सत्यमेव जयते

भारत सरकार GOVERNMENT OF INDIA
रेल मंत्रालय MINISTRY OF RAILWAYS

केवल कार्यालयीन उपयोग हेतु
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एसी ईएमयू/एमईएमयू के ट्रान्सफार्मर के अनुरक्षण की लघु पुस्तिका

MAINTENANCE HANDBOOK ON TRANSFORMER OF AC EMU/MEMU

TARGET GROUP – TECHNICIANS & SUPERVISORS OF AC EMU/MEMU CAR SHEDS, WORKSHOPS

केमटेक/ई/2005/टीएफपी–ईएमयू/1.0
CAMTECH/E/2005/TFP-EMU/1.0

अक्टूबर 2005
October 2005

Centre for Advanced Maintenance TECHnology

उच्च अनुरक्षण प्रौद्योगिकी केन्द्र

Excellence in Maintenance

महाराजपुर, ग्वालियर – 474 020
Maharajpur, GWALIOR - 474 020

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FOREWORD

With increasing passenger traffic in Metropolitans & their connected cities, reliability of AC EMU/ MEMUs has become very important. Proper maintenance of transformer is vital to ensure trouble free operation of EMU/MEMUs.

CAMTECH has prepared this handbook to cover all essential aspects of maintenance and overhauling of transformer of AC EMU/MEMUs. It describes technical details, description of different parts, various maintenance schedules including POH, failures, causes and their remedies. It also describes transformer oil purification and condition monitoring of transformer by dissolved gas analysis (DGA).

I am sure the handbook will prove to be very useful to our maintenance staff in EMU car sheds/ workshops.

CAMTECH, Gwalior — ***R.N.Misra***
Date:24.10.2005 — ***Executive Director***

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PREFACE

The transformer is one of the most important equipment of AC EMU/ MEMU. Proper maintenance of transformer is essential to ensure reliability of AC EMU/ MEMUs in service.

This handbook on maintenance of transformer has been prepared by CAMTECH with the objective of making our maintenance personnel aware of correct maintenance and overhaul techniques to be adopted in field.

It is clarified that this handbook does not supersede any existing provisions laid down by RDSO or Railway Board. The handbook is for guidance only and it is not a statutory document.

I am sincerely thankful to Exe. Director/ EMU, RDSO/LKO for his valuable comments. I am also thankful to all field personnel who helped us in preparing this handbook.

Technology upgradation and learning is a continuous process. Hence feel free to write to us for any addition or modification in this handbook. We shall highly appreciate your contribution in this direction.

CAMTECH, Gwalior
Date:24. 10. 2005

Randhawa Suhag
Director/Electrical

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ISSUE OF CORRECTION SLIP

The correction slips to be issued in future for this handbook will be numbered as follows:

CAMTECH/E/2005/TFP-EMU/1.0/ C.S. # XX date---

Where “XX” is the serial number of the concerned correction slip (starting from 01 onwards).

CORRECTION SLIPS ISSUED

Sr. No.	Date of issue	Page no. and Item no. modified	Remarks

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CHAPTER 1

GENERAL DESCRIPTION

1.1 INTRODUCTION

Transformer is one of the most important traction equipment of AC EMU/MEMU. It is double wound with primary and secondary windings interleaved together to give a sandwich construction.

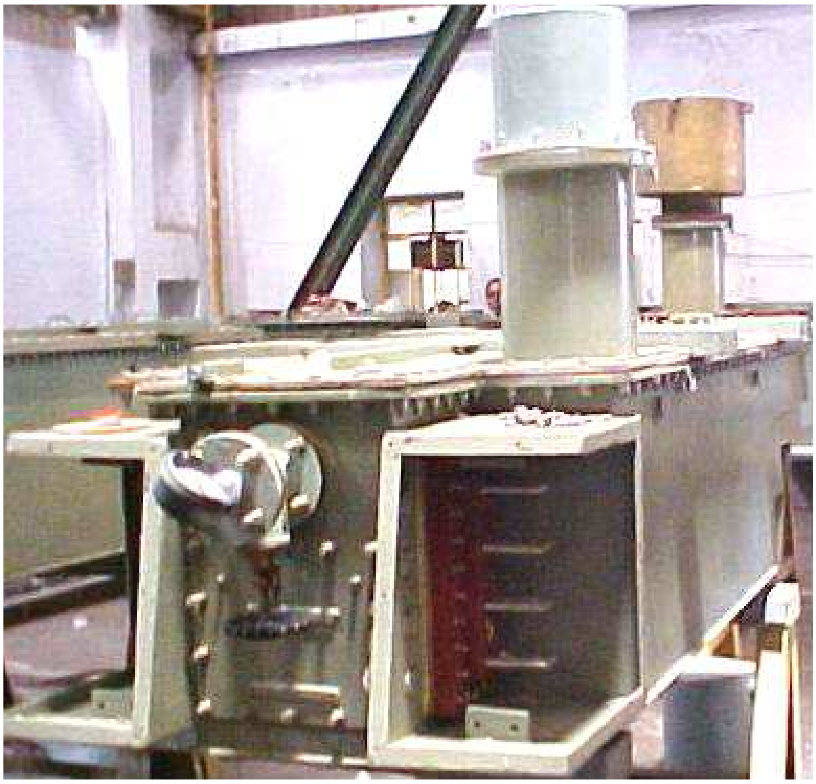

Figure 1.1 TRANSFORMER

Current at 25 kV is taken from OHE to its primary winding via the pantograph, the vacuum circuit breaker and the high tension main bushing. The return path for this current is via the earthing brushes mounted in the axle cap of each traction motor and the running rails.

The secondary winding of the transformer is in two sections, one section having five tapped sections, other being untapped. This arrangement gives a total twenty-two voltage steps by various connections of transformer tappings and voltage dropping reactors. This voltage, which is controlled by the tap-changing switchgroup, is applied to the silicon rectifiers, the full wave output of which is fed to the traction motors via the smoothing reactor.

Two tertiary windings, auxiliary I and II are provided. Auxiliary I, 266 V winding feeds the single phase a.c. auxiliary machines. Auxiliary II, 141 V winding supplies power to normal lights & fans, head lights stabilizer, the auxiliary rectifier for main compressor motor.

The transformer is oil-immersed type and oil is forced circulated and cooled in radiator by blower set.

