



... for a brighter future

The Inside Story of the UVC TR Set



UChicago ►
Argonne_{LLC}



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Purpose – Convert 3Ø AC to DC

- INPUT:
 1. 3 Ø, 1400Vac
 2. 970 Amperes

- OUTPUT:
 1. -95kVdc
 2. 20 Amperes

Internal Components – 2000 Gallons of Shell DIALA AX



SHELL DIALA[®] OIL AX

Electrical insulating oil

Product Description

Shell DIALA[®] Oil AX meets standard specifications required by both ANSI/ASTM D 3487 and NEMA TR-P8-1975 for domestic electrical oil applications. These two specifications of electrical oils, Type I and Type II, are covered in these specifications. Type I oil is intended for use where normal oxidation resistance is required. Shell DIALA[®] Oil AX is a Type II oil and is for more severe service applications requiring greater oxidation resistance. Shell DIALA[®] Oil AX has high electrical resistance and is thermally and oxidatively stable.

Applications

- intended for use in transformers, circuit breakers, oil-filled switches and in X-ray equipment

Features and Benefits

- proven product reliability
- excellent physical, chemical, and electrical properties

Approvals and Recommendations

- ANSI/ASTM D 3487
- NEMA TR-P8-1975
- U.S. Government Military Specification VV-I-530A and Amendment 2 for Class I and Class II fluids (Type I and Type II, respectively); supersedes the Department of the Navy specification OS-1023
- NATO symbol S-756, British Standard BS 148:1972

Table 1/ Physical Properties of Shell DIALA[®] Oil AX

	Test Method	ANSI/ASTM/NEMA Limits - Type I and II	DIALA AX Oil Typical Values
Code Number			68690
Aniline Point, °C	D 611	63-84	74
Color	D 1500	0.5 max	<0.5
Flash Point, °C	D 92	145 min	156
Interfacial Tension, dynes/cm @ 25°C	D 971	40 min	47
Pour Point, °C	D 97	-40 min	-47
Specific Gravity, 15/15°C	D 1298	0.91 max	0.885
Viscosity:	D 445/ D 88		
@ 0°C, cSt/SUS		76.0/350 max	62.3/288
@ 40°C, cSt/SUS		12.0/66 max	9.1/55.8
@ 100°C, cSt/SUS		3.0/36 max	2.31/33.9
Visual Examination	D 1524	Clear & Bright	Clear & Bright

Table 2/ Electrical Properties of Shell DIALA[®] Oil AX

	Test Method	ANSI/ASTM/NEMA Limits - Type I and II	DIALA AX Oil Typical Values
Dielectrical Breakdown Voltage @ 60 Hz, Disc electrodes, kV	D 877	30 min	> 35
@ 60 Hz, VDE electrodes, kV	D 1816 (1)	28 min	> 28
0.040 - inch (1.02 mm) gap		56 min	> 56
0.080 - inch (2.03 mm) gap			
Dielectric Breakdown Voltage Impulse @ 25°C, needle-to-sphere grounded 1-inch (25.4 mm) gap, kV	D 3300	145 min	> 180
Power Factor, 60 Hz:	D 924		
@ 25°C, %		0.05 max	0.003
@ 100°C, %		0.30 max	0.06
Gassing Tendency, µL/min	D 2300	+30 max	+12

(1). New, filtered, dehydrated and degassed oil.

Table 3/ Chemical Properties of Shell DIALA[®] Oil AX

	Test Method	Requirement Type II	Typical Values DIALA AX
Oxidation Inhibitor Content, %sw	D 2668 or D 1473	0.3 max	0.23
2,6-ditertiary butyl pacesol			
Corrosive Sulfur	D 1275	Non-corrosive	Non-corrosive
Water, ppm	D 1533	35 max	<30
Neutralization No. mg KOH/g	D 974	0.03 max	<0.01
Oxidation Stability @ 72 hrs. Sludge, %sw	D 2440		
TAN-C, mg KOH/g		0.1 max	0.01
		0.3 max	0.01
Oxidation Stability @ 164 hrs. Sludge, wt%	D 2440		
TAN-C, mg KOH/g		0.2	0.01
		0.4	0.03
Oxidation Stability Rotating Bomb, min.	D 2112	195 min	220
PCB Content, ppm	D 4059	ND	ND

N/A - Not Applicable

ND - Not Detectable, which is reported as <2 ppm.

