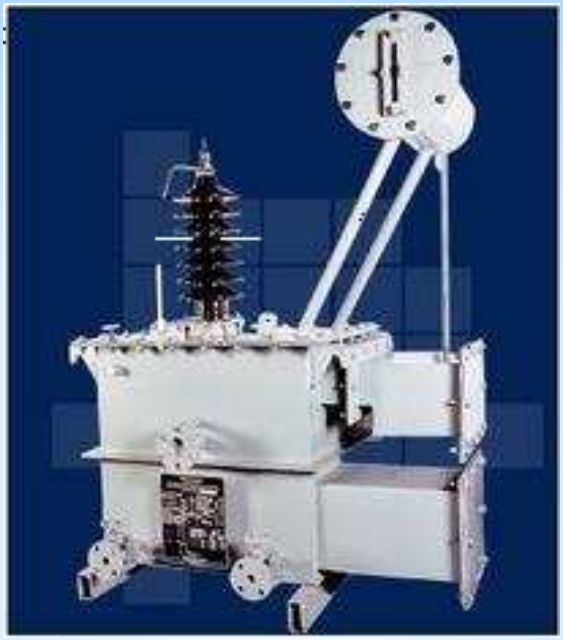
केवल कार्यालयीन उपयोग हेतु
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सत्यमेव जयते

भारत सरकार GOVERNMENT OF INDIA
रेल मंत्रालय MINISTRY OF RAILWAYS



ऑक्जिलरी ट्राँसफॉरमर पर ट्रेनिंग पैकेज

Training Package on Auxiliary Transformer

लक्ष्य समूह : टीआरडी अनुरक्षण कर्मचारी

TARGET GROUP: TRD Maintenance Staff

कैमटेक / ई / 10–11 / टीआरजी–एटी / 1.0
CAMTECH/ E/ 10-11/ Trg-AT/ 1.0

अगस्त 2010
August 2010

अआमा संRDSO
रेल अग्रदूत Transforming Railways

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EXIT

ऑक्जिलरी ट्रॉंसफॉरमर पर ट्रेनिंग पैकेज

Training Package on Auxiliary Transformer

गुणवत्ता नीति

रेलों में यात्री और माल यातायात की बढ़ती माँग को पूरा करने के लिए गुणवत्ता प्रबंध प्रणाली में अनुसंधान, डिजाइनों और मानकों में उत्कृष्टता तथा सतत सुधारों के माध्यम से सांविधिक और नियामक अपेक्षाओं को पूरा करते हुए सुरक्षित, आधुनिक और किफायती रेल प्रौद्योगिकी का विकास करना ।

QUALITY POLICY

"To develop safe, modern and cost effective Railway Technology complying with Statutory and Regulatory requirements, through excellence in Research, Designs and Standards and Continual improvements in Quality Management System to cater to growing demand of passenger and freight traffic on the railways".

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प्राक्कथन

ट्रेनों के सुचारु परिचालन के लिये कलर लाईट सिग्नल, केबिल, केबिल हट, एसपी, एसएसपी, लेबल क्रॉसिंग इत्यादि को विद्युत की आपूर्ती करने में ऑक्जीलरी ट्रांसफार्मर बहुत महत्वपूर्ण भूमिका अदा करता है। इसलिए इस उपकरण के उचित अनुरक्षण का सही ज्ञान बहुत जरूरी है।

कैमटेक ने ऑक्जीलरी ट्रांसफार्मर पर यह ट्रेनिंग पैकेज बनाया है जिसमें बनावट, अनुरक्षण अनुसूचियाँ, ओवरहॉलिंग विधि, विफलताऐं एवं उनके निदान, कण्डीशन मॉनीटरिंग इत्यादि दिए गये हैं। इस ट्रेनिंग पैकेज में मॉडल प्रश्न भी दिए गये हैं।

मुझे आशा है कि यह ट्रेनिंग पैकेज टीआरडी विभाग में हमारे अनुरक्षण कर्मचारियों के लिए उपयोगी सिद्ध होगा।

केमटेक, ग्वालियर *एस. सी. सिंघल*
दिनांक : 27 अगस्त 2010 *कार्यकारी निदेशक*

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FOREWORD

Auxiliary Transformer plays very important role in smooth running of trains as it provides electrical supply to colour light signals, cabins, cable huts, SPs, SSPs, level crossings etc. Therefore knowledge of proper maintenance of this asset is essential.

CAMTECH has prepared this training package on Auxiliary Transformer which contains construction, maintenance schedules, overhauling procedures, failures and their remedies, condition monitoring etc. Model questions are also given in the training package.

I hope this training package will prove to be useful for the maintenance personnel working in TRD department.

CAMTECH, Gwalior ***S.C. Singhal***
Date : 27th August 2010 ***Executive Director***

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भूमिका

विद्युतीकृत खण्ड़ में कलर लाईट सिग्नल उपकरणों, स्विचिंग स्टेशनों और ट्रैक्शन सब स्टेशनों इत्यादि को 240 वोल्ट, 50 हर्टज, सिंगल फेज विद्युत की आपूर्ती करने के लिए ऑक्जीलरी ट्रांसफार्मर की आवश्यकता होती है। यह केबिन, स्टेशन, ब्लाक हट, आर आर आई और लेबल क्रॉसिंग गेट सिग्नल को भी सप्लाई देता है।

कैमटेक द्वारा ऑक्जीलरी ट्रांसफार्मर पर यह ट्रेनिंग पैकेज अनुरक्षण कर्मचारियों को सही अनुरक्षण एवं मरम्मत तकनीकों से अवगत कराने के उद्देश्य से तैयार किया गया है।

यह स्पष्ट किया जाता है कि यह ट्रेनिंग पैकेज आरडीएसओ या रेलवे बोर्ड या एसी ट्रैक्शन मैनुअल द्वारा विर्निदिष्ट किसी भी विधान को विस्थापित नहीं करता । यह ट्रेनिंग पैकेज केवल मार्गदर्शन हेतु है एवं यह एक वैधानिक दस्तावेज़ नहीं है।

मैं, कार्यक्षेत्र के उन सभी कर्मचारियों का आभारी हूँ जिन्होने इस ट्रेनिंग पैकेज को बनाने में हमारी सहायता की ।

तकनीकी उन्नयनता और सीखना एक सतत् प्रक्रिया है। अतः इस ट्रेनिंग पैकेज में जोड़ने/सुधारने के लिये हमें लिखने में स्वतंत्र महसूस करें । इस दिशा में हम आपके योगदान की सराहना करेंगे।

केमटेक ,ग्वालियर
दिनांक : 27 अगस्त 2010

पीयूष गुप्ता
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PREFACE

Auxiliary Transformer in Electrified section is required for supplying 240 V, 50Hz single phase supply for colour light signal equipment, switching stations and traction sub stations etc. It also provides supply for cabins, stations, block-huts, RRIs and level crossings with gate signals.

This training package on Auxiliary Transformer has been prepared by CAMTECH with the objective of making our maintenance personnel aware of correct maintenance and repair techniques.

It is clarified that this training package does not supersede any existing provisions laid down by RDSO, Railway Board or AC traction manual. This training package is for guidance only and it is not a statutory document.

I am sincerely thankful to all field personnel who helped us in preparing this training package.

Technological up-gradation & learning is a continuous process. Please feel free to write to us for any addition/ modification in this training package. We shall highly appreciate your contribution in this direction.

