OPERATION & MAINTENANCE MANUAL FOR DISTRIBUTION TRANSFORMER

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DTRM - 03 06
ISSUE B 03 2006

AREVA T&D India Limited

A WORD ABOUT OURSELVES

We **AREVA T&D India Limited,** are constituents of global power major AREVA worldwide. In our Indian operations, we include manufacturing of vital Power system components such as Power and Distribution Transformers. Air circuit breakers, vacuum circuit breakers, EHV equipment, HTand LT motors, Lightning Arrestors, Current transformers, Capacitor Voltage Transformers, Wavetraps, Relays and Control panel to name a few. Our Distribution Transformer operations are located at Naini in district Allahabad of Uttar Pradesh.

Naini works is equipped with state of art manufacturing facilities and latest technologies,

We have a long tradition of engineering excellence through worldwide continuous development and we take pride in our technological strengths.

We also take equal pride in our association with our valued customers and thus in rendering our services to the nation.

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PART- I

This Part describes the following :-

1. FORWORD :

AREVA Transformers are designed and manufactured to ensure ease of installation and reliability in service with a minimum of attention.

The purpose of this instruction manual is to stress the importance of observing essential installation and maintenance procedure.

Attention to these few points will amply ensure trouble-free service and low maintenance costs. Many of the recommendations seem obvious, but it is only by careful attention to all such details that efficient and trouble free operation of transformers is achieved.

When installed and commissioned with care transformers usually require less maintenance than any other kind of electrical power apparatus. A regular program of inspection should be established and consistently carried out. The frequency of such inspections is being determined by the conditions under which the units operate. For example, a transformer operating under arduous conditions requires more maintenance than one operating under light-load conditions. Atmospheric pollution, temperature, humidity, altitude etc. have effect on the performance of transformer. Therefore, the inspection and maintenance schedule has a bearing on local condition also.

2. DESCRIPTION OF TRANSFORMER :

The Transformer is connected between rated voltages for rated kVA as declared in Rating & Diagram plate. Transformer provided with detachable radiators for ONAN/ ONAF cooling.

CORE & WINDINGS :

The magnetic circuit is of three-limb core type construction. Each limb being mitered joined with the top and bottom yokes. The laminations are made high grade non aging cold rolled grain oriented steel. The limbs are firmly clamped by fiber glass bands and the yoke laminations are bolted together along with the yoke clamping channels.

The windings are arranged on the core limbs in a concentric manner with low voltage windings (copper foil / spiral winding) next to the core and high voltage layer winding over it. Concentric windings are thoroughly insulated from each other by oil ducts and press board cylinders. The-oil ducts are so arranged as to provide maximum circulation of oil to each and every point of the wi ıding thereby providing an effective medium of cooling.

TAP CHANGER :

The Transformer is provided with an OFF CKT SWITCH/OFF CIRCUIT LINKS /ON LOADTAP CHANGER (whatever applicable) on HV, catering to the declared voltage variation for a constant power output.

IN CASE OF OFF CIRCUIT SWITCH or, OFF CIRCUIT LINKS, THE TAP CHANGING OPERATION SHOULD BE CARRIED OUT ONLY WHEN THE TRANSFORMER IS ISOLATED FROM THE SUPPLY.

TRANSFORMER ACCESSORIES :

Please refer the Outline General Arrangement drawing. Schematic diagram of Marshalling Box for location of accessories and specification of individual instruments.

1. SITE ARRANGEMENT

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Before commencing erection, the following arrangements shall be made at site,

i. Lifting Equipment:

A mobile crane (suitable to lift weight as indicated in R & D plate) with 15 meters lift is essential for assembling the accessories of the transformer. If the sub-station is equipped with a crane room, transformer erection may be carried out there and afterwards the transformer may be rolled to its position. (We recommend that weights indicated on Rating & Diagram Plate to be considered for selection of crane capacity)

ii Oil Purifier:

We recommend a stream line oil purifier of more than 100 LPH capacity. The capacity of the filtering machine required for atleast 6 to 8 hours per cycle.

iii Oil Tank:

One or more oil tanks of sufficient storage capacity shall be provided if required.

iv Tools:

a) 1/2" Venylhose 10 m long.
b) Drum opener.
c) Crowbar, pipe roll, hammers etc. (For package opening & shifting)
d) 1/2"wire rope sling -5m long.
e) Scrapers for scraping gasket surface
f) Chain pulley block 1 Ton capacity &2 Meter long.
g) 3/8" wire rope sling, 2 Meter long
h) Small screw spanners for nuts up to 8mm size.
i) Electric hand lamp
j) Screw drivers
k) Cutting plier (insulated)
l) PVC wire for insulation test and voltage value test.
m) Cotton cloth
n) Clean cloth waste
o) D-Shackle
p) Brush
q) Slide wrench

r) Spanners:

2" BS / M48
1 1/2"/M36
1 1/2"/M30
1"/M24
3/4"/M20
5/8"/M16
1/2"/M12
3/8"/M10
14mm
12mm
6mm

2. MANNER OF DISPATCH:

Considering transport limitations, weight requirements or risk of damage during transit, the transformers are dispatched in one of the following conditions :-

(1) Fully assembled

(2) Accessories and fittings dismantled and main tank filled with oil.

3. RECEIPT AT SITE:

Immediately after the transformer is received at site, the contents must be checked as per the packing note. Particularly, for transformers, which are dispatched filled with oil, level must invariably be checked for any pilferage during transit. The oil level is indicated by the oil level gauge (shipping oil gauge) provided on conservator/body of tank.

All shortages and damages should be immediately reported to us. In case insurance is from our end, details of damages and shortages must be received by us within 10 days of receipt of consignment, as any claim reported after the above said period is not entertained by our underwriters.

4. HANDLING:

While unloading the transformers and its accessories at site, care must be exercised for lifting the heavy packages through the lifting lugs/jacking pads provided for the purpose and duly marked. Never use auxiliary points for lifting of heavy packages. A reference to the General Arrangement Drawing of the particular job would be worth referring.

5. STORAGE:

Though it is desirable that after arrival of the transformer at site, the erection and commissioning is completed with minimum delay, however it may not be practical in all the cases to do so. It is, therefore, advisable that following precautions are followed

i) All the accessories should be stored in a covered dry place on a hard surface.

ii) Detachable radiators, if not mounted on the transformer, must be stored under cover, after duly blanking off the flanges to avoid any ingress of dirt, water or any foreign material inside the radiators.

iii) Bushings, when dispatched loose, should be stored properly boxed under a shed.

iv) Equipment meant for indoor use, such as control panels instruments etc. should be stored indoors only.

v) Fragile components must be handled very carefully. All packings should be kept above ground by the use of supports so as to allow free airflow underneath.

vi) Transformer oil received in drums must also be stored under cover. The drums should not be stored in vertical position. While drums are lying on the ground the opening should be at the lowest point so that there is always an out flow of the oil in case of any leakage rather then water entering into the oil.

vii) The accessories which are to be stored for a long period should be repacked after preliminary inspection so that the contents are not. lost in due course of time.

viii) For transformers received either fully assembled or the main tank filled with oil, an oil sample should immediately be drawn to check for its dielectric strength if it is found below the acceptable limits, the remedial measures must immediately be taken to avoid further deterioration of oil and transformer insulation.

If the storage is prolonged over 2/3 months, it is desirable that the complete transformer is assembled fitted with silica gel and kept energised at a low voltage before commissioning so as to keep the temperature inside the transformer above the ambient temperature.

ix) In order to avoid further handling, it is desirable to erect the transformer on its foundation immediately on receipt at site. It is not uncommon that the transformer left on soft ground after the rainy season or even otherwise, because of its heavy weight, tends to sink thus making the situation still worse.

x) While unloading at site, the transformer should be so placed that easy access is available all around the transformer to have a visual inspection and that the Rating & Diagram plate is visible.

6. TRANSFORMER LOCATION:

No special foundation is necessary for the installation of a transformer except a level floor strong enough to support the weight. Transformer should be so installed that easy access is provided all around, so that Rating & Diagram plate, thermometers, valves, oil gauge etc. are easily accessible. Type ONAN" Transformers depend entirely upon the surrounding air for carrying away the heat generated as losses. For indoor installations, therefore, the room must be well ventilated. For recommendation on minimum spacing between the Transformer and its surrounding walls, reference should be made to IS: 10028 (Code for Selection, Installation and Maintenance of Transformer).

It is needless to mention that all electrical installations shall comply with the requirement of Indian Electricity Rules and reference may be made to IS: 10028 (which highlights these point). All connections to earth shall be made in accordance with IS:3043 (Code of Practice for Earthing).

7. ERECTION:

Erection is preparing the transformer for service. A reference should be made to the Out line Drawing of the Transformer for the location of various fittings and accessories. At this stage the transformer is expected to be mounted in its normal position with rollers or otherwise. Certain parts like radiators, conservator, explosion vent etc. may have been dismantled for transport purposes. Before erection it is essential to examine all parts which will be in contact with the oil to ensure scrupulous cleanness. Those parts after thorough inspection should be re -fitted in position shown in the relevant outline drawings of the transformer.

The following checkpoints are essential to be followed before starting the erection work:-

i) Before starting the erection ensure all the components supplied loose are available at site. This should be confirmed by a cross -check with reference to the OGA arrangement.

ii) Parts detached for transport such as radiators, conservator, explosion vent, bushings etc. should be examined for cleanliness.

iii) Rinse thoroughly, if necessary, with hot transformer oil, parts which are in contact with oil in the transformer such as radiator heat exchanger, pumps, pipe work etc.

iv) Check the porcelain bushing for any damages of crack. Clean the bushing with a dry nonfluffy cloth.

v) Bushings should be assembled using proper gaskets for the various joints.

vi) If gaskets is over pressed or aged its reuse is strictly discouraged. Replace all such gaskets with a set of new one.

vii) Current transformers must be mounted with care so that correct polarities are observed.

viii) While mounting the Buchholz relay, check for direction of the arrow marked on the body for correct mounting arrow should be pointing towards conservator. The pipe assembly should, be at an upward inclination of 3-4^0 (degree). Mounting of various accessories shall be done according to OGA drawing. The mounting installation of various accessories (whichever applicable) is given in Sec. II-Transformer Accessories

After referring the above checks, following mounting procedure to be carried out.

MARSHALLING BOX :

Control wire of trip & alarm circuit from accessories like magnetic oil gauge, Buchholz relay. Temperature indicators etc. are connected to the top of the terminal strip in the marshalling box. The bottom terminals in the box are provided for running control wires from control room for alarms & trip devices. A reference of the schematic drawing of marshalling box is essential.

After the erection is complete the transformer is topped up with transformer oil if such the case be

xii) Erection Report:

After the erection is complete, an erection report should be prepared for each transformer in the formats given at end of this section.

8. Oil FIILING AND COOLING SYSTEMS :

For the transformer received at site, partially filled with oil, procedure as described below should be followed for filling of transformer oil.

Oil filling Point:

The oil filling must be carried out through a valve situated at the bottom of the trans former.

9. COMMISSIONING:

INFORMATION ONLY

GENERAL:

After the installation work is over, the transformer is to be made ready for commissioning. Prior to putting the transformer into service, attention should be paid to the following checks and tests. These should be carried out under the strict supervision of an experienced person. The instructions given below are of a general nature and are likely to vary depending upon the site condition and design features of the transformer. Problems arising out of peculiar situations have to be assessed and solved on case to case basis. In the event of any difficulty or doubt, reference should be made to AREVA for necessary clarifications.

GENERAL CHECKS:

These checks are given in the list given at the end of this section. These are to be strictly observed and recorded properly.

10. TEST BEFORE SWITCHING ON :

The following tests should be carried out

I) RATIO AND VECTOR GROUP:

Voltage ratio between HV and LV at all taps should be checked. For 3 winding transformer ratio between pairs of winding should also be taken.

II) DIELECTRIC STRENGTH TEST OF OIL:

Oil samples from the bottom of the tank and diverter switch tank of on load tap changer, whereever applicable, should be tested. In order to obtain representative sample of the oil, extreme care should be taken and absolute cleanliness should be observed when drawing the sample. Proceed as follows:

i) Use only wide-necked glass bottles of at least one litre capacity with glass stoppers (not corks) for collecting the sample.

ii) Before use, the bottle should be thoroughly cleaned with pure Benzene or Petrol or Carbon Tetra Chloride.

iii) The sample is to be drawn from the respective valve after the transformer is left undisturbed for sufficient time.

iv) In order to remove any moisture or dirt adhering to the valve passage, allow about 4 to 5 liters of oil to drain off into a clean dry vessel before collecting the sample into the bottle.

v) The sample should then be tested for its dielectric strength as per the latest edition of IS:6792. It is expected that every sample pass the test, if the normal transit and storage precautions are taken.

ELECTRIC STRENGTH AND PRESENCE OF MOISTURE:

The electrical strength is considerably reduced by the presence of moisture or fibers and drastically by a combination of both.

The electric strength test on the oil should be carried out in accordance with the method specified in IS:6792. The oil should have minimum breakdown voltage 50kVrms under any circumstances.

Any value less than it is the indication that filtration is required. A reference of the drying procedures can be made from the maintenance schedule. The electrical strength test should be repeated after filtration. Dusts of fibers are not so easily detected, but the periodic filtration of the oil to maintain the electrical strength will usually ensure adequate freedom from such impurities. Oil samples may be got tested from a reputed and recognised test lab once in 5 years for other parameters.

INSULATION RESISTANCE :

Check the IR values between windings and between winding to earth. A 2.5 kV or 1.0 KV megger preferably motor operated should be used for measuring IR values. At ambient temperatures this measured set of IR values should not be less than 50% of the works measured values. A table enumerating the multiplying factors for temperature correction is annexed with this section.

ENERGISING:

When all the checks and tests are found satisfactory, air should be vented from all air release plugs/screws provided on the main transformer, radiators, bushings, Buchholz relay etc. After completely venting the air out, the transformer should be energised and maintained on no load for duration of 12 hours. During these 12 hours the Buchhotz relay should be constantly monitored for any collection of air.

After 12 hours of no-load operation the transformer should be de-energized and air venting should be carried out again to release all the trapped air. After this venting operation, the transformer should be re-energised and maintained on no-load for duration of 6 hours before putting it on load.

After commissioning of the transformer, detailed report of pre-commissioning test should be furnished as early as possible ta AREVA Limited, NAINI, as per schedule given in this manual at the end of this section.

ANNEXURE 1

CONVERSION FACTOR FOR IR VALUE AT 60 °C

°C	Multiplying factor (MF)	°C	MF
10	0.05	48	0.49
15	0.067	49	0.52
20	0.088	50	0.55
21	0.091	51	0.58
22	0.097	52	0.64
23	0.11	53	0.67
24	0.12	54	0.69
25	0.125	55	0.74
26	0.13	56	0.78
27	0.135	57	0.84
28	0.14	58	0.9
29	0.15	59	0.93
30	0.165	60	1.0
31	0.17	61	1.05
32	0.18	62	1.1
33	0.195	63	1.2
34	0.21	64	1.25
35	0.22	65	1.35
36	0.235	66	1.4
37	0.25	67	1.5
38	0.265	68	1.7
39	0.29	69	1.75
40	0.30	70	1.85
41	0.31	71	1.95
42	0.34	72	2.1
43	0.37	73	2.2
44	0.39	74	2.35
45	0.4	75	2.45
46	0.45	76	2.6
47	0.48	77	2.75
		78	2.95
		79	3.12
		80	3.3

INFORMATION ONLY

MAINTENANCE
AND
TROUBLE SHOOTING

MAINTENANCE AND TROUBLE SHOOTING

A rigid system of inspection and preventive maintenance will ensure long life, trouble-free service and low maintenance it shall consist of regular inspection, testing and reconditioning giving details of all inspections and tests as laid down in this manual.

The principal of maintenance is to maintain the insulation of the transformer in good condition. Moisture, dirt and excessive heat in contact with oxygen are the main causes of insulation deterioration and avoidance of these will in general, keep the insulation in good condition.

FOLLOWING ARE THE FACTORS AFFECTING THE LIFE OF TRANSFORMER

Moisture : Due to higher affinity of water, the transformer oil and the insulation paper absorb moisture from air, which results in decrease of dielectric strength. Hence preventive steps are to be taken to guard against moisture penetration to the transformer. This will include blocking of oil openings for free access of air during storage and frequent reactivation of breather in service.

Oxygen : Oxygen if present inside the transformer due to air pockets trapped in the windings, oil etc. The oxygen reacts to the cellulose of the insulation and decomposes it, which will result in sludge formation, which in turn blocks free circulation of oil.

Solid impurities : Dielectric strength of oil diminishes appreciably by minute quantities of solid impurities. It is therefore a good practice to filter the oil after it has been in service for a reasonable time. Please refer the recommended maintenance schedule given in the manual.

1. INSULATION RESISTANCE:

This is best measured by a megger. The megger reading gives a good picture of the amount of moisture absorbed by windings. Temperature has a direct bearing on the insulation resistance and it comes down with the rise of temperature. For class A insulation, the insulation resistance in mega ohms gets halved for every 10 to 15 °C.

As regards its minimum permissible value there is no hard and fast rule, since it varies with the size of the transformer and voltage ratio. A safe general rule is to aim for about 2 mega ohms for each kV of voltage rating of the transformer, when the transformer is at 60 °C. The following values may be considered as satisfactory.

Rated Voltage (kV)	Minimum safe insulation resistance In Mega ohms at Temp. (Deg. C)				Impressed Voltage of Megger (V)
	30	40	50	60	
33	500	250	125	65	2500
11/6.6	200	100	50	25	1000
0.400	10	4	2	1	500

Just as continuity of a circuit is by no means, a measure of current carrying capacity, a high insulation value can not be taken as indicating a high dielectric strength. It is therefore essential to conduct high voltage test, to check the dielectric strength. Even if the insulation resistance of the transformer is high.

2. DRYING:

When the oil samples reveal the low BDV of insulating oil, drying must be deemed necessary. The most important practical method of drying out is by circulation of hot oil through a streamline filter (or its commercial equivalent) - This is a machine incorporating oil heater and vacuum chamber. It is prudent to blanket the transformer tank to prevent losses of heat. Lowering the oil below the top inlets may prevent radiation from radiators. If the radiators are provided with shut off valves the top valve may be close to prevent circulation of oil in the same. The dia-phragm of the explosion vent pipe and hand hole covers should be removed. Alternatively hand hole covers can be raised about 15 cms to allow moist air to escape. All openings should be protected from weather.

To start with, oil is drawn from the bottom and let into the transformer at the top. This will remove any moisture/impurities. After about 8-12 hours circulation in this manner the cycle is reversed, the oil is drawn from the top and fed at the bottom of the transformer.

The oil temperature as measured by the oil temperature indicator should be of the order of 60 degree. It should be ensured that under any circumstances the oil temperature at the filtering machine does not exceed 65 degree. The circulation is continued till the insulation resistance and oil sample tests are found satisfactory.

It is advisable to plot IR values and oil temperatures against time. It will be observed that in the beginning IR value drops down as the temperature goes up. The IR value will be low till the moisture is coming out of the insulation and starts rising before steadying.

However this method helps only when the oil "breathes" into transformer moisture in a limited extent. Opposite to this if water has found its entry into the transformer due to either in proper storage or damages during transit or any other reason the dry out of only oil will not suffice. The core-coil assembly also requires processing and hence involvement from our end is a must. Such cases should be immediately reported to us.

3. EXTERNAL CONNECTIONS INCLUDING EARTHING :

All connection should be tight if they appear blackened or corroded, unbolt the connection and clean down to the bright metal with emery paper.

Remake the connection and give it a heavy coating of petroleum jelly. It is particularly important that heavy current carrying connection should be properly maintained.