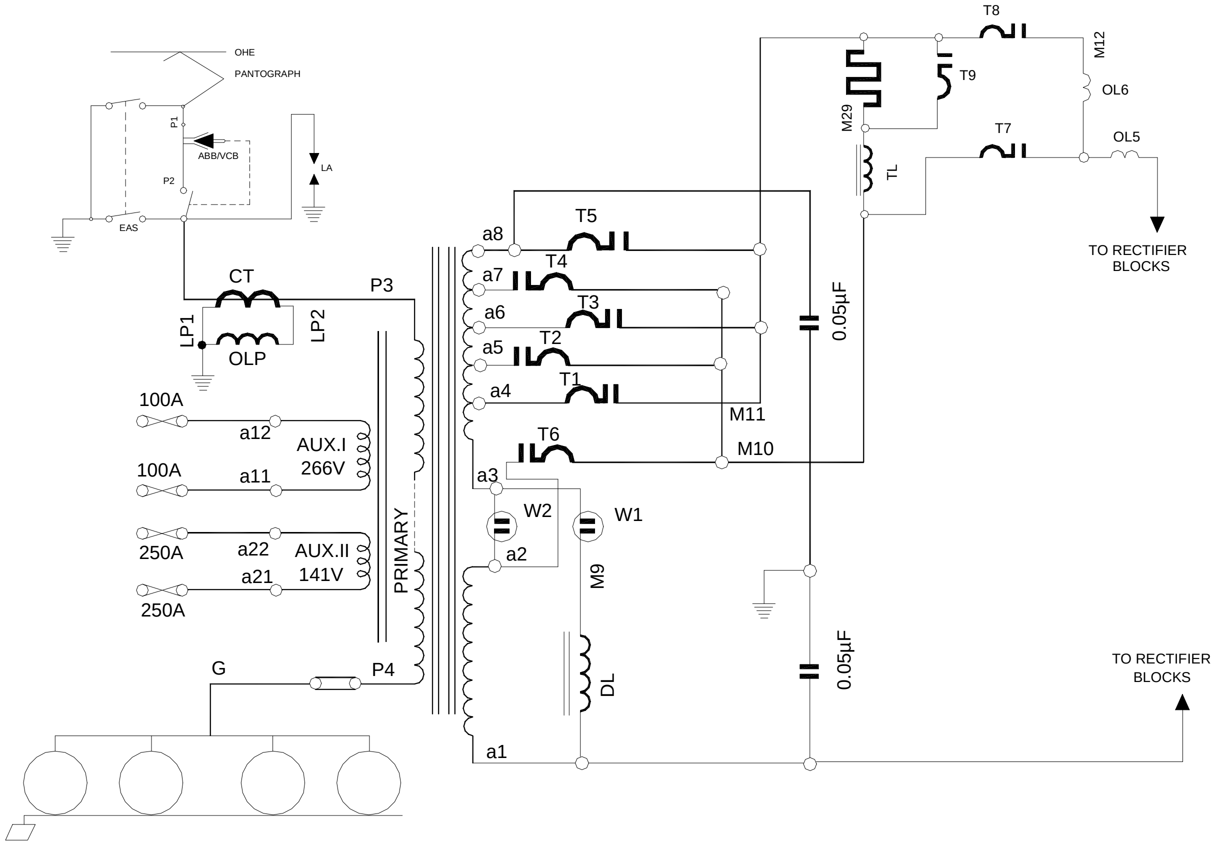

Figure 1.2 CIRCUIT DIAGRAM

1.2 TECHNICAL DETAILS

Make	BHEL
Continuous Rating	1000 KVA at 25 kV
Primary winding	25 kV/40 Amp.
Secondary winding	782 Volt/ 1280 Amp.
Auxiliary winding I	266 Volt/55 Amp.
Auxiliary winding II	141 Volt/250 Amp.
Frequency	50 Hz
Cooling	OFAF

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Secondary winding

Across	Voltage	kVA
$a_3 - a_4$	78.2	100
$a_3 - a_5$	156.4	200
$a_3 - a_6$	234.6	300
$a_3 - a_7$	312.8	400
$a_3 - a_8$	391.0	500
$a_1 - a_2$	391.0	500
$a_1 - a_4$	469.2	600
$a_1 - a_5$	547.5	700
$a_1 - a_6$	625.6	800
$a_1 - a_7$	703.8	900
$a_1 - a_8$	782.0	1000

Thermostat setting	75°C

Approximate Weight	**(in Kg)**
Core and winding	1375
Tank and fittings	715
OFAF cooler	460
Oil in conservator	40
Total oil	795
Total weight	3402

Oil quantity	**(in Litres)**
Oil in tank	668
Oil in Radiators & Pipe works	87
Conservator	77
Pipe work	100
Total oil	675

Cooling pump

Capacity	363.6 litres/minute at 70°C against a 7.32 meter head.
RPM	1430
Size of suction branch	76 mm
Size of delivery branch	73 mm

Pump motor

BHP	1.5
RPM	1430
Rating	240 ± 22.5%V, 1 phase, 50 Hz.

1.3 DIFFERENT PARTS OF TRANSFORMER

1.3.1 Core

The core is a three limbed shell type construction, each limb being inter-leaved with the top and bottom yokes. The laminations are made from high-grade non-ageing silicon alloy cold rolled grain-oriented steel. After cutting and punching the sheets are deburred, stress relieved and varnished.

Figure 1.3

1.3.2 Windings

H.V. (primary), L.V. (secondary), and auxiliary (tertiary) windings are arranged on the centre limb and are inter-leaved to give a robust mechanical construction. Tapings are provided on secondary for voltage variation and are brought out individually for connection to an external tap changer switch group.

Figure 1.4

1.3.3 Terminal Arrangement

The H.V. (primary) line terminal is brought out to the H.V. turret through the cover & connection is made to condenser bushing/ cable head bushing.

The L.V. (secondary) terminals, 8 in number each capable of carrying 1280 amperes, are taken from the side of the tank through epoxy resinated terminal boards with copper bars embedded into it.

Figure 1.5

Four terminals of two auxiliaries are taken through another epoxy resinated terminal board in a similar fashion as in the case of L.V. The primary earthing terminal is taken through a 6.6 KV porcelain bushing and is connected to earth.

1.3.4 Tank

The tank is of welded mild steel plate construction, shot blasted on the inside and outside to remove the scale before painting. The tank is designed to withstand a pressure of 0.55 kg/sq.cm. Inside of the tank is coated with Copal varnish and the outside with three coats of high quality paint, comprising of a primary coat of anti-corrosive paint, an intermediate coat and a finish coat of battleship grey.

Figure 1.6

1.3.5 Fittings

The following fittings are provided with transformer.

1. Conservator with oil gauge.
2. Silica-gel breather mounted on the conservator.
3. Buchholz relay
4. Thermostat
5. Relief vent
6. Drain valve
7. Filling holes
8. Filter valve
9. Oil inlet and outlet valves.
10. Drain plug with locking valves.
11. Air release plug.
12. Pressure Relief Valve (PRV)
13. Turret
14. Main Bushing

1.4 DESCRIPTION OF IMPORTANT FITTINGS

1.4.1 Conservator With Oil Gauge

It is a drum containing transformer oil and is mounted in the HT compartment. It is connected to the transformer via the Buchholz protection relay. As the volume of oil of transformer tank expands and contracts according to heat produced, this expansion and contraction of oil causes the level of the oil in conservator to rise and fall. The aim of conservator is to

- Maintain the oil level in tank
- Provide space for the expansion of oil.

An oil gauge indicator is also provided on one side of conservator drum with a scale having marking according to temperature.

Figure 1.7

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1.4.2 Breather

It is attached to conservator tank and contains silica gel, which prevents the moist air from entering into the tank during contraction of oil. When oil is hot there is expansion and gas passes to atmosphere through it. When oil is cooled, there is contraction and the air enters in it.

Air entering the breather is first drawn through an oil seal and passes upwards through the silica gel crystals to the connecting pipe at the top. During this upward passage of air, any moisture present is absorbed by the dry silica gel. The oil seal ensures that the gel absorbs moisture only when the transformer is breathing. Thus it prevents transformer oil from moisture contamination.

Figure 1.8

1.4.3 Buchholz Relay

A gas actuated double element Buchholz device (BUD) is fitted in the pipe connection between the conservator and the transformer tank in which the metal to metal (silver) contacts are used. Under normal conditions, it is full of oil.

Figure 1.9

Buchholz relay is provided with an indicating flag and a mechanical latch so that when it is closed by operation of either FAST or SLOW contacts of the Buchholz device, it remains closed until the reset button is pressed. Contact BIR/1 is connected in the air blast circuit breaker (or VCB) circuit to trip in the event of a Buchholz operation and red ABB/VCB 'OFF' light is lit in the faulty unit.

Relay BIR trips permanently and the transformer is disconnected from the supply through circuit breaker tripping if any of the following faults occurred:

a. Broken down core bolts.

b. Shorted laminations.

c. Bad contacts

d. Over heating of some part of the windings.

e. Falling of oil level arising from leakage.

f. Ingress of air, through defects in the oil circulating system.

g. Puncture of bushings.

h. Short circuit between phases.

i. Earth faults.

j. Winding short circuits.

k. Oil level falling below height of mounting position of the protector.

1.4.4 Thermostat

The thermostat fitted is a type GM thermostat of Teddingation control with a range of 57/ 99 deg. C continuously adjustable and is set at 75°C.

Undue rise in temperature of the transformer oil causes the transformer thermostat to operate, which in turn picks up the transformer thermostat relay (TTR). Operation of the relay TTR interrupts the feed to the motor contactors and also lights unit fault lamps in the faulty unit.