Storage Precautions

The critical electrical properties of Shell DIALA[®] Oil AX are easily compromised by minute concentrations of contaminants. Typically encountered contaminants include moisture, particulates, fibers and surfactants. Therefore, it is imperative that electrical insulating oils be kept clean and dry. It is strongly recommended that storage containers be dedicated for electrical oil service and include air-tight seals. It is further recommended that electrical insulating oils be stored indoors in climate controlled environments.

Handling & Safety Information

For information on the safe handling and use of this product, refer to its Material Safety Data Sheet at <http://www.shell-lubricants.com/msds/>. If you are a Shell Distributor, please call 1+800-468-6457 for all of your service needs. All other customers, please call 1+800-840-5737 for all of your service needs. Information is also available on the World Wide Web: <http://www.shell-lubricants.com/>.

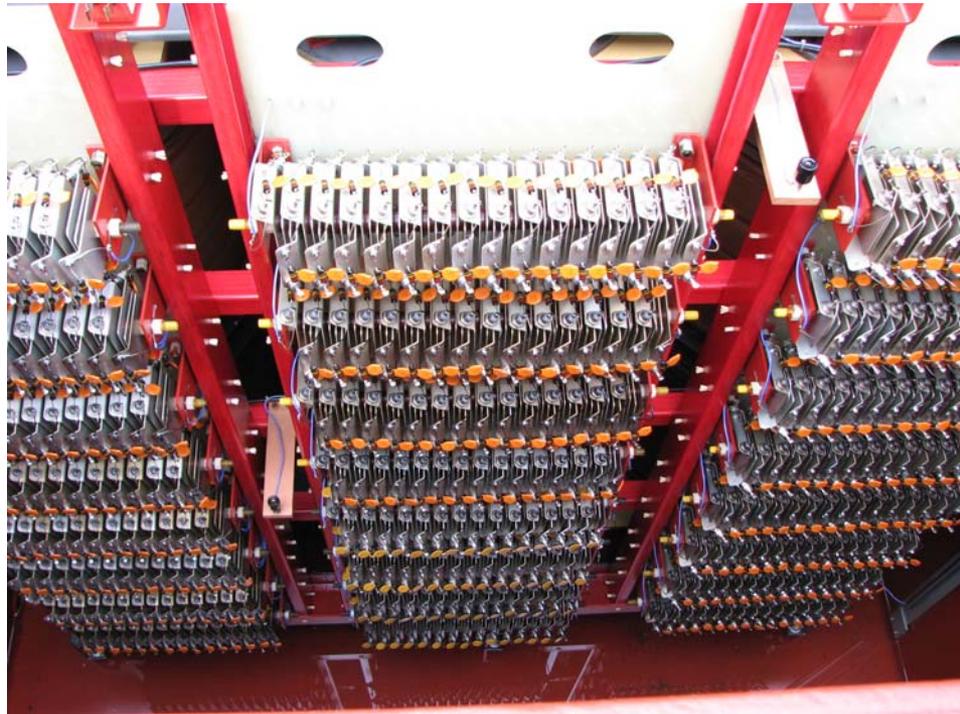
Internal Components - T501



Primary Voltage: 1400Vac
Primary Current: 960A
Primary Turns: 64

Secondary Voltage: 23,625V L-N
(2 Y's per Leg)
Secondary Current: 16.4A
Secondary Turns: 1080