Before opening the transformer at site (Example untanking the active part) matter should be referred to us along with serial number of the transformer (Refer the R & D Plate) so that specific instruction can be made available.

4. GASKETS:

Check the transformer for leakages periodically. The bolt should be tightened evenly around the joints to avoid uneven pressure. Broken or leaking gaskets should be replaced as soon as possible.

5. ROLLERS:

After the transformer has been in service for a long period, roller should be carefully checked. They should be greased and rotated to see that they turn freely.

6. PAINT WORK:

During storage and service, the paintwork should be critically inspected at least once a year and where necessary repainting and retouching carried out. If the metal surface is exposed and becomes rusty or greasy due to delay in touching work, the surface must be thoroughly cleaned before re-painting with primer and final paint. Paint as mentioned in the General Arrangement drawing of transformer should be used. In case paint of another chemical base is to be used, paint manufacturer should be consulted for compatibility with existing paint. Painting of the transformer once in 3 to 5 years is recommended as good practice by us.

RECOMMENDED MAINTENANCE SCHEDULE FOR TRANSFORMER :

SL No.	Inspection Frequency	Items to be Inspection	Inspection notes	Action required
1.	Daily	(i) Ambient temperature	————	————
		(ii) Winding temperature	Check the MRP of temp recorder.	Shut down the Transformer & Investigate if either is persistently higher than specified.
		(iii) Oil temperature	reasonableness	
		(iv) Load Amperes	Check against rated	
		(v) Voltage	figures	
		(vi) Position of tap switch		
2.	Weekly	(i) Inspect general condition see if there is any unusual Noise, check oil level in Conservator	—	
		(ii) Oil level in transformer	Check against transformer oil level	If low, top up with dry oil, examine transformer for leaks
		(iii) Explosion vent diaphragm - - -		Replace if cracked or broken
		(iv) Dehydrating breather	Check that air passages are free. Check color of active agent.	If silica gel is Pink change by spare charge The old charge may be reactivated for use
3.	Quarterly	(i) Bushing	examine for cracks and dirt deposits.	Clean or replace
		(ii) Oil in transformer	Check for dielectric strength and water content.	Take suitable action to restore quality of Oil.
		(iii) OLTC (If applicable)	Check oil in OLTC Driving mechanisms	————
		(iv) Indoor transformers	Check ventilation	————

4.	Yearly	(i) Oil in transformer	Check for acidity & sludge	Filter or replace
		(ii) Winding	Check for insulation value	Filter the oil and ensure proper megger value.
		(iii) Gasket joints	————	Tighten the bolts to avoid uneven pressure
		(iv) Cable boxes	Check for sealing arrange-ements or filling holes. Examine compound for cracks.	Replace gasket if leaking.
		(v) Relays, alarms and their circuits	Examine relay and alarm operation, contacts, their fuses etc. Check relay accuracy etc.	Clean the compound and replace contacts and fuses. Change the setting, if necessary
		(vi) Earth resistance	————	Take suitable action, if earth resistance is high

Leakage through oil seal/gasket joints:
It may need replacement of the said items please contact AREVA for spares.

NOISE IN THE OPERATION OF TRANSFORMERS:

The noise or hum is due to the fact that the core, which is made of thin laminations, vibrates because of alternating magnetic flux and therefore expands or contracts ever so slightly with each cycle of magnetisation w hich causes the audible hum. The contraction caused due to magnetisation is called magneto striction; To reduce the hum/ the core must be tightly clamped together. In certain cases abnormal noise can occur due to single phasing of the incoming supply/ over fluxing or low frequency from supply.

DUAL VOLTAGE ON PRIMARY:

Such transformers are usually designed with series parallel turn arrangement on HV. The connection diagram will be given along with test certificate and Rating & Diagram Plate. The ail level is to be lowered and the top cover is to be opened for having access to the links provided internally. Change the links as per the instruction given in the diagram, ensure tightness of the nuts holding the link in position/ check up the ratio by applying three phase 400 volts and primary and measuring the secondary voltage and then fitting back the top

SPARES AND REPLACEMENT:

MI orders and correspondence relating to spaiaparts and replacements should be addresses o the nearest T&D Branch office of the AREVA Limited and should have the information as asked in the format given at the end of this manual.

TROUBLE - SHOOTING CHART FOR TRANSFORMER

Trouble (1)	Cause (2)	Remedy (3)
RISE IN TEMPERATURE		
(1) High temperature	over voltage	Change the circuit voltage or transformer connections to avoid over-excitation if possible, reduce load.
	Over current	Heating can often be reduced by improving power factor of load. Check parallel circuits for circulating currents which may be caused by improper ratios or impedances.
	High ambient temperature	Either improve ventilation or relocate transformer in lower ambient temperature or after the setting of the temperature alarm, if permissible.
	Higher circulating current due to unequal voltages when kept parallel with other transformers	Adjust tapping so that the voltages are equal. The cause for high circulating current may be investigated.
	Slugged oil	Use filter press to wash off core coils. Filter oil to remove sludge.
	Short-circuited core	Test for exciting current and no load loss. If high, Inspect core, contact AREVA
	Defect in the calibration or contact of the thermometer	Re-calibrate the instrument
	Defect in the setting of the thermometer	Examine and set right the defects.
	Low oil level	Examine and set right the defects.
(2) ELECTRICAL TROUBLES		
Winding failure	Lightning, short-circuit, overload, defective oil or entry of foreign matter aging of insulation, loose contact in jumpers, tap-switches or bushings.	Usually, when a transformer winding fails the transformer is automatically disconnected from the power source by the opening of the supply breaker or fuse. Smoke or

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		cooling liquid may be expelled from tank. accompanied by noise. **DO NOT REENERGISE THE TRANSFORMER**, contact nearest AREVA office
Unbalanced voltage	tap switch defect	Lower oil and check tap switch contacts
	Supply voltage unbalanced Winding open circuited	Check the 3 phase voltage Contact AREVA office
Audible internal arcing	Isolated metallic part low BDV	The source should be immediately determined. Make certain that all normally grounded parts are grounded, such as the clamps and core.
Bushing flash over	Lightning	Provide adequate lightning protection
	Dirty bushing	Clean busing porcelains completely.

3. MECHANICAL TROUBLES :

Leakage through bushings	Foreign material in thread Oval nipples, Poor threads Improper assembly	Tight or change screw
Leakage at gasket or uneven compression	Poor scarfed joints, insufficient Improper preparation of gaskets and gasket surface	Make tight screw joints or gasket joints
Leakage in welds	Shipping strains, imperfect welds,	Repair leaks in welds
Pressure relief diaphragm cracked	Improper assembly Mechanical damage	Replace diaphragm. Inspect in side of pipe for evidence of rust or moisture. Be sure to dry out transformer if there is a chance that drops of water may have settled directly on windings or other test may vulnerable locations, as oil not always reveal presence of free water.
	Obstructed oil flow or breathing	Check to see that valve between conservator and tank is open and that ventilator on conservator is not blocked.
Rusting and deterio-ration of paint finish	Abraded surfaces and weathering	Cleaning and repainting

4. OIL TROUBLES
(See also IS: 1866)

Low dielectric strength	Condensation in open type transformers from improper ventilation.	Make certain that ventilating openings are unobstructed
	Broken pressure relief diaphragm. Leaks around cover accessories	Replace diaphragm. Re gasket, if necessary
Badly discolored	Contaminated by varnishes/ Carbonised oil due to overheating of Winding/ core	Check the source of over heating Correct and replace the oil
Oxidation (Sludge)	Exposure to air	Wash down core and coils and tank. Filter and reclaim or replace oil.
5. Fuses blowing off	a. Internal defect	Examine and rectify the defect.
	b. Jumper defect	
	c. External fault not cleared by protective switch gear	
	d. Size of the wire inadequate	Replace with a wire of suitable size.
	e. Overload	Reduce the load.
	f. Radiation being inadequate	Provide suitable gradation
Low oil level alarm	a. Oil leaks	
	b. Float defective	Examine and do the needful
	c. Defect in the indicator	
	d. Wiring defect	
Oil samples failure	a. Defective sampling	Draw again samples of oil for testing carefully.
	b. Gap being low in testing kit	Adjust the testing kit.
	c. Presence of foreign matter	Remove the foreign matter by filtering the oil.
	d. Deterioration of oil due to aging.	Change the oil.
	e. Absorption of moisture	Dry out the oil and remove the moisture completely.
Low I.R. Values	a. Moisture absorption	Dry out the windings.
	b. Bad oil	Replace the bad oil with good quality oil
	c. Presence of sludge	Remove the sludge by filtering the oil.
	d. Deterioration of insulation	Examine and do the needful
	e. External connections not. removed	By megger of the transformer alone
	f. Low clearance	Examine and do the needful
	g. Defect in megger	Examine and do the needful

PRE - COMMISSIONING CHECKS
AND
TEST RESULT

INFORMATION ONLY

Customer:..... Site.....

Equipment Details: (Rating, Ratio, Maker's Ref., Sl. No. Year etc.).....

Vector Group: ..... Amps (HV/LV):.....

Tapping Range: ..... Impedance:.....

Temperature Rise: .....Oil .....Winding

GENERAL CHECKS:

CHECKPOINT	**STATUS**		**REMARKS**
	O.K	**NOT O.K**	
1. Direction & Mounting angle of OSR & Buchholz relay.			
2. Dryness of silica gel, seal removal & oil level in bottom cup.			
3. Oil level in Main conservator.			
4. Oil level in OLTC conservator.			
5. Oil filling OTI / WTI pockets.			
6. Earthing of main tank, cooler bank, neutral, fans, pumps etc.			
7. Absence of oil seepages/leakages.			
8. Bushing &their oil levels.			
9. Explosion vent & rupture pin setting.			
10. Touch up painting &washing.			
11. Overall clearances.			

CHECKS ON ELECTRICAL ACCESSORIES:

A. MARSHALLING BOX (Sl.No. & Rating)

GENERAL CHECKS:

GENERAL CHECKS:

CHECK POINTS	**STATUS**		**REMARKS**
	O.K	**NOT O.K**	
1 WTI (Sl .No., Make & Model)			
.....			
a. Transit lock release.			
b. Switch settings & operation.			
c. Connection.			
d. Ambient reading.			
e. Heater shunt shorting link.			
f. Matching with repeaters.			
g. Power supply & current converter Unit.			
2. OTI (Sl. No., Make & Model)			
a. Transit lock release.			
b. Switch setting & operation.			
c. Connections.			
d. Ambient reading.			
e. Matching with repeaters.			
3. Space heater & Thermostat setting.			
4. Cabling, Glanding, Termination etc.			
5. Earthing & Touch up painting.			
6. Overload settings for fans & pumps.			
7. Timer setting.			
8. Closure of opening & tightness.			

B. FANS-: (Model. RPM/kW/HP .....)

1. Glanding & Earthing.
2. Mounting &Terminal cover condition.
3. Direction &Smoothness of operation.
4. Manual-Local
5. Manual-Remote
6. Auto & Stand by operation.

C. O.L.T.C.(Sl.No. & Make, Type.....)

GENERAL CHECKS:

CHECK POINTS	**STATUS**		**REMARKS**
	O.K	**NOT O.K**	
1. Oil filling box (where reqd)			
2. Mechanical end limits of DM (Drive Mechanism)			
3. Coupling position &rotation lag.			
4. Manual operation.			
5. Local electrical operation.			
6. Electrical end limit operation.			
7. Remote electrical operation.			
8. Tightness of external shaft coupling & bending of lock washer.			
9. Fitment of window & shaft covers.			
10. Cabling, Termination, Glanding etc.			
11. Space heater &thermostat setting.			
12. Continuity check during transition.			
13. Earthing.			

D R.T.C.C: (Sl.No. & Rating .....)

1. Installation & Earthing.
2. Cabling, Glanding, Termination etc.
3. Setting of Timers.
4. Functioning of Indication Lamps.
5. Functioning of Hooters/Buzzer.
6. Annunciation / Relay checks

a. .....

b. .....

c. .....

d. .....

e. .....

f. .....

g. .....

h. .....

7. Tap position indicator.
8. W.T.I. Repeater.
9. O.T.I. Repeater.
10. O.L.T.C. Operation.

a. Individual.

b. As Master.

c. As Follower

11. Emergency Trip.
12. Out of step & MP Timer operation.
13. Operation of AVR & LOC.

E. Operation of Pumps, NRV, Flow Indicators:

1. Direction of pump operation.
2. Manual operation.
3. Auto operation.
4. Stand -by change over.
5. Flow Indication
6. Non Return Valve (NRV) operation.

SITE TESTS AND THEIR RESULTS

INFORMATION ONLY

NOTE: Instruments provided by Customer will normally be used for the test after ascertaining these operation in the applicable ranges.

A. Insulation Resistance:

Range, Make, kV rating & Type of tester: .....

Top oil Temperature.....

Megger Values:.....

	15 Sees.	60 Sees.		15Secs.	60.Secs.
H.V. to L.V. :	.....	.....	HV. to Earth.	.....	.....
H.V.toT.V. :	.....	.....	L.V. to Earth	.....	.....
L.V to TV. :	.....	.....	TV to Earth	.....	.....

B. Current Transformer:

C. T DETAIL
CHECK POINT
Continuity
Approx. Ratio
Polarity(Only for REF./DIFFL. CT)

C. APPROXIMATE VOLTAGE RATIO : Apply single phase 240 or 440 volts on each HV line lead and 'N' or pair of HV line leads and easure LV voltage on all taps in all phases.

Tap No.	HV Volts (applies)	LV1 volts	LV21	Tertiary
1.	1U-1 V	1V-1W	1W-1 U	2U-2V 2V-2W 2W-2U 3U-3V 3V-3W 3W-3U
2.	1 U-1 N	1V-1N -	1W-1 N	2U-2W 2V-2U 2W-2V 3U-3W 3V-3U 3W-3V
3.				2U- 2N 2V-2N 2W-2N 3U-3N 3V-3N 3W-3N
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				

D. Magnetic balance: (For Star winding only)

VOLTAGE ACROSS	1U-1N	1V-1N	1W-1N	2U-2N	2V-2N	2W-2N

E. EXCITATION WITH REDUCED VOLTAGE :

1. For LV winding of up to 1.1 kV class, apply single phase, 2 wire 240V or 415 volts from HV side (keeping) neutrals isolated) on each leg.

	APPLIED VOLTS (V) ON PHASE					Measured current (mA)
Tap No.	1 U	1V	1W	2U	2V	2W

2. For LV winding of class higher than 1.1 kV, apply 1 phase, 2 wire 240V or 415 volts from LV side (keeping neutrals isolated) on each leg.

	APPLIED VOLTS (V) ON PHASE					Measured current (mA)
Tap No.	1 U	1V	1W	2U	2V	2W

F. OIL BREAKDOWN VALUES: (Average of six readings with2.5 mm. gap)

a. Main Tank top oil sample : .....
b. Main tank bottom oil sample: .....
c. O.L.T.C. oil sample: .....

G. VECTOR GROUP CHECK :

Short term in all U to 2U and apply 3 phase, 3 wire 415 volts supply across 1U-1V-1 Wand Measure voltage across:

1. STAR-STAR CONNECTION

1V-2V.....
1V-2W .....
1W-2W .....
1W-2V .....
1N-2N .....
1N-2U .....
2N-2U .....
1U-1V :.....
1V-1W I.....
1W-1U :.....

2. STAR-DELTA CONNECTION

1V-2V .....
1V-2W: .....
1W-2W: .....
1W-2V : ...
1U-1V: .....
1V-1W: .....
1W-1U :.....

3. DELTA-DELTACONNECTION :

1U-1V :.....

1V-1W:..... :.....

1W-1U :..... :.....

H. PHASING CHECK ON MULTI-RUN OF CABLES (HV-LV) :

Ensure absence of cross connections by physical inspection and continuity check.

1. PHASING CHECK BEFORE PARALLELING :

Ensure absence of cross connections by physical inspection and by measurement of volt age across corresponding phases on the LV by applying low voltage on the HV.

J. TRANSITION CONTINUITY CHECK ON OLTC :

Check by voltage measurement on LV/ HV busing analog voltmeter on all phases.

PRE-COMMISSIONING CHECKS:

TO BE CARRIED OUT AFTER THE TRANSFORMER IS CONNECTED TO THE LINES & BEFORE ENERGISATION

CHECK POINT	STATUS O.K/NOT O.K.	REMARKS

1. Clearances in air. (Refer OGA)
2. Arcing horn gaps set. (Refer OGA)
3. Tightness of Bushing lugs, Cable/Line connections, Termination etc.
4. Simulation of Alarm &Trip circuits

(Verify breaker/ Master trip operation by initiating operating contacts of)

a. Buchholz Relay.

b. Winding Temperature Indicator.

c. Oil Temperature Indicator.

d. Oil Surge Relay.

e. Pressure Relief Device/Vent Switch

1. M.O.LG.

g. Oil/Water flow indicator/D.RG.

h. Sudden pressure Relays.

i. Over Current Relays.

j. Earth fault Relays.

k. DifferentialRelays.

l. InterTrippingRelays

m. Others.

5. Air Venting from :

a. Bushing

b. Radiators, Headers, Couplings

c. Buchholz Relay.

d. O.L.T.C, Cover/Head.

e. Main tank cover/Thermosyphon etc.

f. Disconnecting chamber.

Transformer Successfully Energised On..... At..... Hrs.
on tap No..... and is Operating Satisfactorily
Incoming Voltage ..... Ambient Temp.: .....
Winding Temperature : ..... Oil Temperature .....

AREVA ENGINEER	**CUSTOMER'S ENGINEER**
Signature.....	.....
Name.....	.....
Designation	.....

DATA REGARDING ACCESSORIES :

1. H.V. BUSHINGS

Make:.....

Rating: .....

Sl.No.:.....

2. LV. BUSHING :

Make:.....

Rating : .....

Sl.No.:.....

3. O. L T. C. DETAILS :

Make:.....

Rating : .....

Sl.No.:.....

4. FACIA DETAILS :

Make:.....

No.of Window:.....

Voltage:.....

Model No.:.....

5. DRYCOL:

Breather SL No. ..... Panel Sl. No.....

5. PRESSURE RELIEF DEVICE :

Make &Sl.No. "Pressure setting : .....

6. SUDDEN PRESSURE RELAY :

Name of Visiting Engineer : .....

Signature.....

Date.....

INFORMATION ONLY

PART - II

TRANSFORMER

ACCESSORIES

We acknowledge, with thanks the technical support taken in the preparation of this section from the information provided by our esteemed suppliers. The information provided herein is, though meant to be a descriptive treatise over the instruments generally used in our product necessarily does not purport to be the complete technical literature of the same.

Further the instrument selected for this section represent the vast spectrum of almost all the accessories used in our product. However make of the instruments and the very constitution of the instruments may change depending on the requirements and discretion of the organization without any prior notice.

EXPLOSION VENT

The diaphragm fitted at the exposed end and inner end of the vent Should be inspected at frequent intervals and replaced if damaged. Whenever lower diaphragm of Double diaphragm explosion vent ruptures, oil rises inside the explosion vent pipe and is visible in the level indicator on explosion vent. Failure to replace the outer diaphragm quickly will allow ingress of moisture which will contaminate the oil. If diaphragm is broken because of fault in the transformer, an inspection should be carried out to determine the nature and cause of the fault.

CARE AND MAINTENANCE OF EXPLOSION VENT

(1) The diaphragm fitted at top end of Explosion Vent as shown in sketch, must be inspected for any sign of damage before the transformer is commissioned.

If the diaphragm is found to damaged it must bereplaced immediately to avoid oil contamination with moisture.

