POWER TRANSFORMER INSPECTION AND MAINTENANCE ESSENTIAL

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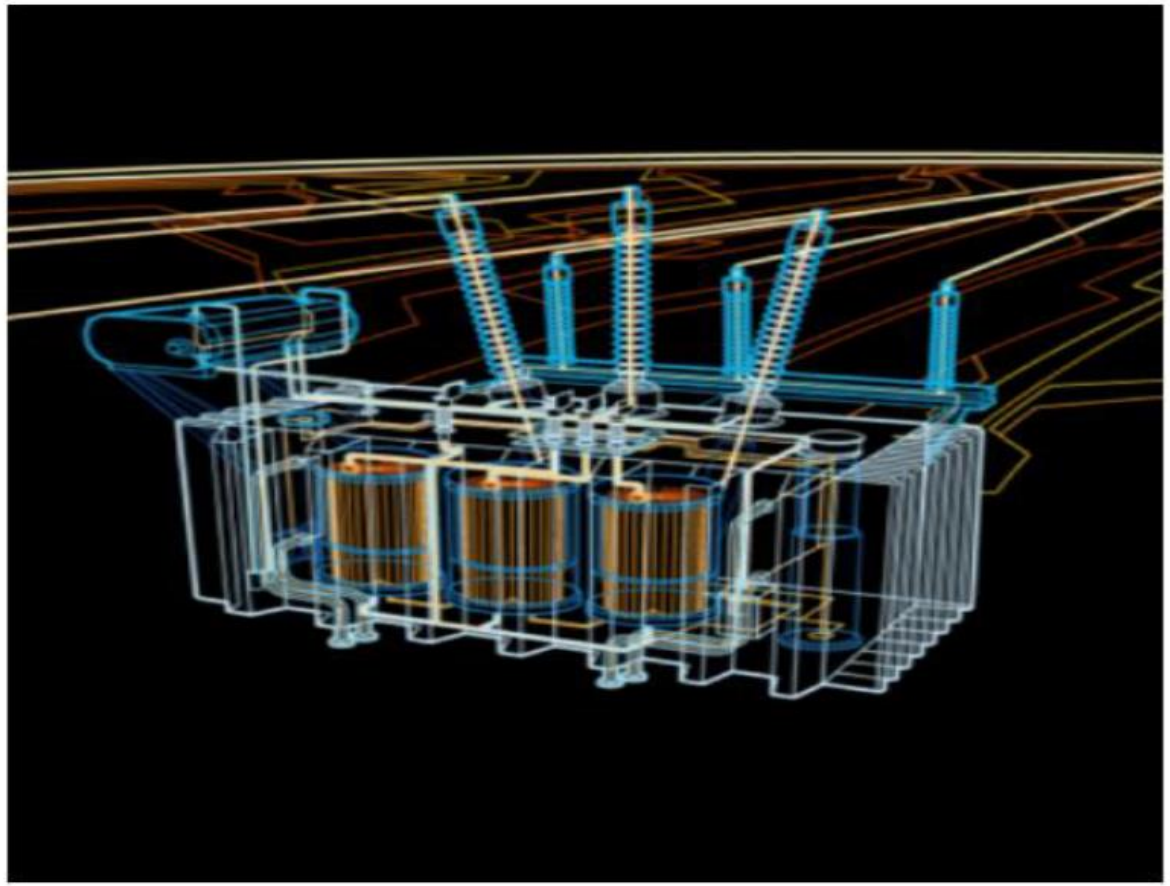
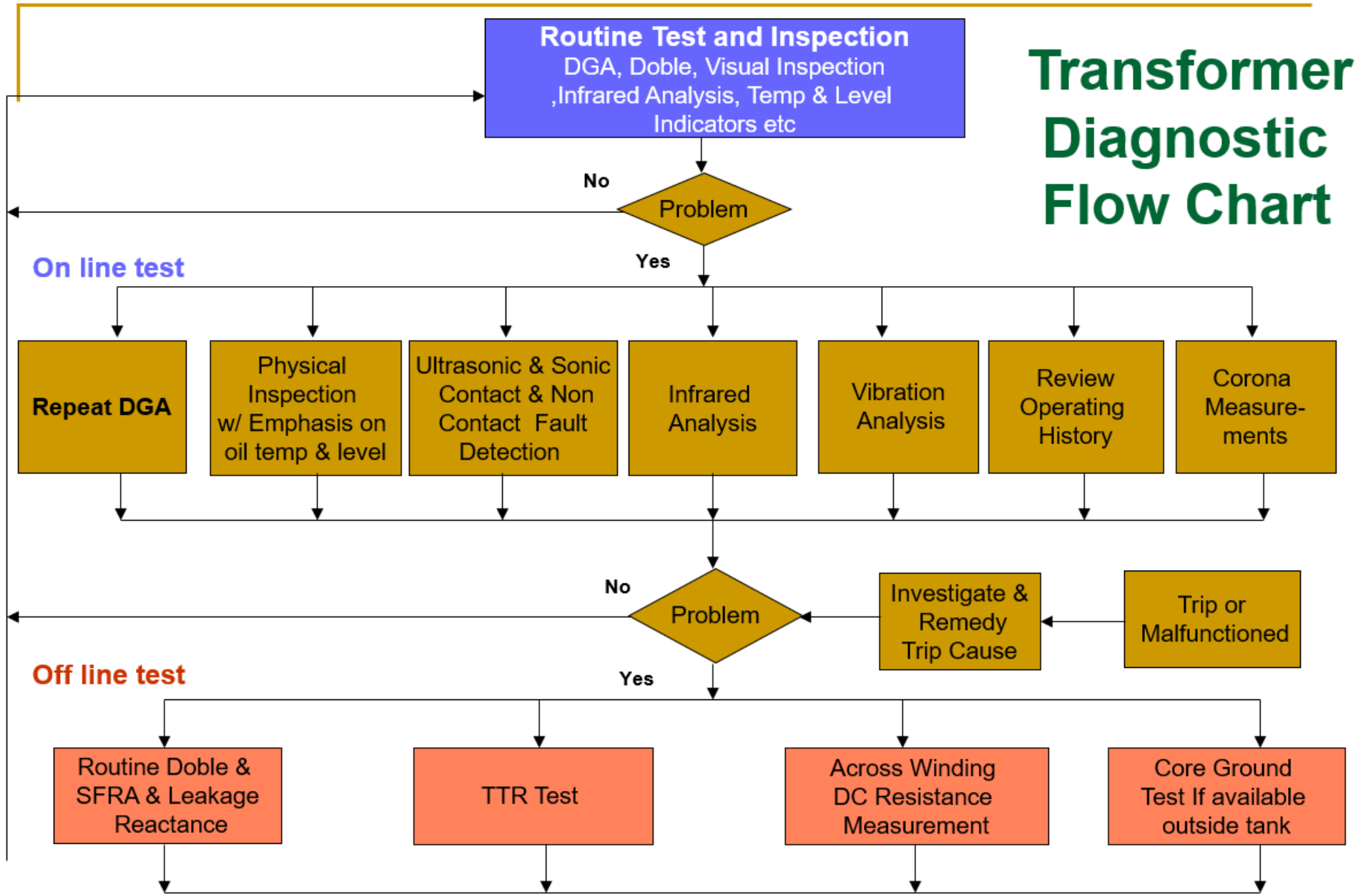
POWER TRANSFORMER



