

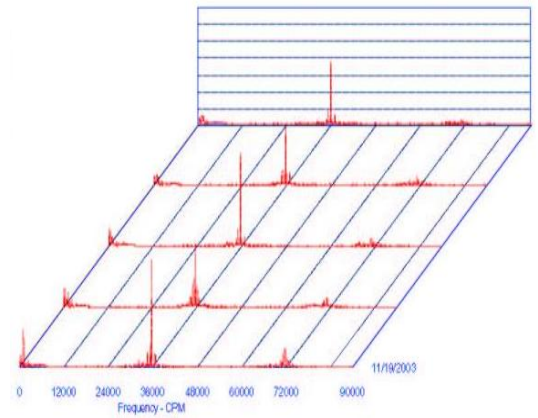
**Plant Services Division**

**Our Purpose:** To increase our customer's profitability by ensuring the highest level of asset availability in order to decrease downtime and maintenance costs.

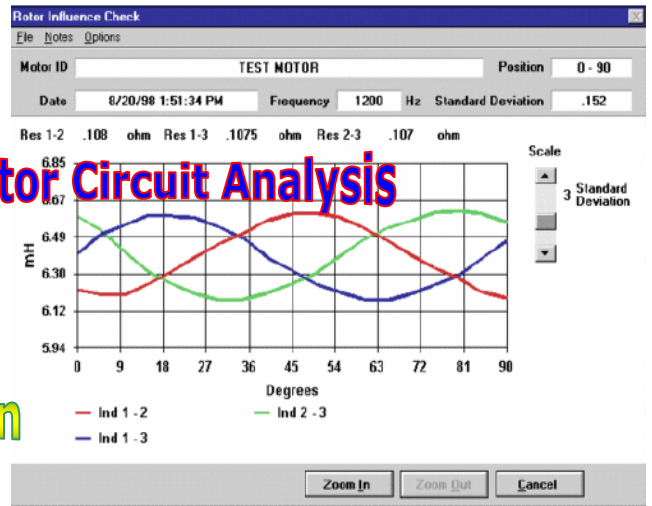
**Our Mission:** To support our customer's maintenance process:

- By providing accurate and timely asset health information.
- By assisting in the development of appropriate maintenance strategies to utilize that information.
- By providing the necessary mechanical support to implement those strategies.
- By providing training in precision maintenance practices.

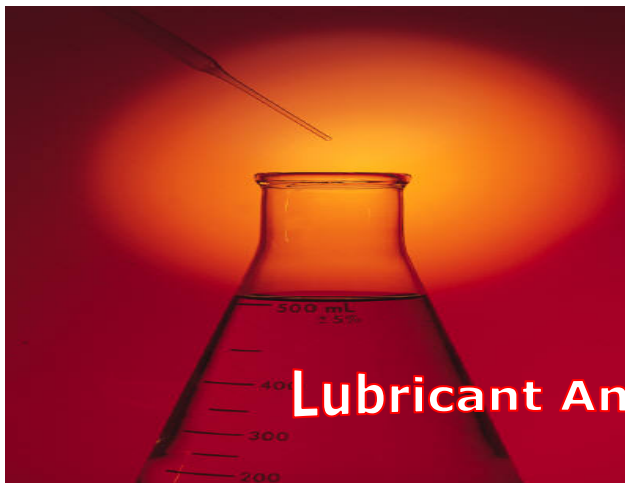
**Vibration Analysis**



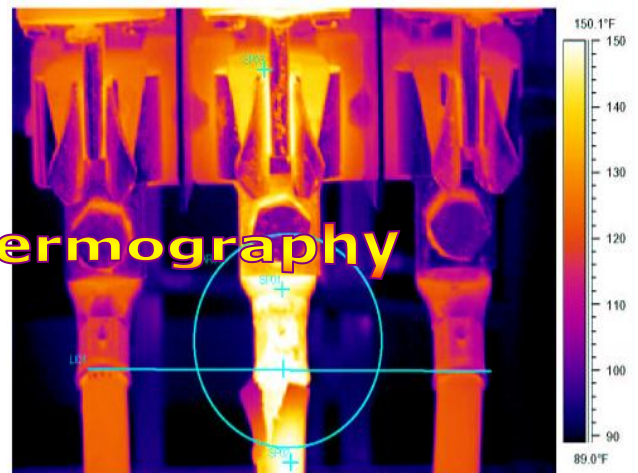
**Machinery Inspection**



**Motor Circuit Analysis**



**Lubricant Analysis**



**Thermography**



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## **Plant Services Division**

### **ASSET RELIABILITY SERVICES AND MECHANICAL SUPPORT**

The overall asset reliability program will reduce maintenance cost by providing the following objectives:

- **Improve maintenance efficiency**
- **Improve maintenance effectiveness**
- **Improve maintenance planning**
- **Increase asset availability**
- **Extend asset life cycles**

To accomplish this, strong communication and joint planning strategies directed at addressing the information generated by the asset reliability system will be developed.

We will work closely with representatives and maintenance planners to ensure that these objectives are accomplished.

#### **1. Vibration Data Collection and Analysis – Predictive Maintenance**

The purpose of collecting vibration data is to determine the condition of the equipment being monitored. This information is used to ensure that new equipment has been properly installed and that existing equipment is running properly. This information becomes part of maintenance planning and scheduling, which will improve equipment availability.

#### **2. Oil Analysis – Predictive and Proactive Maintenance**

The purpose of analyzing machine lubrication is to ensure that the specified lubricant is used and to determine its condition. The lubricant is checked for the presence of contaminants and wear metals, which signals problems with the machine. This service provides information that is used to schedule lube changes based on lubricant's condition rather than relying only on machine hours.