Figure 1.10

When the transformer oil has cooled, the thermostat TT and the relay TTR return to normal position, allowing traction power to be restored, but leaving the flag indication to show that a trip has occurred. The flag can be reset by operation of a button on the relay.

1.4.5 Relief Vent

A major fault inside the transformer causes instantaneous vaporization of oil, leading to extremely rapid build up of gaseous pressure. If this pressure is not released with in few milliseconds, the transformer tank can rupture, spilling oil over a wide area. This relief vent provides instantaneous releasing of such dangerous pressure and protects the transformer.

1.4.6 Pressure Relief Valve

In case of severe fault in the transformer, the inter pressure may built up to a very high level which may result in an explosion of tank. To avoid such a contingency, a pressure relief valve is fitted on the transformer. It is spring-loaded and has contacts for giving visual indication and ABB/VCB tripping.

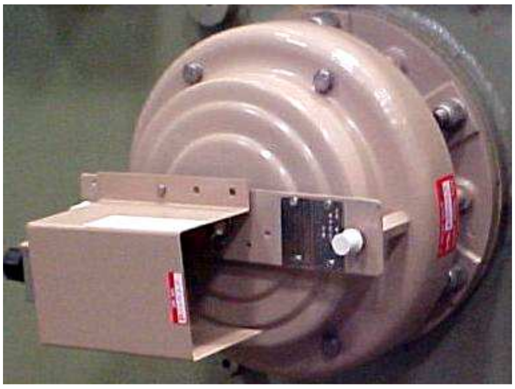

Figure 1.11

When pressure in the tank rises above predetermined safe limit, this valve operates and performs following function:

a. Allows the pressure to drop by instantaneously opening a port of about 150mm dia.

b. Gives visual indication of valve operation by raising a flag.

c. Operates a micro switch which gives PRV trip indication by glowing LED and ABB/VCB tripping in the faulty unit.

The valve restores its position as soon as the pressure in the tank drops below set limit. The flag and switch remain operated until they are reset manually.

1.4.7 Main Bushing

25 kV condenser type bushing assembly are in service in most of the AC EMU/MEMU. On some AC EMU/ MEMU cable head type termination is in service.

The 25 kV condenser type bushing assembly consists of three major parts viz. roof bushing, condenser sleeve and transformer bushing. Originally this type of bushing is oil filled. But due to failure of condenser bushing resulting in its bursting and splashing of hot oil on to the floor of motor coach and this hot oil often leads to the fire in the motor coach. In order to avoid such fire cases on EMUs/ MEMUs, RDSO has issued SMI No. RDSO/WAU/01 dt. 20.05.98. According to this SMI, oil is to be removed from condenser bushings and use of cable head terminations in lieu of condenser bushings.

1.5 COOLING EQUIPMENT

The cooling equipment is common for both transformer and reactors and consists of the following:

a. Pump
b. Forced air blast oil cooler (radiator)

Transformer oil from main transformer is pumped by means of a centrifugal pump to an air blast cooler (radiator) through 63.5 mm nominal bore pipe work fitted with flexible stainless steel couplings to make into account the expansion of pipe due to heat. The force-cooled oil is admitted into the reactors tank and then back to transformer tank as shown in figure given below.

The pump used for this transformer is a glandless centrifugal pump with all moving parts completely enclosed and sealed. The pump and driving motor are built as a unit on a common shaft. A window is fitted in the shaft end to enable direction or rotation to be observed.

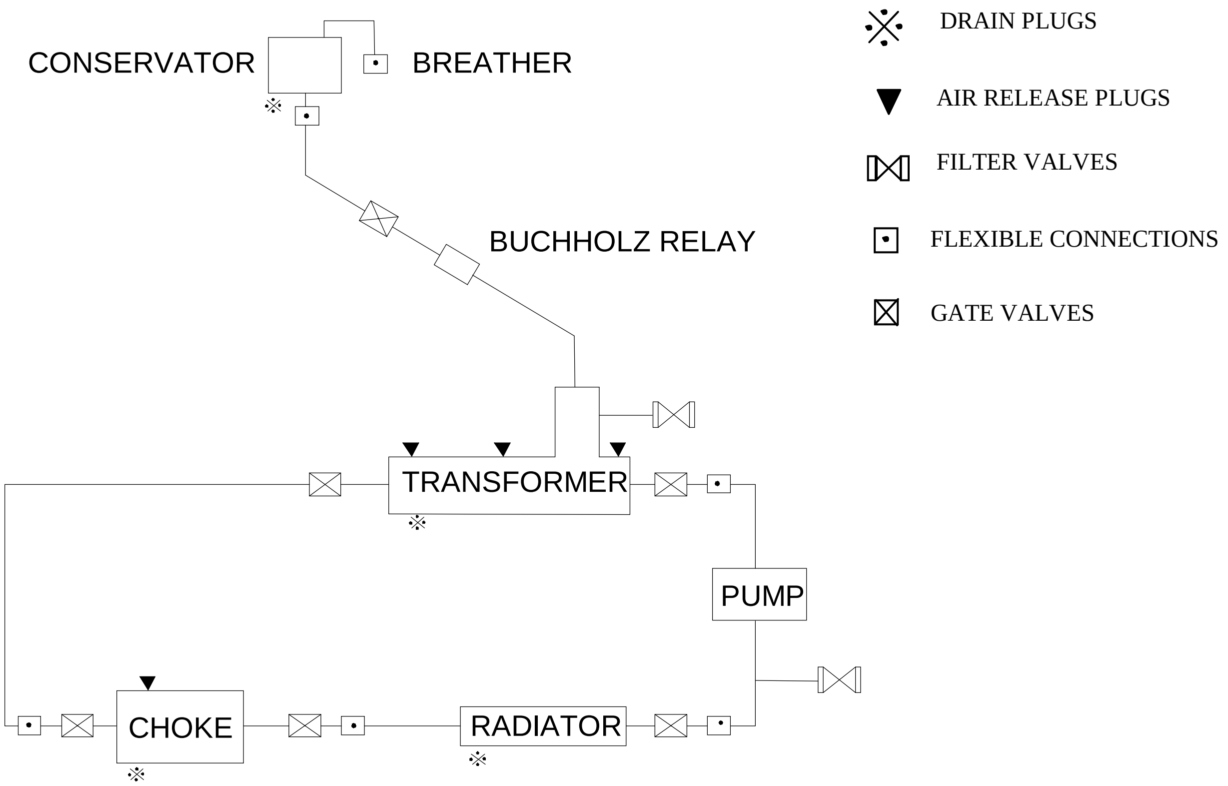

Figure 1.12 OIL CIRCUIT

1.6 FACTORS AFFECTING LIFE OF TRANSFORMER

Life of transformer is affected by the following factors:

1. Moisture
2. Oxygen
3. Solid Impurities
4. Varnishes
5. Slackness of winding

1.6.1 Effect of Moisture on Transformer Life

Presence of moisture in oil is highly undesirable as it affects adversely the dielectric properties of oil. The moisture present in oil also affects the solid insulation of transformer. As paper insulation is highly hygroscopic in nature, when transformer is filled with oil, it absorbs the moisture from oil which affects its insulation properties as well as reduces its life. Solubility of moisture in oil increases with increase in temperature and oxidation products of oil. When the oil in service oxidizes, acids are formed. These acids increase moisture solubility of oil. Acids coupled with moisture further decompose the oil forming more acids and moisture. Thus the rate of deterioration of oil increases.

Check the colour of silicagel in each inspection and if found pink, replace or reactivate crystals at 150 to 200 degree C. Test transformer oil for electric strength and water content in IC schedule & POH and carry out purification with high vacuum type transformer oil filteration plant if required. Arrest the oil leakage if any.

1.6.2 Effect of Oxygen

Oxygen may be present inside the transformer due to air remaining in oil. The oxygen reacts and decomposes the cellulose of insulation. This forms an organic acid soluble in oil and sludge, which blocks the free circulation of the oil. The adverse effect of oxygen, which may be aggravated by catalytic action between hot oil and bare copper, increase the operating temperature.

Carry out oil purification with high vacuum type transformer oil purification plant periodically to remove atmospheric gases (air) and sludge.