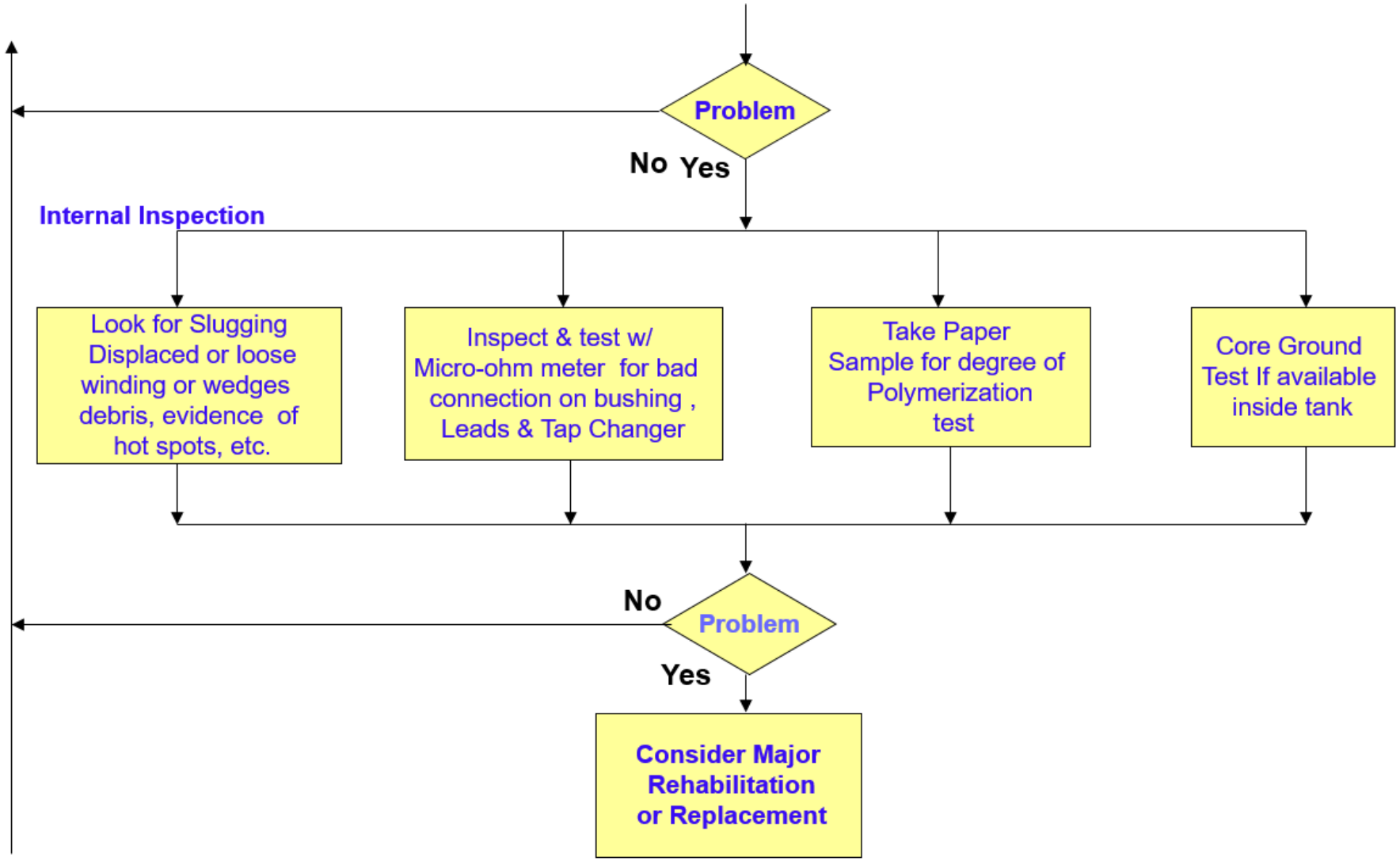
Failure: They Happen

As you know, transformer failures can results in catastrophic fires, creating Significant treats to **HEALTH, SAFETY And ENVIRONMENT** along the way – not To mention the **PUNISHING IMPACT on BUSINESS CONTINUITY.**

Transformer Diagnostic Flow Chart

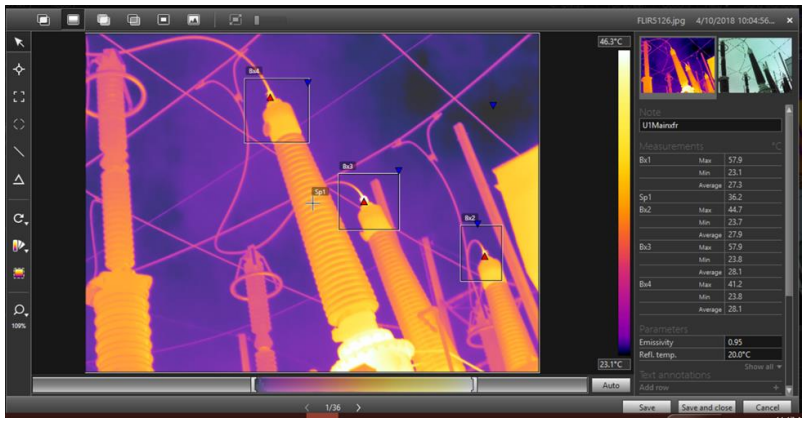


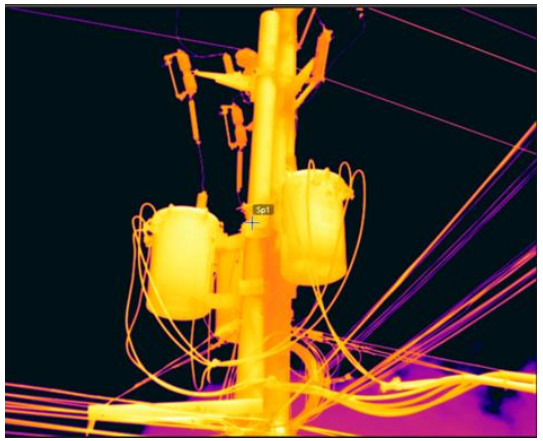
Transformer Diagnostic Flow Chart



ON-LINE MAINTENANCE INSPECTION

1. Thermographic Inspection





Thermography is a non-destructive test method that used to detect poor connections, unbalanced load, deteriorated insulation or other potential problems in energized electrical components including power transformer.