CAMTECH, Gwalior ***Peeyoosh Gupta***
Date:27th August 2010 ***Jt. Director Electrical***
e - mail id : direlcamtech@gmail.com

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संशोधन पर्चियों का प्रकाशन

इस पुस्तिका के लिये भविष्य में प्रकाशित होने वाली संशोधन पर्चियो को निम्नानुसार संख्यांकित किया जायेगा :

केमटेक / ई / 10–11 / टीआरजी–एटी / 1.0 सी, एस / # XX दिनांक ---------

जहॉ XX सम्बन्धित संशोधन पर्ची की क्रम संख्या है (01 से प्रारम्भ होकर आगे की ओर)।

प्रकाशित संशोधन पर्चियॉ

संशोधन पर्ची की संख्या	प्रकाशन की तारीख	संशोधित पृष्ठ संख्या एवं मद संख्या	टिप्पणी

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ISSUE OF CORRECTION SLIPS

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

CAMTECH/E/10-11/Trg.-AT/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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1.0 प्रस्तावना / INTRODUCTION

Auxiliary Transformers in electrified sections are required for colour light signal equipment for signal lights, switching stations and traction sub stations. Auxiliary transformer provides 25kV/ 240V, 50Hz single phase supply for cabins, substations, feeding and switching posts, stations, block-huts, RRIs and level crossings with gate signals.

Auxiliary transformer is a static device and works as a step down transformer which transforms power from one ac circuit to another ac circuit at the same frequency. These circuits are conductively disjointed but magnetically coupled by a common time varying magnetic field. It can raise or lower the voltage with a corresponding decrease or increase in current.

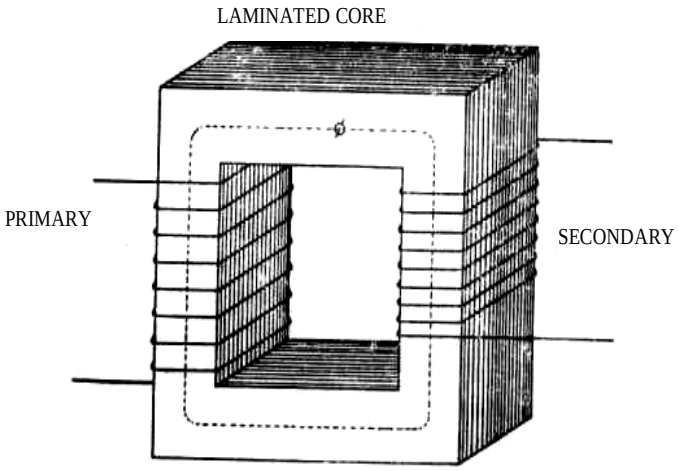
The windings which form the electrical circuits must fulfill certain basic requirements, particularly the di-electric, thermal and mechanical stresses imposed on it during testing as well as in service and cater for over loads under adverse conditions.

2.0 कार्य सिद्धांत / WORKING PRINCIPLE

In general, working principle of a transformer can be expressed on the basis of law of electromagnetic induction as following:

a. When a conductor cuts the magnetic flux or magnetic flux cut the conductor, an emf is induced in the conductor.

b. The magnitude of this emf is proportional to the rate of change of flux.

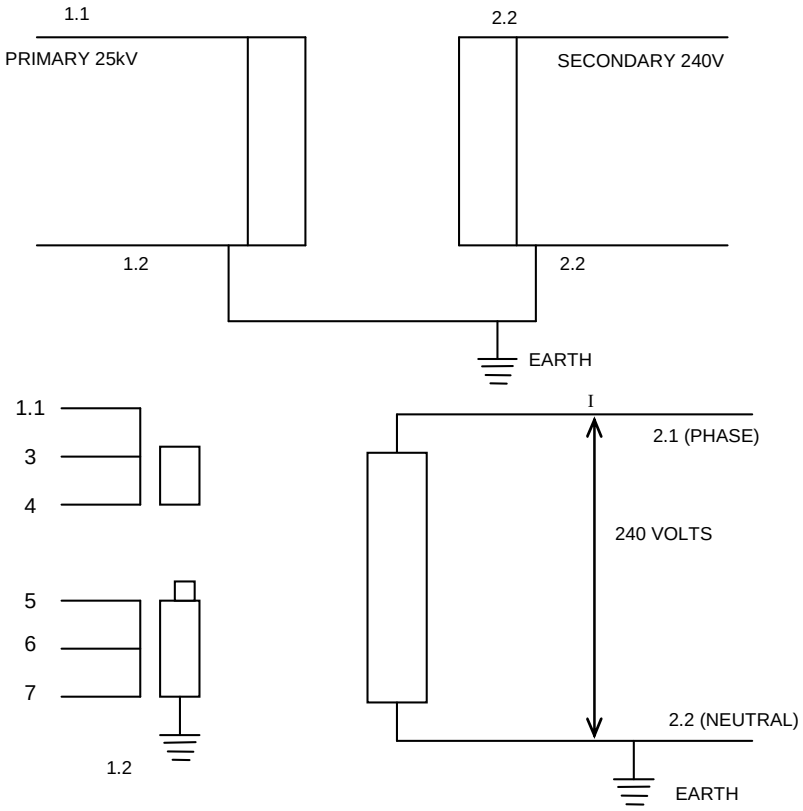


When the primary winding is connected to an ac supply mains, current flows through it. Since this winding links with an iron core, so current flowing through this winding produces an alternating flux in the core. Since this flux is alternating and links with the secondary winding also, therefore it induces an emf in the secondary winding. The frequency of induced emf in secondary winding is the same as that of the flux or that of the supply voltage.

The induced emf in the secondary winding enables it to deliver current to an external load connected across it. Thus the energy is transformed from primary winding to the secondary winding by means of electro-magnetic induction.

The flux ϕ of the iron core links not only with the secondary winding but also with the primary winding, so produces self-induced emf in the primary winding. This self induced emf in the primary winding opposes the applied voltage and therefore sometimes it is known as back emf. The induced emf in the primary winding limits the primary current in the same way that back emf in a dc motor limits the armature current.

आक्जीलरी ट्रांसफार्मर का रेखा चित्र
Line Diagram of Auxiliary Transformer

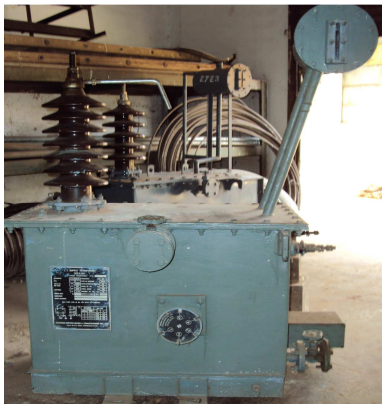


Connections	Tap No	Primary	Secondary	Ratio	
5-4	1	26250 V	240 V	109.375	105%
4-6	2	25000 V	240 V	104.166	100%
6-3	3	23700 V	240 V	98.75	95%
3-7	4	22500 V	240 V	93.75	90%

3.0 विभिन्न क्षमता के ऑक्जीलरी ट्रांसफार्मरों के तकनीकी आँकड़े/ TECHNICAL DATA OF AUXILIARY TRANSFORMERS OF DIFFERENT CAPACITY

The technical details of different capacity auxiliary transformers used in TRD are as following:

3.1 5 केव्हीए ऑक्जीलरी ट्रांसफार्मर/5 kVA Auxiliary Transformer



The rating and other particulars of the auxiliary transformer are as follows:

i.	Type	Double wound, single phase, oil immersed natural air cooled and step down transformer for outdoor installation.	
ii.	Rated voltage of primary winding	25 kV	
iii.	Rated voltage of secondary winding	240 Volt.	
iv.	Rated current a. Primary winding b. Secondary winding	 a. 0.2 A b. 21 A	
v.	Rated frequency	50 Hz ± 3%	
vi.	Rated power	i. 5 kVA	
vii.	Insulation level of winding	Primary	Secondary
	a. Rated lightening impulse withstand voltage peak b. Rated short duration power frequency withstand voltage c. Rated induced over voltage	a. 190 kV b. 70 kV rms c. 80 kV rms	- 3 kV rms -
viii.	Tapings	Off-circuit tap changer to give rated secondary winding voltage for a primary winding voltage variation of plus 5% to minus 10% in steps of 5%. Tapings may be provided either on primary or on secondary winding. All tapings are capable of carrying full load current continuously.	
ix.	Polarity	Subtractive	

x.	Temperature rise limits	The temperature rise over an ambient temperature of 45°C at rated load conditions shall not exceed the value indicated below :- a. Winding: 50°C (measured by the resistance method) b. Insulating oil : 40°C (measured by thermometer) c. Current carrying parts in air : 40°C. d. Hot spot temperature : not to exceed 115°C.
xi.	Impedance voltage at rated current at 75°C.	5%
xii.	Type of cooling	"ONAN"
xiii	Temperature class of insulation	Class "A" for all the windings.
xiv.	Current density for primary & secondary windings (max)	2.5 A/mm^2
xv.	Maximum permissible losses a. No load loss. b. Load loss at 75°C.	 a. 50 W b. 200 W
xvi.	Minimum creep age distance of the porcelain housing.	i. 900 mm for 36 kV class. ii. 90mm for 3.6 kV class.