Internal Components - CR501 thru CR512



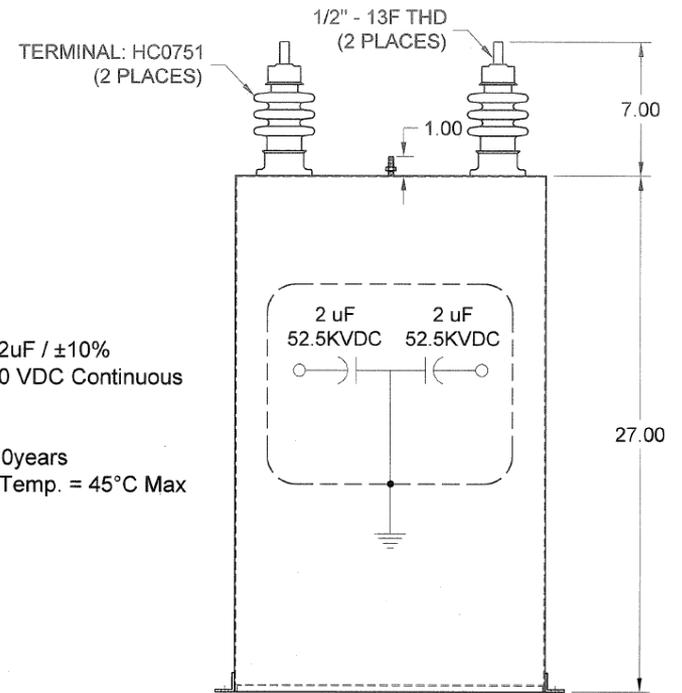
F4P9 diodes – 1440 total
0.05 μ F, 1kV capacitor – 1440 total
220 Ω , 2W resistor – 1440 total

Internal Components - C501



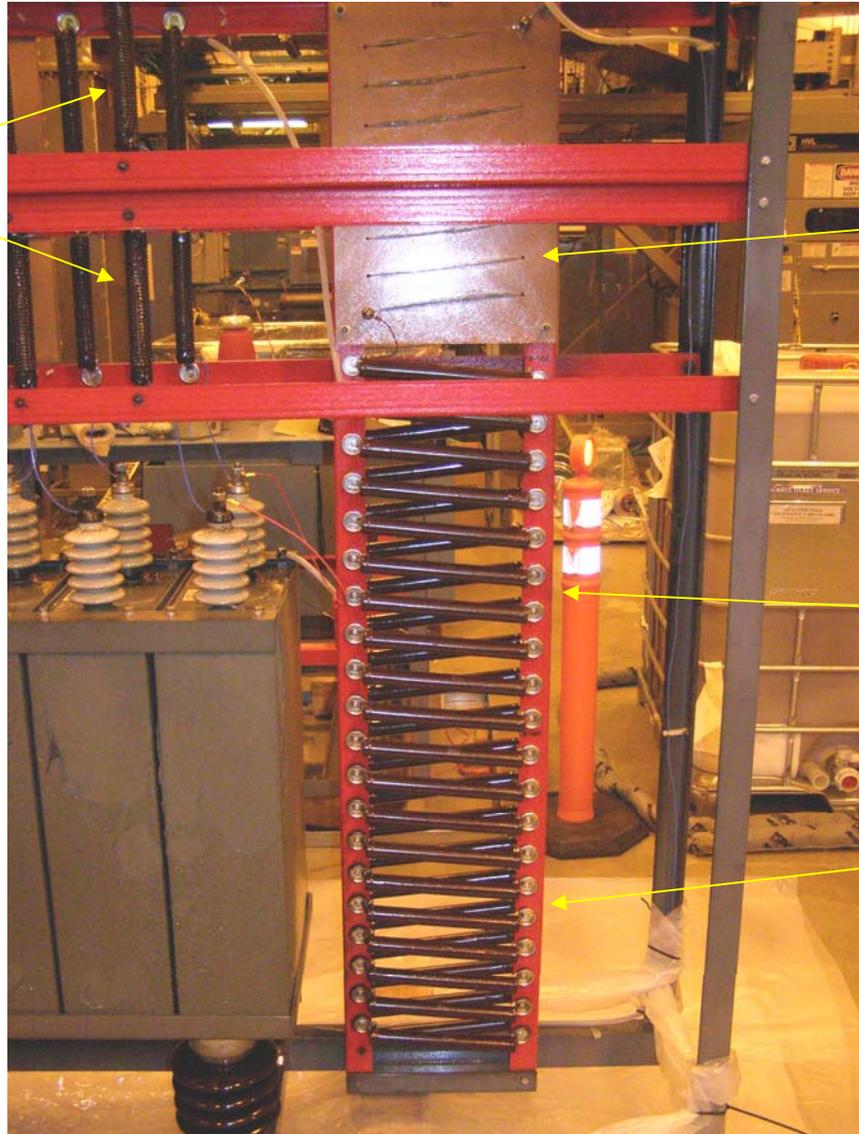
NOTE:
Capacitor: 2 x 2 μ F / \pm 10%
Voltage: 52,500 VDC Continuous
 I_{pk} = 3000Amp
 I_{Rms} = 12Amp
Design Life = 10years
Amb. Operate Temp. = 45°C Max