What to look?

In oil-filled power transformer, monitor the following External components.

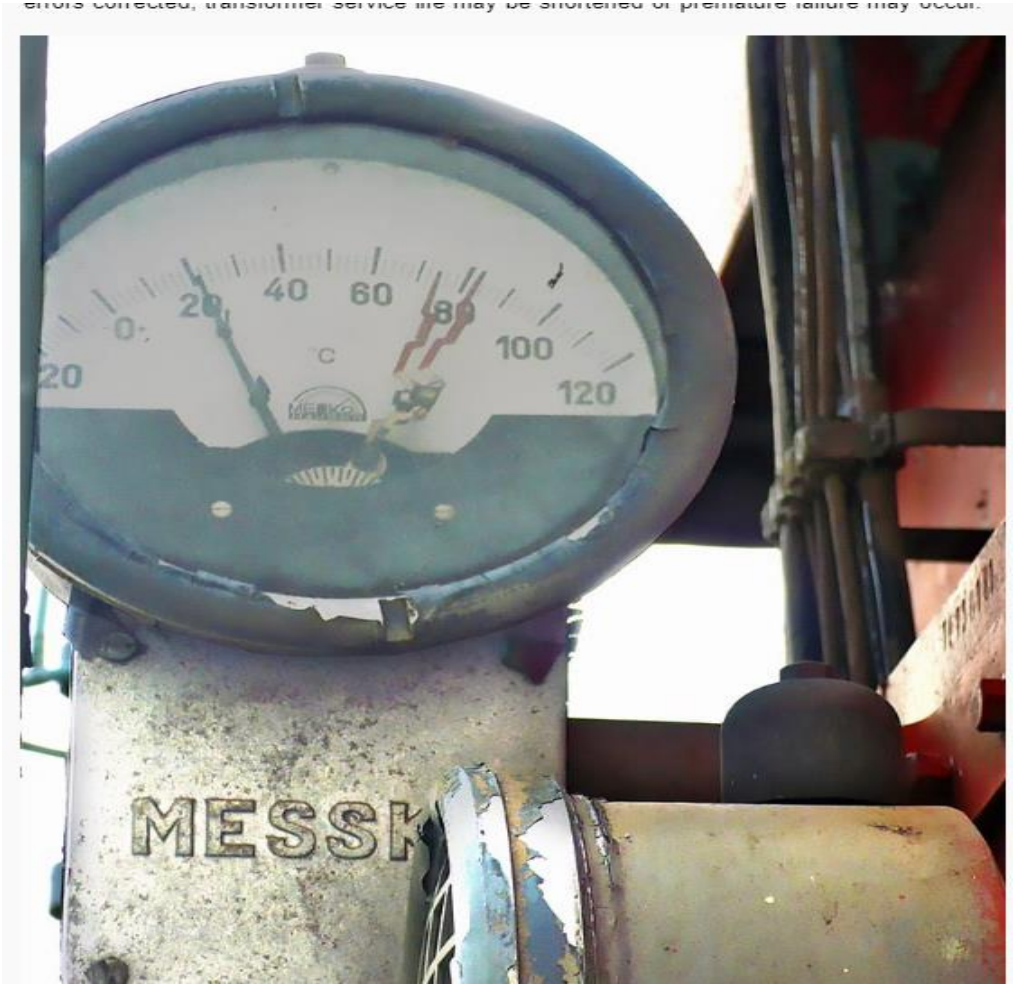
- High and Low-voltage bushing connections – **overheating in a connection indicates high resistance and that the connections s loose or dirty. Also compare phases, looking for unbalance and overloading**
- Radiators/Cooling tubes
- Cooling fans/pumps

Dissolved Gas Analysis - DGA

DGA is the single most comprehensive asset condition assessment and management tool for an oil-filled power transformers.

DGA offers advanced detection of incipient fault condition leading to almost all of the failure modes of transformer faults.

3. Check temperature Indicator



The winding temperature indicator should be reading approximately 15 degrees above the top oil temperature. If this is not the case, one or both temperature indicators are malfunctioning. High temperature may mean overloading, cooling problems, winding problems, core, or connection problems.