3.2 10 केव्हीए ऑक्जीलरी ट्रांसफार्मर / 10 kVA Auxiliary Transformer



i.	Type	Double wound, single phase, oil immersed natural air cooled and step down transformer for outdoor installation.
ii.	Rated voltage of primary winding.	25 kV
iii.	Rated voltage of secondary winding.	240 Volt.
iv.	Rated current a. Primary winding. b. Secondary winding.	 a. 0.4 A b. 42 A
v.	Rated frequency	50 Hz ± 3%
vi.	Rated power	10 kVA

vii.	Insulation level of winding	Primary	Secondary
	a. Rated lightening impulse withstand voltage peak.	a. 190 kV	-
	b. Rated short duration power frequency withstands voltage.	b. 70 kV rms	3 kV rms
	c. Rated induced over voltage.	c. 80 kV rms	-
viii.	Tapings	Off-circuit tap changer to give rated secondary winding voltage for a primary winding voltage variation of plus 5% to minus 10% in steps of 5%. Tapings may be provided either on primary or on secondary winding. All tapings are capable of carrying full load current continuously.	
ix.	Polarity	Subtractive	
x.	Temperature rise limits.	The temperature rise over an ambient temperature of 45°C at rated load conditions shall not exceed the value indicated below. a. Winding: 50°C (measured by the resistance method). b. Insulating oil: 40°C (measured by thermometer). c. Current carrying parts in air: 40°C. d. Hot spot temperature: not to exceed 115°C.	
xi.	Impedance voltage at rated current at 75°C.	5%	
xii.	Type of cooling.	"ONAN"	
xiii	Temperature class of insulation.	Class "A" for all the windings.	
xiv.	Current density for primary & secondary windings (max).	2.5 A/mm^2	
xv.	Maximum permissible losses. a. No load loss. b. Load loss at 75°C.	 a. 60 W b. 300 W	
xvi.	Minimum creep age distance of the porcelain housing	i. 900 mm for 36 kV class. ii.90mm for 3.6 kV class.	
xvii.	Mass of core & winding.	80 kg.	
	Mass of oil	98 kg.	
	Total mass	300 kg.	
	Volume of oil	110 lts.	

3.3 25 केव्हीए ऑक्जीलरी ट्रांसफार्मर / 25 kVA Auxiliary Transformer



i.	Type	Double wound, single phase, oil immersed natural air cooled and step down transformer for outdoor installation.	
ii.	Rated voltage of primary winding.	Normal- 25 kV Min - 19 kV Max - 27.5 kV	
iii.	Rated voltage of secondary winding.	240 Volt.	
iv.	Rated current a. Primary winding. b. Secondary winding.	 a. 1.0 A b. 105 A	
v.	Rated frequency	50 Hz ± 3%	
vi.	Rated power	25 kVA	
vii.	Insulation level of winding a. Rated lightening impulse withstand voltage peak. b. Rated short duration power frequency withstands voltage. c. Rated induced over voltage.	Primary a. 190 kV b. 70 kV rms c. 80 kV rms	Secondary - 3 kV rms -
viii.	Tapings	Off-circuit tap changer to give rated secondary winding voltage for a primary winding voltage variation of plus 5% to minus 10% in steps of 5%. Tapings may be provided either on primary or on secondary winding. All tapings are capable of carrying full load current continuously.	
ix.	Polarity	Subtractive	
x.	Impedance voltage at rated current at 75°C.	5%	

xi.	Temperature rise limits	The temperature rise over an ambient temperature of 45°C at rated load conditions shall not exceed the value indicated below. a. Winding: 50°C (measured by the resistance method). b. Insulating oil: 40°C (measured by thermometer). c. Current carrying parts in air: 40°C. d. Hot spot temperature- not to exceed:115°C.
xii.	Type of cooling.	"ONAN"
xiii	Temperature class of insulation	Class "A" for all the windings.
xiv.	Current density for primary & secondary windings (max.)	2.5 A/mm^2
xv.	Maximum permissible losses a. No load loss b. Load loss at 75°C.	 a. 60 W b. 300 W
xvi.	Minimum creep age distance of the porcelain housing	i. 900 mm for 36 kV class. ii. 90 mm for 3.6 kV class.
xvii.	Mass of core & winding.	220 kg.
xviii.	Total mass	515 kg.

3.4 100 केव्हीए ऑक्जीलरी ट्रांसफार्मर / 100 kVA Auxiliary Transformer



i.	Type	Double wound, single phase, oil immersed natural air cooled and step down transformer for outdoor installation.
ii.	Rated voltage of primary winding.	25 kV
iii.	Rated voltage of secondary winding	240 Volt.
iv.	Rated current a. Primary winding. b. Secondary winding.	 a. 4.0 A b. 416.66 A
v.	Rated frequency	50 Hz ± 3%
vi.	Rated power	100 kVA

vii.	Insulation level of winding	Primary	Secondary
	a. Rated lightening impulse withstand voltage peak.	190 kV	-
	b. Rated short duration power frequency withstands voltage.	70 kV rms	3 kV rms
	c. Rated induced over voltage.	80 kV rms	-
viii.	Tapings	Off-circuit tap changer to give rated secondary winding voltage for a primary winding voltage variation of plus 5% to minus 10% in steps of 5%. Tapings may be provided either on primary or on secondary winding. All tapings are capable of carrying full load current continuously.	
ix.	Polarity	Subtractive	
x.	Temperature rise limits.	The temperature rise over an ambient temperature of 45°C at rated load conditions shall not exceed the value indicated below :- a. Winding: 50°C (measured by the resistance method). b. Insulating oil: 40°C (measured by thermometer). c. Current carrying parts in air: 40°C. d. Hot spot temperature: not to exceed 115°C.	
xi.	Impedance voltage at rated current at 75°C.	5 .19%	
xii.	Type of cooling.	"ONAN"	
xiii	Temperature class of insulation	Class "A" for all the windings.	
xiv.	Current density for primary & secondary windings (max).	2.5 A/mm^2	
xv.	Maximum permissible losses. a. No load loss b. Load loss at 75°C.	 a. 60 W b. 300 W	
xvi.	Minimum creep age distance of the porcelain housing.	i. 900 mm for 36 kV class. ii. 90mm for 3.6 kV class.	
xvii.	Mass of core & winding	360 kg.	
	Mass of oil	275 kg.	
	Total mass	880 kg.	
	Volume of oil	310 lts	

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4.0 संरचना / CONSTRUCTION

4.1 सामान्य / General

Auxiliary Transformer transfers power from 25 kV OHE, single phase 50 Hz. system to 240 volt system. It consists a HV winding and a LV winding. Both windings are separated electrically but magnetically coupled. Primary and secondary windings are wound on a common magnetic core. One end of primary winding is connected to 25 KV system through a bushing and other end is connected to tank (Earth) through bushing and link. Secondary terminals (both) are mounted on the tank through bushings. One terminal is used as phase and other is earthed and used as neutral. Windings along with core are immersed in insulating oil in a tank. For contraction and expansion of air in conservator tank, there is a silica-gel breather. Oil level indicating glass window is provided on the side of conservator tank. Two nos. of valves are provided on top & bottom side of tank for centrifuging of oil or drainage. There is a tap changer on primary or on secondary side of transfomer for suitable out-put voltage as OHE voltage is varying in nature.



