Reinhold Environmental Ltd.

2007 APC Round Table & Expo Presentation

July 8-10, 2007
Chattanooga, TN
Hosted by TVA


CUSTOM ENGINEERED
POWER
SOLUTIONS

What we'll cover…

- Precipitator summary
- TR Configurations
- Components
- Testing & Maintenance
- Inspection
- Oil sampling
- Closing statements

TR SET LIFE EXTENSION

By: Marty Watson

The electric power supply to the ESP is an integral part of providing the environmental performance required in our power plants. The TR and the power modules which feed them are at the heart of the generating system.

Most Utility Engineers have not been concerned with TR integrity up to this point.

“THEY NEVER FAIL, WHY SHOULD I DO DIFFERANT”

“EVERYTHING FAILS SOONER OR LATER”

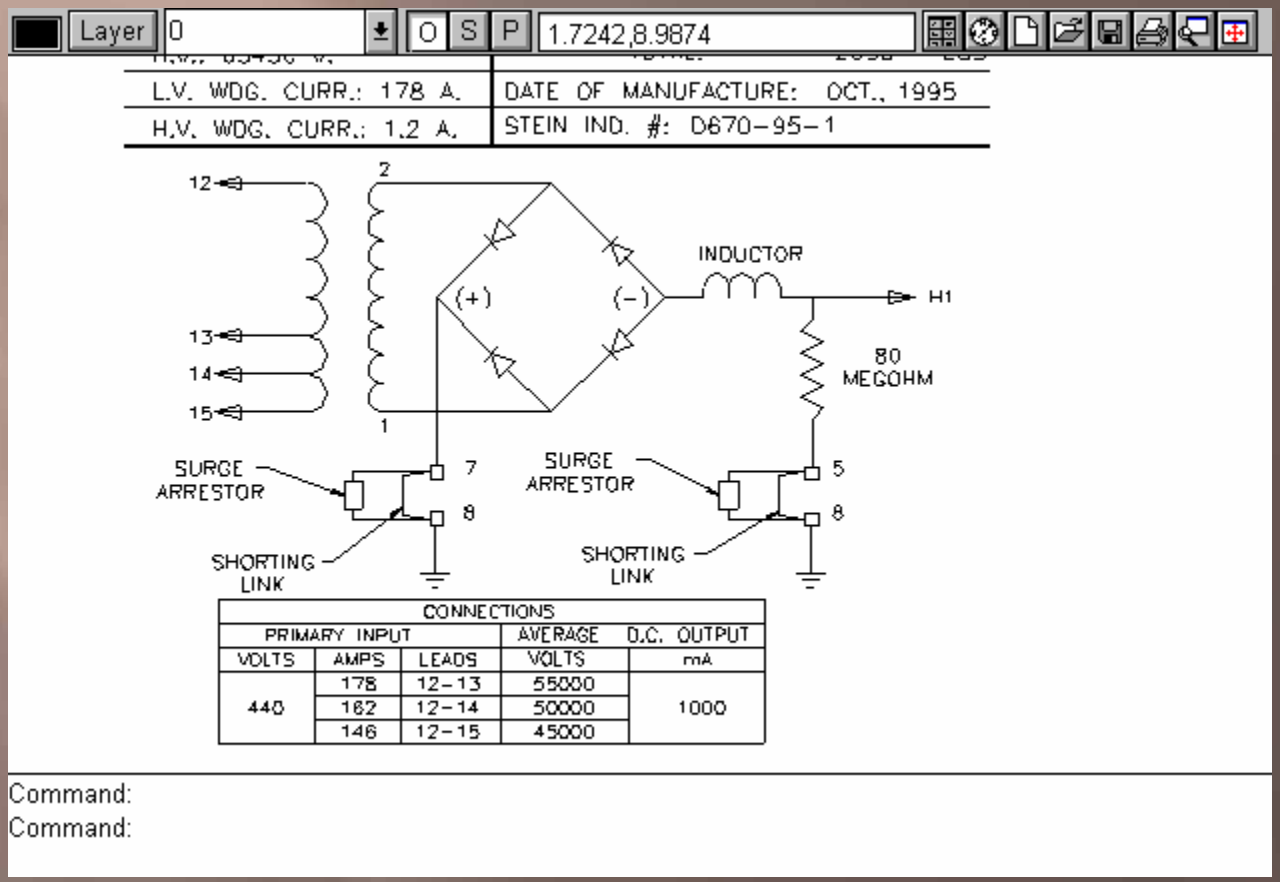
It could become a serious problem soon! 80 to 90% of the installed base has reached the end of the design life.