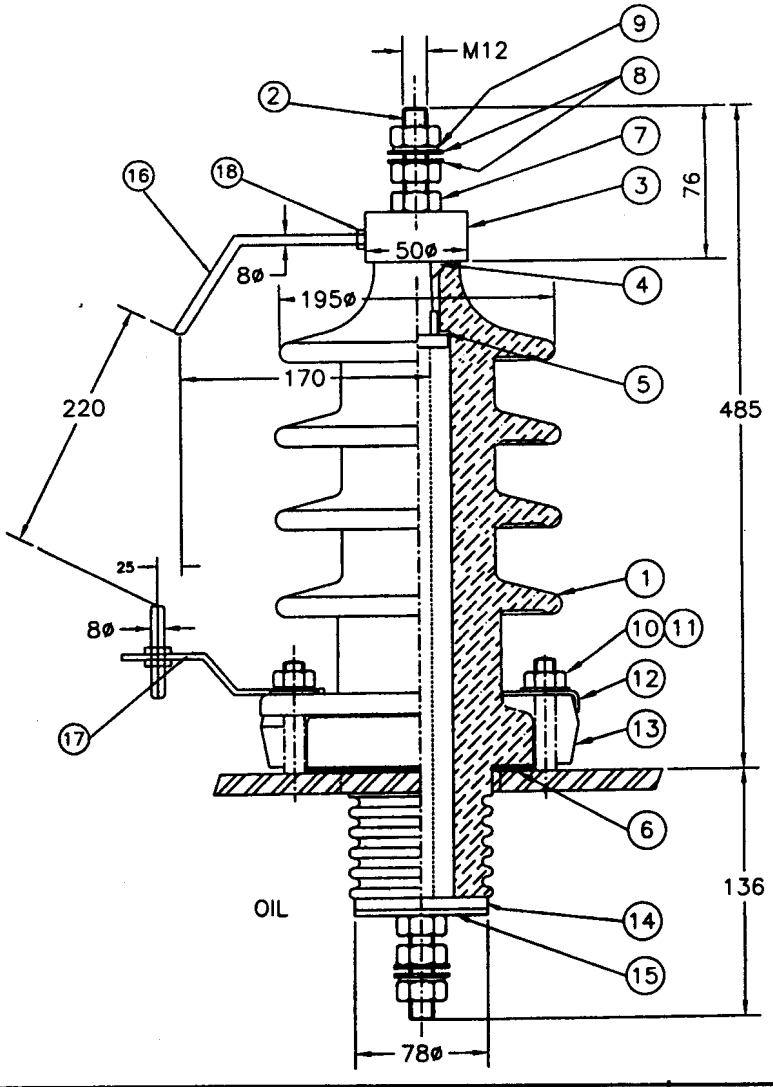
(2) When the Explosion Vent is fitted with an air release plug of pet -cock, it is recommended to keep it open while filling oil is conservator and must be closed after oil filling operation is completed

BUSHINGS

Porcelain insulators and Connectors should be cleaned at convenient intervals and minutely examined for any cracks or other defects. Smaller narrow cracks are difficult to detect. How-ever, they are likely to develop rapidly. All such bushings should be replaced. Similarly oil inside the oil communicating type bushing should be checked by unscrewing air release screws provided on bushing top. The cause of any serious loss of oil should be investigated. In case of sight of oil leakage in the bushings, the matter should be referred to us.

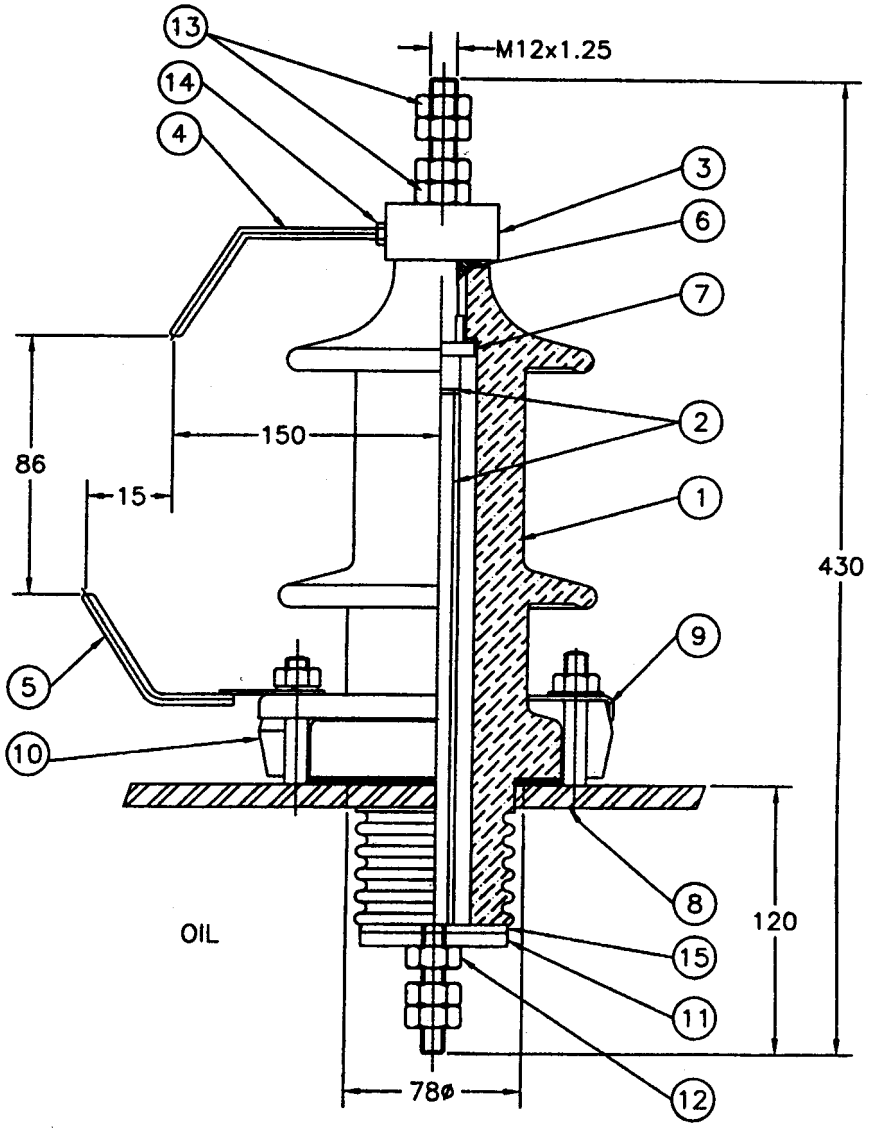
A general arrangement of various bushings are shown in drawings. Applicable bushing, in conjunction with outline general arrangement of transformer can be referred for details.

ARRANGEMENT OF 36 kV. BUSHING TO IS : 3347 (PART-V, SEC-2) 1979



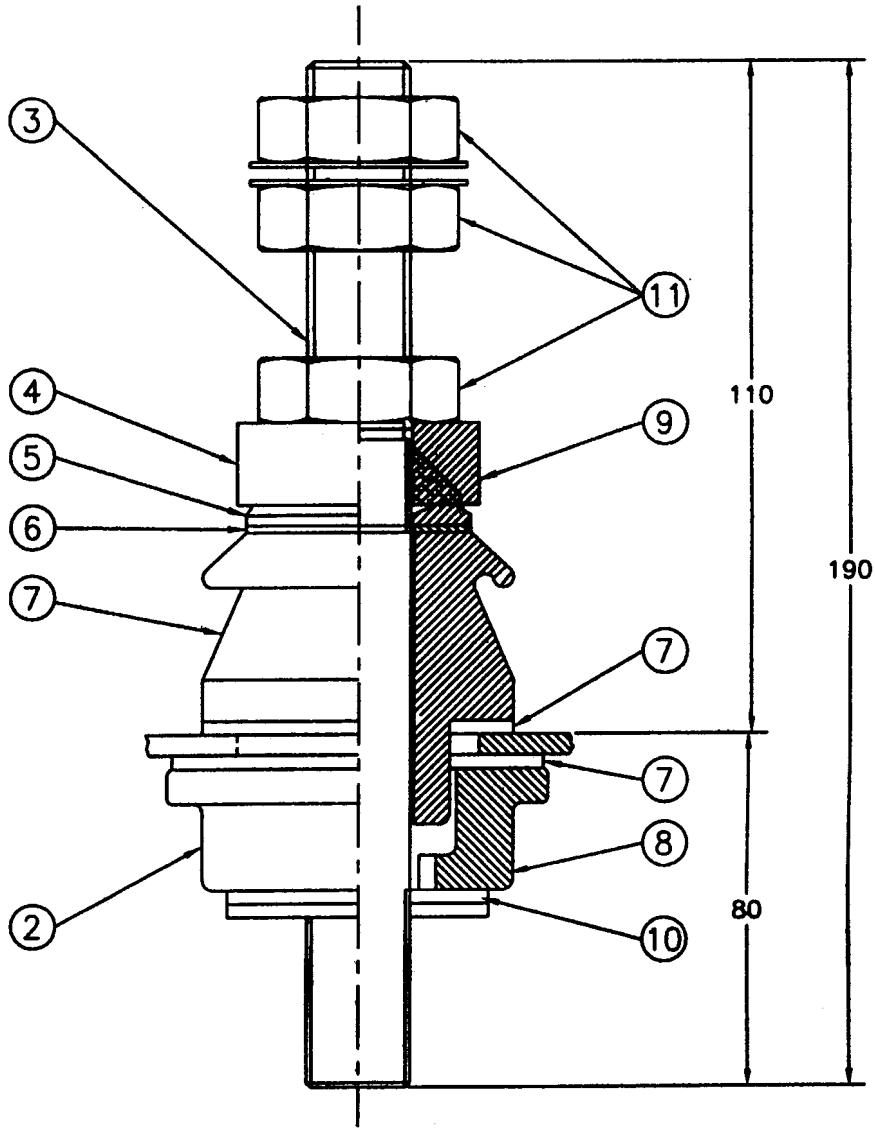
IT. No.	DESCRIPTION	MATERIAL
1	INSULATOR	PORCELAIN
2	STEM HEAD	COPPER
3	CAP	BRASS
4	SEALING WASHER FOR STEM	N.B.R.
5	SEPARATOR	RED FIBER
6	SEALING WASHER FOR GEN. PURPOSE	S.R.B.C.
7	HEXAGONAL NUT FOR STEM	BRASS
8	PLAIN WASHER	BRASS
9	SPRING WASHER	SP.ST.
10	HEXAGONAL NUT	M.S.
11	PLAIN WASHER	M.S.
12	BUSHING CLAMP	M.S.
13	CLAMPING MEMBER	ALUMINIUM
14	WASHER	S.R.B.C.
15	WASHER	M.S.
16	TOP ARCHING HORN	M.S.
17	BOTTOM ARCING HORN	M.S.
18	HEX NUT	M.S

ARRANGEMENT OF 12, 17.5 k.V. BUSHING TO IS : 3347 (PART-III/ SEC-1 & 2)



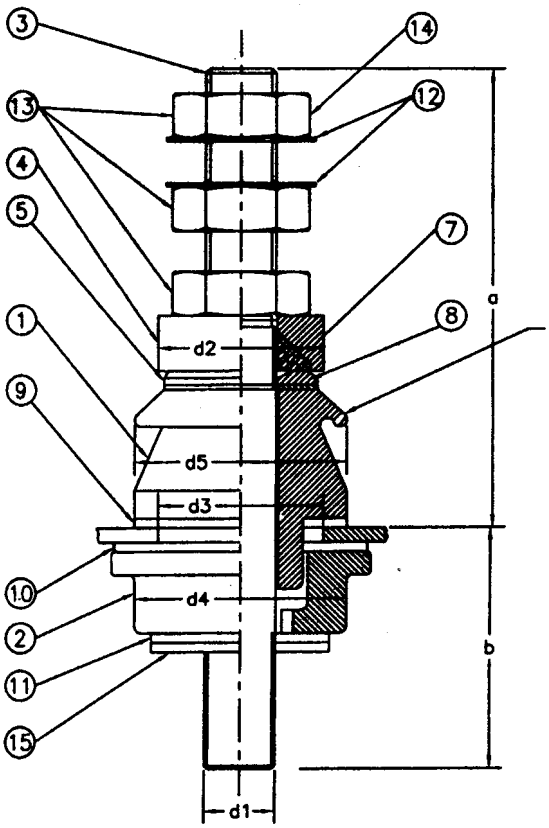
IT.No.	DESCRIPTION
1	INSULATOR
2	STEM
3	CAP
4	UPPER SPARC GAP HORN
5	LOWER SPARC GAP HORN
6	SEALING WASHER FOR STEM
7	SEPARATOR
8	SEALING WASHER
9	CLAMPING RING
10	CLAMPING
11	WASHER
12	LOCK NUT
15	LOCK NUT
14	LOCK NUT

ARRANGEMENT OF 1 kV / 250 AMPS BUSHING TO IS : 3347 (PART-1 / SEC-1)

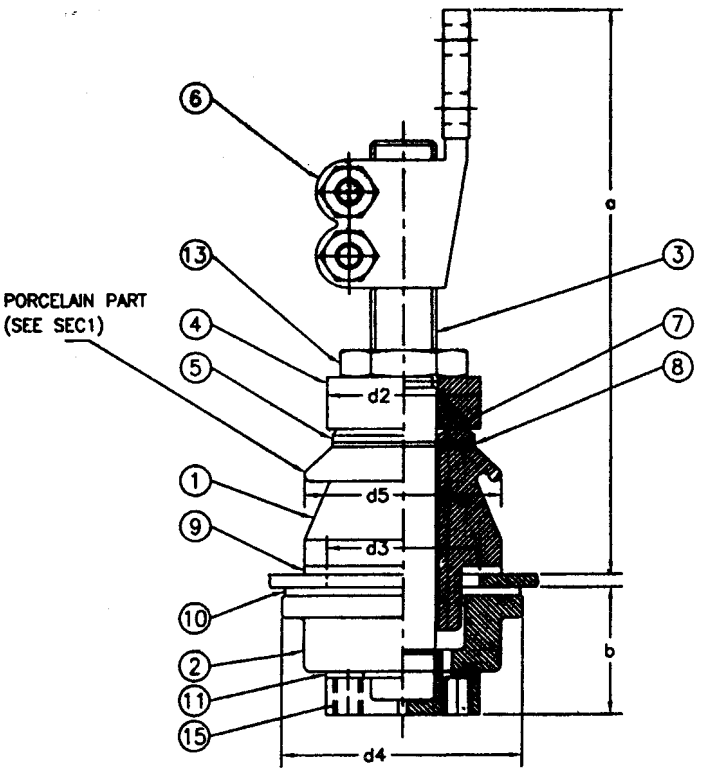


IT.NO.	DESCRIPTION
1	UPPER INSULATOR
2	LOWER INSULATOR
5	STEM
4	WASHER (TOP END)
5	WASHER (STEM)
6	SEALING WASHER (TYPE M)
7	SEALING WASHER (TYPE N)
8	SEALING WASHER (TYPE P)
9	SEALING WASHER FOR STEM
10	NUT
11	HEX. LOCK NUT

1 kV BUSHING ASSEMBLY
TO IS : 3347 (PART-1 / SEC-2) 1979



FOR 250 AND 630 AMPS.



FOR 1000. 2000 AND 5150 AMPS.
4 TO 8 UPTO & INCLUDING 1000 A AND
6 TO 10 ABOVE 1000A.

IT. NO.	DESCRIPTION
1	INSULATOR TOP
2	INSULATOR BOTTOM
3	STEM
4	WASHER (TOP END)
5	WASHER (STEM)
6	CONNECTING LUG
7	SEALING WASHER (STEM)
8	SEALING WASHER (TYPE M)
9	GENERAL PURPOSE WASHER (TYPE N)
10	GASKET (TYPE X)
11	GASKET (TYPE R)
12	WASHER ACCORING TO IS:2016-1967
9	NUT
10	SPRING WASHER TYPE B ACCORDING
	TO IS: 5063 - 1972
11	LINK NUT FOR STEM

TYPE OF STEM	BUSHING RATING KV/A KV/A	a KV/A	b KV/A	d1	d2	d3	d4	d5
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ALUMINIUM	UPTO & INCLUDING							
	1/250		68	M12	28	28	60	50
	1/630		60	M30x2	56	56	110	90
	1/1000	340	65	M42x3	70	70	125	104
	1/2000	377	70	M48x3	80	90	150	125
	1/3150	-	-	-	-	-	-	-
COPPER	UPTO & INCLUDING							
	1/250	138	138	M12	28	28	60	50
	1/630	178	178	M20	40	45	85	70
	1/1000	263	263	M42x3	56	56	110	90
	1/2000	340	340	M42x3	70	70	125	104
	1/3150	372	372	M48x3	80	90	150	125

SILICA - GEL BREATHER

BREATHING PROCESS OF THE TRANSFORMER :

Breathing is the process where in transformer sucks, in or pushes out the air from it's body. When Transformer is loaded or unloaded, the oil temperature inside the Transformer tank rises or falls. Accordingly, the air volume inside the tank changes, by either sucking in or pushing out the air. This phenomenon is called "Breathing" of the Transformer.

Now, the air, which is being sucked in, contains either foreign impurities and/or Humidity, which changes dielectric strength of oil. For proper working of transformer, it is absolutely necessary that dielectric strength of Transformer oil remains unimpaired. Hence, it is necessary that, the air entering into the Transformer is free from moisture & foreign impurities.

OPERATION & WORKING :

The breather is connected to an outlet pipe of the conservator vessel and the air, which is being sucked by Transformer, is made to pass through the silica Gel Breather to dehumidify the air to remove foreign impurities.

The Silica Gel, which is filled in the Breather, is hard blue crystals, which has considerable absorption power for moisture. When, it gets saturated with moisture, it changes its color to pinkish white. For proper dehumidification of air, it is absolutely necessary that this charge of Silica Gel is reconditioned form pinkish white to deep blue by heating it to a temperature up to 200 ^{o}C.

The air, which is passed through Gel is first made to pass through the oil compartment of the Breather. This oil removes all foreign impurities from air which enters the Gel compartment. Hence, Oil sealed type Silica Gel Breather will keep the oil properties constant, thereby ensur-ing proper working and hence longer life of the Transformer.

ADVANTAGES OF CLEAR VIEW DESIGN OVER WINDOW TYPE :

Because of excellent visibility of entire mass of Silica Gel (Due to transparent compartment) change in color of Gel in any part of the mass is clearly visible, even from a distance, as against very poor visibility in window type design.

The entire oil cup is also transparent. Hence change in the level of Oil as well as any sedimentation in oil is clearly visible as against almost invisibility in Window type.

INSTALLATION :

The Breather is connected to Transformer by either threaded or flanged joint (after removing the Seal) as per below mentioned details. Before putting the Breather in to service, remove the Oil Cup and fill it up with fresh transformer oil upto line marked on Cup. Remove the Seals on the airholes of the Cup and fit the Cup to the Breather. The Breather is now ready for installation.

MAINTENANCE:

As the color of the Silica Gel changes to pinkish white after prolonged use, it needs recharging. For this, detach Breather from the Transformer. Detach the Oil Cup (6) and remove the Gel plug (7) by unscrewing it (For Breather capacity 500 gm. and onwords) or unscrew threaded washer (For Breather capacity of 250 gm. and less).

Take out the Silica Gel and heat it in oven up to 200 °C until the color of Gel changes to deep blue. Refill the Gel in the Breather, fit Oil Cup and Gel plug/threaded washers. The Breather is ready for reuse. Please ensure that, plastic container is not heated along with the Gel in oven.

The Gel content or the size of the Breather is determined by the volume of air passing through the Breather the Oil contents of the Transformer and the atmospheric conditions at the place of installation. Hence, the Transformer Manufacturer or the ultimate user should decide the size of Breather that would suit his Transformer.