4.2 ट्रांसफार्मर के विभिन्न पुर्जे और अवयव / DIFFERENT PARTS & COMPONENTS OF TRANSFORMER

Auxiliary Transformer consists of the following parts and components.

1. Transformer tank
2. Core
3. Winding
4. HV bushings and LV bushings
5. Conservator
6. Breather
7. Tap changer
8. Radiator
9. Oil outlet valve
10. Oil inlet valve
11. Oil level indicator.

4.2.1 ट्रांसफार्मर टैंक / Transformer Tank



The tank for the auxiliary transformer is constructed from good commercial grade low carbon steel suitable for welding with a single tier construction, so as to reduce welding to the minimum while fabricating. The tank is adequately strengthen with lifting lugs to permit hoisting of the transformer filled with oil through lifting lugs by a crane or other means.

4.2.2 कोर / Core



The core is made of high permeability cold rolled grain oriented/non aging electrical silicon steel laminations conforming to IS: 3024.

The laminations used for stacking the core are free from defects due to storage/atmospheric effects. Both sides of the laminations are coated with suitable insulation capable of withstanding stress relief annealing. In assembling the core, air gaps are avoided.

The core is electrically connected to the tank to drain off any electrostatic potential that might have been built up.

4.2.3 वाईन्डिग / Windings



The primary and secondary windings are of spiral/helical type. These windings are made of continuous electrolytic copper conductor, paper insulated to class 'A' insulation.

Normally, no joint is used in the winding conductor. If a joint becomes inescapable, it is brazed with high silver alloy grade Ba, Cu Ag 6 conforming to IS: 2927 or electrically butt-welded.

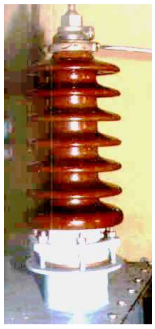
The ratio of width to thickness of copper conductor used for winding is kept as small as possible but shall not exceed 5:1 so as to avoid tilting of conductors when the windings are subjected to axial and radial forces during short circuits.

The auxiliary transformer windings have following insulation levels.

		Primary	Secondary
a.	Rated voltage between winding and earth.	25 kV	240 V
b.	Rated short duration power frequency withstand voltage	70 kVrms	3 kVrms
c.	Rated lightning impulse withstand voltage	190 kV peak	-
d.	Induced over voltage withstand.	80 kV rms	-

4.2.4 एच वी और एल वी बुशिंग / HV & LV Bushings

The bushings comply with IS: 2099 and IS: 3347. The line terminal of the primary winding is brought out through a 36 kV class bushing for connection to the overhead equipment and the neutral terminal brought out through a 3.6 kV class bushing and connected to the tank externally be means of a suitable tin coated copper link. The steel enclosure of the AT is connected to earth during service.





The 3.6 kV bushing and connection of the link to the tank is covered by sheet steel of not less than 2 mm thickness welded on to the tank and locked up with bolted cover as shown in fig a.

The porcelain housing of both bushing are comply with the requirements as per IS: 5621 and are of a single piece construction i.e. there is no joint in the porcelain housing. The shed profile has a lip at the extremities, but free from ribs on the underside so as to avoid accumulation of dust, pollutants and permit easy cleaning. The bushing is free from corona.

Primary and secondary bushing are provided with identical tinned copper stems of 20 mm diameter for 36 kV class bushing and 12 mm diameter for 3.6 kV class bushing. The stem is threaded to metric size at suitable places as per IS: 1367as shown fig. b



Fig a Steel Cover



Fig-b Terminal

The bushings shall withstand the following test voltages.

		Primary	Secondary
a.	Highest test voltage for equipment	36 kV rms	3.6 kV rms
b.	Rated short duration wet power frequency withstand voltage	70 kV rms	10 kV rms
c.	Rated lightning impulse withstand voltage	190 kV peak	40 kV peak
d.	Minimum creepage distance	900 mm	90 mm

4.2.5 कन्ज़रवेटर / Conservator



It is a drum containing transformer oil and mounted at the top of the transformer and connected to the main tank by a pipe. 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

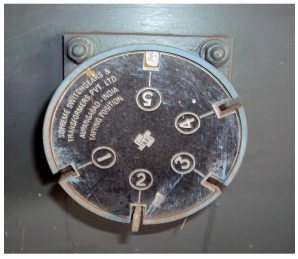
- Maintains the oil level in tank
- Provides space for the expansion of oil.

4.2.6 ब्रीदर / 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, it contracts and the air enters in it. It prevents transformer oil from moisture contamination.

4.2.7 टेप चेंन्जर / Tap changer



The tap changer is used for regulate the output voltage manually according to line voltage. The taps of the transformer can be changed by the tap changer manually.

4.2.8 रेडिएटर / Radiator



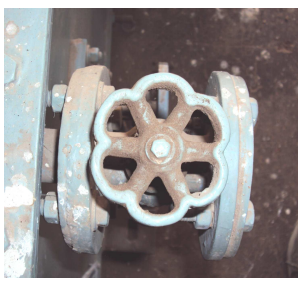
Radiator tubes or fins provide better and effective cooling of transformer oil by increasing the surface area of the tank to the atmosphere.

4.2.9 निकास वाल्व / Outlet Valve



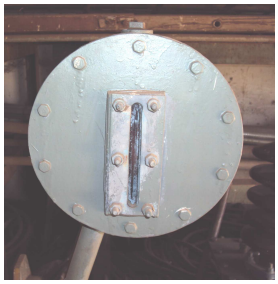
It provides passage to drain the oil during overhauling or as and when required oil sample for testing.

4.2.10 प्रवेश वाल्व / Inlet Valve



It provides passage to pour the transformer oil in the tank during purification or in case of shortage found in the tank.

4.2.11 ऑयल लेवल संकेतक / Oil level Indicator



It indicates level of insulating oil in the transformer tank. It has markings on transparent sheet for maximum & minimum levels.

5.0 अनुरक्षण / MAINTENANCE

5.1 मासिक अनुरक्षण / Monthly Schedule

S.No	Maintenance	Observation
1	Visual inspection of transformer.	Any sign of oil leakage, over heating
2	Clean the transformer externally conservator, bushing and tank.	By clean cotton cloth.
3	Check the condition of silica gel & oil in the cup of breather.	Silica gel reactivates/ replace if colour is pink. Top up the oil in cup if less
4	Check all connections of HT and LT bushing terminals	Tighten if loosen
5	Check oil level in conservator.	Top up with new oil of 60 kV BDV up to mark, if required.
6	Visual check of D. O. fuse and assembly.	Over heating, connections etc.
7	Clean the AT enclosure and remove the vegetation.	Neat and clean
8	Check the condition of pole mounted ICDP switch and its fuses.	- Overheating of lugs, use proper rating fuse and loose connections. - Use fuse wire 20 SWG for 34 Amp. and 22 SWG for 24 Amp.
9	Check caution board and anti climbing device.	Availability and its conditions

5.2 त्रैमासिक अनुरक्षण / Quarterly Schedule

S.No.	Work To Be Carried Out	Observation
1	Check all points stated carried out in monthly schedule.	
2	Check the condition of the D.O. fuse barrel and fuse element.	- Breakage, overheating - Use proper size fuse element for AT,s
3	Measure the arcing horn gap for HV bushing.	**Split horn gap maintain 82.5mm (minimum).**
4	Check condition of foundation.	Any crack or damages
5	Check structure bond and earth connection.	Tightness
6	Check any unusual sound of equipment.	soundless

5.3 अर्द्ध वार्षिक अनुरक्षण / Half Yearly Schedule

S.No.	Work To Be Carried Out	Observation
1	Check all points stated carried out in monthly and quarterly schedule.	
2	Check the BDV of oil	BDV minimum- 30 kV (with 2.5mm gap).
3	Measure Insulation Resistance between. a. HV- Earth b. HV- LV c. LV- Earth	 -200 M ohm. Minimum (use 2.5 kV megger) -200 M ohm. Minimum (use 2.5 kV megger) -2 M ohm minimum (use 500 V megger)
4	Check secondary voltage on each tap. a. No load b. Full load	Permissible limit.
5	Measure the earth resistance and check earthing connections.	Not more than 10 ohm.