Implementing specific inspections, maintenance and diagnostics into an overall maintenance program will allow the following:

1. Gauge current condition
2. Guide scope and schedules of future maintenance practices
3. Determine the plan for the capitalization: upgrade / remanufacture - life extension

MM / MW

Research Cottrell



TR set components

- Transformer core / coil assembly
- Rectifier
- Choke Coil
- Gauges
- Arrestors
- Fluids
- Bushings LV / HV
- Grounding switch assemblies

Transformer Windings

Rectifier & Reactor Choke Coils

Bushings

- Primary Voltage
- Secondary Voltage
- Ground Connections
- Current Feedback
- Voltage Feedback

Types of Tests

- Megger
- TTR
- Winding Resistance
- Power Factor
- Oil tests

Winding Resistance & TTR

- Transformer Ohm meter measures winding resistance
- TTR measures turns ratio

Power Factor/Megger

- Meggar, 1000 VDC analog to check diode, feedback resistors, and winding insulation integrity
- Power Factor "Doble M-4000" measures integrity and moisture within the paper of the winding or any type of insulator

LOW VOLTAGE CIRCUIT BREAKER
INSPECTION AND TEST REPORT

Customer: U.S. AgriChem
Owner/Use: FT MEADE PLANT
Address:

Client Id: 62
Job No: 58113
Date: 4/14/04

BREAKER IDENTIFICATION

NAMEPLATE INFORMATION: Mfg: CE POWER; Type: LAF conversion; Pump Saver; Frame Size: 800; Unit Rating: 200

SETTINGS AS TESTED

	As Found	As Left	As Tested
Long Time Element Pickup	NA	200	200
Long Time Element Time Band	NA	CLASS 10	CLASS 10
Short Time Element	NA	NA	NA
Short Time Element Time Band	NA	NA	NA
Ground Fault Element Pickup	NA	100	100
Ground Fault Element Time Band	NA	NA	NA
Instantaneous Element Pickup	NA	NA	NA

PROM IDENTIFICATION - FROM LEFT TO RIGHT

Long Time Element	Pole 1		Pole 2		Pole 3	
Trip Amps	% of Setting	Minimum Trip Time	Maximum Trip Time	As Found	As Left	As Found	As Left	As Found	As Left
800	300	27	30	NA	25.0	NA	25.7	NA	25.0
Short Time Element									
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ground Fault Element									
150	150	0	0.3	NA	5.3	NA	5.4	NA	5.3
Instantaneous Element Tests									
Trip Amps	% of Setting	Trip		As Found	As Left	As Found	As Left	As Found	As Left
NA	NA			NA	NA	NA	NA	NA	NA
NA	NA			NA	NA	NA	NA	NA	NA

INSULATION RESISTANCE TESTS: 1 KV (In Megohms or "G"=1000 Megohms)

As Found	As Left	As Found	As Left	As Found	As Left
A-G NA	20000+	B-G NA	20000+	C-G NA	20000+
A-B NA	20000+	B-C NA	20000+	C-A NA	20000+
A-C NA	20000+	A-C NA	20000+	A-C NA	20000+

CONTACT RESISTANCE TESTS: (In Microhms)

As Found	As Left	As Found	As Left	As Found	As Left
NA	172	NA	177	NA	169

VISUAL INSPECTION / MECHANICAL / FUNCTIONAL OPERATIONS: Acceptable [X] Not Acceptable (See Comments) [ ]

COMMENTS: STARTER WAS OPERATED 20 TIMES IN TEST CELL WITH 480VAC APPLIED

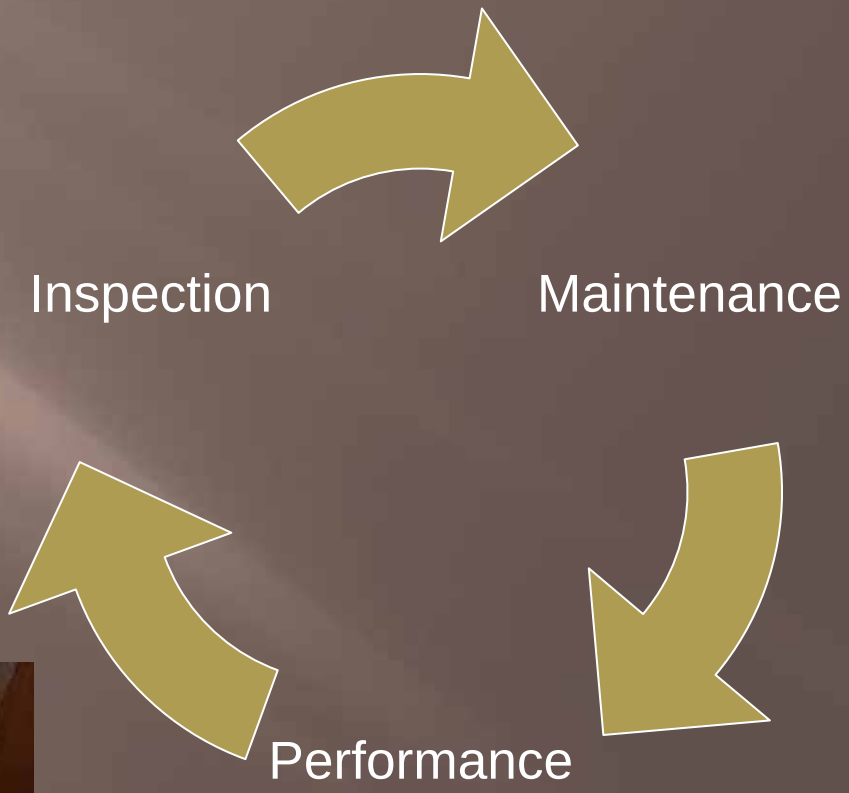
Technician: MB Test Set Nos: Sheet No:

Suggested maintenance

- Perform inspection & maintenance once per year as a minimum
- Monitor any trends, “gas analysis”
- Prevent future problems
- Reduce the probability of unplanned T/R outages and consequential non-compliances due to opacity excursions, generator capacity limits, lost revenue

Why do inspection & maintenance?