1 μ F post-to-post, (2) 2 μ F post-to-case



Internal Components - R501, R502, R503 & R504

R504: (2) 16Ω,
300W resistor series
at each capacitor post



R501: 13' of #16AWG
Nichrome wire

R502: (20) 50kΩ
200W

R503: (20) 50kΩ
200W

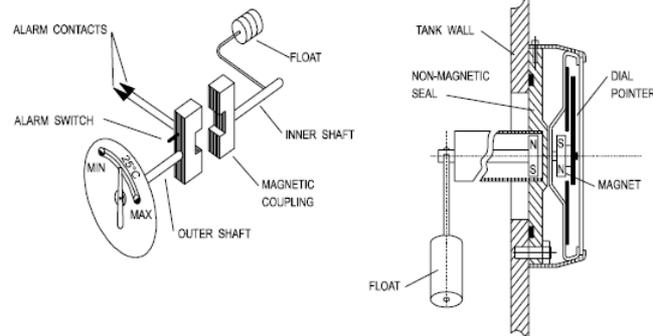
Interlocks - S501 & S502



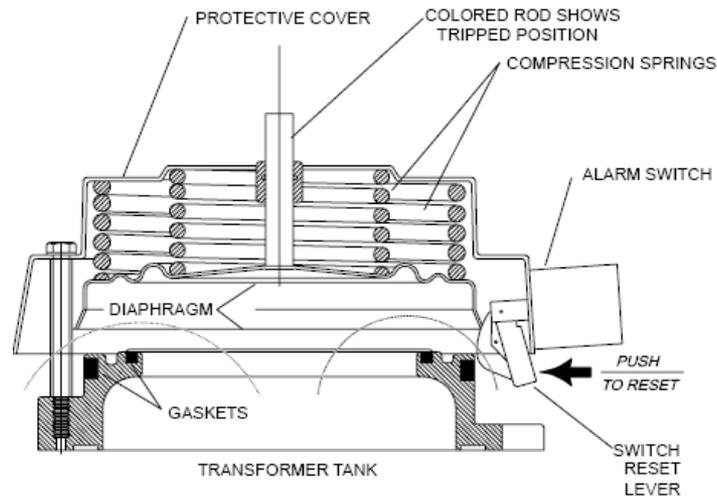
N2 Pressure

S502: Oil Level
Faults at LOW

S501: Over
Temperature
Fans on at 60°C
Faults at 80°C



Interlock - S503



Interlocks - S504 & S505



1400V 3Ø input