5.4 वार्षिक अनुरक्षण / Yearly Schedule

S.No.	Work To Be Carried Out	Observation
1	Check all points stated carried out in monthly, quarterly and half yearly schedules.	
2	Check winding continuity on all tapings.	By mulltimeter
3	Check taps changer for smooth operation.	No obstruction during operation.
4	Check dissolves gas analysis (DGA) of transformer oil and polatisation index.	- Gases should be in permissible limit. - Time index is 600sec / 60sec.
5	Check the acidity of transformer oil.	Maximum 0.5 mg KOH/gm.
6	Conduct ratio test by applying AC supply to HV winding and LV side winding.	Measure the voltage.
7	Painting to be done.	If required.
8	Check HT and LT jumper its connections.	Flash mark, loose connection and overheating etc.

6.0 पीओएच / POH

Overhauling of a transformer is normally undertaken either if it is faulty or at the end of 7 to 10 years of service. Overhauling (POH) of transformer can be done either in repair shop or through trade.

6.1 ओवर हॉलिंग विधि / Steps for Overhauling

6.1.1 सामान्य सफाई / General cleaning

First of all remove as much dirt as possible particularly around the transformer tank, radiator, conservator, HV & LV bushing, neutral link block covers etc. Blow the dust of transformer & radiator with compressed air.

6.1.2 पीओएच के दौरान किये जाने वाले कार्य / Activities to be done during POH

The items which are required to be checked/ attended during overhauling are given below:

a. Record brief history of the equipment.

b. Visual Inspection:

- Check the complete tank for any deformation and crack.
- Check HV & LV bushing for any cracks/chipped discs.
- Check condition of silica gel container and silica gel.
- Check the oil leakage from auxiliary transformer tank, oil pipes, flange joints, conservator, drain plugs and vent plugs.
- Check the thread condition of filter inlet and out let valves, drain plug and breather socket.
- Check condition of all gaskets/washers.
- Check conservator tank, oil level indicator glass.
- Check condition of arcing horn.
- Note all the defects and deficiencies.

6.1.3 उपकरण को खोलने से पहले / Before opening of equipment

The following test to be carried out on transformer before opening of transformer.

a. इन्सुलेशन प्रतिरोध / Insulation resistance

Check the insulation resistance of windings between .

a. H V winding to earth by 2.5 kV megger.
b. L V winding to earth by 500V megger.
c. H V winding to L V winding by 2.5 kV megger.

b. निरन्तरता परीक्षण / Continuity Test

Check the continuity of the following windings with the help of multimeter.

- Primary winding
- Secondary windings

c. टेप चेन्जर / Tap changer

Check the condition and operation of tap changer at all tap positions.

d. ट्रांसफार्मर ऑयल का बीडीवी / BDV of transformer oil

Measure the BDV of transformer oil by automatic break down voltage kit.

e. पोलेराईजेशन अनुपात / Polarization ratio

The test consists of applying dc high voltage 2500V, with the help of a megger, continuously between winding and earth, and noting the insulation resistance at the end of 10sec, 60sec.

f. ट्रांसफार्मर ऑयल का डीजीए / DGA of transformer oil

Dissolved gas analysis (DGA) of the oil of a transformer is a very useful technique to assess the internal condition of the transformer.

g. ट्रांसफार्मर ऑयल का परीक्षण / Test on transformer oil

Measure the specific resistance (resistivity), water contents, dielectric dissipation factor (Tan delta), flash point, neutralization value, sludge etc of transformer oil.

h. अनुपात परीक्षण / Ratio test

Conduct ratio test of auxiliary transformer.

i . Before carrying out the work, the following works to be carried out.

- Drain out the transformer oil from tank.
- Disconnect all leads and remove tank top cover, accessories, conservator, fitting etc.
- Disconnect HV & LV bushings and store them in a safe place.
- Disconnect the earth leads from the transformer primary earth bushing terminal link block.
- Disconnect all the power cable connection from secondary winding side bushing.



6.1.4 ट्रांसफार्मर को खोलने के बाद / After opening the transformer

a. Measure Insulation Resistance of winding.

b. Check all core support bolts for any cracks and replace them if required.

c. Check condition of core, winding and lamination.

d. Check for accumulation of water content/ sludge inside the tank.

e. Check earth connections.

f. Check condition of soldered joints.

g. Check the insulation paper for any damage and reinsulated if necessary.

h. Check the condition of tap changer contact tips at all tap positions.

6.1.5 किए जाने वाले कार्यों का विवरण / Details of Work to be Carried Out

a. Clean winding and core with new filtered oil.

b. Tighten core bolts and other fasteners to secure the core and winding properly and replace by new one if worn out.

c. Bake the winding and core by keeping in oven at a temperature of 60 °C.

d. Observe daily improvement in IR values of winding.

e. Clean the tank thoroughly from inside and outside.

f. Check visually inside of tank for any flash mark, hit mark, damage etc.

g. Do the varnishing of the tank inside area with copal varnish.

h. Paint the tank from out side with battleship gray paint.

i. Check the oil drain cocks and change washers by a new one, tight and lock them.

j. Check the secondary terminal blocks fixing studs for tightness and they should be oil leak proof.

k. Check the HV bushing fitting surface, it should be clean and plain.

l. Check the inlet and outlet valves for their proper working and check for oil leakage.

m. Replace all gaskets, oil seal, 'O' ring or other rubber/ neoprene items.

n. Tighten earth connection of the equipment.

o. Replace worn out contacts of tap changer.

p. Replace oil level indication glass, if required.

6.1.6 फिटिंगों का निरीक्षण / Inspection of Fittings

a. सिलीका जैल ब्रीदर / 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 °C to 200 °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.

b. रेडिएटर / Radiator

- Clean the radiator tubes thoroughly by compressed air and high pressure water jet if applicable.
- Check radiator tubes and fins for any damage if applicable.

c. कनज़रवेटर / Conservator

- Clean conservator and glass indicator thoroughly.
- Check the conservator for any damage, intactness of indicator glass and condition of glass.

6.1.7 सूखने के बाद वाईन्ड्रिंग को लगाना / Reassemble after Drying Out the Winding

a Replace all gaskets with new one before assemble the equipment.

b. Fill the new filtered oil with 60 kV BDV in the tank.

c. Assemble the equipment and connect all winding connections of HV, LV bushings, tap changer and HV earthing connection.

d. Check, clean and re-fit all accessories of the transformer.

6.1.8 असेम्बली के बाद ऑक्जीलरी ट्रांसफार्मर का परीक्षण / Testing of Aux. Transformer After Assembling

Carry out the following tests on the auxiliary transformer after assembling of winding and core in tank.

- Meggering.
- Continuity test.
- Ratio test.
- Voltage out put at different taps.
- Magnetising current.

6.1.9 अन्तिम जाँच / Final Checking

- Check visually for any oil leakage from any point, coupling, joints etc.
- Check any unusual sound of equipment.
- Check and ensure oil level in conservator, it should be maximum mark.
- Release air from top screw of HV bushing.
- Measure final IR values and compare with previous recorded values.
- Measure BDV of oil and moisture content (ppm).
- Check arcing horn gap.