BUCHHOLZ RELAY PROTECTION OF TRANSFORMER

GENERAL :

Power Transformer are considered to be a highly reliable type of equipment, yet, in order to ensure the continuity of service that modern conditions demand, protective devices are required. The purpose of such devices is to disconnect faulty apparatus before large-scale damage is caused by a fault to the apparatus or to other connected apparatus. Such devices generally respond to a change in the current or pressure arising from faults and are used for either signaling or tripping the circuit.

Protective devices in the ideal case must be sensitive for all faults, simple in operation, robust for service and economically feasible. Considering liquid immersed Transformers, a near-ideal "protective device" is available in the form of Gas and Oil relay described here. The relay operates on the well-known fact that almost every type of electric fault in a "liquid immersed transformer" gives "rise to gas. This gas is collected in the body of the relay and is used in some way or other to cause the alarm or the tripping circuit to operate.

The principle of the Gas and Oil relay was first successfully demonstrated and utilized by "Buchholz" many years back. In a series of experiments carried out extensively in Germany it was proved that the relay is capable of bringing to light incipient fault thereby preventing further spreading of the fault and extensive damage and thus saving expensive and protracted repairs. So successful is the principle of this relay that despite the continued search for better protective devices in other electrical fields the Gas and oil Relay is still on it's own in providing protection against a variety of faults.

APPLICATIONS :

Double element relays can be used indicating minor or major faults in a transformer. The alarm element will operate, after a specified volume of gas has collected to give an alarm indication.

Examples of incipient faults are.

Broken-down core bolt insulation.

Shorted laminations.

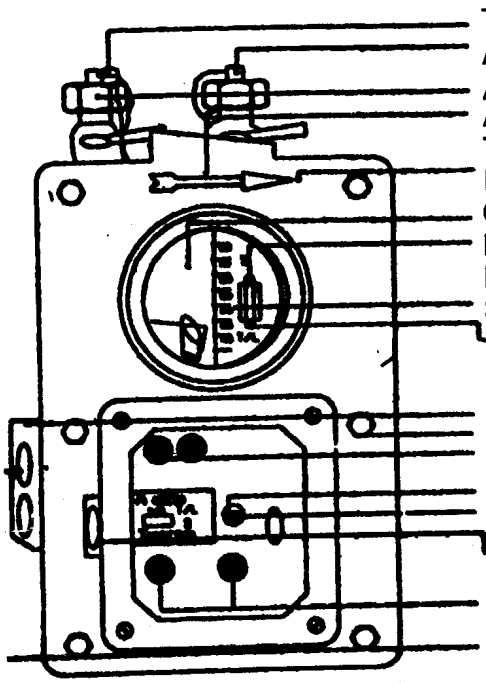
Bad contacts.

Overheating of part of windings.

The alarm element will also operate in the event of oil leakage, or if air gets into the oil system. The trip element will be operated by an oil surge in the event of more serious faults such as. Earth faults.

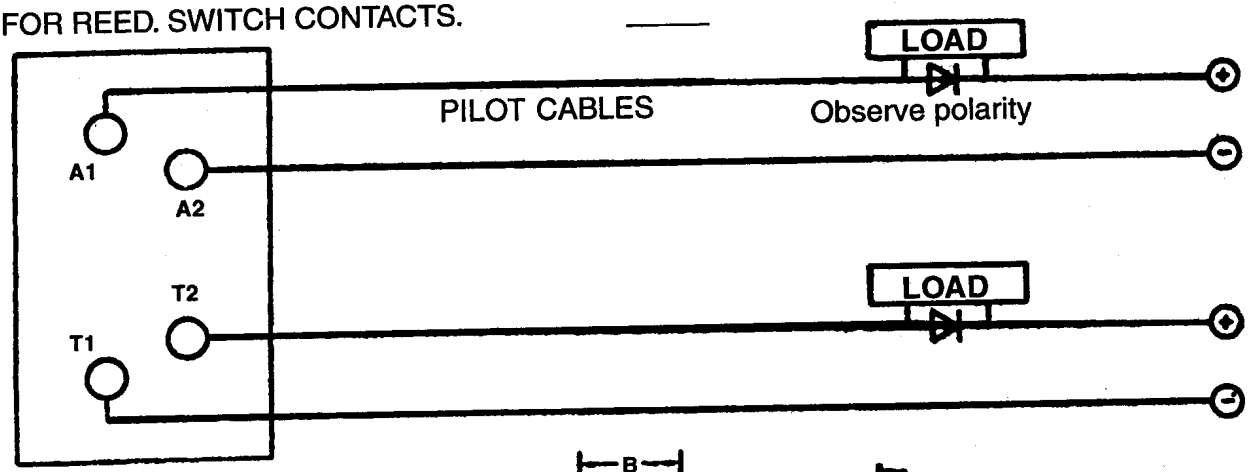
Winding short circuit.

BUCHHOLZ RELAY

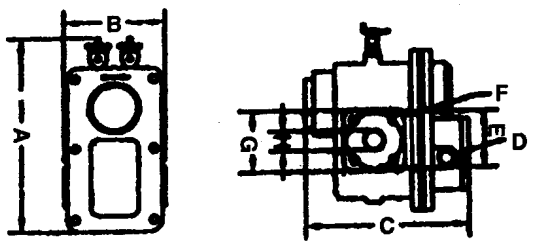


TEST COCK (1.7)
AIR VENT COCK (1.8)
ACORN NUT (1.9)
ARROW INDICATES DIRECTION OF OIL FLOW TO TO CONSERVATOR
INSERTED ASSEMBLY (2)
GLASS WINDOW FOR OBSERVING COLOUR OF GAS-
RED INDICATOR AT 'S' GIVES VISUAL INDICATION THAT RELAY IS IN 'SERVICE' POSITIOIN
SCALE FOR OAS VOLUME INCC (1.4)
RED INDICATOR AT 'T/L' GIVES INDICATION THAT RELAY IS IN 'TEST' OR LOCKED POSITION
ENCLOSURE 1.
OUTLET (1.2) TO CONSERVATOR
ALARM SWITCH TERMINALS
LOCKING NUT 1.5
SLOT ON TEST KEY (1.3)
3/4" CONDUIT FOR SIDE ENTRY OF TERMINALS FROM EITHER SIDE (1.6)
TRIP SWITCH TERMINALS
INLET (1.10 FROM TRANSFORMER

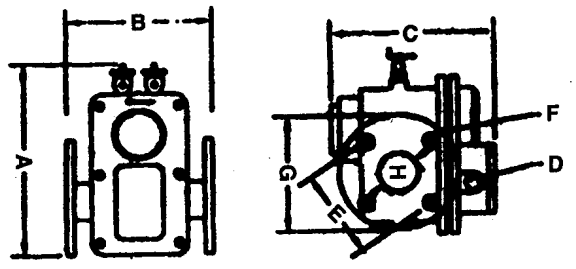
ARRANGEMENT OF TERMINALS AND MEANS OF PROTECTION FOR REED. SWITCH CONTACTS.



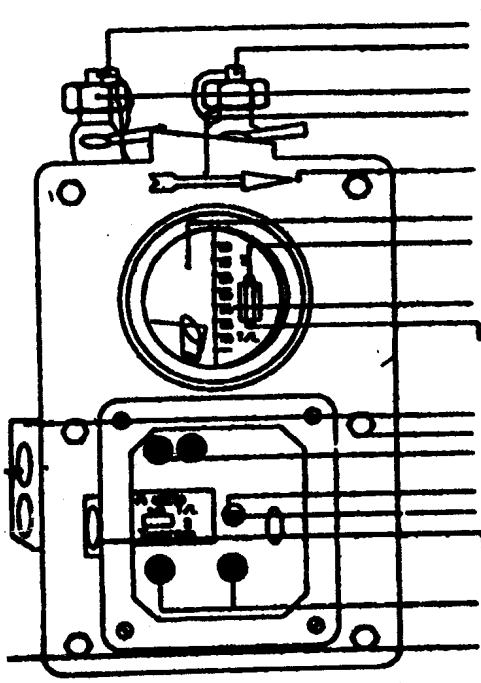
RELAY TYPE GORI



GOR 2 AND GOR 3

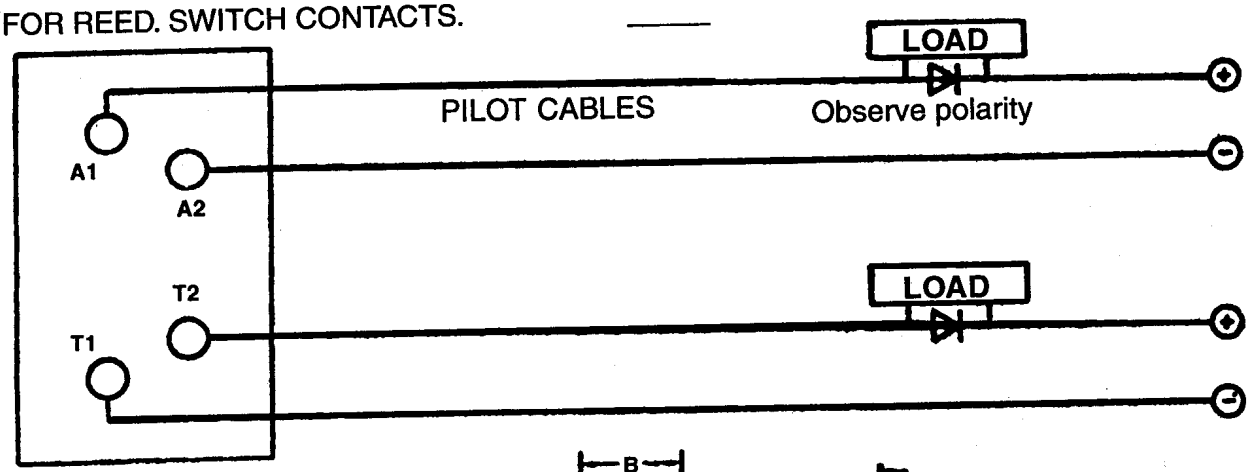


BUCHHOLZ RELAY

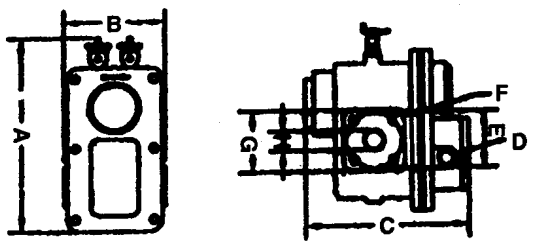


TEST COCK (1.7)
AIR VENT COCK (1.8)
ACORN NUT (1.9)
ARROW INDICATES DIRECTION OF OIL FLOW TO TO CONSERVATOR
INSERTED ASSEMBLY (2)
GLASS WINDOW FOR OBSERVING COLOUR OF GAS-
RED INDICATOR AT 'S' GIVES VISUAL INDICATION THAT RELAY IS IN 'SERVICE' POSITIOIN
SCALE FOR OAS VOLUME INCC (1.4)
RED INDICATOR AT 'T/L' GIVES INDICATION THAT RELAY IS IN 'TEST' OR LOCKED POSITION
ENCLOSURE 1.
OUTLET (1.2) TO CONSERVATOR
ALARM SWITCH TERMINALS
LOCKING NUT 1.5
SLOT ON TEST KEY (1.3)
3/4" CONDUIT FOR SIDE ENTRY OF TERMINALS FROM EITHER SIDE (1.6)
TRIP SWITCH TERMINALS
INLET (1.10 FROM TRANSFORMER

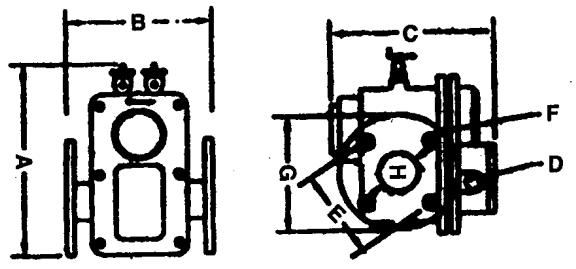
ARRANGEMENT OF TERMINALS AND MEANS OF PROTECTION FOR REED. SWITCH CONTACTS.



RELAY TYPE
GORI



GOR 2
AND
GOR 3



Puncture of bushings.

Short circuit between phases.

The trip element will also be operated if a rapid loss of oil occurs. Single element relay, can be used to detect either incipient or major faults in oil filled potential transformers, reactors, capacitors etc. A special single element relay is available for the protection of on load tap change equipment.

ADVANTAGES :

Castings treated against porosity through a special process.

Unique internal design of "housing" prevents false air traps on top of the relay. Well-designed internal layout gives clear view of color of gas inside the relay through glass window for fault analysis.

Bucket type float design with inherent ability to with stand vacuum treatment of transformer. Built in test facility for checking continuity of both Alarm & Trip circuits.

Anti vibration custom-built mercury switches give high stability against mechanical shocks and vibration.

ISI mark of quality on every relay.

CONSTRUCTION :

The Buchholz relay essentially consists of enclosure i.e. an oil tight container and an inserted assembly &comprising of two pivoted elements fitted with switches.
The enclosure is provided with inlet and outlet for the liquid. To allow connection of pipes, the enclosure openings can be designed with pipe thread or flange.

The front inspection glass is provided with a graduation (100 to 300 cc) to allow reading the accumulated volume of gas and observe color of gas for fault analysis. For checking the function of the inserted assembly a Task key is provided. There is also a visual indication on the scale of service and Test/Locking position, in the form of "movement of a red indicator" on the reading scale. This allows the testing of the Alarm and trip circuits before installation and even when the transformer is in service.

Just above the inspection glass an arrow shows the specified direction of flow of the insulation liquid to the conservator. Enclosure and its inserted assembly cover are made out of Cast Iron/ weather resistant light alloy.

FUNCTIONAL TEST :

Testing the relay function with the test key.

A test system is provided in the Buchholz relay that allows the functional test of the upper and lower switching system.

To test the relay function loosen the nut on the test key and rotate the key with a screwdriver in the Anti clockwise direction till the SLOT on the test key points towards the T/L position. Both the alarm (upper switching system) and trip (lower switching system) will show continuity.

On bringing the SLOT on the test key to S (service) position by rotating the key clockwise the Alarm & Trip circuits will not show continuity. The circuits will be actuated to 'ON' position only when there will be a fault in the Transformer.

Repeat the functional test each time a relay is started or maintenance completed. Testing the relay function with the test pump. Screw the test pump/Air bottle to the test cock.Open the test cock and pump air gently in to the Buchholz relay until the upper switching system operates.
For operating the lower switching system air has to be pumped suddenly with a jerk which will in turn operate the lower switching system.

ELECTRICAL CONNECTION :

To allow installation of the "single wire" open the terminal box cover comprising of the name-plate and the instruction sticker on the backside. Then pass the wire through one or the two conduit screwing into the terminal box. By using either one of the other openings, facility is given for the cable to enter the terminal box from the left or right. The upper two studs are terminals for the Alarm switching circuit and are denoted by "A" Like wise the lower two studs are terminals for the Trip switching circuit and are denoted by "T".

INSTALLATION :

Installation into pipeline :

For installing the relay into pipeline proceed as follows :
See that Buchholz relay is positioned with the arrow pointing towards the conservator, the connection box is in the Y plane (vertical) and the Test cock and air vent cock are at top. Mount the Buchholz relay as close as possible to the tank in the pipeline between transformer & conservator.

Keep pipe bends as wide as possible. Avoid close bend.

Make sure pipe ascends to the conservator at angle between one degree to nine degrees.

See that the relay enclosure is not subjected to stress. If necessary, use expansion compensators.

Ensure that the slot on the Test Key remains in the T/L (Test/Locking) position during storage or loose transportation of the relay.
Ensure that the slot on the Test Key remains in the "S" (Service) position and the Test Key Bolt is tightened, just before commissioning of the relay.

Filing with Insulation Liquid :

To fill the Buchholz relay, proceed as described below.
Remove the protective acorn nut from the air vent cock.
Open the air vent cock to let air escape until insulation liquid emerges.
Shut the air vent cock.
Check liquid level in conservator.

Maintenance:

The Buchholz relays are not sensitive to external influences. No servicing is needed during operation. On routine inspections of the protection equipment, test the function of the Buchholz relays described earlier and check the alarm& trip devices connected to them.

BASIC CHARACTERISTICS:

The Gas and Oil Relay provide protection against a number of internal faults but it also is able to indicate in several cases the type of fault. This is possible because the gas collected in relay can, from its color, odour and composition, indicate where the fault may be and what its nature is. By examining the gases collected it is possible to infer the nature of fault.

Thus :

If the gas is colorless and odorless or with only a faint odour of oil, the gas is air trapped in the oil or the insulation.

If the gas is Grayish White with sharp and penetrating odour and non-inflammable it is due to overheated or faulty insulation (fuller board etc.)

If the gas is yellowish in color and inflammable it may be due to surface leakage on material like wood.

If the gas is dark Grey and inflammable it may be due to a flash over in oil or due to excessive overheating of the oil caused by a fault in the winding or the core.

On the operation of the alarm if investigation of the collected gas does not indicate a serious fault it is possible to leave the transformer in service till it is convenient to carry out a thorough inspection.

This occurrence is possible on a newly commissioned transformer due to air trapped in the oil or the insulation. On repeated and frequent alarm signals the transformer should be taken out of service for thorough check up.

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FUNCTION :

The function of a double elements relay will be described here.
During normal operation of a transformer the Buchhoiz'relay is completely filled with oil. Buoyancy and the moment due to counter weights keep the floats in their original top position.;

In the event of some fault in the interior of the transformer tank gas bubbles are produced and accumulate in the Buchholz relay on the way to the conservator. In consequence, the oil level in the relay enclosure drops which in turn lowers the upper bucket.

This causes the mercury switch / Reed switch to operate an alarm signal.

The lower bucket does not change its position, because when the gas reaches the upper inside wall of the pipe it can escape into the onservator. Hence, minor fault in transformer tank will not trigger the lower switching assembly and will not trip the transformer.

In case the liquid continues to drop due to loss of oil, the lower bucket also goes down. In consequence, the lower switching system operates the if the level of oil goes below the bottom level of the pipe connected to the relay.

Alternately in the event the liquid flow exceeds a specific value (which is continuously adjustable,by means of a flap) the lower bucket if forced down thus triggering the lower switching system to operate.

As the liquid flow rate decreases or the level of the liquid rises the bucket returns to its original position. The single element relay has only one operating element and it responds to either gas collection oil surges. The method of operation is similar to that described for double element relay. Single element relays are suitable for the protection of oil filled reactors, capacitors and potential transformer. The single element oil surge relay has been specifically designed for use with on load tap change equipment and it will by pass normal amounts of gas which are generated by tap change operations and will only responds to oil surges and loss of oil.

OPERATING CHARACTERISTICS :

Buchholz relay of the double element type are made in three sizes. The sizes are distinguished by the numerical prefix 1,2 or 3. This refers to the diameter of the bore of the oil pipe connecting the transformer to the conservator tank.

They are referred to as Types GOR1, GOR2 and GOR3, where the Alphabets indicate "Gas and Oil Operated Relay" and the number refers to the pipe bore diameter as 25,50 and 80 mm. respectively.

The implications of the various Type Nos. and their operating conditions can be listed as follows.

TYPE NO.	SPECIAL OPERATING CONDITIONS
GOR1	**Double element mercury switch type**
GOR2	**Buchholz Relays Normally open Type**
GOR3	

The symbol/VO. following their type" markings indicate that the relays contain red switches and are normally open type.

The symbol/ S following their type marking of all relays mentioned herewith indicate that the relays are suitable for silicon Oil normally used in Elector static precipitator transformer.

All relays mentioned above are normally open types. Normally closed type relays can also be supplied on request.

RELAYS FOR USE IN AREAS OF SEISMIC DISTURBANCE :

When transformers are required for use in areas subject to earthquakes or for traction application, we can supply special relays which use magnetically operated Reed switches instead of mercury switches.