S504:
Faults at 1psi

S505:
Faults at 8psi

TR Set Output and Current Sense

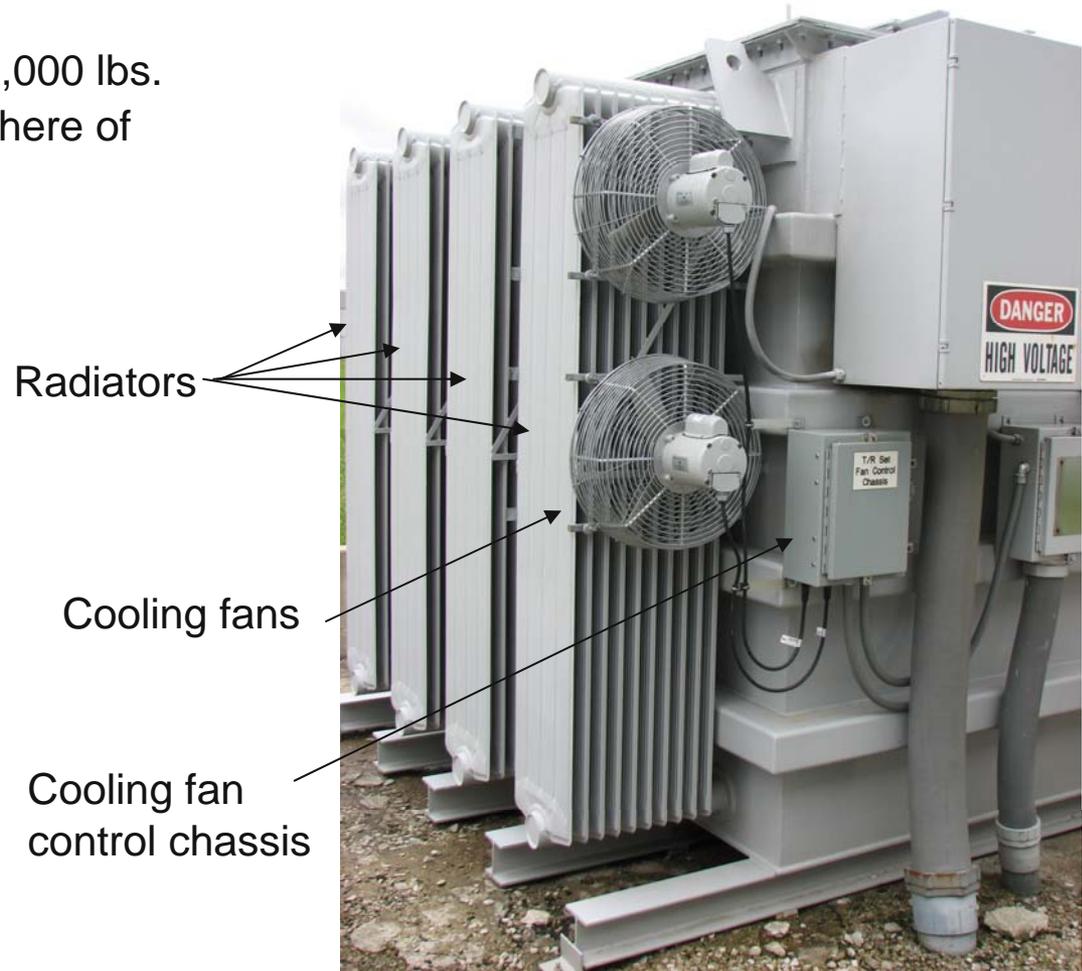


E204: Isolation Products
I-117 termination

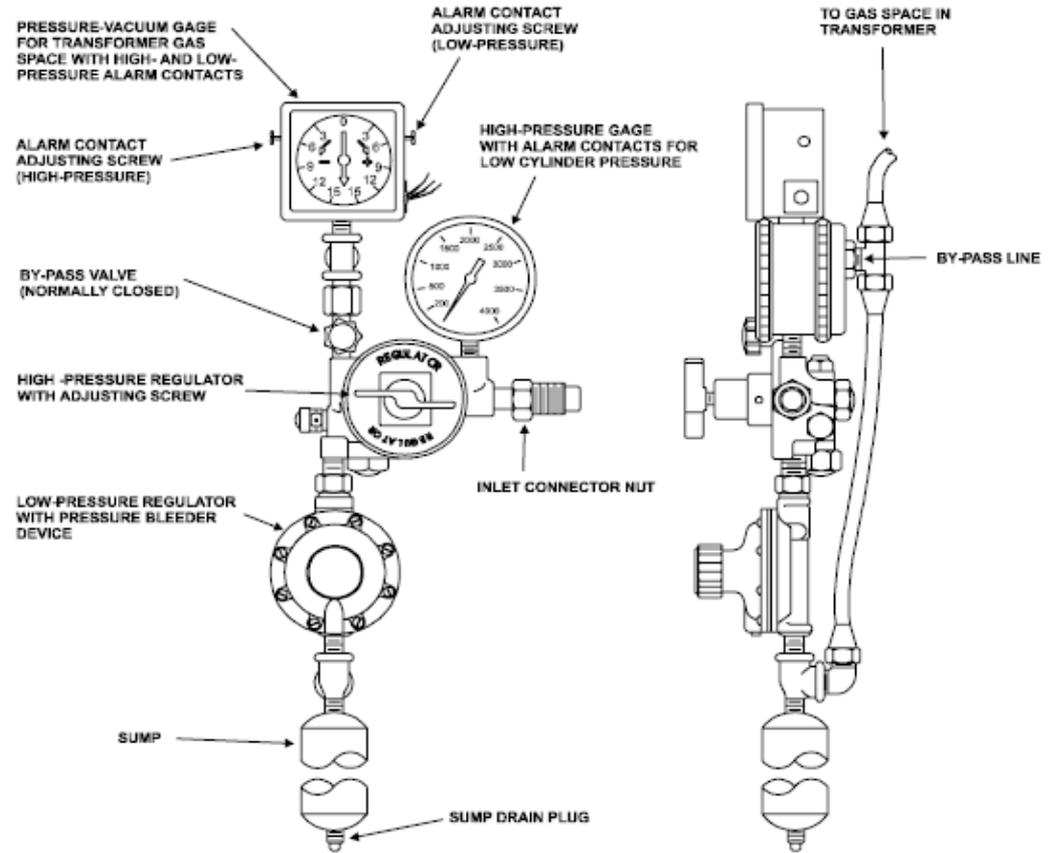
R508: 0.4Ω shunt

Ancillary

Tank Assembly weighs 39,000 lbs.
and withstand one atmosphere of
pressure and vacuum



Ancillary cont.



Maintenance

- Inspect for N2 and Diala leaks
- Test interlocks
- Process mineral oil every 5 years to remove moisture
- Change N2 bottles
- Functionally test fans and controls for proper operation