7.0 ऑक्जीलरी ट्रांसफार्मर के जीवन को प्रभावित करने वाले कारक FACTORS AFFECTING LIFE OF AUXILIARY TRANSFORMER

Life of auxiliary transformer is affected by the following factors:

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

7.1 ट्रांसफार्मर के जीवन पर नमी का प्रभाव / 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 silica gel in each inspection and if found pink, replace or reactivate crystals at 150 to 200 °C. Test transformer oil for dielectric strength and water content in maintenance schedule and carry out purification with high vacuum type transformer oil filtration plant if required. Arrest the oil leakage if any.

7.2 ऑक्सीजन का प्रभाव / 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.

7.3 ठोस अशुद्धताओं का प्रभाव 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.

7.4 वार्निश का प्रभाव / 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.

7.5 वाईन्डिंग के ढीले होने का प्रभाव / 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.

8.0 ट्रांसफार्मर तेल / TRANSFORMER OIL

The auxiliary transformers are supplied complete with insulating oil conforming to IS: 335. The transformer is shipped with windings and core under oil. In addition, 10 per cent extra oil is supplied in non returnable sealed steel drums. The insulating oil is procured from the manufacturers approved by RDSO. The manufacturers are submit test certificates as per IS: 335 for oil.

The characteristics of insulating oil before energizing the AT shall be conforming to the parameters stipulated in IS: 1866.

8.1 ट्रांसफार्मर तेल का परीक्षण / Testing of Transformer Oil

In order to improve the performance and to prolong the life of the transformers, EHV grade oil is used as per the requirement laid down by RDSO. Application and interpretation of tests on transformer oil in service is given below.

8.2 प्रयोग में आ रहे ट्रांसफार्मर तेल के परिक्षणों का अनुप्रयोग और उनकी व्याख्या / Application and Interpretation of Tests on Transformer Oil in Service

Sr.	Tests	Value as per IS: 1866		
		Permissible limits	To be re-conditioned	To be replaced
1.	Electric strength (Breakdown voltage) Below72.5 kV	Min. 30 kV	Less than the value specified	If minimum value is not attained after reconditioning.
2.	Specific resistance (Resistivity) Ohm/cm at 27°C	Above 10×10^{12}	Between 1×10^{12} to 10×10^{12}	Below 1×10^{12}
3.	Water content Below 145 kV	Max. 35 ppm	Greater than the value specified.	-
4.	Dielectric dissipation factor, Tan delta at 90°C.	0.01or less	Above 0.01 to 0.1	Above 0.1
5.	Neutralization Value mg KOH/g of oil.	0.5 or Less	Above 0.5	Above 1.0
6.	Interfacial tension N/m at 27°C.	0.02 or more	0.015 and above but below 0.02	Below 0.015
7.	Flash point in °C	140 or more	125 and above but below 140	Below 125
8.	Sludge	Non-detectable	Sediment	Perceptible sludge

8.3 निर्माता के कारखाने में परीक्षण के समय नये तेल की महत्वपूर्ण गुणधार्मिकतायें (REF: IS 335) Important Characteristics of New Oil when Tested at the Manufacturer's Works (Ref: IS 335)

S.No	Characteristics	Test Method (Ref. to IS: or Appendix)	Requirements
1.	Appearance	A representative sample in 100 mm thick layer	The oil is clear and transparent free from suspended matter or sediments.
2.	Electric strength (break down voltage) a. New unfiltered oil. b. After filtration.	IS: 6792-1972	a. Min. 30 kV (rms) b. If the above value is not attained, the oil shall be filtered, 60 kV(rms), RDSO's requirement.
3.	Resistivity at a. 90°C b. 27°C	IS: 6103-1971	Min. 35×10^{12} Ohm-cm 1500×10^{12} Ohm-cm
4.	Dielectric dissipation factor (tan delta) at 90°C	IS: 6262-1971	Max. 0.002
5.	Water content	Appendix E of IS: 335-1983	Max. 50 ppm
6.	Interfacial tension at 27°C	IS: 6104-1971	Min. 0.04 N/m
7.	Flash point	IS : 1448	Min. 140°C

S.No	Characteristics	Test Method (Ref. to IS: or Appendix)	Requirements
8.	Dissolved gas content		4 – 8%
9.	Neutralization value a. Total acidity b. Inorganic acidity/alkalinity	 IS: 1448 - do -	 a. Max. 0.03 mg KOH/g b. Nil

8.4 ट्रांसफार्मर तेल का परिशोधन / 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 presence of moisture.

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

For purifying the transformer oil, machine conforming to RDSO's specification no.ETI/PSI/103 may be used.

8.5 तेल का नमूना / Oil Sampling

8.5.1 सामान्य सावधानियाँ / General precautions

i. Use always clean, dry and amber glass bottles as per IS: 6855-1973

ii. Take oil sample preferably in dry weather and avoid any external contamination.

iii. Oil sample shall be at least as warm as the ambient air.

8.5.2 नमूना लेने की विधि / Sampling procedure

i. First drain at least one liter oil to eliminate any contaminations which is accumulated in the drain cock.

ii. Rinse the bottles with the oil being sampled.

iii. After taking the sample, ensure that the cock is correctly closed.

iv. Check that the label marking are correct and complete.

v. Store samples in a dark place.

vi. Ensure that the sampling is done by an experienced person.

vii. Ensure that each of sampling bottle is filled up to 95 to 98 percent of its capacity.

9.0 विफलताओं के कारण और उनके निदान / CAUSES OF FAILURES AND THEIR REMEDIES

9.1 सामान्य विफलताऐं / Common Failures

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

- Oil leakage
- Low BDV
- Bushing failure
- Winding failures
- Excessive overheating of oil
- Low IR value
- Humming sound

9.1.1 तेल का रिसाव / 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.
From couplings & their joints	- Cracks in couplings. - Defective coupling joints.	- Replace 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.

9.1.2 निम्न बीडीवी / 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.

9.1.3 बुशिंग विफलताऐं / Bushing Failure

Types of failure	Possible causes	Remedial action
H V Bushing flash over	- Lightening discharge or over voltage - Arcing horn gap is less. - Dirty bushing.	- It may be a break in the turns or end lead, flash marks on the end coil and earthed parts close to it. - Measure split type arcing horn gap minimum 82.5 mm. - Bird electrocuted - Ensure cleaning of porcelain bushing during each inspection.
H V Bushing porcelain insulator petticoat broken / cracked.	- External hitting.	- Ensure proper cleaning and visual checking of porcelain bushing during each inspection.

9.1.4 वाईन्डिंग विफलताऐं / Winding Failures

Types of failure	Possible causes	Remedial action
Primary winding lead open circuited / earthed.	Short circuit due to overload.	Check the winding in one or all phases would show signs of overheating and charring.
Bulging and inter turn short, inter layer short or inter coils short.	Coils shrink and in between insulation failure.	Investigate for over loading and take corrective action accordingly.
Shorting between LV and HV coils.	Insulation failure.	During manufacturing/ rewinding of the transformer, the coils should be pressed down, heated and cooled repeatedly until the coil height stabilizes.

Types of failure	Possible causes	Remedial action
Flash mark on the core and support.	Dead short- circuit due to lateral or displacement of the coil.	- 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.
	- Winding loose on the core.	- Replace the transformer and core to be lifted for thoroughly checking and take corrective action accordingly. - Repair the winding if possible

9.1.5 ट्रांसफार्मर का अत्याधिक गर्म होना / Excessive overheating of transformer

Type of failure	Possible causes	Remedial action
Temperature rise of transformer oil.	- Any internal fault such as short circuited core, core bolts/ clamps insulation failure etc.	- Replace the transformer and core to be lifted for thoroughly checking. Take corrective action according to observations and oil test report.
	- Low oil level in conservator.	- Check the oil level in conservator and top up if required.
	- Slugged oil.	- Carry out purification of oil to remove sludge.