1.6.3 Effect of Solid Impurities

The solid impurity present in the oil reduces its dielectric strength considerably. A good remedy is to filter the oil periodically.

1.6.4 Effect of Varnishes

Some varnishes having oxidizing effect, react with transformer oil and precipitate sludge on windings. Synthetic varnishes having acid inhibiting properties, generally delay the natural formation of acid and sludge in the oil.

1.6.5 Effect of Slackness of Winding

After few months of service, the transformer coils may suffer natural setting. This may wear the conductor insulation at some places and lead to an inter-turn failure. The coils may also get displaced under load conditions or momentary short circuit conditions, which may result in electrical and magnetic unbalance and produce even greater displacement. A good practice is, therefore to lift the core and windings to take up any slackness present at the first major schedule.

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CHAPTER 2

MAINTENANCE

Periodic maintenance of transformer is essential to ensure safety, reliability and trouble free operation of EMU/ MEMU over a long time period. Maintenance schedules are given as under.

Schedule	Periodicity
Trip inspection	10 Days
IA Schedules	45 Days
IB Schedules	90 Days
IC Schedules	180 Days
POH	18 Months

Work to be carried out under different schedules is given as under.

2.1 TRIP INSPECTION

S. No	Work/ Inspection to be done	Standard value
1.	Check transformer oil level in conservator tank and top up with 50 kV oil, if required.	15 degree C. (min.)
2.	Check transformer for oil leakages.	No leakage
3.	Check colour of silica gel crystals and replace if found pink.	Blue in colour

2.2 IA SCHEDULE / IB SCHEDULE

S. No	Work/ Inspection to be done	Standard value
1.	Check transformer oil level in conservator tank and top up with 50 kV oil, if required.	15 degree C. (min.)
2.	Check transformer for oil leakages.	No leakage
3.	Check colour of silica gel crystals and replace if found pink.	Blue in colour
4.	Check radiator and its pipe line connections for any oil leakage.	No leakage
5.	Open the radiator protective net and blow the dust of radiator with compressed air and clean it with high pressure water jet. Provide the radiator net.	Clean
6.	Release the gas of transformer from Buchholz device (BUD) and check the operation.	No gas OK

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S. No	Work/ Inspection to be done	Standard value
7.	Check the Buchholz device, conservator, MPH, gate valves and flexible couplings for any oil leakage or damage.	No leakage, no damage.
8.	Check the Buchholz device for intactness of glass, operation of vent cocks, condition of drain plug.	No abnormality.
9.	Check terminal blocks for any oil leakage, flash mark etc. and also check intactness of each connection.	No leakage, intact.
10.	Check main bushing visually for any damage and clean porcelain roof bushing insulator & complete bushing surface thoroughly. Also check intactness of roof bushing connection.	Clean, Intact

2.3 IC SCHEDULE

S. No	Work/ Inspection to be done	Standard value
1.	Check transformer oil level in conservator tank and top up with 50 kV oil, if required.	15 degree C. (min.)
2.	Check transformer for oil leakages.	No leakage
3.	Check colour of silica gel crystals and replace if found pink.	Blue in colour
4.	Check radiator and its pipe line connections for any oil leakage.	No leakage
5.	Open the radiator protective net and blow the dust of radiator with compressed air and clean it with high pressure water jet. Provide the radiator net.	Clean
6.	Release the gas of transformer from Buchholz device (BUD) and check the operation.	No gas OK
7.	Check the Buchholz device, conservator, MPH, gate valves and flexible couplings for any oil leakage or damage.	No leakage, no damage.
8.	Check the Buchholz device for intactness of glass, operation of vent cocks, condition of drain plug.	No abnormality.
9.	Check terminal blocks for any oil leakage, flash mark etc. and also check intactness of each connection.	No leakage, intact.
10.	Check main bushing visually for any damage and clean porcelain roof bushing insulator & complete bushing surface thoroughly. Also check intactness of roof bushing connection.	Clean, Intact

S. No	Work/ Inspection to be done	Record value
11.	Check the insulation resistance of winding between	
	A. Primary to earth by 2.5 kV megger.	
	B. Secondary to earth by 1000V megger.	
	C. Primary to secondary by 1000 V megger.	
	D. Primary to Aux.I by 1000V megger.	
	E. Primary to Aux.II 1000V megger.	
	F. Aux.I to earth by 1000V megger.	
	G. Aux.II to earth by 500V megger.	
	H. Secondary to Aux.I by 1000 V megger.	
	I. Secondary to Aux.II by 1000 V megger.	
	J. Aux.I to Aux.II by 1000V megger	
12.	Ensure tightness of all connections including TFP earthing and roof bushing connection.	Tight
13.	Collect oil sample of transformer oil and send it to the lab for testing as per **Annexure 'A'**. Confirm the report from lab before releasing the rack for service.	

Annexure 'A'

As per RDSO SMI no. RDSO/ELRS/SMI/ 158 dt. 19.01.1995, following tests to be carried out on the transformer oil during IC schedule.

i. Draw a sample of the oil from the transformer as per the method given in IS: 6855-1973 or IS: 9434-1979 depending upon the characteristics to be evaluated. The quantity of oil drawn should be 4 litres instead of 2 litres prescribed in these standards.

ii. Check the oil characteristics for tests given in table given below.

Sr. No.	Tests	Test methods	Permissible limits	Requirement of new filtered oil
1.	Visual inspection	As per IS 12463-1988	---	The oil shall be clear & transparent and free from suspended matter or sediments.
2.	Dissolved gas analysis	SMI-138	As per SMI-138	---
3.	Electrical strength (break down voltage)	IS:6792-72	30 kV (rms) (min.)	60 kV (rms)
4.	Water content (PPM)	IS:335-1983	35 PPM (Max.)	25 PPM (Max.)
5.	Specific resistance at 90 degree C (Ohm-cm)	IS: 6103-71	0.1 x 10^{12} ohm-cm (Min.)	35 x 10^{12} ohm-cm (Min.)
6.	Total acidity	IS:1448-67	0.5 mg KOH/gm. (Max.)	0.08mg. KOH/ gm.

iii. If the colour of the oil has became dark brown, which is indicative of presence of dissolved copper, change the oil with new filtered oil meeting characteristics given in Annexure I of SMI 158.

iv. For interpretation of results of dissolved gas analysis, follow the instructions given in RDSO SMI No. 138.

v. If dielectric strength and water content are beyond the permissible limits given in above table, the oil is likely to be cloudy with acrid smell and it should be filtered under vacuum as per IS:10028 (III) 1981 & IS: 1866-1983.

Filtration of EHV grade oil to be carried out at a vacuum level of 98% at a temperature of 60 degree C and of inhibited oil at a pressure of 0.15 torcillie at a temperature of 60 degree C, provided the specific resistance is within limits. Filtration should continue till such time the oil is completely dried. Check the filtered oil sample for electrical strength and water content and if these parameters are within the limits, the oil is fit for use and if not, repeat filtration till electrical strength and water content are within limits.

vi. If the specific resistance is beyond permissible limit, replace the oil with new filtered oil meeting characteristics given in Annexure 1 of SMI 158.

2.4 POH

Details of work to be carried out during POH is given as under:

2.4.1 General

First of all remove as much dirt as possible particularly around the transformer tank, radiator protective net, terminal block covers & PRV etc. Open the radiator protective net and blow the dust of transformer & radiator with compressed air.

2.4.2 Incoming Tests/ Inspection

Before carrying out any incoming tests, disconnect following connections.

- Disconnect roof bushing connection from HT primary cable/ condenser bushing.
- Disconnect the earth leads from the transformer primary earth bushing terminal block.
- Disconnect all the power cable connection from secondary winding side terminal blocks.
- Disconnect all the cables from auxiliary windings terminal blocks.