- Remove water from catch basin
- Clean debris from radiators
- Check for discolored or cracked insulators
- Inspect Dow 200 oil reservoir
- Check external connections
- etc.

What is the status of the internal components?

Insulating Fluid

■ Function

- Electrical insulator
- Heat transfer medium

■ Testing

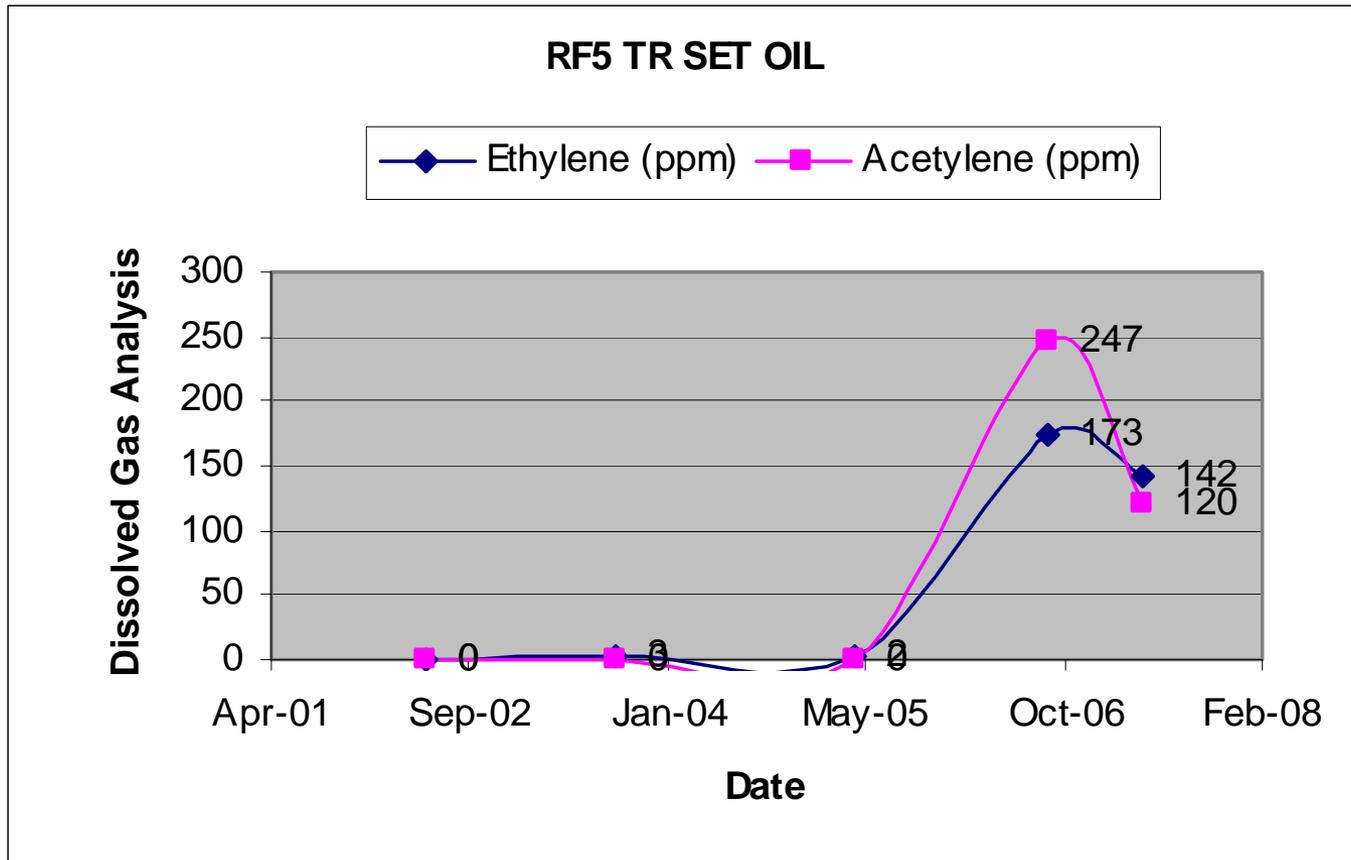
- Color
- Dielectric strength
- Interfacial Tension
- Moisture
- Acidity
- Specific gravity
- Visual
- Power factor
- Dissolved gas