- Prevention of Failure
- Monitor Performance
- Ensure Opacity Compliance



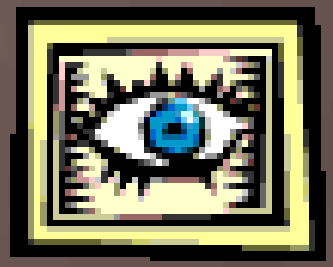
Inspection

- Inspection should be performed once per calendar year. Three easy things to look for!
  - Look
  - Listen
  - Smell

Inspection

Look

- Any signs of leaking from HV or LV bushing
- Fluid weeping from LV junction box
- Fluid coming from drain valve
- Fluid coming from the tank or radiator



Inspection

Listen

- Does it sound like the unit is arcing internally?
- If so, shut unit down, open and inspect

Inspection

Smell

- Internal inspection, does the oil smell burnt? Take the unit out of service as soon as possible. After repair is made, DE GAS IS A MUST!
- Send oil out for DGA test after repair and processing

Inspection

- How hot is the unit?
- Check the temperature gauge
- 90 to 95 C is ok, but if it is showing hotter, take it out of service, possibly a loose connection or the controller is not calibrated properly

Formal Inspection & Maintenance

" EXPERIENCED PERSONEL ONLY"

BEFORE REMOVING TR FROM SERVICE

- Check the insulating fluid
- Dielectric strength
- Water content
- Dissipation factor
- Dissolved gas analysis

OFF LINE

- The unit should be powered down, locked out, and disconnected from the LV and HV
- Torque all connections at the LV / HV termination points
- HV bushing should be cleaned to prevent future flashovers

Drawing a fluid sample

- Glass syringe method is preferred to avoid false readings
- Clean the sample valve thoroughly before
- Draw off 1 pint prior to sampling to avoid any sludge that might be trapped in the valve
- Pay close attention to the level gauge
- Draw a sample and seal it
- Send it to the lab

Oil Analysis

DGA (Dissolved Gas Analysis)

- Most sensitive indicator
- Easily obtained

Measured gasses for sample diagnosis:

- Hydrogen (H_2)
- Methane (CH_4)
- Ethane (C_2H_6)
- Ethylene (C_2H_4)
- Acetylene (C_2H_2)
- Carbon Monoxide (CO)
- Carbon Dioxide (CO_2)

DGA Interpretation

- Will determine if anything is going wrong very early in the failure mode
- High hydrogen and acetylene can indicate arcing and insulation break down
- High methane and ethane can indicate arcing in a confined space
- All very valuable, and inexpensive tests

DGA standards

IEEE Std C57.104 Table 1
Dissolved Key Gas Concentration Limits (ppm*)

C2H2 limits modified to be 0.2 times limit for C2H4

Status		hyd	methane	acetylene	ethylene	ethane	car monox	car diox	total dis comb gas
Condition 1	<=	100	120	35	50	65	350	2500	720
Condition 2	>=	101	121	36	51	66	351	2500	721
	<=	700	400	50	100	100	570	4000	1920
Condition 3	>=	701	401	51	101	101	571	4001	1921
	<=	1800	1000	80	200	150	1400	10000	4630
Condition 4	>	1800	1000	80	200	150	1400	10000	4630

Condition 1 Normal Operation
Condition 2 Caution. Monitor periodically and observe trends.
Condition 3 Extreme caution. Monitor often. Observe trends. Investigate cause.
Condition 4 Increasing probability of failure.

Oil quality interpretation

- Dielectric breakdown – when insulating fluid begins to conduct
- Acid number – oxidation of insulating fluids will result in the production of acidic compounds. The build up of acidic compounds will increase the formation of sludge.
- Interfacial Tension – the IFT of insulating oil is sensitive to the presence of oxidation byproducts and can be used together with acidity measurements as an indicator to monitor sludge development

- Color number and visual – The color number will increase as oil darkens due to oxidation or the presence of contamination.
- Power Factor – Measure of dielectric losses in an insulating fluid due to heat dissipation when the fluid is placed in an AC electrical field.

Oil quality standards

- Mineral fluid moisture levels up to 35 ppm does not require action
- Mineral fluid dielectric integrity should be greater than 28kv
- Silicone fluid moisture levels up to 50 ppm does not require action
- Silicone fluid dielectric integrity should be greater than 35kv

Remanufacture / Repair ?

- Remanufacturing / Repair options for all OEM types of equipment
- Individual components are now available in the after market
- Fast turn around times are available
- Warranties still apply