2.4.2.1 Visual Inspection

- Clean the body of the transformer and tightened all the bolts in the body of the transformer.
- Check the complete tank for any deformation and crack.
- Check the oil leakage from transformer tank, radiator, the oil pipes, the flange joints, flexible couplings, conservator, Buchholz device, drain plugs, vent plugs and both side terminal blocks.
- Check the thread condition of filter valve, drain plug and oil sample valve, air release vents and replace all gaskets/washers.
- Check the conservator for any bend and damage.
- Check the under frame oil pipe lines, gate valves, tank etc. for any hitting mark, damage etc.
- Note all the defects and deficiencies.

2.4.2.2 Meggering

Check the insulation resistance of windings between:

A. Primary to earth by 2.5 kV megger.
B. Secondary to earth by 1000V megger.
C. Primary to secondary by 1000 V megger.
D. Primary to Aux.I by 1000V megger.
E. Primary to Aux.II 1000V megger.
F. Aux.I to earth by 1000V megger.
G. Aux.II to earth by 500V megger.
H. Secondary to Aux.I by 1000 V megger.
I. Secondary to Aux.II by 1000 V megger.
J. Aux.I to Aux.II by 1000V megger.

2.4.2.3 Continuity Test

Check the continuity of the following windings with the multimeter:

- Primary winding across P3 & P4
- Secondary windings across a1& a2, a3 & a8
- Auxiliary winding I across a11 & a12
- Auxiliary winding II across a21 & a22

2.4.2.4 Ratio test

Apply 225 V a.c. to the primary winding of the transformer and measure the voltage appearing at the following terminals of the terminal blocks.

TAP	Nominal voltage	Range (volts)	Terminal no.
1	0.704	0.700-0.708	a3 - a4
2	1.408	1.400-1.412	a3 - a5
3	2.112	2.100-2.125	a3 – a6
4	2.816	2.800-2.825	a3 – a7
5	3.52	3.500-3.535	a3 – a8
6	3.52	3.500-3.535	a1 – a2
7	4.220	4.200-4.240	a1 – a4
8	4.928	4.900-4.955	a1 – a5
9	5.632	5.600-5.660	a1 – a6
10	6.336	6.300-6.365	a1 – a7
11	7.04	7.00-7.075	a1 – a8
12	Auxiliary winding-I = 2.40 V at terminals a11 & a12		
13	Auxiliary winding- II = 1.27 V at terminals a21 & a22		

The above tolerances are ± 0.5% of the stated voltage ratio of the transformer at no load.

Note:- For taps 7 upwards, it will be necessary to short terminals a2 & a3 with a piece of insulated conductor.

2.4.3 Transformer Oil Testing

As per RDSO SMI No.RDSO/ELRS/SMI/158 dtd. 19.01.95, following tests to be carried out on the transformer oil during POH.

i. Draw a sample of the oil from the transformer as per the method given in IS: 6855-1973 or IS: 9434-1979 depending upon the characteristics to be evaluated. The quantity of oil drawn should be 4 litres instead of 2 litres prescribed in these standards.

ii. Check the oil characteristics for tests given in table given below.

Sr. No	Tests	Test methods	Permissible limits	Requirement of new filtered oil
1.	Visual inspection	As per IS 12463-1988	---	The oil shall be clear & transparent and free from suspended matter or sediments.
2.	Dissolved gas analysis	SMI-138	As per SMI-138	---
3.	Electrical strength (break down voltage)	IS:6792-72	30 kV (rms) (min.)	60 kV (rms)
4.	Water content (PPM)	IS:335-1983	35 PPM (Max.)	25 PPM (Max.)
5.	Specific resistance at 90 degree C (Ohm-cm)	IS: 6103-71	0.1×10^{12} ohm-cm (Min.)	35×10^{12} ohm-cm (Min.)
6.	Dielectric dissipation factor (Tan Delta) at 90 degree C.	IS: 6262-71	1.0 (Max.)	0.002 (Max.)
7.	Total acidity	IS:1448-67	0.5 mg KOH/gm. (Max.)	0.08mg.KOH/ gm.
8.	Sediments and perceptible sludge	IS:1866-88 Appendix-A	0.05% by wt.	No sediment or perceptible sludge shall be detected.
9.	Flash point	IS: 1448-1970	125 deg. C (Min.)	100 deg. C (Min.)
10	Interfacial tension at 27 degree C	IS: 6104-71	0.018 N/m (Min.)	0.04 N/m (Min.)
11	Oxidation Inhibitor	IS: 335-1983 Appendix 'D'	0.3% by mass (Max.)	0.3% by mass (Max.)

Compare the results with the result recorded earlier on the same oil. Any abrupt change in the value of the parameters is indicative of the unhealthiness of the transformer. The transformer should be opened for detailed internal inspection for any incipient fault. However, if the flash point falls by 15 degree C from its initial value, replace the oil with new filtered oil without opening the transformer.

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iii. If the colour of the oil has became dark brown, which is indicative of presence of dissolved copper, change the oil with new filtered oil meeting characteristics given in Annexure I of SMI 158.

iv. For interpretation of results of dissolved gas analysis, follow the instructions given in RDSO SMI No. 138.

v. If either of the parameters i.e. flash point, interfacial tension, specific resistance, total acidity and dielectric dissipation factor are beyond the permissible limits, replace the oil with new filtered oil.

vi. Measure and record the inhibitor content in the oil, if inhibited.

2.4.4 Purification of Transformer Oil

If transformer is not due for core lifting and other test results are satisfactory, connect the transformer for oil purification. The oil should be purified under vacuum as per IS: 10028 (III) 1981 & IS: 1866-1983.

Filtration of EHV grade oil is to be carried out at a vacuum level of 98% at a temperature of 60 degree C and of inhibited oil at a pressure of 0.15 torcillie at a temperature of 60 degree C. Filtration should continue till such time the oil is completely dried. Check the filtered oil sample for electrical strength and water content and if these parameters are within the limits, the oil is fit for use and if not, repeat filtration till electrical strength and water content are within limits.

2.4.5 Internal Inspection

In order to obtain optimum service life from the EMU transformer, it is suggested that transformer is opened and core is lifted at an interval of 6 to 8 years of service. Core should also be lifted during first POH after commissioning for tightening of the pressure bolts.

Following work is to be carried out if transformer is due for internal inspection.

2.4.5.1 Removing of Active Part (Windings) From Tank

- Close all the gate valves of transformer and its pipes lines.
- Drain oil from transformer pipe lines.
- Disconnect all electrical connections of transformer.
- Disconnect and remove main bushing.
- Disconnect all pipe line connections to the transformer.
- Open all base parts from transformer tank.
- Provide hydraulic trolley below the transformer tank and lift the transformer by the trolley.
- Remove all the foundation bolts fixing transformer to the motor coach.
- Remove the transformer with the help of hydraulic trolley.
- Bring the transformer in transformer repairing section.
- Clean thoroughly the transformer body.

- Drain the transformer oil completely.
- Remove all the bolts from the transformer tank top covers.
- Remove all three number inspection covers.
- Disconnect all windings connections from terminal blocks and also remove the earthing connection of active part.
- Lift the active part (windings) with top cover with the help of crane.
- Place the active part on wooden blocks and remove the top cover by removing its fixing bolts.

2.4.5.2 Inspection of Active Part (Windings)

- Lower and raise the active part 4 to 5 times in a dry oil bath so as to remove the sludge from the ducts in the core/ windings.
- Place the active part (windings) in a large vessel vertically on wooden blocks and hose down with clean dry oil. Do not impinge hot oil jet on the transformer windings.
- Check all the core support bolts for any crack at the welded joint and replace them if required.
- Check the tightness of yoke bolts by torque wrench.
- Check the spacers and wedges for proper position and thickness.
- Check the lead paper insulation for any damage and reinsulated if necessary.
- Check the distance between the bus bars and yoke.
- Check the bushing stud and insulator for any damage and replace if necessary.
- Check the tightness of bus bar leads and also crimping terminal joints.
- Check the condition of insulating separators.
- Tighten all pressure bolts until Belleville washers are flattened and then rotate by 1/6 turn in opposite direction.
- Bake the active part (windings) in oven at a temperature of 60 degree C.
- Check insulation resistance with 1 kV megger between end frame and core.