4. Check Oil Conservator

This gauge indicates oil level by displaying
A temperature. Compare the indicated tem-
perature on the conservator level gauge with
The top oil temperature indicator. They should be
Approximately the same.

Calibrate or replace the conservator oil level
If needed.

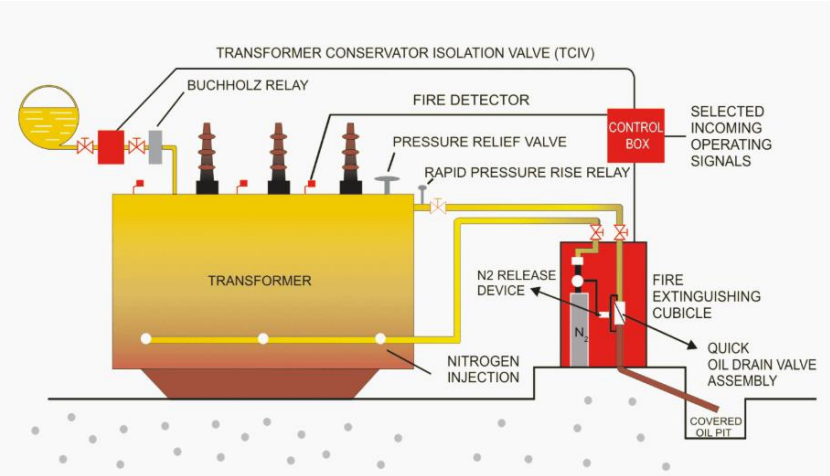
If atmospheric gases (nitrogen, oxygen, CO2) and
perhaps moisture increase suddenly in the DGA,
a leak may have developed in the conservator
diaphragm or bladder

5. Check Conservator Breather

Check the dehydrating (desiccant) breather for proper oil level if it is An oil type unit. **Check the color of the desiccant** and replace it when approximately one-third remains of the proper color.

Notice the **pink desiccant at the bottom of the blue indicating that this portion is water saturated.** Notice also that oil is visible in the very bottom 1-inch or so of the unit. Many times, the oil is Clear, and the oil level will not be readily apparent

6. Check Nitrogen system



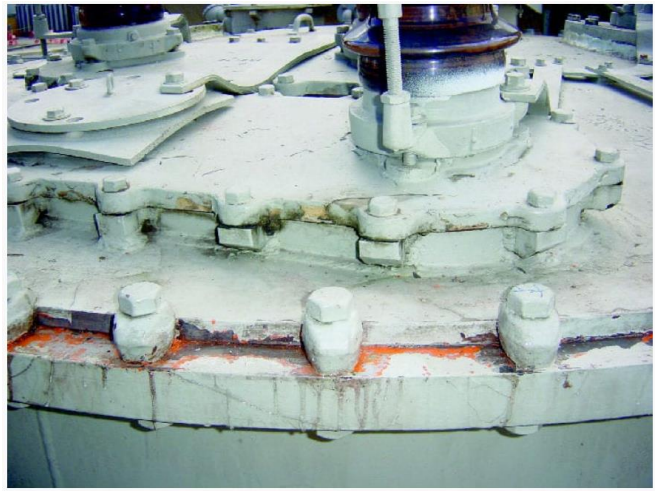
If the transformer has a nitrogen blanket, **check the pressure gauge for proper pressure**. Look for the operators recording of pressures from the Pressure gauge. If does not change, the gauge is probably defective.

Check for **any increased usage of nitroge**n which indicates a leak. Smaller transformers such as station service may not have nitrogen bottles attached to replace lost nitrogen

A nitrogen leak can develop and all the N2 will be lost. This allows air with oxygen and moisture to enter and deteriorate the oil and insulation. Watch for increased oxygen and moisture in DGA.

An ultrasonic and sonic leak detection instruments are usually used for locating N2 leaks.

7. Check for Oil Leaks



Oil leak is very dangerous, especially if not spotted on time. What should maintenance people would do? They should check the entire transformer for oil leaks. Leaks usually develop due to **gasket wearing out**. **Ultraviolet exposure**, or from **expansion or contraction**, especially after transformer have cooled, due to **thermal shrinkage of gaskets and flanges.**

Leaks can be repaired by applying an epoxy or other Patch. Flange leaks may be stopped with these methods Using rubberized epoxy forced into the flange under Pressure.