The outward appearances of these relays are exactly same as those with mercury switches but they are distinguished from them by the symbol/VO following their type marking. The latter V (for vibration) indicates that the relay contains reed switches and the letter 0 that the contacts are normsiHy open. Thus a Type GOR2NO signifies a 50 mm. (pipe size). Double float relay with normally open Reed Switches.

OPERATION:

In the double element relay, collection of gas causes the oil level within the relay to fall. This in turn causes the upper element to rotate on its pivots, bringing the magnet it carries into a position where it operate the Alarm switch.

An oil surge through the relay will cause the lower element to rotate bout its pivots and bring its magnet into a position so as to operate the tripping switch.

CONNECTION :

The terminal box and the terminals are the same as that of mercury switch type relay. In the reed switch relay, each reed switch is protected by a inductor in series. These inductors are intended to protect the reed switch contacts from the effects of capacitive loads, such as are imposed by long leads or pilots cables, and must not be removed from relays in service.

Protection of reed switch contacts against the effects of inductive loads, such as those imposed by contactors and Electromagnetic relays, is achieved by means of a diode wired across each load. This diode must be rated with forward current at least as high as the steady load current and connected observing polarity so as to absorb the back e.m.f. These diodes are not pro-vided with the relay.

The mounting position and Testing on site procedure are same as that of "Mercury Switch type".Buchholz relay.

OPERATING CHARACTERISTICS :

All double element relays are adjusted so that their performance lie within the limits given in table. In addition the Reed switch Relay is capable of withstanding shocks of up to 4g. Such shocks will not of them selves cause the relay to operate.

SWITCH DATA:

TYPE	Normally Open
CONTACT RATING	250 VAAC. (r.m.s.) or D.C.max.
SWITCHING CURRENT	5AAC. (r.m.s.) or D.C.max.
SWITCHING VOLTAGE	300 Volts D.C.max. 240 Volts AC. (r.m.s.) or max
ACTUATING TIME (Including Bounce)	650 Volts D.C. min.
BREAKDOWN VOLTAGE	70 milli-ohms max.
INITIAL CONTACT RESISTANCE	greater than 700 Hz.
RESONANT FREQUENCY	2 mill; seconds (Typical)

THESE SWITCHES HAVE RHODIUM CONTACTS, LOCATED MID -WAY ALONG THE LENGTH OF THEIR GLASS, THE TUBES CONTAIN AN ATMOSPHERE OF NITROGEN.

PROTECTION OF REED SWITCH CONTACTS :

The effects of CAPACITIVE LOADS such as are imposed by long leads, are suppressed by means of small inductors mounted within the relay and wired one in series with each switch. The effects of INDUCTIVE LOADS such as are imposed by contactors and EM Relays, are suppressed by means of a diode wired across each load. Diode to be rated with forward current at least as high as steady load current and connected so as to absorb back e.m.f.

ARRANGEMENT OF TERMINALS AND MEANS OF PROTECTION FOR REED SWITCH CONTACTS :

SPECIFICATIONS OF RELAYS :

Parameter	Rating	Tolerance
Contact system	Mercury Switch	
Type of contact	Make contact	Optional make or break
Switching voltage	220V, AC/DC	12V to 250V, AC/DC
Switching current	5A, AC/2A.DC	0.05 to 5A.
Switching capacity	1000W/VA	IW/VAto 1000W/VA
Frequency	50 Hz.	0 to 60 Hz
Limiting temp. of insulation liquid	+120 DC	14 DC for two hrs.
Gas Volume alarm	100cm3to300cm^3	Continuously adjustable
Insulating liquid flow rate	65 cm/sec, to 160 cm/sec (depending on size)	

Relay casing tested at 8KG/cm2 for 1 minute
Max. permissible flow ,
400cm/sec.
rate of insulating liquid
Vibration sensitivity 0.01 inches peak to peak.
at frequency of 100
cycle/sec.

Assembled relays are pressure tested with transformer oil at 3kg/cm2 for 60 minutes.Electrical circuits are tested at 2000 volts R.M.S. for one minute.
Insulation resistance measured at 500 volts is not less than 10 mega ohms in air.

IMPORTANT :

The various parts of a relay, including the body, form one complete calibrated unit and must not be interchanged with those of other relay.
wb strongly recommend that relays should not be taken apart, and under no circumstances should any alteration be made to the angle of the flap on the trip element. This has been correctly adjusted during manufacturing.

DIMENSIONS AND RATING:

RELAY TYPE		GOR1	GOR2	GOR3
No. of Switching system		2	2	2
Pipe Bore in mm.		25	50	80
For transformer rating in MVA		<1.0	<1.0	<10.0
Main dimension	A	250	250	270
in mm	B	128	184/215	215
	C	205	205	220
	D	3/4" or 1"	Conduit Thread	
Flange PCD	E	72	115	145
dimensions Holes/				
in mm. Thread				
Flange	G	78 Square	150	185
Steady oil flow for		70	75	90
Tripping operation		to	to	to
in cms/sec.		130	140	160
Gas volume for		90	175	200
Alarm contact		to	to	to
in cc.		165	225	330

NATURE OF FAULT AND CORRESPONDING RELAY RESPONSE :

SLNo	Nature of fault	Relay Response	
1.			
(a)	Minor faults: Failure of insulation		
	On core bolts between core lamination		
	of winding due to excessive heat		
(b)	Over heating due to bad electrical contact		
(c)	Capacitance discharge to earth		
(d)	Corona discharge in bad oil		
(e)	Release of air from : Fresh oif. New windings. Core etc.		
2.	Major Faults :		
(a)	Short circuit between :	Alarm & Trip	
	Phase winding	ii	ii
	Phase and earth	ii	ii
	Winding turns	ii	ii
	Winding tapping	ii	ii
(b)	Puncture to earth of bushing	ii	ii
(c)	Open circuit by :	ii	ii
	Disconnection of	ii	ii
	Conductor joint	ii	ii
	Conductor break	ii	ii
3.	Mechanical faults:		
(a)	Sinking of oil level below the bottom of	Alarm & Trip	
	the pipe bore on the conservator side due to low oil content or low oil temperature		
(b)	Loss of oil by leakage	ii	ii
(c)	Ingress of air through circulating system	ii	ii

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	the pipe bore on the conservator side due to low oil content or low oil temperature	
(b)	Loss of oil by leakage	ii ii
(c)	Ingress of air through circulating system	ii ii

TESTING AT SITE :

Every Buchholz Relay after installation should be checked for its performance at site by low injection of "air" through one of the pet -cocks for closing the alarm circuit and sudden air injection at approximately 1.6kg/cm sq for closing the trip circuit.

DIAGNOSIS OF TROUBLE FROM COLOUR OF GAS COLLECTED:

The gases collected in the relay loose their colors in short time observations should, therefore,be made as quickly as possible. The following colors are given as a guide.

Color of Gas	Identification
Colors less	Air
White are milky	Gas of decomposed paper and cloth insulation
Yellow	Gas of decomposed wood insulation.
Grey	Gas of overheated oil due to burning of iron.
Black	Gas of decomposed oil due to electric arc.

For notes on further tests. Combustibility or chemical, reference may be made to IS : 3638 (Application. Guide for Gas -operated Relays).

TEMPERATURE INDICATORS

INSTALLATION AND MAINTENANCE INSTRUCTIONS

APPLICATION :

The temperature indicator is used as an Oil Temperature indicator (OTI) or as a Winding Temperature Indicator (WTI) for the protection of liquid immersed power transformers. In the case of dry type transforms it is used as Temperature Indicator (1.1) to monitor the temperatur to the windings.

SCOPE OF SUPPLY:

OTI-Instrument with specified range. Number of Control Switches, length of capillary and sensing bulb.

WTI-Same as OTI but fitted with specified thermal image device.

TRANSMITTER (OPTIONAL)-A precision potentiometer is mounted inside the case of OTI or WTI to transmit the measured temperature to remote point (s).

REPEATER (OPTIONAL)-Analogue or Digital indicator supplies separately for remote indication of the temperature measured by OTI or WTI.

OPERATION-The instrument operates as OTI when its sensing bulb is mounted in an oil filled pocket located in the hottest oil of an oil immersed transformer.

The instrument operates as TI when its sensing bulb is exposed to the medium adjacent to the windings of a dry type transformer.

When a proportionate load current of the transformer is passed through the thermal image device, the instrument operates as a WTI integrating the simulated temperature rise of the thermal image device and the top oil temperature measured by the sensing bulb.

Remote indication of the temperature measured by the OTI or WTI is provided by connecting the transmitter to the repeater either directly or through a resistance transducer (resistance to current converter).

CONSTRUCTION :

LIQUID FILLED SYSTEM.-"A sensing bulb, a measuring bellows and a small bore capillary tubeconnecting the two form the measuring system. A second bellows (compensating bellows) connected with a second capillary running parallel to the first capillary and terminated at the headofthe bulb form the temperature compensating system. Both the systems are completely filled with thesame liquid (other than mercury). The two bellows are linked to a compensating lever in such a manner that effect of ambient temperature changes on the capillary line and measuring bellows is compensated. The movement of the measuring bellows is related only to the temperature being measured by the sensing bulb. This movement is amplified by the link and (ever mechanism/ which directly drives the rotating disc carrying the control switches. An indicating pointer mounted on the same disc moves over a calibrated dial. Head compensa-tion is provided by sealing both the systems under initial pressure, which is greater than the possible head pressure due to differences in the elevation between the bulb and indicator.

MAXIMUM POINTER (RED COLORED)-Located on the indicator lid, is respectable fromoutside the case by a screw driver blade. Unscrew and remove the back cap to reach the screwdriver-slot.

CAUTION : Never use the switch testing knob for setting the maximum pointer. If used, the switch contacts will close and initiate the external control circuits when the instrument is in operation.

SWITCH TESTING KNOB-Is fitted on the indicator lid to check mercury switches setting and potentiometer operation. This knob when rotated moves the indicating pointer, switch mecha-nism and potentiometer wiper together and facilitates testing these circuits without opening the lid, Rotate the knob slowly and steadily for an accurate check. Never allow the knob to spring back suddenly or quickly, as this will cause damage.

THERMAL IMAGE DEVICE-A heater coil is fitted around the measuring bellows and supplied from a current transformer in the load circuit of the transformer. The heater coil simulates hot-spot temperature of the windings overtop oil temperature for a given load. The measuring bellows reacts to this simulated temperature rise in addition to the top oil temperature meas-ured by the sensing bulb and the instrument functions as a WTI displaying the hottest spot temperature of the winding. An adjustable shunt resistor is provided for shunting a portion of the current through the heater coil to obtain precise thermal image. Data sheet/Graph is supplied with each WTI giving irrelevant details of the thermal image device.

REMOTE INDICATION (Model Specific)-A precision potentiometer is mounted inside the indicator to function as a transmitter for remote indication of the temperature measured by the OTI/WTI. Technical data of the transmitter and repeater along with details of adjustments are given in the relevant data sheet supplied with each indicator.

ELECTRICAL CONNECTION-All internal electrical contacts are wired to the terminal blocks mounted inside the indicator case. A wiring diagram is fixed inside the case of each indicator Switches are identified by marking on them.

Reference of Marshalling Box circuit shall be made for further details.

PREIMPLANTATION TESTING :

Equipment:

Controlled constant temperature bath with continuously stirred lfquid.
Certified Standard Thermometer.
Continuity test circuit.
High voltage break - down tester.
A constant current source.
NOTE : Calibration baths are generally suitable for use only in a workshop. If required for use in the field, they should be used under cover and in a non-hazardous environment.

PRECONDITIONING:

Before commencing any tests check the following.
The instruments are as per purchaser specification.
The instrument is not damaged in anyway and any such damage is rectified before testing.
The instrument is mounted correctly.
The shipping stop is removed.

OTI CALIBRATION:

Place the sensing bulb of the temperature indicator under test in the well stirred constant temperature bath. Allow 5 minutes setting time before taking readings. Check the reading near to but not less than the minimum value of the indicator scale. For increasing value of temperature, repeat the procedure to obtain at least two further readings the highest value being near to but not greater than the maximum scale value of the indicator. The reading should be agree "with the standard thermometer within +- 1.5% f.s.d. (Maximum scale value) Otherwise following adjustments should be made.

ZERO ADJUSTMENT :

Use this adjustment for correcting readings near the minimum scale value. Firmly hold the tongue adjuster by a 2BA spanner and slacken the lock nut with a second 2BA spanner. To move the indicating pointer up or down the scale, turn the tongue adjuster by a small amount anti-clockwise or clockwise respectively. Retighten the lock nut holding firmly the long adjuster.Do not twist the measuring bellows while carrying out his adjustment as this may cause dam-age to the linkage/ bellows.

SPAN ADJUSTMENT (Model Specific):

Use this adjustment for correcting reading near the maximum scale value. Slacken the shoulder screw half a turn but do not remove the same. Turn the range adjuster screw anti-clockwise or clockwise to increase or decrease respectively the sweep of the pointer. Make the adjustment in small increments and carefully. Half a turn in either direction may correspond to approximately 0.5 DC reading. After adjustment, retighten the shoulder screw.

WTI CALIBRATION :

During calibration, keep the instrument lid fixed in position. Place the sensing bulb in the con-tinuously stirred bath, the temperature of which is maintained at the specified value. Allow 5 minute setting time temperature of which is maintained at the specified value. Allow 5 minutes setting time and apply the specified current must remain switched on at specified value for at least 40 minutes before taking reading.. To achieve the readings within the accuracy limits or to reset the temperature rise to a different value, the following adjustments should be made.

GRADIENT ADJUSTMENT :

Open the instrument lid, and carefully with draw the calibrating shunt.
1. After removing the nut & retaining washer, one adjustable center band and two fixed bands at the ends are provided in the shunt. One supply lead is connected to the center band and the other lead to the lower band on the shunt. Slacken the screw in the retaining band of the center band. To reduce the temperature rise move the center band nearer to the lower band. To in-crease the temperature rise, reverse the procedure. Retighten the screw on the center band after adjustment. Replace the shunt and lid. Repeat the calibration check after adjustment until the accuracy limits is achieved.

SWITCH SETTING (Model Specific) PC 252 :

The switch settings are adjustable as indicated below:

Indicator scale range	Switch setting adjustable to close between	Switch differential (close to open) adjustable between
0-120 °C	40 °C and 120 °C	6 °C and 80 °C
20-140 °C	50 °C and 140 °C	6 °C and 90 °C
30-150 °C	50 °C and 150 °C	6 °C and 100 °C
0-150 °C	45 °C and 150 °C	7.5 °C and 150 °C
0-240 °C	80 °C and 240 °C	12 °C and 160 °C

NOTE : Unless specified otherwise, the instruments are supplied with minimum switch differential.

Connect across the switch contacts the continuity test circuit and check the correct operation of the switches at their set points to make (close) and break (open) contacts. The switches should operate at set points within 4— 2.5% of switch setting arm pointer indication. Otherwise the following adjustments should be made.

SWITCH ADJUSTMENT :

Slacken switch setting screw on each switch setting arm. Move the left hand arm pointer over the switch scale to the required temperature for making (closing) contact and right hand arm pointer to the required temperature for breaking (opening contact. Retighten both switch setting screws. By closing the left hand arm pointer to the right hand arm pointer minimum differentials obtained. A built- in stop automatically sets the minimum differential. While slack-ening and tightening the setting screws, steady the disc with the other hand to prevent undue strain on the mechanism. The indicating pointer can be moved with a finger in clockwise direction to check the operation of the switches at set points. By moving the pointer slowly and steadily, AC accurate check is obtained. Never allow the pointer in an anti clockwise direction. By doing so the measuring bellows is likely to be damaged. An alternative procedure is to check the switch operation while calibrating the instruments for temperature readings.

INSTALLATION:

MOUNTING : Mount the incrementing a vertical position. Other wise errors, particularly in the horizontal plane, will up set the zero setting of the mercury switches. Place a spirit level on the top of the indicator case to ensure correct positioning and operation of the mercury switches. If vibration exists at the mounting position, mount the indicators a non vibrating structure.Suitable Anti vibration mountains are supplied. Don to use these maintains during transport.

CAPILLARY LINE :

Do not stretch hard, twist or bend the capillary to a radius less than 75 mm. Continuously support the capillary by suitable clips at intervals of 300 mm to 450mm. Allow necessary slack at the bulb end for mounting and removing the bulb with out sharp bends at the joint. Wind in spiral (minimum diameter 150 mm) the possible excess length of capillary close to the indica-tor or the bulb.

HANDLING AND STORAGE :

Handle the instrument with most care. Do not twist the capillary while unpacking, storage or installation. Avoid sharp bends especially where the capillary joins the indicator and bulb. Allow minimum 75 mm radius of bend. Never lift or carry the instrument by holding the capillary only. Before storing or transporting, pack the instrument in the paper board box supplied. Before lowering the instrument into the box wind the capillary in spiral close to the indicator (minimum spiral diameter 150mm). Locate all the cushions before closing and seal-ing the box. Where necessary, provide additional wooden packing case for transport.
CAUTION : When Anti-vibration mountains are supplied do not use these during transport.

MAINTENANCE :

Normally no maintenance is required for the temperature indicators. However adjustment or replacement of switches and resetting of the maximum pointer may become necessary.

REPAIRS:

If a mercury switch is damaged in anyway, it may be undipped from the switch carrier and the lead s removed with a hot soldering iron. After re-soldering the leads to a new switch and locating back the switch in the clip, the switch should be rebalanced. This is done by making the switch to topple in its carrier at the instant when the mercury flows towards of away from the electrodes. By sliding the switch a little in the appropriate direction in the clip, correct toppling is achieved. After correctly balancing the switch check the operation at preset tem-perature. If necessary re-zero the switch scale by slackening the switch zeroing screw at the top of the switch scale and rotating the scale to required position. Retighten the screw after adjust-ment if the bellows bulb or capillary is damage repairs can be done only at the manufacturer's factory.

WORKING PROCEDURE OF TEMPERATURE INDICATORS :

Measuring System : When heated, volumetric expansion of a liquid will be proportional to the rise in temperature, A sensing bulb, a measuring bellows and a small bore capillary tube connecting the two form the measuring system which is filled with liquid. When the bulb is exposed to a rise in temperature, the liquid inside the measuring system expand proportion-ately causing corresponding volumetric changes in the bellows. Since one end of the bellows is anchored it will move linearly in proportion to the measured temperature.

Temperature Compensation : A second bellows (compensating bellows) and a capillary terminated at the head of the bulb provided complete compensation of ambient temperature changes are identical in the twin system for any ambient temperature change. The two bellows are linked in such a manner that these volume changes are cancelled out. Thus the measuring bellows outputs is related directly to the temperature being measured by bulb.

Head compensation : The head pressure will have no effect on the bellows since the systems are sealed under initial pressure which greater than the head pressure.

Operating Mechanism : Link and lever mechanism amplifies the movement of the measuringbellows and drives directly a rotating disc carrying the control switches and indication pointer.

Adjustments : Zero adjustment can be made by repositioning the pointer through a tongue adjuster and span adjustment through a spring loaded screw.

Switching : Electrically isolated heavy duty mercury switches, which are independently adjust-able to operate at preset temperatures are provided to actuate Control Circuits.

COMPONENTS :

Bulb: Brass with Silver joints - Natural finish

Bellows: Phosphor Bronze -Tin plated.

Capillary: Copper with Stainless Steel Armour sheathing.

Case: Cast Aluminum (LM6m)-Stove enamel painted.

Window : Clear transparent plastic.

Switch: Dry-electrode mercury and glass switch with Tungsten electrodes in Borosilicate glass tube

Switch Leads: Standard copper wire insulated with silicone Rubber sleeve.

Other Parts: Non-ferrous metals duly surface treated or other corrosion resistant material.

SPECIFICATION :

Standard Ranges

Accuracy of indication +1.5%f.s.d.