2.4.5.3 Attention on Tank

- Clean the tank thoroughly from inside and outside.
- Check visually inside of tank for any flash mark, hit mark, damage etc.
- Check the tank from outside for any damage, welding crack of angles/ channel and repair if required.
- Do the varnishing of the tank inside area with Copal varnish.
- Paint the tank from out side with battleship gray paint.
- Check the oil drain cocks and change washers by a new one, tight and lock them.
- Remove the terminal blocks and check visually for any damage. Repair them if required.
- Check the secondary and auxiliary terminal blocks fixing studs for tightness and they should be oil leak proof.
- Check the P4 bushing fitting surface, it should be clean and plain.
- Check the top and bottom gate valves for their proper working and check for oil leakage.

2.4.5.4 Top Cover Attention

- Clean the top cover (plate) thoroughly from the top-side, bottom side and turret area.
- Check visually for any flash mark on bottom side and welding cracks of channels/angles.
- Check the vent plugs (3 nos.) and replace nylon/ copper washer with new one, if required.
- Top cover bottom side to be varnished properly with copal varnish and top side to be painted with battleship grey paint.
- Check active part holding suspension device for straightness and uniform ness.

2.4.5.5 Re-Tanking of Active part

- Fit the top cover on active part properly.
- Replace all gaskets with new one before re-tanking the active part.
- Re-tank the clean, dry active-part in tank.
- Tighten all the bolt of the top cover.
- Connect all winding connections on terminal blocks including earthing connection of active part and fit the inspection covers.
- Check, clean and re-fit all accessories of the transformer tank cover.

Figure 2.1

2.4.5.6 Testing of Transformer After Re-tanking

Carry out the following tests on the transformer after re-tanking of active part in tank.

- Meggering
- Continuity test
- Ratio test

2.4.6 Inspection of Fittings

2.4.6.1 Buchholz Relay

- Clean the complete assembly with fresh transformer oil.
- Check the Reed switch on test bench for its healthiness.
- Check manually the free operation of BUD floats.
- Check visually the glass indicator for any damage.
- Check the operation of assembly by allowing the oil flow.
- Check the pet cock for free operation.

2.4.6.2 Silica Gel Breather

- Check the silica gel breather visually for any abnormality/ damage.
- Reactivate silica gel by heating in a shallow pan at a temperature of 150 deg. C to 200 deg. C for two or three hours until the crystals should have regained their original blue tint.
- Clean and dry all parts of the breather before filling the container with silica gel.
- Fill the fresh or reactivated silica gel crystals.
- Verify that the oil level in the oil cup is correct after reassembly.

2.4.6.3 Thermostat

- Clean the thermostat assembly with petrol.
- Check the contact closing temperature with the help of thermo-meter.
- Check visually the presence of transformer oil in thermostat pocket.

2.4.6.4 Pressure Relief Valve

- Check the diaphragm visually for healthiness.
- Check the springs visually for any defect and ensure their tention.
- Clean the PRV contacts with petrol and check its operation manually.
- Ensure free movement of PRV plunger manually.

2.4.6.5 Radiator

- Clean the radiator tubes thoroughly by compressed air and high pressure water jet.
- Check radiator tubes and fins for any damage.
- Replace both side cover gasket of radiator with new one.

2.4.6.6 Pipe Lines And Couplings

- Clean all the pipelines and coupling thoroughly.
- Check all the pipelines, flexible couplings for any damage, hitting marks etc.
- Check all the supporting clamps and brackets of the pipelines for any damage, welding crack etc.
- Paint all the pipelines with grey paint.

2.4.6.7 Conservator

- Clean conservator and glass indicator thoroughly.
- Check the conservator for any damage, intactness of indicator glass and condition of glass.
- Check flexible coupling below conservator for any damage, oil leakage etc.
- Paint the conservator with grey paint.

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2.4.6.8 Main Bushing

- Clean the roof bushing insulator, condenser sleeve and transformer bushing thoroughly.
- Check visually roof bushing porcelain insulator for any crack, flash mark etc.
- Check condenser sleeve for any damage, crack etc.
- Remove oil from the condenser bushing if provided.
- Check and record tan- delta of the bushings (without oil at 1,2 and 5 kV). If the value of the tan delta is greater than 3%, replace the bushing.
- Check flange to flange distance in the condenser bushing, it should be of 2200± 5 mm. If this gap is found to be less, carry out modification as advised vide RDSO modification sheet No. RDSO/WAU/3/ Dated 24-07-1981.

Note:- Replace the condenser bushing with cable head termination system as per RDSO specification No. ELRS/SPEC/BL-0003 –May 99 and SMI No.193.

2.4.7 Final Fitment of Transformer on Motor Coach

- Fit the transformer on motor coach with the help of hydraulic trolley.
- Fit all the fitting such as Buchholz device, main bushing, conservator, breather etc.
- Connect all the pipe lines, flexible couplings and pipe lines support.
- Connect all electrical connection, earthing leads etc.
- If transformer oil has been replaced due to any reason, replace the oil of choke tank also.
- Fill the transformer oil up to proper level.
- Ensure open condition of all gate valves.
- Connect the transformer to the oil purification plant for purification of transformer oil and carry out purification as described under section 2.4.4.
- Check the transformer, conservator, Buchholz device, pipe lines, couplings, gate valves, radiator etc. visually for any defect or deficiency.

2.4.8 Final Checking

- Check visually for any oil leakage from any point, coupling, joints etc.
- Ensure the open condition of all the gate valves.
- Check and ensure oil level in conservator, it should be minimum 15 degree C mark.
- Release air from vent plugs.
- Check the function of Buchholz relay.
- Ensure connection of thermostat and oil in TT pocket.
- Ensure operation of PRV plunger and its connections.
- Check the transformer fuses.
- Provide all terminal block covers.

CHAPTER 3

TRANSFORMER FAILURES

3.1 COMMON FAILURES OF EMU TRANSFORMER

Some of the common failures/ defects occurred in EMU/MEMU transformer are as under:

- Oil leakage
- Low BDV
- Bushing failure
- Flexible (metallic) expansion coupling failure
- Winding failures
- Temperature rise/ actuation of thermostat.
- Actuation of PRV
- Low IR value
- Humming sound

3.1.1 Oil Leakage

Location	Possible causes	Remedial action
From screw joints	- Foreign material in threads - Poor threads - Improper assembly	- Remove the foreign material. - Check the threads & replace if required. - Ensure proper assembly.
From gasket joints	- Insufficient or uneven compression. - Improper preparation of gaskets and gasket surfaces. - Old gaskets	- Tight gasket joints uniformly. - Provide proper gaskets. - Provide new gaskets.
From weld joints	- Shipping strains, imperfect weld.	- Repair welds following proper procedure as per SMI 102.
From flexible couplings & their joints	- Cracks in flexible couplings. - Defective coupling joints.	- Replace flexible couplings and secure the pipe lines near couplings properly. - Make proper coupling joints and tight the screws.
From drain plugs.	- Defective thread portion. - Defective oil seal.	- Check the threaded portion. - Replace the oil seal and tight the drain plug.

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3.1.2 Low BDV

Type of failure	Possible causes	Remedial action
Low BDV	Moisture contamination in transformer oil due to inactive silica gel (pink colour).	Reactivate silica gel crystals or replace them. Purify the transformer oil to restore dielectric strength.
	Leaks around cover accessories, breathing air from leaks.	Attend leaks, regasket if necessary. Purify the transformer oil to restore dielectric strength.
	Humid atmosphere in rainy season.	Purify the transformer oil to restore dielectric strength and check the BDV & water content.

3.1.3 Bushing Failure

Types of failure	Possible causes	Remedial action
Power contact nearest to condenser sleeve flashed.	- Tilted bushing. - Flange to flange distance less.	- Check for any tilting and correct if required. - Check and maintain flange to flange distance of 2200 ± 5 mm. If this gap is found to be less, carry out modification as advised vide RDSO modification sheet No. RDSO/WAU/3/ Dated 24-07-1981.
Roof bushing flash over.	- Lightening. - Dirty bushing.	- Gapless lightening arrestor may be provided. - Ensure cleaning of porcelain bushing during each inspection.
Roof bushing porcelain insulator petticoat broken / cracked.	- External hitting.	- Ensure proper cleaning and visual checking of porcelain bushing during each inspection.