Small leaks in welds and tanks may be stopped by Peening with a ball-peen hammer, cleaning with the Proper solvent, and applying a “patch” of the correct epoxy

8. Check Pressure relief Device

Figure shows a pressure relief device With the yellow indicating arm. With the Transformer under clearance, check the Pressure relief device indicating arm on Top of the transformer to see if has operated.

If it has operated, the arm will be in the up (vertical) position, **and a trip alarm and shutdown relays should be activated.**

Caution: *Do not re-energize a transformer after this Device has been operated and relays have de-energized the transformer, until extensive testing to determine and correct the cause has been carried out.*

Explosive, catastrophic failure could be the result of energization after this device has operated.

9. Check Oil Pumps

If the case of transformer that has Oil pump(s), maintenance staff must check **flow indicators and pump isolation valves** to ensure oil is circulating properly.

It might even happen that the pump motor have reversed rotation and flow indicators may still show that oil is flowing. To prevent this dangerous situation and ensure that motors are turning in the proper direction, **use an ammeter To check the motor current.**

Compare results with the full-load current indicated on the motor nameplate. If the motor is reversed the current will be less than the nameplate full load current.

10. Check Fans and Radiators

Maintenance staff must check and test all isolation valves at the top and bottoms of radiators to ensure they are open. Inspect cooling fans and radiators for cleaning and fans for proper rotation. Checking for dirty or damaged fan blades or partially blocked radiator is obligatory.

You should know that fans are much, much more efficient if the blades are clean and rotating in cool air. It’s worth mention that fans should blow cool air through the radiators and they not be pulling air through.

Air should be coming out of the radiator against your hand.

11. Check Buchholz Relay

Inspect the isolation valve on the Buchholz relay to ensure it is open. When the transformer is offline and under clearance examine the Buchholz relay by lifting the window cover.

How it works? If there is gas inside, the oil will be displaced, and the gas will be evident as a space on top the oil. If sufficient gas is found to displace the upper float, the alarm should be activated. the small valve at the top left is to bleed the gas off and reset the relay.

If the transformer has been online some time (service aged), and gas is found in the Buchholz, oil samples must be sent to the lab for DGA for extensive testing. Consult with the manufacturer or other transformer experts.

A definite cause of the gas bubbles must be determined and corrected before re-energization of the transformer.

12. Check Sudden Pressure Relay

https://youtu.be/wZby17mlQmw

The purpose of this relay is to alarm if there is a sudden pressure rise inside the tank. This relay is very sensitive and will operate if the pressure rises only a little.

If a very small pressure change occurs caused by a small electrical fault inside the tank, ,this relay will alarm. In contrast, the pressure relief device (Buchholz Relay) operates if a large pressure builds inside the tank caused by heavy arcing and heating causing the oil to boil and bubble.

Inspect the isolation valve to ensure it is open. With the transformer offline and under clearance, functionally test the sudden pressure relay by slowly closing the isolating valve. Leave it closed for a few seconds and reopen the valve suddenly.

This should activate the alarm. If the alarm does not activate, test the relay and replace it with new one if it fails to function.

OFF-LINE (DE-ENERGIZED) MAINTENANCE INSPECTION

1. **Insulation Resistance Test** – IEEE Standard no.43

R – Vt + 1, R = kV + 1

R= Recommended minimum resistance at 40^{o}C

Vt = rated machine terminal to terminal potential, in rms kilovolts

2. **Polarization Index** – The steepness of the dielectric absorption curve taken

At a given temperature indicates the relative dryness of the insulation at a constant voltage

Polarization Index = R_{10}/R_1

Values should be 1.3 -1.6 for 60/30 second ratio and 2-4 for 10/1 minute ratio

3.Insulation Power Factor Test – The purpose of this test is to determine the state of dryness of the winding and insulation system and to determine a power factor for the overall insulation, including bushing, oil and winding.

The power Factor should not exceed 0.5% at 20^{o}C.

4. **Winding resistance test** – To check for the loose connection, broken strands, and high contact resistance in the winding and in the tap changer.

Result are compared to other phases in wye connection or between pairs of terminal on delta connected winding to determine if a resistance is to high.

Value of 5% of any of the above comparison is consider satisfactory.

5. **Transformer Turn Ratio (TTR)** – TTR detects shorted turns which indicates insulation failures by determining if the correct turns ratio exist. Shorted turns may result from short circuit or dielectric (insulation) failure.

The ratio obtained from the field test should conform with the factory data, within 0.5%'

New transformer of good quality normally within 0.1%


QUESTIONS