Dissolved Gas Analysis

– a measured volume of fluid is placed in a vacuum chamber where the gas emerges from the fluid. The extracted gas is then placed in a gas chromatograph where it is separated into component gases and the amount of each measured. This test provides detailed information about transformer faults .

- Hydrogen
- Methane
- Ethane
- Ethylene
- Acetylene
- Carbon monoxide
- Carbon dioxide
- Oxygen

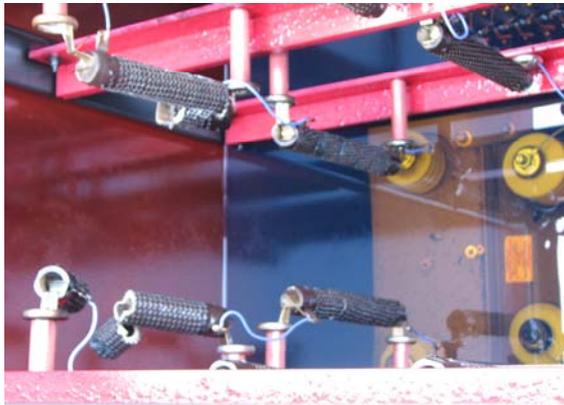
Why RF5 TR Set was Inspected



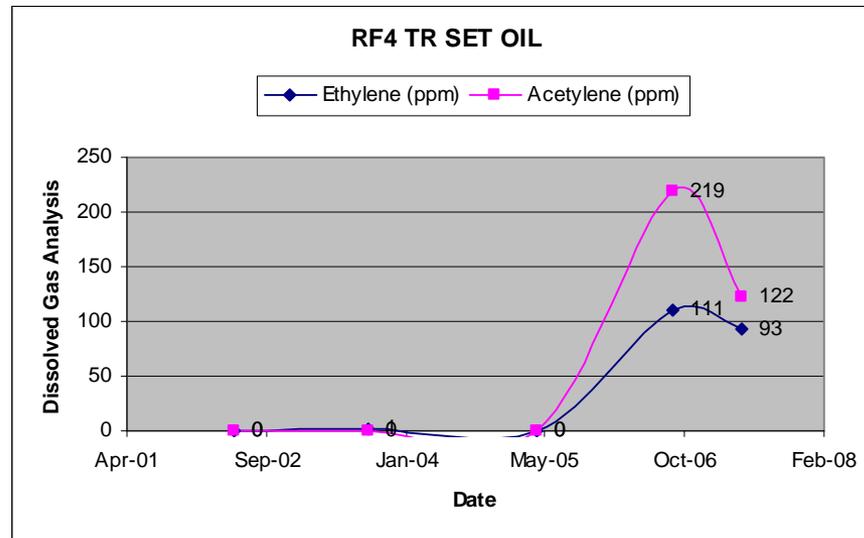
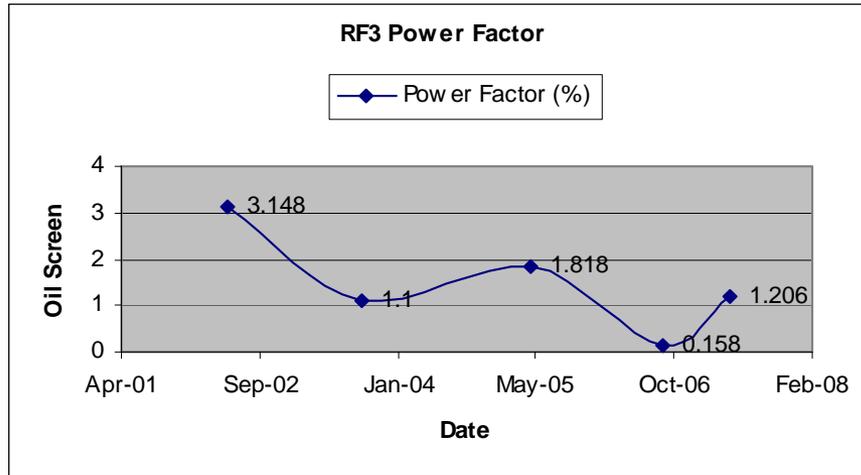
Discovered



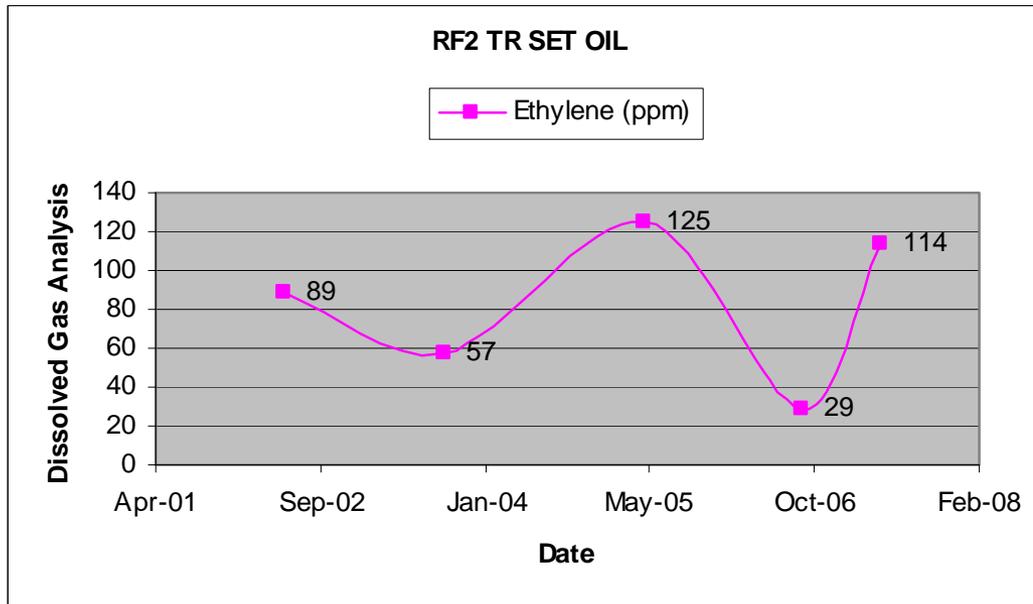
- 1 Failed capacitor
- 4 Damaged 16Ω , 300W resistors
- Loose transformer ground connection
- Carbon deposits on components and walls
- Loose and missing core blocking hardware
- Mechanical hardware, resistor pieces and transformer core hardware on tank floor.



RF3 and RF4 TR Set Inspections Required



Inspection Required cont.



Questions, Comments or Rebuttals?