9.1.6 निम्न आईआर मान / Low IR value

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

9.1.7 भिनभिनाहट की आवाज / Humming sound

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

10.0 कन्डीशन मॉनीटरींग / CONDITION MONITORING

10.1 फायदे / Advantages

Condition Monitoring of Auxiliary Transformer involves monitoring of certain parameters. Maintenance activities can be decided and carried out based on the prescribed values of these parameters.

Normally, any equipment is maintained in three ways namely:

a) Routine Maintenance
b) Periodic Maintenance
c) Condition based maintenance

In Routine maintenance, activities are involved which are essential for day to day working like checking of Oil level, colour of silica gel in breather, abnormal sound, oil leakage, etc.

In Periodic maintenance, activities involved are those which ensure the working of the transformer over a long period such as oil testing, IR measurement of the windings etc.

It is established that over maintenance of any equipment leads to more number of failures. Therefore the trend should be to minimise the maintenance which can be achieved through Condition based monitoring.

A transformer never fails all of a sudden except due to short circuiting or lightening surges. Normally fault is developed gradually and may lead to its failure if not detected in incipient stage.

Dissolved gas analysis is very powerful tool to monitor the health of transformer during service.

10.2 विलीन गैस विश्लेषण(डीजीए)/ Dissolved Gas Analysis (DGA)

The transformer oil acts as a coolant and insulating medium in the transformer. It absorbs heat from the core and dissipates it to atmosphere. Also it insulates various parts of the transformer which are at different potentials. The oil is possess the properties as specified in IS: 335.

Condition of the oil indicates the health of the transformer. If the deviation in the properties of the oil takes place, cause for this can be found out and necessary measures can be taken accordingly. Dissolved gas analysis is very useful tool to achieve this. The DGA has following advantages:

- It assesses the internal condition of the transformer.
- The knowledge of solubility of Hydro-carbons and fixed gases at different temperatures in the oil helps to dissolved gas analysis.
- The absolute concentration of fault gas indicates status of insulation whereas relative concentration provides a clue to the type of the fault.

Formation of gases takes place in oil filled transformer due to following reasons.

- Oxidation
- Vaporisation
- Insulation decomposition
- Oil Breakdown
- Electrolytic action

For DGA generally Rogers' Method is used which analyses proportion of one gas with respect to other gas. The gases involved are

i) Methane (CH_4) and Ethane (C_2H_6) - at 120^0 C
ii) Ethylene (C_2H_4) - at 150^0 C
iii) Acetylene (C_2H_2) - at very high temp
iv) Hydrogen (H_2)
v) Carbon di-oxide (CO_2)
vi) Carbon Mono oxide (CO)

Guide lines for condition monitoring of transformer by DGA technique are indicated in table 2.04 of ACTM Vol.II (Part I)

10.3 डीजीए के परिणामों का विश्लेषण/Analysis of DGA Results

- If methane/hydrogen ratio is 1, slight over heating below 150^0 C.
- If methane/hydrogen ratio is 1 and ethane to methane is 1, overheating between 150^0 - 200^0 C.
- If ethane to methane ratio is 1, overheating is between 200^0C – 300 ^{0}C.
- If ethylene to ethane ratio is 1, normal conductor over heating.

- If methane to hydrogen and ethylene to ethane ratio are 1, circulating currents and overheated of joints.
- If acetylene to ethylene is 1, flash over without power flow current.
- If ethane to methane and acetylene to ethylene are 1, Tap changer selector breaking current.
- If Ethylene to Ethane and Acetylene to Ethylene are 1, Arc with power flow through or persistent arcing.

Note:

i) Ratios < 1.0 are designated as 0.
ii) Ratios > 1.0 are designated as 1.

10.4 स्वस्थ ट्रांसफार्मर में विलीन गैसों की अनुज्ञेय सान्द्रता/Permissible Concentration of Dissolved Gases in the Oil of a Healthy Transformer

Gas	Less than 4 years in service (ppm)	4 - 10 years (ppm)	More than 10 years (ppm)
H_2	100 - 150	200 - 300	200 - 300
CO_2	3000 - 3500	4000 - 5000	9000 - 12000
CO	200 - 300	400 - 500	600 - 700
CH_4	50 - 70	100 - 150	200 - 300
C_2H_6	100 - 150	150 - 200	200 - 400
C_2H_4	30 - 50	100 - 150	800 - 1000
C_2H_2	20 - 30	30 - 50	200 - 150

10.5 विभिन्न दोष अवस्था में गैस का स्तर (सभी सान्द्रता पीपीएम में)/ Gas Level for Different Fault Conditions (All Concentration are in PPM)

Gases / Fault	Hydrogen (H_2)	Methane CH_4	Ethane C_2H_6	Ethylene C_2H_4	Acetylen C_2H_2	Carbon dioxide CO_2
Arcing	500 - 1000	20-130	10-30	10-30	40-100	3000-4000
Partial Discharge	500 - 1000	20-130	10-30	10-30	10-15	3000-4000
Hot spot	20-150	10-30	10-30	150-200	10-15	3000-4000
Gradual Overheating	20-150	10-30	150-200	10-30	10-30	3000-4000

11.0 क्या करें और क्या न करें/ DO'S AND DON'TS

11.1 क्या करें/Do's

1. Replace DO fuse periodically.
2. Always use transformer oil procured from RDSO approved suppliers.
3. Check silica gel regularly.
4. Examine the bushings for dirt deposit, coating and clean them periodically.
5. Attend any type of oil leakage at the earliest possible.
6. Clean conservator thoroughly before refilling.
7. Ensure periodic testing of transformer oil.
8. Maintain record of transformer and oil, transformer wise for future reference.
9. Check DO assembly barrel spring tension.
10. Always use proper size lugs in cable for connections.
11. Use proper rating of fuses on primary and secondary side.
12. Use silica gel breather minimum capacity of 250 grams at least.
13. Use motorised megger to measure IR values.

11.2 क्या न करें/Don'ts

1. Don't use under capacity pulley and tirfor for unloading
2. Don't leave any loose connection.
3. Don't meddle with protection system.
4. Don't allow conservator oil level to fall below (minimum oil level) 1/3 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. Don't energise the transformer without conducting commissioning checks.
14. Don't over load the transformer.
15. Don't use cotton waste for cleaning any inside part of transformer the bushing.

12.0 मॉडल प्रश्न / MODEL QUESTIONS

12.1 विषयपरक प्रकार / Objective Type

1. Before starting work on faulty circuit it should be ensured that
   a. The faulty circuit has been isolated from power supply and earthed.
   b. The worker is capable to do the work.
   c. The connections are not approachable.
   d. None of the above.

2. One can protect himself from electric shock by wearing hand gloves of good.
   a. Conducting material
   b. Insulating material
   c. Semiconductor material
   d. Any of the above.

3. Which of the following are safety precautions?
   a. Don't touch live wire or equipment with bare hands.
   b. Before switching on DO fuse, see no one is working on Auxiliary Transformer.
   c. Use insulated material hand gloves.
   d. All of the above.

4. Which material is recommended as fire extinguisher in electrical cases?
   a. Carbon tetra chloride
   b. Carbon di- oxide
   c. Sulphur hexafluoride
   d. Any of the above.

