items. A family tree has to be given, including all drawings, arts lists and other relevant documents which are part of the documentation. Also a complete list of all documents and a complete list of all components ("Bill of Material").

10.1.2 Manual

The manual includes all necessary information for correct operation, maintenance, faultfinding and repair of the transformer. Including spare parts catalogue and instruction for assembly, dismantling and replacement of the individual components.

10.1.3 Language

All documents, including reference documents, shall be in English.

10.2 Structure

10.2.1 Drawing, Tracing and Descriptions

The documentation shall be structured by the following order:

1. Family Tree
2. List of drawings (sorted by Indent-NO.)
3. Bill of materials (sorted by Indent-NO.)
4. Drawings, etc. (sorted by subassembly components, corresponding to the family tree).

All documents have to be given in proper folders. Loosen documents Will be not be accepted.

10.2.2 Manual

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 drawings and documents, which are used as reference documents, have to be given as annexure to the manual.

10.2.3 Standards / Units

Only IEC – Standards or internationally recognized standards shall be accepted. Only SI Units will be accepted.

10.2.4 Drawings, Tracing and descriptions

6 Sets of hard copies and one set of softcopy of complete design document, Drawings, BoM, etc.

10.2.5 Manuals

4 sets of copies (According to 8.4.2)

10.2.6 Delivery Requirement

- Acceptance : As per bid document
- Delivery : As per bid document
- Packing : As per bid document
- Delivery address : As per bid document
- Type test : As per Tender document
- Routine Test : As per Tender document
- Purchasing specification: As per bid document

11.0 Scope of supply:

	Qty / Loco
Transformer	: 1 No.
Series Resonant choke	: 2 Nos.
D.C. Link circuit choke aux. converter	: 6 Nos.
High Voltage bushing mounted on Transformer	: 1 Set
RTD – PT 100 mounted on Transformer	: 1 No.
Conservator tank with Breather	: 2 Nos.
Hose with nipple (3EHP431215R0001)	: 2 Nos.
Connecting Hose complete with nipple (3EHP431217R0001)	: 1 No.
Connecting Hose complete with nipple (3EHP431253R0001)	: 2 Nos.
Quick Couplings as per drawing no.-CLW/ES/3/SK-4/0315 Alt.H (one set consists of one male and one Female)	: 6 Nos.
Elbow Union as per drawing no.-CLW/ES/3/SK-5/0315 Alt.H	: 2 Nos.

Transformer Oil-Shell Diala DX or equivalent APAR OIL. Conforming to IEC 60296 Class II

The Transformer and conservator tank should be completely filled with Oil. One-barrel (209 liters) to be separately provided for filling in oil pipes and other accessories.

Set of Transformer fixing bolts and plates as per Spec no. CLW/ES/3/SK-1/0315 Alt.H : 1 Set

Supply should also confirm to drawing no.-CLW/ES/3/SK-1/0315 Alt.H to CLW/ES/3/SK-5/0315 Alt.H

12.0 Documents to be supplied by bidder:

The tender shall integrate the following along with the quotation.

i) Clause wise comments on the specification and Test Program.
ii) Detailed drawings.
iii) Past experience with supporting papers (if Any)
iv) Quality Assurance Program
v) Machinery & Plant for Such Job.

13.0 Technical documents to supplied by Contractor:

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

i) Type Test reports
ii) Routine Test reports along with each set
iii) Maintenance manual
iv) Design data calculation and drawings of transformer submitted by that supplier to CLW and RDSO during design approval.

Design data:

- Make and type
- Type of Construction
- Particular 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 cooling equipment, details of devices associated with the Transformer.
- Design calculation
- Reliability predictions for transformer.
- Drawings.
- List of materials used in construction of the transformer general arrangement of transformer , windings and core and connected auxiliary.

14.0 Quality assurance:

Quality assurance should be as per ISO 9000.

15.0 Reference:

Supplier / OEM - ABB Sécheron SA

NOTE:

1. The contractor shall emboss following data in their Products.
   (i) Make
   (ii) Year and month of manufacturing
   (iii) Serial No.
   (iv) Trade mark, If any
   (v) Drawing. No.
   (vi) Order No.
2. Standard fasteners of M/s TVS, M/s un-brako and Spring washers of M/s Forbes make only to be used.
3. Firm should provide Min/Max Oil level scale in Conservator tanks.
4. For other references, if any, CLW specification for LOT 7500 KVA transformer No. CLW/ES/3/0315, Alt 'H' may be referred or RDSO may be approached.