3.1.4 Flexible (metallic) Expansion Couplings Failure

Types of failure	Possible causes	Remedial action
- Couplings broken/ cracked from flexible portion. - Coupling joints loose and oil leaking.	- External hitting or continuous vibrations. - Loose joint - Gasket worn out.	- Check the pipelines near couplings for proper support. Provide additional support if required. - Ensure tightness of joints during each schedule. - Provide new gaskets during POH.

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3.1.5 Winding Failures

Types of failure	Possible causes	Remedial action
- Primary winding lead open circuited / earthed.	- Short circuit due to overload.	Check the setting of over load relay and its CT. Investigate for over loading and take corrective action accordingly.
- Bulging and inter turn short.	- Coils shrink and in between insulation failure.	During manufacturing/ rewinding of the transformer, the coils should be pressed down, heated and cooled repeatedly until the coil height stablises.
- Shorting between LV and HV coils.	- Insulation failure.	Nomex paper insulation sheet should be provided between H.V. & L.V. coils so as to strengthen the insulation level. Ensure that this insulation sheet does not cause any obstruction in the passage of oil flow.
- Shorting between secondary bus bars.	- Insulation failure.	Additional pressboard separator barrier of suitable thickness should be provided in between LV bus bars at locations where shorts generally have occurred

Note :

Actuation of PRV, BIR and OLR takes place during failure of transformer winding and circuit breaker is tripped. Circuit breaker should not be reclosed as it might result in additional internal damage and fire hazard.

Check transformer for any external mechanical or electrical damage to bushings, terminal board connections and other parts. Take oil sample for DGA, BDV and other tests. Check the transformer thoroughly and take corrective action according to observations and oil test results.

3.1.6 Temperature Rise/ Actuation of Thermostat.

Type of failure	Possible causes	Remedial action
Actuation of Thermostat & TTR	- Insufficient cooling due to dusty radiator tubes.	- Ensure proper cleaning of radiator tubes. Carry out one cyclic check of thermostat setting & TTR working as pre summer precaution.
	- Insufficient cooling due to partial close condition of gate valves.	- Check and ensure fully open condition of all gate valves.
	- Non working of MPH/ MVRH.	- Ensure working of MPH and both the MVRH.
	- Any internal fault such as short circuited core, core bolts/ clamps insulation failure etc. (In this case TTR will trip along with BIR.)	- Replace the transformer and core to be lifted for thoroughly checking. Take corrective action according to observations and oil test report.

Type of failure	Possible causes	Remedial action
	- Low oil level in conservator. - Sludged oil.	- Check the oil level in conservator and top up if required. - Carry out purification of oil to remove sludge.

3.1.7 Actuation of PRV

Type of failure	Possible causes	Remedial action
Actuation of PRV	- Internal fault such as winding failure, insulation failure etc. - Obstructed oil flow. - Obstructed breathing. - Conservator oil level too high.	- Refer winding failures. - Check all the gate valves for fully open condition. - Check breather line for any obstruction. - Oil level should be adjusted to proper level (15 to 30 degree C.) to allow ample space for expansion of oil.

3.1.8 Low IR Value

Type of failure	Possible causes	Remedial action
Low IR value	- Moisture in oil. - Insulation failure between winding and core. - Internal connection leads insulation damage.	- Purify the oil with high vacuum type oil purification plant and test the oil for electrical strength and water content. - Replace the transformer. Lift the active part and check the winding thoroughly for insulation damage and take corrective action accordingly. - Check the internal connection leads by lifting the active part and retape insulation paper of damaged portion.

3.1.9 Humming Sound

Type of failure	Possible causes	Remedial action
Humming sound	- Loose core - Winding loose due to shrinkage of coils	- Lift the active part and tight all the pressure bolts and clamping bolts. - During manufacturing/ rewinding of the transformer, the coils should be pressed down, heated and cooled repeatedly until the coil height stablises. - The winding pressure bolts and core clamping bolts should be tightened during the first POH after commissioning to take care of shrinkage.

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CHAPTER 4

PURIFICATION OF TRANSFORMER OIL

The object of oil purification is to remove all contaminants such as water, carbon deposits, dirt, sludge, dissolved moisture and gases. The most important quality to be preserved is the di-electric strength, which is affected by the presence of moisture.

The insulating materials used in the winding are hygroscopic by nature and therefore moisture is absorbed through defective breathers, gaskets and addition of untreated make up oil. It is essential to remove these impurities by purifying the oil when the dielectric strength goes below the permissible limits.

The purification plant should be capable of removing dissolved air/ moisture in the form of free and finely dispersed water vapour and moisture in solution, sludge and fibers, gases, carbonaceous products formed due to arcing and drum scale or any other solid particles from insulating oil.

The plant should be capable of purifying the rated capacity of transformer oil to the following parameters in maximum three phases.

a. Suspended impurities	–	maximum 1 micron particle size.
b. Water content	–	from 100 ppm to less than 5 ppm
c. Gas removal	–	from fully saturated i.e. 10 to 12% by volume with air/gas down to less than 0.25%
d. Acidity correction	–	with addition of clay filters the neutralization index should go down from 0.5 to 0.05 mg KOH/ gm of oil.
e. Dielectric strength	–	Minimum 60 kV
f. Dissipation factor of oil/ tan delta at 90°C	–	0.002

The switching ON & OFF of the heater groups should be thermostatically controlled so that the temperature of the oil during treatment is not be permitted to rise above 60°C. Operating vacuum should be better than 1 torr.

Filtration of EHV grade oil to be carried out at a vacuum level of 98% at a temperature of 60 degree C and of inhibited oil at a pressure of 0.15 torcillie at a temperature of 60 degree C, provided the specific resistance is within limits. Filtration should continue till such time the oil is completely dried. Check the filtered oil sample for electrical strength and water content and if these parameters are within the limits, the oil is fit for use and if not, repeat filtration till electric strength and water content are within limits.

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4.1 INSULATION RESISTANCE DURING DRYING OUT

Readings of temperature and insulation resistance should be recorded every two hours, from commencement until the full operation is completed. If these readings are plotted on a graph, the appearance will be as shown in fig 4.1.

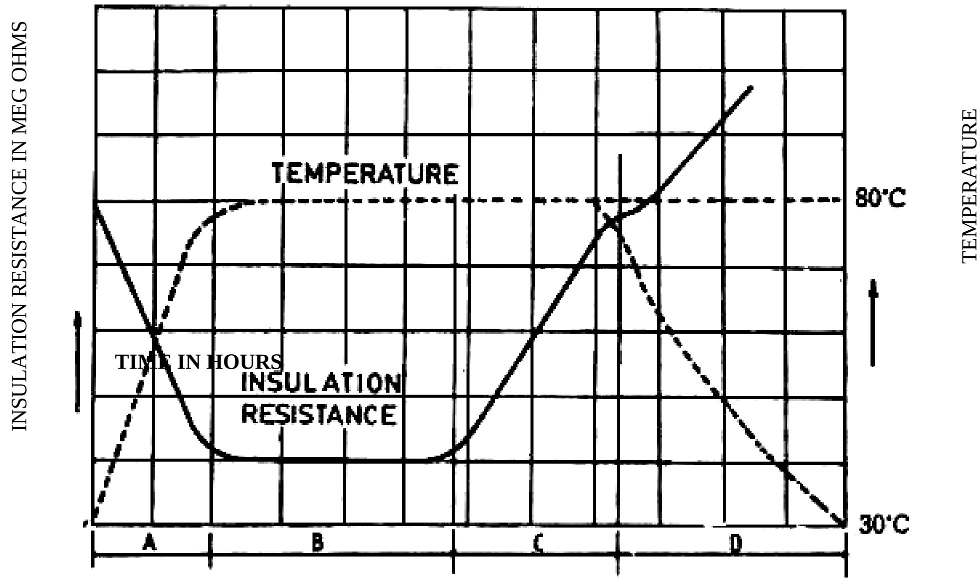

Figure 4.1 INSULATION RESISTANCE GRAPH

It is observed that there are four distinct stages:

A. Initially the insulation resistance drops down to a low value because of rise in temperature of the oil up to about 60 degree C.