Control Switches : Up to 4 numbers, electrically isolated normally open S.RS.T. dry electrode mercury and glass switches.

Switch Rating : 5 Amps. (For PC252) & 2 Amps. (For PC 414) continues 250 volts AC. or AC Overload rating of 10 Amps. (For pC252 &4 Amps. (For PC 414) in AC. circuit only for shor duration such as motor starting. Switching is independently adjustable of making and breaking contacts at preset temperatures.

Capillary : Standard length 3m, 5m, 6m, 10m, & 12m Stainless Steel Armour sheathed.

Case Finish : Stove enameled hammer tone deep blue outside and all white inside.

Case Mounting : Projection mounting with back straps. Weather-proof case (protective class IP 55 of IEC 529) is suitable for outdoor service. However, a canopy type weather shield will improve visibility under tropical conditions.

Capillary Entry : Bottom of case-vertical.

Maximum Pointer : Reset table from outside by means of a screw driver is fitted to the instrument window. A special damping device ensures accuracy of readings even under vibration conditions.

Switch Testing : A switch testing knob is fitted on the instrument lid to facilitate checking of the switch setting from outside, without removing the instruments lid. Electrical connections an mode to the terminal block inside the instrument case Approved insulating materials are used and all circuit to ground tested at 2500 Volts. AC 50 Hz for 60 seconds. A wiring diagram is fixed inside the instrument case.

OPTIONAL ANCILLARIES :

Thermal Image Device : An electrical heater coil fitted around the measuring bellows, simulates the winding to top oil temperature differential in addition to the top oil temperature being measured by the instrument bulb.The temperature in the hottest part of the winding or hot spot temperature is displayed directly by the instrument. Thus, the instrument funcations as a winding Temperture Indicator.

Precise thermal image is obtained by shunting a portion of the heater coil current through an adjustable shunt resistor mounted inside the instrument case.

Since the thermal time constant of the heater coil is nearly the same as the transformer wind-ing, the instrument simulates closely the actual temperature of the winding in relation to time.

For different ranges of instruments, separate Data Sheets/Graphs are available.

Remote Indication (Model Specific): A precision potentiometer, mounted inside the instruments case, functions as a Transmitter and operates an Electrical Repeater for remote reading of measured temperature.

In one scheme the transmitter is directly connected to the repeater. Alternative scheme is to connect the transmitter to a Resistance Transducer, which will supply direct current for operating repeaters.

Resistance Transducer (Model Specific): When the transmitter is connected to the Resist-ance transducer (resistance to current converter) the latter measures the varying resistance of the transmitter and produces an output of proportionate direct current. When both Local and Remote sites have repeater instruments, a single transducer will supply both instruments, each instrument being in series with the transducer output. The transducer output may be used for digital display and data logging.

The resistance transducer should be mounted in the-temperature indicator compartment of the marshalling kiosk.

MOVING COIL ELECTRICAL REPEATER

(FOR TEMPERATURE INDICATORS)

APPLICATION : Liquid- in- metal expansion type temperature indicators are used as OTI or WTI for local indication. For remote indication of the temperature measured by these indica-tors Moving Coil Electrical Repeaters are used.

OPERATION : The precision potentiometer, mounted inside the case of the local temperature indicator, functions as a transmitter of the temperature values measured by the local indicator.It is used in variable voltage divider mode with its output voltage proportional to the values of the temperature being measured by the local temperature indicator. The signal transmission is in voltage mode, which is converted to equivalent current mode to operate the Moving Coil Ammeter used as a Repeater at the remote point.

SPECIFICATION : Precision potentiometer: Wire Wound with a nominal total resistance of 440 or 2400 or 2800Ohms with a tolerance of +- 2% of maximum values of resistance. The potentiometer is used in used in variable voltage divider mode with a linearity of +- 1% input voltage.

Siting : Mounted inside the case of temperature indicator.
Moving Coil Repeater : Ammeter with shielded and pivot-jewel movement.
Auxiliary supply Voltage : 25-35Volt/90-240Volt ac/dc
Auxiliary Supply Burden : Max3VA.
Range : Same temperature range as the local temperature indicator.
Accuracy : +- 1.5 DC of local temperature indicator readings.
Adjustment : Zero +- 3.5 DC
Span : +- 5.0 DC
Loop Resistance : Max. 210 Ohms. (Max.70 Ohms. each lead)
Dial : White background with black scale mark.
Case Dimension : 171x136x89 mm
Panel Cut-Out : 162x127mm
Mounting : Flush Mounting
Siting : Indoors - Control Panel

CALIBRATION : Connect the Auxiliary supply and signal (potentiometer) leads as shown in Drawing. Adjust the Repeater to the OFF position by means of the mechanical zero adjustment before energising. Then apply specified power supply.

Check the readings of the Repeater with the pointer indication of local Temperature Indicator. the indicating pointer of the local Temperature indicator may be moved clock wise to check the readings of the Repeater either by the switch test knob or by a finger when the lid is open. Never allow the local indicator pointer to spring back suddenly to quickly and also force the pointer in an anti clockwise direction. By doing so the measuring bellows is likely to be damiged. An alternative procedure is to check the Repeater readings while calibrating the local emperature indicator for temperature readings. Wire wound trimming potentiometer are provided for Electrical Zero and Electrical Span adjustment.

ELECTRICAL ZERO : Check the Repeater reading at the low end of the dial. If the repeater sading does not agree with the Temperature Indicator reading within+- 1.5 DC, adjust the zero set till the readings agree. Clockwise movement of the potentiometer will increase the ZERO setting and anti clockwise movement will decrease the same. Use suitable screwdriver blade for this purpose.

ELECTRICAL SPAN: The indicating pointer of the Temperature Indicator can be operated in ockwise direction to check the Repeater reading at the maximum dial marking. If the repeater reading does not agree within+- 1.5DC of the Temperature Indicator reading same may be reset by SPAN adjustment potentiometer mounted in the Repeater. Clockwise movement of this potentiometer will in crease the span and anti clockwise movement will decrease e span.

Repeat the tests until accuracy limit of +- 1.5 DC is achieved.

Since the distance between the local temperature Indicator and the Moving Coil Repeater will vary the corresponding lead Resistance also vary. Therefore it is necessary to recalibrate the peater after installation.

ROUTINE TESTS :

CALIBRATION : Moving Coil Electrical Repeater calibrated for an overall accuracy of +- 1.5 DC of local Temperature Indicator pointer indication.

APPLIED VOLTAGE TEST : Tested 2500 r.m.s. 50Hz for 60 sec. between all terminal and earth (case).

INSULATION RESISTANCE : Measured at 500v, dc under normal ambient temperature for a value of not less than 20M Ohms between all terminals and earth (case).

SOAK TEST : The entire system powered for a period of 72 hours to simulate normal operating conditions for determining the input and output conditions and the function performed during this period.

NOTE : It is important that the 3 signal leads are isolated from all other power leads. Since the signal trans, mission is by voltage mode, the signal leads should be shielded and the shield should be grounded at the signal source end i.e. local Temperature indicator end.

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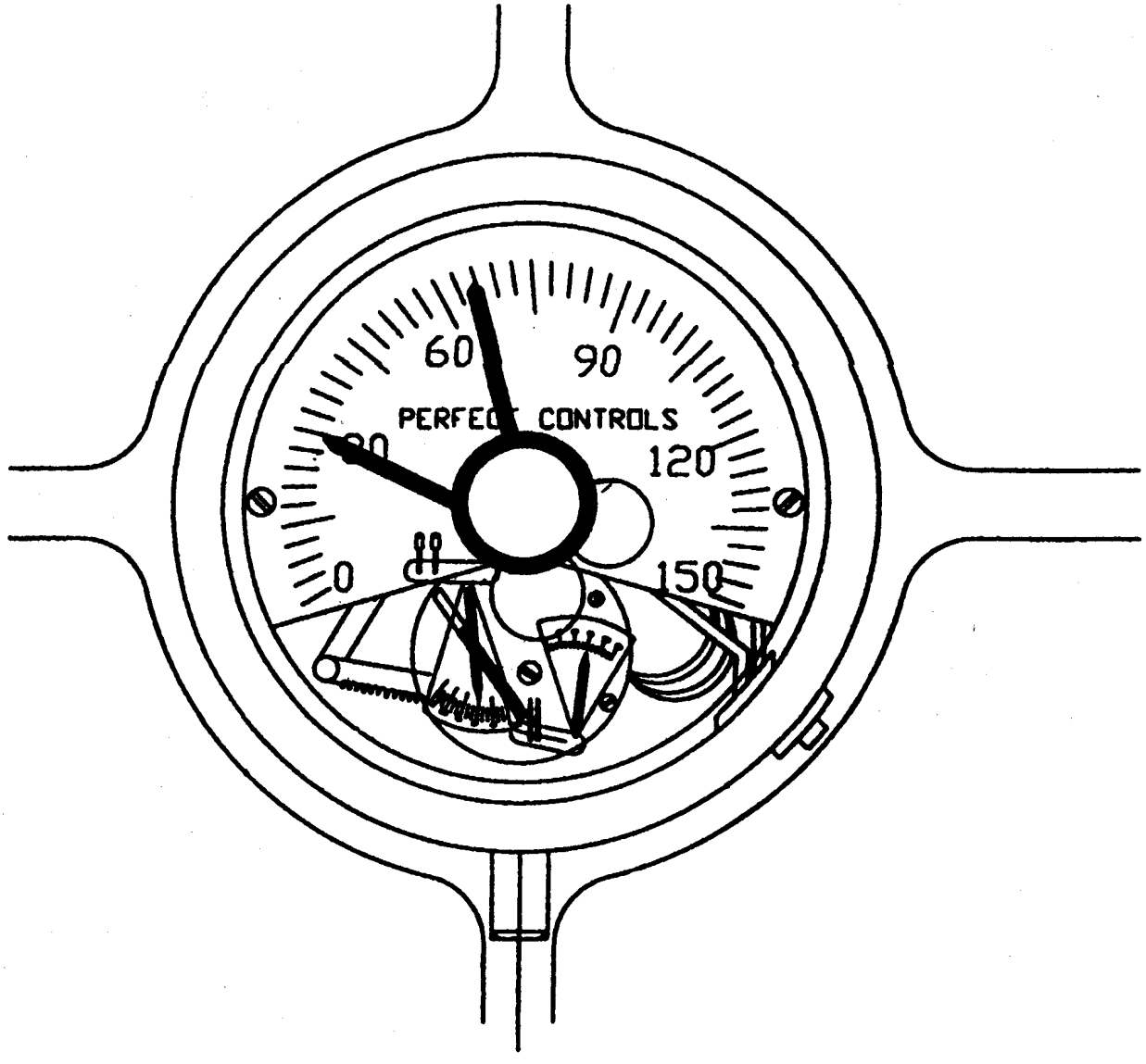
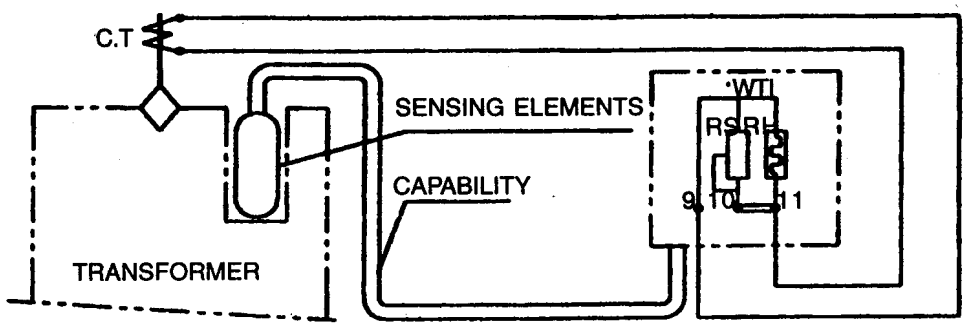
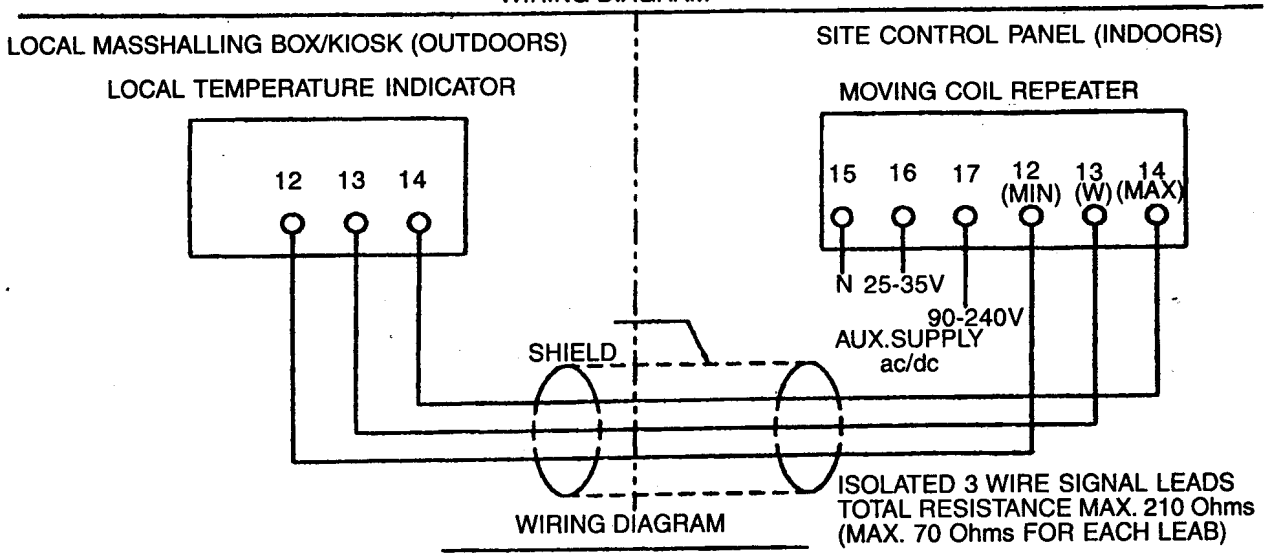
(MODEL-PC 414)





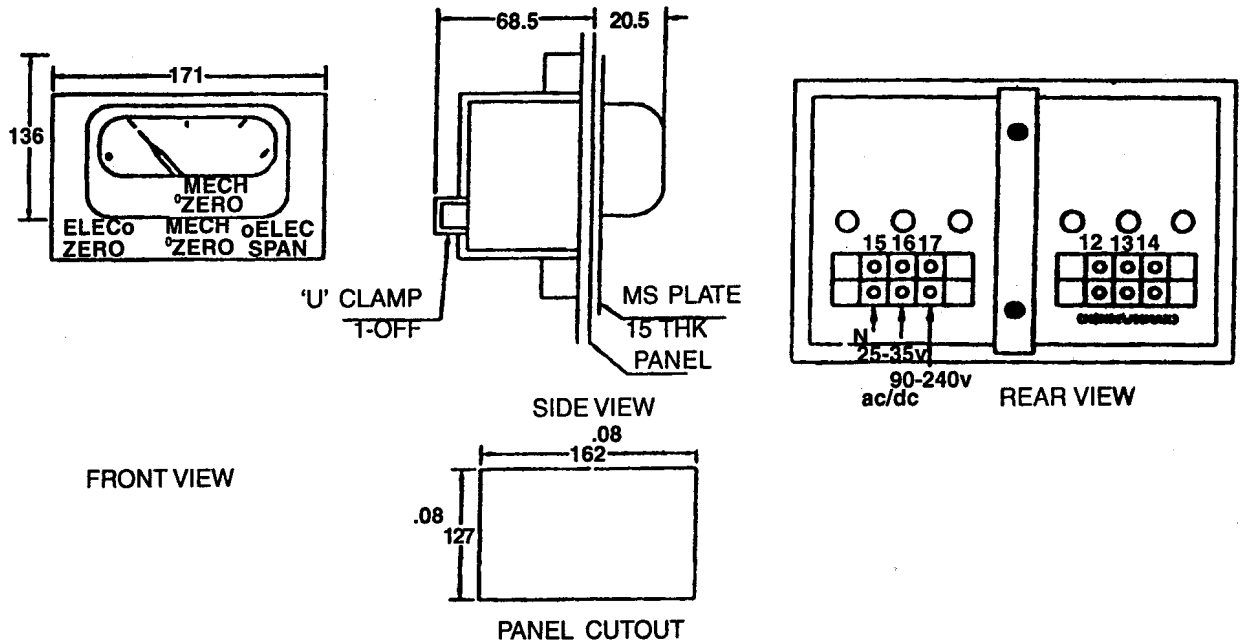
RS : ADJUSTABLE SHUNT
RH : DELLOWS HEATER

WIRING DIAGRAM



WIRING DIAGRAM

WTI REPEATER



TEMPERATURE INDICATORS
INSTALLATION AND MAINTENANCE INSTRUCTIONS

GENERAL:
A thermal system partially filled with a volatile liquid operating on the principle of vapor pressure of the liquid is used for the measurement of temperature. In the case of Mercury-in steel Thermometers, the liquid filled is of course Mercury as the name indicates. The main advantage is that these could be used for distant reading purposes.

Embodying a Burden Tubes as the responsive element in conjunction with a geared quadrant and pinion type movement, these thermometers have been designed to meet the demand of industry, for reliable and robust instrumentation for indicating and controlling temperature in a multitude of industrial application.

SPECIFICATION :
These instruments are prepared in a tailor made to suit the exact requirement of every customer as per their drawing and or specification.

DIAL :
Nominal dial sizes are.
4" (100 mm.), 6" (150 mm.)

CASING :
Normally of cast aluminum, painted stove enamels black, but where desired this can be supplied in hydraulically pressed stainless steel plate having a mirror finish polished surface.

BEZEAL :
In cast aluminum or in stainless steel (pressed plate type)

DIAL :
Aluminum with white background and black lettering or vice versa if so desired.

SENSING BULB :
The standard size bulb is 95 mm long x 9/16" diameter and is in brass in the case of Vapor Pressure Thermometers and in mild steel in the case of Mercury in steel Thermometers the bulbs can be provided in Stainless steel so desired.

STEM:
This too is normally provided in brass in Vapory Pressure Thermometers and in mild steel in Mercury-in-steel-Thermometers. Where desired, the stem can be provided in stain less steel.

CAPILLARY:
This is of copper vapor pressure thermometers and in mild steel in the case of mercury install. The standard length of capillary provided is 6 ft. in vapors pressure and 10ft. in mercury-in-steel type. Extra length of capillary can also be provided.

Capillary is armoured in steel and sheathed in PVC in vapor pressure type and in mercury in steel type it is armoured in copper tubing but if so desired, it can be armoured in steel and sheathed in PVC.

NUT CONNECTION :

The Nut connection normally provided is 1/2"BSP adjustable but we can provide the connection in any other size too like 3/4" BSP or 1"BSP of 1/2 NPT and like.
The material of the Nut connections normally is of Brass in the case of vapor pressure and mild steel in the case of mercury-in-steel where required, the Nut connections can be provided in stainless steel.

POCKETS :

To protect and facilitate replacement of bulbs, Pockets is Brass, Mild steel or Stainless steel can be provided.

MOUNTING ARRANGEMENT :

Thermometer casings would be suitable for direct mounting of surface projection mounting with a flange at the rear portion or the casing or for flush mounting with a flange at the front size of the casing. The mounting holes in the flange can also be provided as per PCD detail although normally three holes of 3/16" diameter are provided at equal distance at 1200 angle.

ELECTRICAL CONTACTS :

One set of contact for each to operate an alarm or trip device at preset rising and falling is provided when asked for.

PRESSURE RELIEF VALVE :

APPLICATION : PRV is designed to be used on Power Transformers. When pressure in the tank rises above predetermined safe limit, this valve operates and performs following functions.

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

Gives visual indication of valve operation by raising flag.