5. The BDV of Auxiliary Transformer oil minimum should be.
   a. 20kV
   b. 30kV
   c. 40kV
   d. 50kV

6. The colour of moisturized silica gel is
   a. Pink
   b. Blue
   c. Yellow
   d. Green

7. The material filled in breather of transformer is
   a. Silica gel
   b. Sulphuric acid
   c. SF6
   d. Mineral oil

8. The protective device to internal fault in a Auxiliary Transformer is
   a. Thermal relay
   b. Bucholz
   c .Lead
   d. None of the above

9. Which of the following is not the function of Auxiliary Transformer oil
   a. Cooling of winding and core.
   b. Providing additional insulation
   c. Media for arc quenching
   d. Provides inducting coupling

10. Transformer oil should be free from
   a. Odor
   b. Gases
   c. Temperature
   d. Moisture

11. The short circuit test of a transformer gives
   a. Copper loss at full load
   b. Copper loss at half load
   c. Iron loss at any load.
   d. Sum of iron loss and copper loss.

12. The type of oil, which is suitable as transformer oil is
   a. Crude oil
   b. Organic oil
   c. Mineral oil
   d. Animal oil

13. Auxiliary Transformer is an example of
   a. Current transformer
   b. Potential transformer
   c. Auto transformer
   d. Distribution transformer

14. The colour of fresh transformer oil is
   a. Pale yellow
   b. Dark brown
   c. Blue
   d. Colourless

15. The purpose of conservator tank in a transformer is to
   a. Monitor oil level
   b. Top up the oil
   c. Both a & b above
   d. None of the above

12.2 रिक्त स्थान भरें / Fill in the Blanks

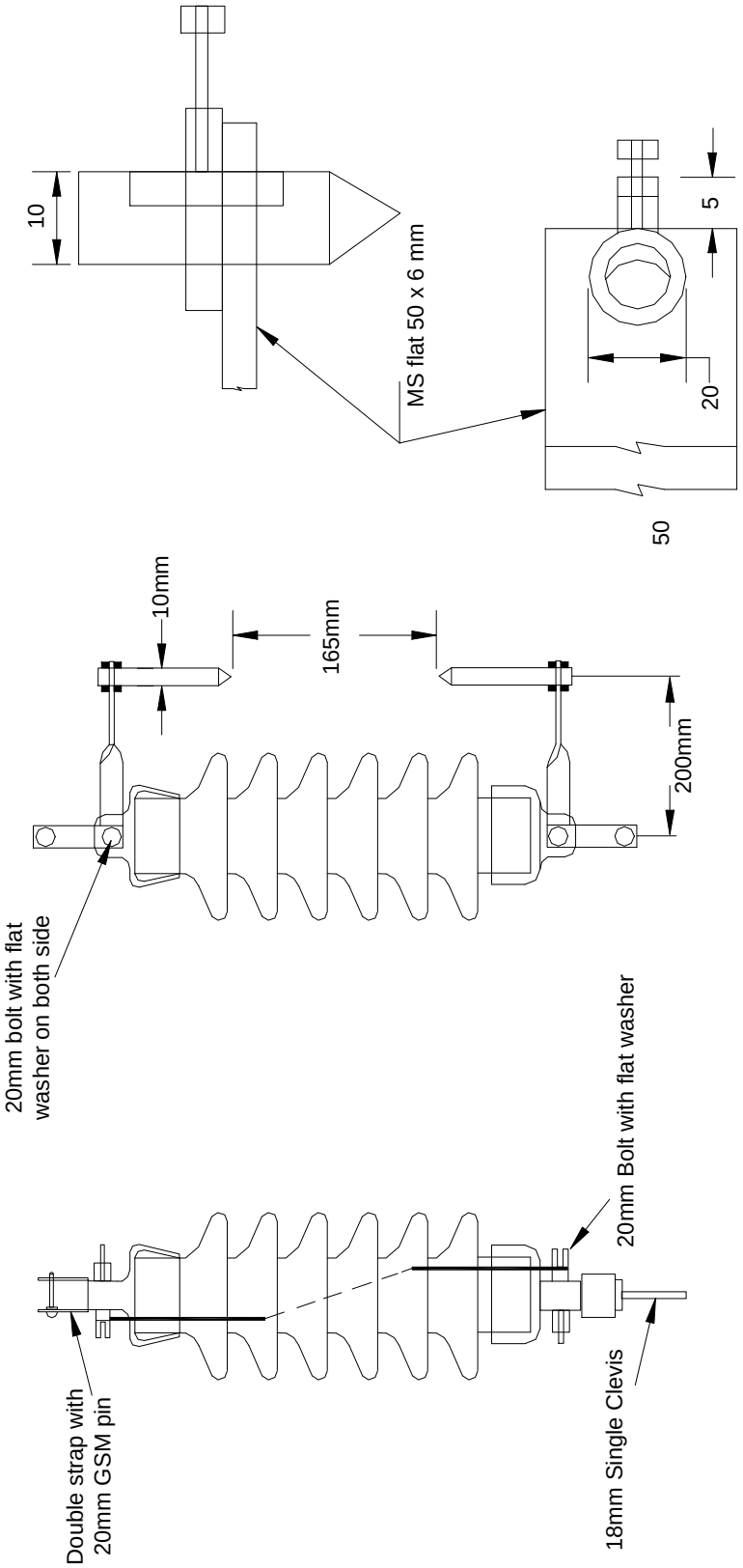
1. Transformer is a …….device
2. Auxiliary transformer has…….windings
3. An emf induced in a coil due to variation of flux in another coil is called……
4. The coils of a transformer are wound on a ……core of …….material
5. Ingress of moisture is prevented by means of …….
6. The breather is attached to ……and contains……
7. Pink colour of silica gel indicates……..
8. The colour of transformer oil become dark brown, it indicates presence of …… …
9. Operating vacuum of transformer oil purification plant should be …….
10. DGA stands for ……..
11. DO fuse element rating of 10 kVA auxiliary transformer is ……
12. DO fuse element rating of 100 kVA auxiliary transformer is ……

13.0 संशोधन / MODIFICATION

Arrangement of additional arching horn fixed to 9 – tonne insulator as per RDSO's Drg No. TI/SK/PSI/ARCHON/RDSO/00001/08/0 has been issued.

A schematic arrangement of additional arching horn fixed to 9 – tonne insulator shown in below.

SCHEMATIC ARRANGEMENT OF ADDITION ARCING HORN
FIXED TO 9 - TONNE INSULATOR



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संदर्भ

1. एसी ट्रैक्शन अनुरक्षण एवं परिचालन मैनुअल वॉल्यूम II (पार्ट I) 1994 ।
2. ऑक्जीलरी ट्रांसफार्मर पर आरडीएसओ द्वारा जारी स्पेसीफीकेशन सं. ईटीआई/पीएसआई/15 (08/2003) एवं ईटीआई/पीएसआई/15ए (07/82) ।
3. विभिन्न कार्यक्षेत्रों का अध्ययन एवं वहाँ से एकत्र सामग्री ।
4. इरकैमटेक ग्वालियर में दिनांक 06 अगस्त 2010 को आयोजित सेमीनार में विभिन्न रेलों से आये हुये प्रतिनिधियों द्वारा दिये गये सुक्षाव।

REFERENCES

1. Manual of AC Traction Maintenance and Operation Volume II (Part – I).1994
2. RDSO specification No. ETI/PSI/15 (08/2003) & ETI/PSI/15A (7/82) on Auxiliary Transformer.
3. Study and collection of literature from field.
4. Suggestions recieved during the seminar held at CAMTECH on date 06th august 2010 on Training Package on Auxiliary Transformer.

हमारा उद्देश्य

अनुरक्षण प्रौद्योगिकी और कार्यप्रणाली का उन्नयन करना तथा उत्पादकता और रेलवे की परिसम्पत्ति एवं जनशक्ति के निष्पादन में सुधार करना जिससे अन्तर्विषयों में विश्वसनीयता, उपलब्धता, उपयोगिता और दक्षता प्राप्त की जा सके।

यदि आप इस संदर्भ में कोई विचार और विशेष सुझाव देना चाहते हों तो कृपया हमें इस पते पर लिखें।

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OUR OBJECTIVE

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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