B. Insulation resistance will continue to remain at a low level despite temperature being maintained at a high level until most of the moisture from the windings and oil has been driven out.

C. The insulation resistance will thereafter rise gradually and level off, indicating that all moisture has been driven out and the drying out operation has been completed. At this point oil circulation should be discontinued.

D. As the oil cools off, the insulation resistance will rise much above the leveling off point at the end stage (C). This is because the insulation resistance value doubles for a fall in temperature of about 10°C to 15°C.

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CHAPTER 5

CONDITION MONITORING OF TRANSFORMER BY DISSOLVED GAS ANALYSIS

5.1 INTRODUCTION

In order to detect incipient faults in the transformer and to arrest deterioration/ damage to the transformer insulation, gases dissolved in the transformer oil are detected, analysed and preventive measures adopted.

Gas Chromatography method is used for detection of the dissolved gases and identification of incipient faults. The most significant gases generated by decomposition of oil and deterioration of paper insulation on the conductor are hydrogen, methane, ethane, ethylene and acetylene. The quantities of these gases dissolved in transformer oil vary depending upon the type and severity of the fault conditions.

5.2 SENSITIVITY LIMITS

Gas Chromatography apparatus should be able to detect the following minimum concentration of dissolved gases:

Hydrogen : 5 ppm
Hydrocarbon : 1 ppm
Carbon oxides : 25 ppm

5.3 ESTABLISHMENT OF REFERENCE VALUES/ BENCH MARKS

To establish a reference value/ bench mark, gas as generated from initial sample of oil from each healthy transformer should be collected. Results of the analysis are taken as a reference value/ benchmark. Results of later periodic analysis are compared with the benchmark for each transformer.

5.4 ESTABLISHMENT OF NORMS

The contents of various dissolved gases in the transformer oil vary with design and operating conditions. It is desirable that the values of concentration of gases of healthy transformers of different age groups are to be gathered by the Railways concerned to evolve suitable norms. However, as a starting point, the permissible concentrations of dissolved gases in the oil of a healthy transformer are given below as guidelines:

Gas	Less than 4 years in service (ppm)	4-10 years in service (ppm)	More than 10 years in service (ppm)
Hydrogen (H_2)	100/150	200/300	200/300
Methane (CH_4)	50/70	100/150	200/300
Acetylene (C_2H_2)	20/30	30/50	100/150
Ethylene (C_2H_4)	100/150	150/200	200/400
Ethane (C_2H_6)	30/50	100/150	800/1000
Carbon dioxide (CO_2)	3000/3500	4000/5000	9000/12000

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5.5 DIAGNOSIS OF FAULT

Basic Diagnosis of DGA is based upon the quantities of gases generated. Types of gases in excess of norms produced by oil decomposition/ cellulosic material depend upon the hot spot temperature produced by faults.

Characteristics gases associated with various faults are as under :

Methane (CH_4)	Low temperature hot spot
Ethane ($C_2 H_6$)	High temperature hot spot
Ethylene ($C_2 H_4$)	Strong over heating
Acetylene ($C_2 H_2$)	Arcing
Hydrogen (H_2)	Partial discharge
Carbon dioxide (CO_2)	Thermal decomposition of paper insulation
Carbon monoxide (CO)	

5.6 WORD OF CAUTION

To start with the diagnosis, it is necessary to be satisfied that measured gas concentrations are significant and high enough to warrant diagnosis, because some amount of gases will always be there due to normal operating conditions without any fault but it can be sufficient to be misleading. The reasons for the situation are:

- Gases formed during the refining processes and not completely removed by oil degassing.
- Gases formed during drying and impregnating the transformer in sheds/ workshops.
- Gases formed in the event of previous faults and not completely removed from the oil-impregnated insulation before being refilled with degassed oil.
- Gases formed during repairs by brazing, welding, etc.

5.7 PROCEDURE FOR FAULT DIAGNOSIS

- Obtain the results of concentration of various gases in terms of microlitre (ppm).
- Compare the concentrations with sensitivity limits. These should be at least ten times the sensitivity.
- If it exceeds sensitivity limits, compare with benchmarks.
- If it exceeds benchmarks, compare concentrations with norms depending upon age and design of transformer.
- If one or more gases are above norms, compare with the last sample results; if increase is sufficient, obtain a check sample.
- If the check sample confirms the results, calculate the rate of increase of gas. If rate of increase is more than 10% per month, it is considered rapid and warrants immediate further investigations including lifting of core and internal inspection.
- If the gas production rate is medium, i.e., less than 10% per month, sampling frequency to be increased from quarterly to monthly.

  Take a planned shut down for further investigation.

CHAPTER 6

DO’S AND DON’TS

6.1 DO’S

1. Check the protection system of transformer periodically.
2. Always use transformer oil procured from RDSO approved suppliers.
3. Check silica gel regularly.
4. Check and thoroughly investigate the transformer whenever any alarm or protection system is operated.
5. Examine the bushings for dirt deposit, coating and clean them periodically.
6. Attend any type of oil leakage at the earliest possible.
7. Clean conservator thoroughly before refilling.
8. Ensure proper functioning of Buchholz relay.
9. Ensure periodic testing of transformer oil.
10. Ensure that oil has been removed from the condenser bushing.
11. Ensure oil in TT pocket.
12. Maintain record of transformer and oil, transformer wise for future reference.

6.2 DON’TS

1. Don’t use under capacity lifting jacks.
2. Don’t leave any loose connection.
3. Don’t meddle with protection system.
4. Don’t allow conservator oil level to fall below 15 degree C. level.
5. Don’t over tight the nuts & bolts to stop any leakage.
6. Don’t use fuses higher than the prescribed ratings.
7. Don’t tamper with earthing connections.
8. Don’t keep the breather pipe open or exposed.
9. Don’t re-energize the faulty transformer unless the oil test report including DGA is satisfactory.
10. Don’t impinge hot oil jet on the transformer windings for cleaning.
11. Don’t use reclaimed oil in transformer.
12. Don’t mix old & new transformer oils.
13. Do not mix EHV grade & inhibited transformer oil.

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ANNEXURE – I

List of Modifications and Special Maintenance Instructions issued by RDSO for Transformer of AC EMU/MEMU.

Sr. No.	Modification/ SMI No.	Brief Description
1.	RDSO/ELRS/SMI/102 Dt. Dec. 1982	Procedure for repairing the defective welds of transformer fitted on AC electric locomotives.
2.	Modification Sheet no. RDSO/WAU/5 Dt. Aug. 1982	Provision of additional parmali wood cleats to support L.T. busbars of BHEL built BG AC EMU transformers.
3.	Modification Sheet no. RDSO/WAU/3 Dt. 24.07.1981	Modification to the mounting arrangement of condenser bushing for 25 kV AC EMUs.
4.	RDSO/ELRS/SMI/120 Dt. 23.11.1984	Maintenance of main transformer oil in service.
5.	RDSO/ELRS/SMI/121 Dt. 30.01.1985	Revised characteristics for new insulating oil for locomotive/ EMU transformer and additional tests for maintenance of oil in service.
6.	RDSO/ELRS/SMI/127 Dt. 27.04.1985	Procurement specification for insulating oil & Condition monitoring of insulating oil.
7.	RDSO/ELRS/SMI/138 Dt. 29.04.1991	Condition monitoring of traction transformers by dissolved gas analysis.
8.	RDSO/ELRS/SMI/158 Dt. 19.01.1995	Code of practice for maintenance of transformer oil in service.
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OUR OBJIVECTIVE

To upgrade maintenance technologies and methodologies and achieve improvement in productivity, performance of all Railway assets and manpower which inter-alia would cover reliability, availability, utilisation and efficiency.

If you have any suggestions and any specific Comments please write to us.

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