Operates a micro switch.

This switch has 1NO and 1NC contacts (Four terminals). Hence switch can be effectively used in control circuit.

TESTS : Tests are-carried out as per extract of test certificate.
CONSTRUCTION AND Working:

This PRV has an integral flange with six holes for mounting. The valve can be mounted vertically or horizontally on the tank. The PRV has got a port of about 150 mm diameter. This port is sealed by a stainless steel diaphragm (4). The diaphragm rests on an '0' ring (3) and is kept pressed by two heavy-duty springs (6). There by keeping the port closed. The other sides of diaphragm are exposed to tank pressure. Whenever the pressure in the tank rises due to any reason, the same pressure acts on the diaphragm from inside. When pressure rises above predetermined safe limit, the diaphragm gets lifted from its seat. This lifting is instantaneous and allows vapors, gases or liquid to come out of tank depending upon the position of valve on tank. The diaphragm restores its position as soon as pressure in the tank drops below set limit. The lift of the diaphragm is utilized to operate flag (12) and micro switch (13) with the help of rod (9). The flag and switch remain operated until they are reset manually.

CHECK FOR VALVE:

The PRV is generally packed in a corrugated box. The method of packing may vary.

The PRV should be checked as follows, before it is installed.

Remove the valve from packing and keep it on a table. Remove all pickings, strings fixed to valve. Check that no parts are damaged on transit. If any damage is found refer to faults and remedies.

Remove the cover of switch box (15). By lifting the operating (9) check operations of switch with the help of an AVO meter. After checking reset the switch by pressing knob (14). Replace the cover.

The flag operation should be checked manually by lifting the rod (9) as per test in the test certificate. Reset the flag by turning down. Handling of flag should be done very carefully.

The product label indicates the suitability of valve for synthetic liquid or for transformer oil. A proper valve should be selected. Normally product label with red letters is used for synthetic liquid and black letters for oil.

A gasket (2) for base is supplied with each valve. It should be noted for general guidance that red gasket (silicone) is provided for synthetic liquid and Black for transformer oil.

Each PRV is tested at our works as per test certificate. However, customer is advised to check the valve by stimulating pressure conditions before it is actually installed on Transformer. If PRV is found operating at pressure out of tolerance limit, it will have to be returned to us for resetting. Changing of bursting pressure can not be done outside our factory. While conducting such Tests at your end care should be taken that small particles do not have a passage through the port opening. Such particles are likely to be trapped between diaphragm and gasket, which will affect functioning of Valve.

If should also be notes that faulty pressure gauge may lead to wrong conclusions. Hence pressure gauge of a to 2.5Kg/cm2 may be used with least count 0.05 Kg/cm2.

CHECK FOR INSTALLATION :

The following checks should be observed before installation of PRV on Transformer.

Check that the orientation of pad is properly done.

Check that the proper bolts MI 2x30 with thick washers are taken for installation.

Bolts other than this size should not be used.

Any other gasket than supplied with the valve should not be used.

Provide cable gland of 3/4" BS Conduit with suitable bush for cable to be used.

After all above checks, PRV is ready for installation.

INSTALLATION :

Each valve should be cleaned from inside (Tank side) with compressed air jet. All particles should be removed from tank side. While cleaning, care should be taken that the jet does not attack the switch and the flag mechanism. The PRV should be installed considering the following aspects.

The indicating flag is easily seen from distance. The valve is accessible for manual resetting and for routine manual checking.

While installing remove dirt and clean the mounting surface. Remove all traces of oil grease. The rubber gasket supplied with the valve should be properly cleaned and be located in the recess carefully.

All the bolts should be tightened evenly so that equal pressure is exerted on gasket and base. Connect control circuits to terminal plate provided in the switch box through cable gland (16).

As per wiring diagram check the operation of flag and switch by lifting operating rod and confirm that both controls operate is required.

The PRV can be put to service.

FAULTS AND REMEDIES :

The valve has rugged construction and it is not likely to get damaged easily. However the indicating flag is delicate item. Hence it is likely to get damaged. The indicating flag can be replaced at your end by asking for replacement.
You can repair with the help of good instrument mechanic minor faults occurring in working-of switch of flag mechanism. However for breakage or damage to major parts like diaphragm, base, valve, cover sent the PRV back to us.

In any case Sr. No. of PRV must be informed so that sending correct replacement is possible. This will also save lot of communication.

GENERAL NOTES :

Store the valve on its base duly packed in polyurethane bag to ensure that dirt or other solid particles do not enter the valve port from tank side.

Do not remove the protection cover on flag box and switch box when it is stored Keep the flat gasket (2) duly tied to the waive. Remove it only when it is to be installed. This gasket should be kept dry.

After installation of valve on transformer, test periodically the functioning of switch operation and flag operation by lifting the operating rod manually. This will ensure the switch operation and flag operation when valve opens due to rise in pressure inside the tank.

It is not possible to change the operating pressure at site.
The valve gaskets are of entirely different nature for synthetic liquid and transformer oil. Hence use proper valve for liquid as described on product label.

SPECIFICATION:

LIQUID IN TANK	:	SYNTHETIC LIQUID OR TRANSFORMER OIL AS PER ORDER
OPERATING PRESSURE	:	0.42, 0.49, 0.56, 0.7 kg/Sq cm
OPERATING PRESSURE	:	ANY ONE VALUE AS PER ORDER 0.07 kg/cq cm (1 LB SQ. INCH)
OPERATING TIME	:	INSTANTANEOUS
VALVE RESETTING	:	AUTOMATIC
SWITCH TOLERANCE	:	MANUAL
VISUAL INDICATOR RESETTING	:	MANUAL
OPERATING TEMPERATURE	:	0 TO 100 deg C (OF LIQUID IN TANK)
ENVIRONMENT	:	INDOOR OR OUTDOOR
SWITCH	:	MICRO SWITCH D.RD.T.
PORT OPENING	:	150 DIA NOMINAL
MAGNETIC OIL LEVEL INDICATOR		

APPLICATION :

In case of transformer application this indicator is used to read oil level inside the conservator. Besides, a mercury switch is provided which annunciates Alarm system when conservator becomes almost empty.

WORKING :

Afloat, which is used as sensor, moves up and down corresponding to rise and fall in oil level. This motion is transmitted to a permanent magnet by using bevel gear and pinion. A similar magnet is kept outside the conservator which carries the pointer and a cam. Pointer continuously reads oil level inside the conservator and cam is set to operate a mercury switch when conservator is drained to empty condition.

Sensing and reading mechanisms are separated by a metallic wall, which eliminates chance of leakage of oil.
Besides, switch and terminals are positioned outside which give east acces to them without draining contents of conservator.

PACKING :

For the purpose of safety, the indicator is dismantled and packed in corrugated box.

Indicator assembly

Float

Float arm

Notes : Float arm is kept outside if length is long.
Switch mechanism is locked to avoid swinging.

PREPARATION :

Float Arm: The arm is supplied either of Fixed length of Adjustable length.
In case fixed length is provided arm bearing Sr. No. of indicator should be taken.
In case of adjustable type, the arm should be cut and male piece should be brazed to suit required conservator.

Indicator : The indicator should be help in vertical position by mounting it on a wooden stand or any fixture.

The lever should be made free by removing string tied to lock its movement.

The lever should be made free by removing the clamp introduced to lock swinging of switch. Remove cover of terminal plate and connect an AVO meter to check closing of switch.

Assemble float arm and float to indicator. The indicator is ready for checking.

CHECKING (Before Mounting):

Check that parts are not damaged in transit.
Move float gently by hand upwards and down wares and check that pointer follows the float movement.
Check that switch closes when pointer approaches minimum level mark (Near Empty level) when float is moving downward and check that the switch opens automatically when float moves up wards.

Remove meter connection and connect Alarm un Check that alarm gets ON and OFF by moving float down up.
Check that the switch takes the load of Arm.
Remove Alarm connection replace covers for Switch box and terminal box. The indicator is ready for mounting on conservator.

MOUNTING :

When indicator is ready after checking, it should be carried to conservator for mounting. It should be handled carefully as switching of Float can damage gear or switch mechanism.
Select proper gaskets apply gasket compound and insert the gasket. Mount the indicator by carefully inserting float mechanism inside conservator, insert washers and tighten nuts evenly. Complete wiring as per wiring diagram.
Indicator is ready for commissioning.

FAULTS AND REMEDIES :

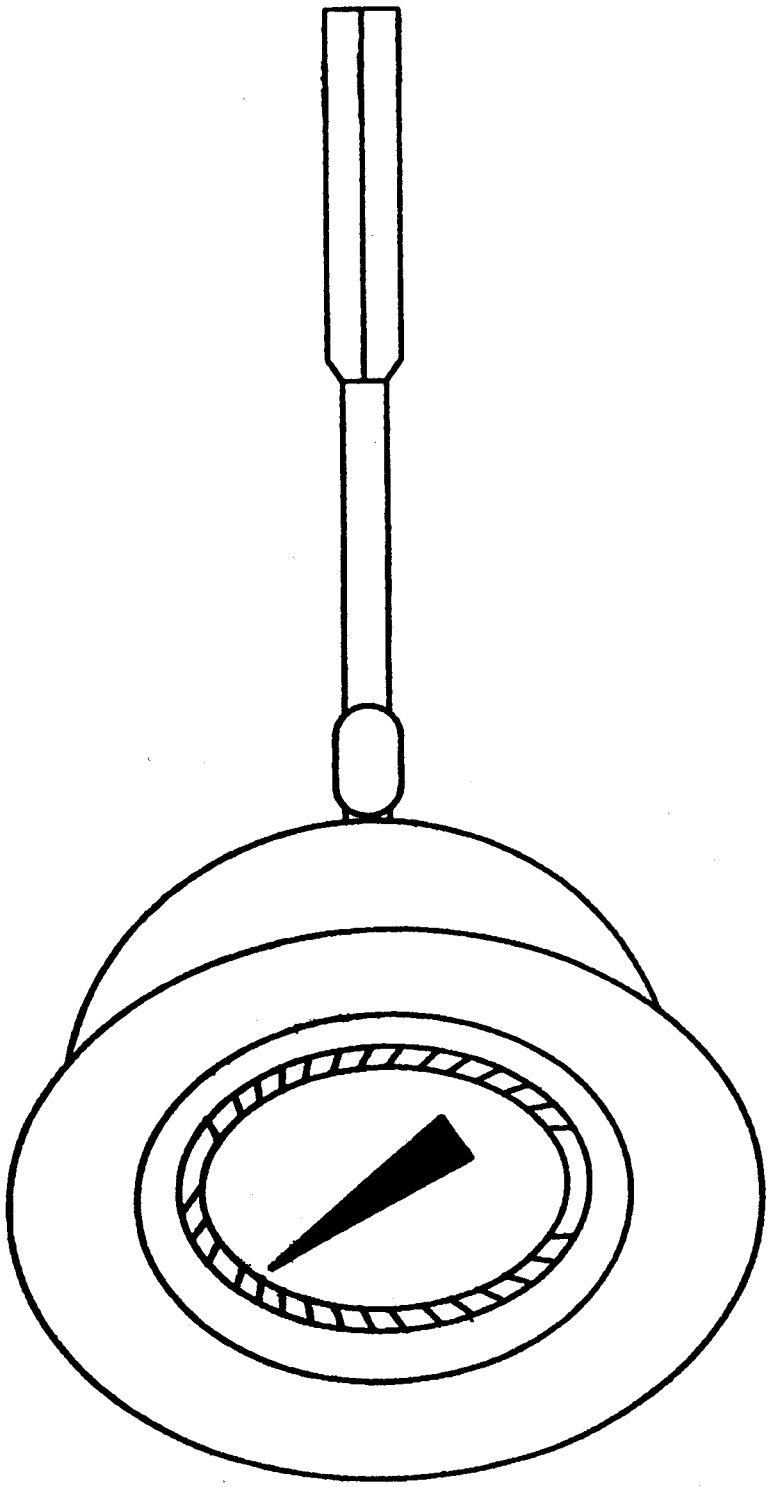
Pointer does not move or Gears damaged or Mercury glass broken or Mercury Spilled out on dial side.	Send indicator back to us for repairs~
Limit stoppers bent or switch unserviceable or float damaged or Arm damaged.	Ask for replacement (Sr. No. of indicator must be informed for any replacement.
Float arm bent	Remove bend

GENERAL NOTES :

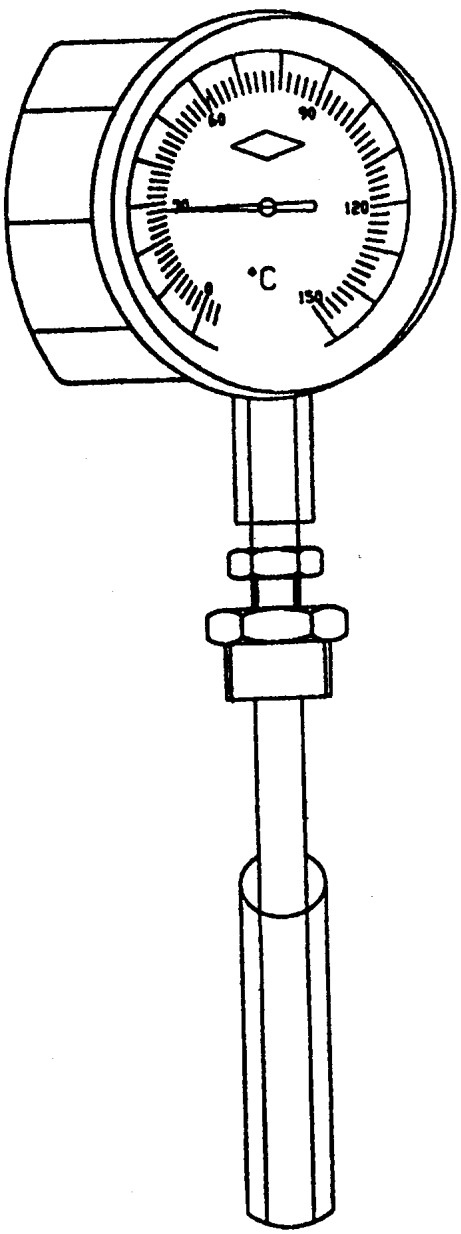
Indicators of different specifications are not interchangeable. Hence care should be taken while storing indicators and their arms.
Float and Indicator, loose or assembled should be handled carefully as they can not repaired if damaged.

The complaint of demand for any spare should be very specific with respect to Sr. No. of indicator.

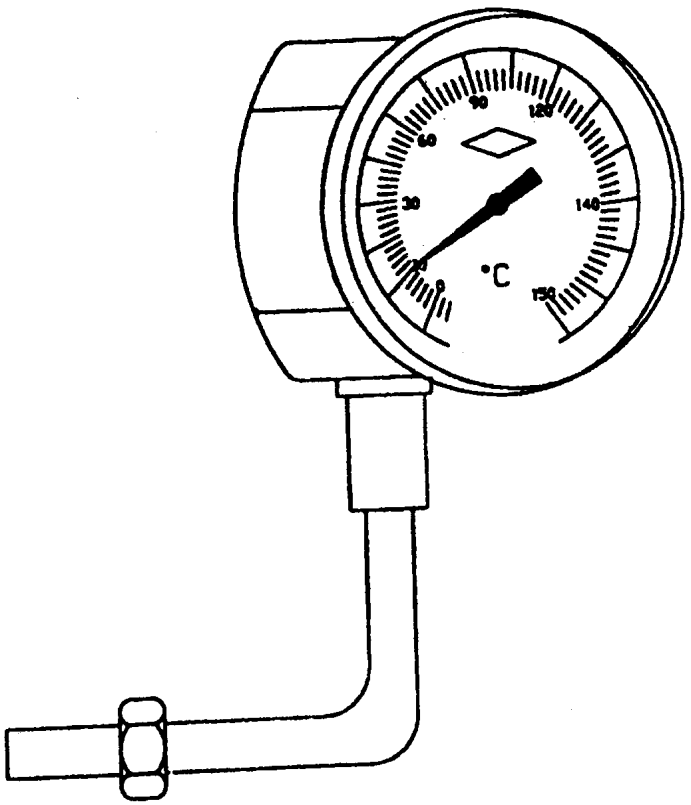
Lot of correspondence and time can be saved just by informing Sr. No, ~ A



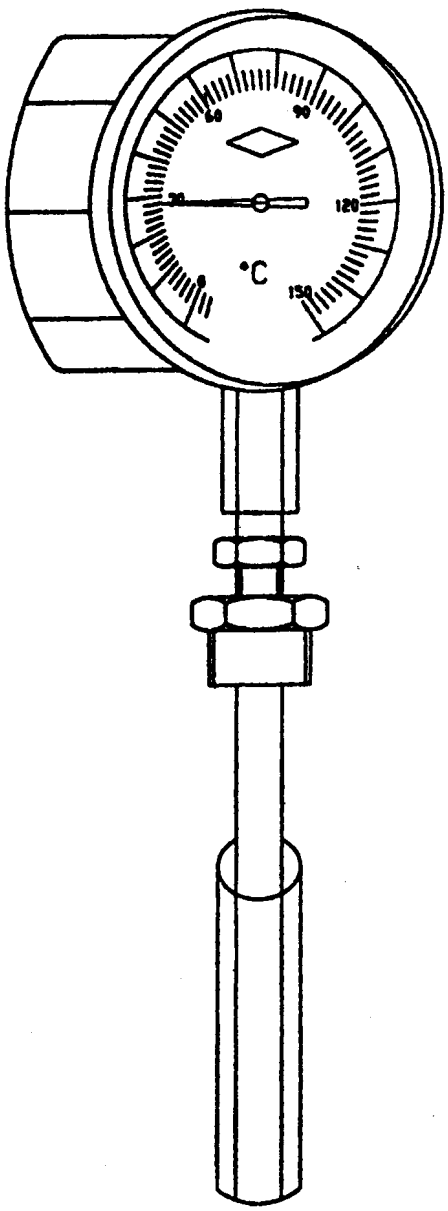
HORIZONTAL TYPE
TEMPERATURE INDICATOR



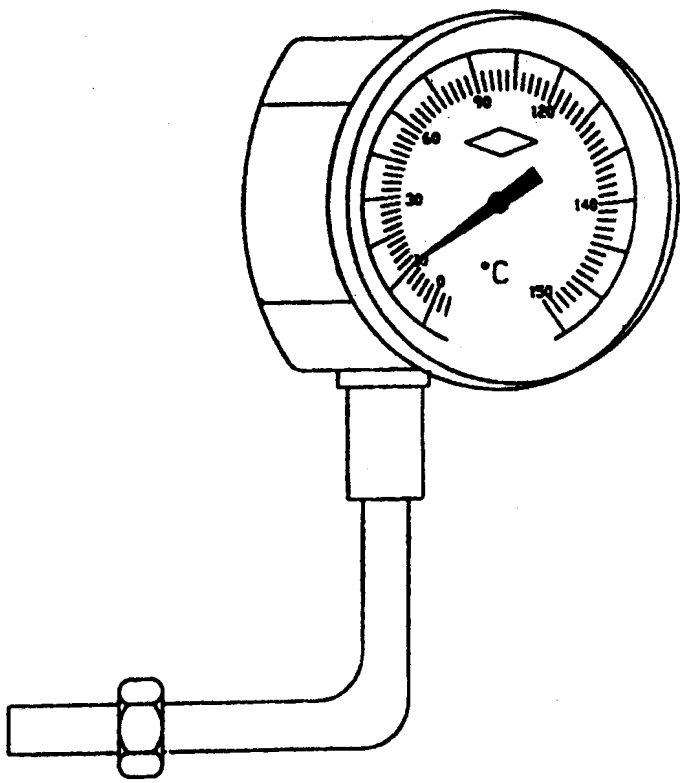
VERTICAL TYPE
TEMPERATURE INDICATOR



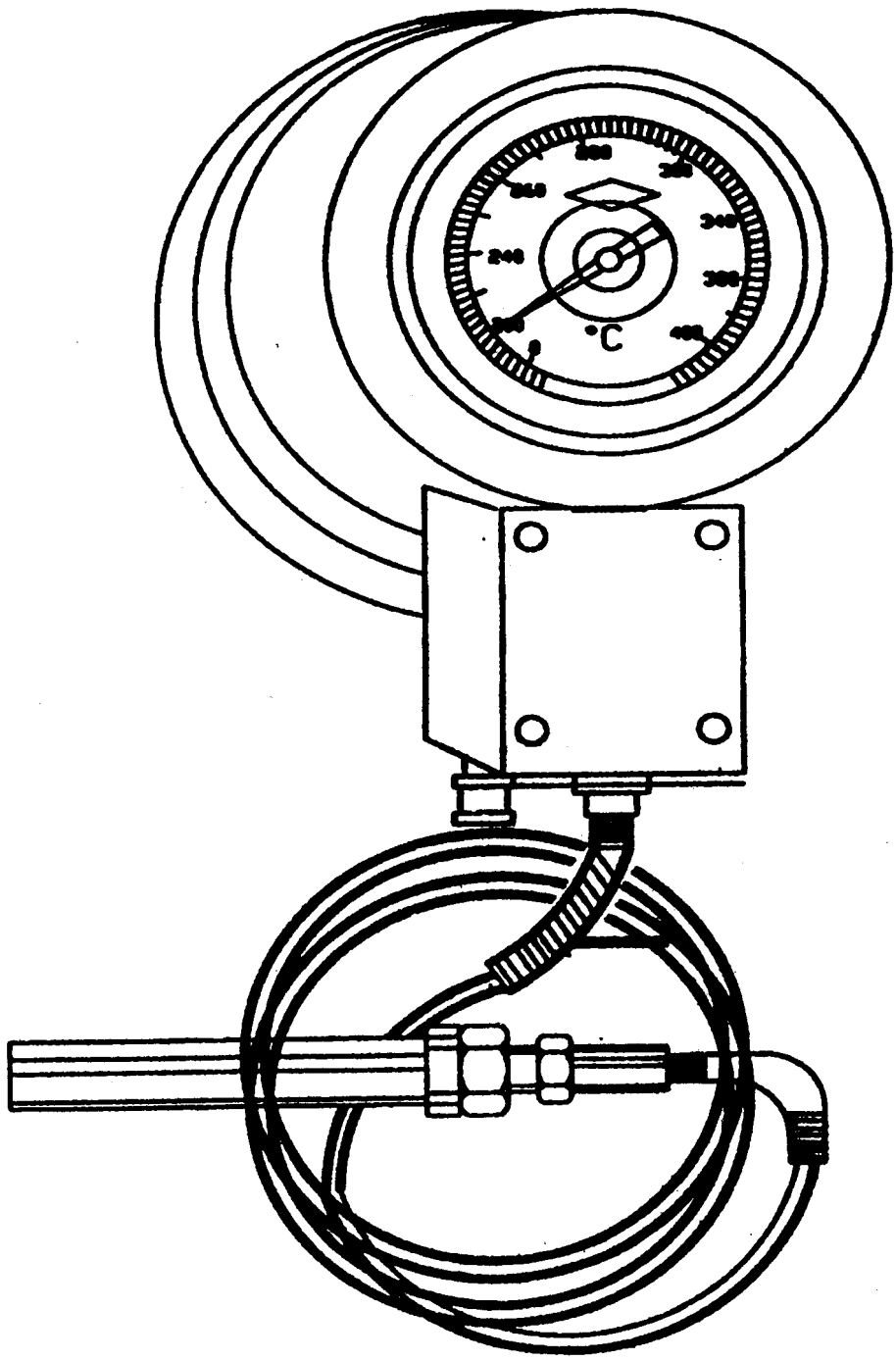
BENT TYPE
TEMPERATURE INDICATOR



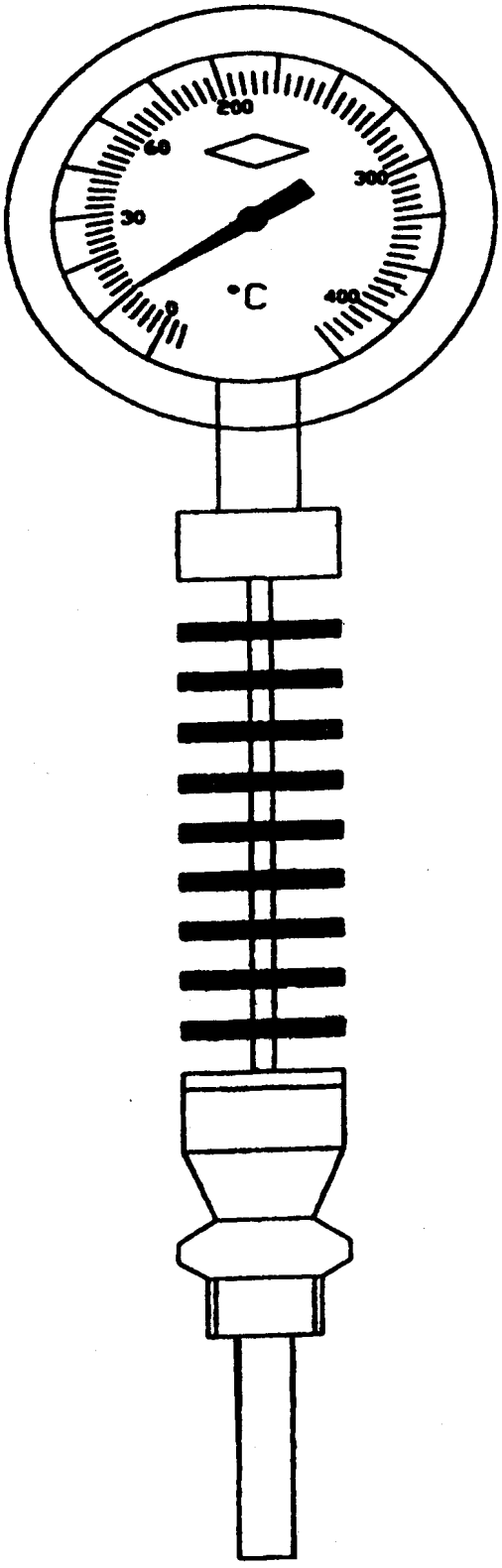
VERTICAL TYPE
TEMPERATURE INDICATOR



BENT TYPE
TEMPERATURE INDICATOR



CAPILARY TYPE WITH ELECTRICAL CONTACTS & JUNCTION BOX TEMPERATURE INDICATOR



VERTICAL TYPE ANTIVIBRATION SPRING
TEMPERATURE INDICATOR

OFF CIRCUIT SWITCHES :

The LV side voltage of transformers in case of varying H.Y can be maintained by changing HV number of turns.

When this is done by "off circuit switch" the supply to transformer on input side must be ISO-LATED before operating the switch.

Normally for off circuit switch the voltage varied per step is 2-1 /2% of normal input voltage. In extreme cases a 9 position switch is employed.

These switches are either rotary liner or push type.

PUSH PULL TYPE SWITCH:

The off circuit tap changer employs novel design in which a special de-clutching arrangement is provided for changing of position. The central per Mali shaft carrying the moving contacts is capable of being pulled away by means of a lever fitted to the externally operating gear thus completely disengaging from the fixed contacts that are mounted on the per Mali boards or panels. It is then possible to rotate the shaft for tap changing tap position by an external operating handle. The central shaft is then pushed back to engage the moving contacts with next set of fixed contacts.

The central shaft can be pushed back only when the moving and fixed contact alignment is perfectly proper. The switch and its operating gear are of robust construction designed for electrical and mechanical reliability in use.

ROTARY TYPE SWITCH :

The off circuit tap changer employees self sustaining spring loaded "0" ring design. The central shaft carrying moving contacts is capable of being rotted by means of a wheel handle fitted externally on the tank body. Before this lock pin should be dis-engaged by pulling out. It is then possible to rotate the shaft for changing the tap position by means of an externally operating handle. The lockup in is then released or will futilities in next pinhole due to its self-loaded spring.

LINEAR TYPE SWITCH :

As compared to the above two switches the only marked difference is in its Innervated contact arrangement and extreme compactness of the over all dimensions.

ON LOAD TAP SWITCH :

By use of this type of switches taps can be changed without de-energising the transformer. The switches are operated by manually or electrically. Electrical operation is possible locally or remote Arrangement for operating two or more OLTC in parallel is also done through the Remote Control Cubicles.

For further details of type and make of OLTC and control features provided the maintenance manual of respective transformer should be consulted.

CURRENT TRANSFORMER :

Current transformer should be handled carefully. If dropped down can damage winding and even the magnetic properties of core are effected. Thus resulting in CT characteristics.

The polarity of C.T. should be checked particularly when used in protection circuit. This must be ensured before energising the transformer.

CAUTION : It is important that the secondary circuit of the current transformers should be kept closed while current is passing through the primary circuit as other wise a dangerously high voltage can be induced in the secondary circuit which may rupture the insulation and can be fatal to the operating personnel.

SPARE ORDERING FORMAT

In the course of its operating life the transformer may need replacement of some of its parts. At our end, the following data are necessary to trace the original records and thus ensuring prompt and error free replacement.

1. Maker's reference no.	(as given in Rating and Diagram plate)
2. Maker's serial no.	(as given in Rating and Diagram plate)
3. Year of manufacture	(as given in Rating and Diagram plate)
4. Rated KVA	(as given in Rating and Diagram plate)
5. Rated volt. HV	(as given in Rating and Diagram plate)
6. Rated volt. LV	(as given in Rating and Diagram plate)
7. Name of the item	(as mentioned in OGA or other relevant drawings)

8. A copy of the drawings referred in point No.7

9. A freehand sketch of the item sought to be replaced if the drawing in point No 7 are not available giving all possible dimensions.

10. Quantity of the item thus sought to be replaced.

SHORTAGE & FAILURE REPORT

In case of shortage or damage, customer should immediately report (within 10 days) this to transport representatives and to the nearest T&D Branch Office of the AREVA LIMITED, giving following information.

a) Maker's reference number of the transformer.
b) Serial number of the transformer.
c) Nature of damage and the item number and description (as given in General Arrangement drawing) of the damage components should be furnished. In the case of failure apart from giving the maker's reference number and the serial number of the transformer, the customer should give the following information also.

1. Flag indication, if and the events leading to failure.

2. Insulation resistance of HV/E, LV/E and HV/LV & corresponding temperature in deg C.

3. Insulation resistance at the time of last filtration &corresponding temperature in deg C.

4. Oil breakdown value.

5. Color of gas in Buchholz relay if any.

The above information is necessary to expedite the matter at our end. Customer may also contact the Customer Service Department at our works at the telephone numbers given on the front cover of this manual.

PART - III

INFORMATION ONLY

1.0 HEALTH & SAFETY MATTERS

Even though the manufacturer of the transformer has put every effort to comply with the rules and regulations applicable to the safe operation of the transformer, the equipment described in this manual is safe to use provided that : —

- ➢ It is installed in a location suitable for its designed purpose.
- ➢ The installation is done by qualified and competent persons.
- ➢ The installed equipment is operated and maintained in accordance with the manufacturer's instructions by qualified and competent persons familiar with the type of equipment involved and its working envirocment.
- ➢ All work is done competently'and in accordance with good engineering practices and in a manner, which is not hazardous either to personnel or to equipment.
- ➢ The recommended pre-commissioning checks are done before energising the transformer.
- ➢ The operation of protective systems and devices for the transfer er are checked regularly.
- ➢ Neglect or deliberate overriding of protection system or device could allow a minor problem to develop into a major problem resulting in total lass of the transformer, damage to other equipment and injury to personne.
- ➢ Prolonged operation under over load, over voltage or over exetation

  condition can have a seriously detrimental effect on the life of equipment. The pressure relief devices are designed to eject liquid, which is likely to be very hot in the event of a fault developing within the transformer.
- ➢ Equipment such as pressure relief devices incorporates heavy springs in compression. If the equipment is dismantled without due safeguard,damage and /or injury may result.
- ➢ The internal atmosphere of a transformer tank, if N2 filled, is replaced by breathable dry air of dew point less than -40°C for a. minimum period of twenty four hours.

1.1.1 ELECTRICAL SAFETY

The following hazards are commonly associated with the installation, operation and maintenance of electrical equipment

- Existence of AC and DC voltage.
- Possible existence of toxic hazards associated with material usfid in the construction of electronic components, cleaning agent and solvents.
- Electric shock due to incorrect earthing, moisture on insulation, bad engineering or working practices.
- Fire or burn out due to incorrect setting or over load or protective devioes, incorrect cables or fuses, insufficient vantilation or incorrect operating voltage.
- Short circuit flash over due to dust or moisture on insulation :ir short circuit on live conductors.
- No work should be done to transformer or its associated eq-iipment unless it is disconnected from supply and all terminals have beer' solidly""earthed.
- If the secondary of a current transformer is disconnected, a dangerously high voltage can be induced in the circuit. If the secondary circuit of a current transformer is to be disconnected it must be shorted L'y a link capable of carrying the rated current.
- Do not apply any voltage or even high voltage megger whsn the equipment is under vacuum.

1.1.2 HAZARDOUS SUBSTANCES

1.1.2.1 TRANSFORMER OIL

- Normally, transformer oil presents no hazard to health. However, serious neglect may affect the skin and cause irritation.
- Oil is a hydrocarbon and will burn. Carbon dioxide, dry chemical, foam or water fog is the extinguishants.

1.1.2.2 MERCURY

- Mercury switches or thermometers containing mercury should be handled carefully. Mercury vapour can be hazardous over a period of time, especially in poorly ventilated room.

1.1.2.3 ENVIRONMENTAL HAZARDS DUE TO OIL SPILLAGE & FIRE CONSEQUENTLY TO FILURE OF TRANSFORMER AT SITE

Oil spillage from transformer tank, bushing, pipe joints etc may cause

the source of major fires. It is recommended that transformer shall be inspected dail' for the oil spillage.

The general CBIP reuornmefidations for the transformer instalation are

a. Soak pits

b. Drain pits

c. Barrier walls

d. Fire detection system

e. Fire hydrant system

f. Fire mufsifyre system

1.2.1 CONTROL OF OIL SPILLAGE

Responsibility Respective operator of sub station

- Keep a track of the maintenance schedule of transformer & ensure that the required routine & preventive maintenance are done as per the schedule.
- On noticing any leakage's from the transformer immediately place a tray/container to collect the spillage and inform the maintenance department for immediate corrective action (for example replacement of gasket etc). Oil shall not be allowed to fall on to ground.
- In case any leakage, to ground takes' piace, remove the same with cotton/cloth/saw dust.
- In case large scale spillage immediately inform the shjft in charge & start collecting the spilled oil to suitable container and assess the rsk of continuous operation of the transformer.

1.2.2 CONTROL OF FIRE

It is necessary to check the healthiness of the transformer fire protection svstem regularly so that the fire risk can be minimised.

- There shall not be any oil leakage.
- During hot oil circulation in the transformer keep fire extinguisher ready near the transformer, all the combustible materials shall be kept at a safe distance.
- Terminal connector, fuses shall be checked against spark,

- Condition of transformer oil shall be checked regularly.
- Proper Housekeeping near transformer may help to reduce the risk of fire.
- Proper fire fighting system as per CBIP recommendation shall be, installed near transformer. Regular inspection & maintenance to be done on the, fire fighting system.

1.2.3 PRECAUTIONS AGAINST FIRE

- Welding on oil filled transformer shall be carried out if unavoidable, as p t the instructions of the manufacturer.
- Hot oil circulation shall be carried out only under the round of the clock supervision to prevent chances of fire on lagging materials etc.

1.3 DO'S AND DON'TS

FOR SAFETY MEASURES / PRECAUTIONS

Safety measures / precautions should be given top most priority Caring inspection / erection / maintenance work. Any mishap during the process will result in delay in erection, endangering human life, endangering equipme; t life etc.

DO'S

- ☑ Insulating oil and insulation of windings and connections are inflammable. Watch for fire hazards.
- ☑ Before entering inside the Transformer, replace Nitrogen gas comp ately with air if it was transported with nitrogen gas inside.
- ☑ Make sure that nothing is kept inside the pockets before one e iters inside the main unit. Also take off the wristwatches and shoes.
- ☑ List up all the tools and materials to be taken inside and ch&ck it after coming out to make sure that no tools are left inside.
- ☑ There must be a protective guard for lamp to be taken inside.
- ☑ Keep inspection covers open for supply of fresh air when some one is working inside.
- ☑ When one person is working inside, second person must be available out side for emergency help.

- ☑ Use rings spanners and tie them to the wrist of the person or some where outside the tank.
- ☑ Be careful during connections where bolted joints are involved so that nut, washers etc. are not dropped inside the tank.
- ☑ If it is required to weld some lugs cr h.ackets etc., these s.-'ouid be welded to tank stiffeners taking all precautions to avoid fire hazards.
- ☑ De-energise the unit by circuit breakers and line switches while working on energised unit.
- ☑ Check the diaphragm of explosion vent and replace it if cracked. .
- ☑ Attach the caution tags "DO NOT OPERATE THE SWITCHES" while working on units, which are energised.
- ☑ Make sure that the fire fighting equipment are available at the oil treatment equipment as well as workplace and adjacent to the transformer,
- ☑ Fire fighting equipment should be checked regularly and shoui I have sufficient quantity of extinguishant.
- ☑ Transformer tank, control cabinets etc. as well as oil treatment equipment shall be connected with permanent earthing system of the station.
- ☑ Check and thoroughly investigate the transformer whenever any alarm or protective device is operated.
- ☑ Check air cell in conservator,
- ☑ Attend leakage on the bushings.
- ☑ Examine the bushings for dirt deposits and clean them periodicdiy.
- ☑ Check the oil in transformer and OLTC for dielectric strength and moisture content and take suitable action for restoring quality.
- ☑ Check the oil level in oil cup and ensure air passages are free in breather. If oil is less make up the oil.
- ☑ If inspection covers are removed or any gasket joint is to be tightened, then tighten the bolts evenly to avoid uneven pressure,

- ☑ Do not re-energise the transformer without conducting all pre-commissioning checks. The results must be compared with factory test results.
- ☑ Do not handle the off circuit tap switch when the transformer is energised.
- ☑ Do not energise the transformer unless the off circuit tap switch handle is in locked position.
- ☑ Do not leave off circuit tap switch handle unlocked.
- ☑ Do not use low capacity lifting Jacks / slings on transformer for jacking / slinging.
- ☑ Do not change the setting of WTI and OTI alarm and trip frequently. Setting should be done as per manufacturer's instructions.
- ☑ Do not leave any connection loose.
- ☑ Do not meddle with the protection circuits.
- ☑ Do not leave marshalling box doors open, they must be locked.
- ☑ Do not switch off the heater in marshalling box except to be periodcally cleaned.
- ☑ Do not allow unauthorised entry near the transformer.
- ☑ Do not close any valve in pump circuit for taking stand by pump and motor into circuit.
- ☑ Do not allow water pressure to exceed the oil pressure in oil to water heat exchangers.
- ☑ Do not mix transformer oils of different make/ base, unless oil is new and conforms fully to IS: 335.
- ☑ Do not continue with pink (wet) silicagel, this should immediately be changed or reactivated,
- ☑ Do not store transformer in gas filled condition for more than three months after reaching site. If storage is required for longer duration, the main body should be filled up with oil.
- ☑ Do not leave tertiary terminals unprotected outside the tank.
- ☑ Do not allow WTI / OT1 temperature to exceed 700C during dr; sut of transformer and filter machine temperature beyond 75^{0}C