#### **3. Thermography Inspections – Proactive**

The purpose of thermography inspections is to check for mechanical or electrical problems by the use of infrared imaging. This information is useful to detect bad connections in electrical circuits, misaligned gears and overheated bearings in machinery.

#### **4. Electrical Motor Diagnostics– Proactive**

Electrical Motor Diagnostics is comprised of two types of testing, Motor Circuit Analysis (MCE) and Motor Current Signature Analysis (Emax). These technologies optimize reliability and increase profit margin by significantly reducing the maintenance costs and production delays that accompany unexpected motor failures.

#### **5. Ultrasonic Thickness Inspection – Predictive Maintenance**

The objective of ultrasonic thickness testing is to determine the thickness of materials used to contain products used in processing. This information is useful in planning repairs and upgrades to systems where the thickness of the material is dropping below safe levels. Proper use of this information prevents unexpected ruptures of containment systems and improves safety.

#### **6. Rotary Equipment Inspection – Predictive Maintenance**

The purpose of conducting regular rotary equipment inspections is to prevent misaligned components from creating damage throughout the unit as it operates over time. The information generated from this inspection is used to schedule component adjustments and replacements on scheduled outages. This will reduce the amount of overall maintenance required on the units, plus extend the component life.

#### **7. Machinery Acceptance Testing – Proactive Maintenance**

Plant Services provides methods and criteria to give confidence that both new and rebuilt machines will operate satisfactorily when installed.

#### **8. Mechanical Support**

Plant Services provides expertise for precision machine alignment, precision machine balancing, engineered solutions and other mechanical services as needed. Plant Services makes craftsmen available for peak repair periods to perform the services mentioned above as well as staff augmentation on long-term basis.

1. Laser Coupling Alignment
2. Laser Sheave Alignment
3. Dial Indicator Alignment
4. Gear Alignment
5. Rotary Vessel Alignments – Tires, trunnions, etc.
6. Field Balancing – Fans, Generators, Turbines, Motors, Engines, etc.
7. Bearing Replacements – Friction and Anti Friction

#### **Training Program**

Plant Services provides certified technicians with on going training and technical education to keep abreast of the most current technologies available. Our goal is to provide our customers with top quality technicians who decrease maintenance costs by reducing down time due to unscheduled repairs.

CONSTRUCTION  
DIVISION

INSULATION  
DIVISION

CABINETRY  
DIVISION

MARINE  
DIVISION

PLANT SERVICES  
DIVISION

# Electrical Motor Diagnostics

**Electrical Motor Diagnostics** is comprised of two types of testing, Motor Circuit Analysis (MCE) and Motor Current Signature Analysis (Emax). These technologies optimize reliability and increase profit margin by significantly reducing the maintenance costs and production delays that accompany unexpected motor failures.

## **Motor Circuit Analysis:**

**MCE** is a low voltage method for testing the condition of electric machinery connections, cables, windings and rotors. **MCE** testing is performed with the unit off line and generates individual readings of Resistance to Ground, Capacitance to Ground, Phase Resistance, Phase Inductance, and Insulation to ground.

**MCE** is performed using a static tester that provides a detailed analysis of motor and circuit condition. The portable unit features diagnostic results that evaluate all five of the motor's fault zones including the power circuit, insulation, stator, rotor and air gap.

## **Motor Current Signature Analysis:**

**Emax** is performed using a portable dynamic tester that evaluates electrical motor condition without shutting down the process. This testing provides for diagnostics and trending of the incoming power quality, power circuit condition, stator health and motor efficiency.

**Emax** Testing can detect: Insulation breakdown; Loose or open coils, stator, rotor or rotor coils; Loose connections; Air gap problems including static and dynamic eccentricity and mechanical problems such as Bearing and alignment issues.

**Motor Circuit Analysis and Motor Current Signature Analysis** when combined provides a complete overview of the system being evaluated, with a high degree of accuracy.

# Vibration Analysis

Vibration analysis technology allows maintenance programs to use their maintenance dollar more efficiently. Vibration data provides an insight to the health of the equipment.

Turbines, pumps fans, motors, and bearings can be examined to see how vibration is affecting their performance. The same technology can also be applied to the structural components of a building including frames and foundations. With the aid of vibration analysis, discovering shaft related problems (imbalance, looseness, and misalignments) becomes a reality. Identifying and evaluation bearing and gearbox conditions are other advantages of vibration analysis.

Vibration analysis can also be performed on new equipment for foundation stability, misalignment, and identifying natural and resonant frequencies. Vibration analysis provides the reality of identifying and correcting potential problems before they become actual problems that result in downtime and reduce productivity.

## Benefits of Predictive Maintenance

- **Minimizes or eliminates costly downtime – increases profitable uptime.**
- **Minimizes or eliminates catastrophic machinery failures – damage from catastrophic failure is usually much more extensive than otherwise would have been.**
- **Reduces maintenance costs.**
- **Reduces unscheduled maintenance - repairs can be made at times that least affect production.**
- **Reduces the possibility of accepting recently purchased new or used machinery with defects - the invoices is not paid until the defects are corrected.**



**THE INSULTECH GROUP**

**CONTRACTING  
ENGINEERING  
CONSULTING  
MAINTENANCE  
MANPOWER**

**ABC Company  
GTSP PdM Report**  
Consultant: John Doe

**Critical C  
High H  
Moderate M  
Low L**

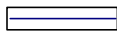
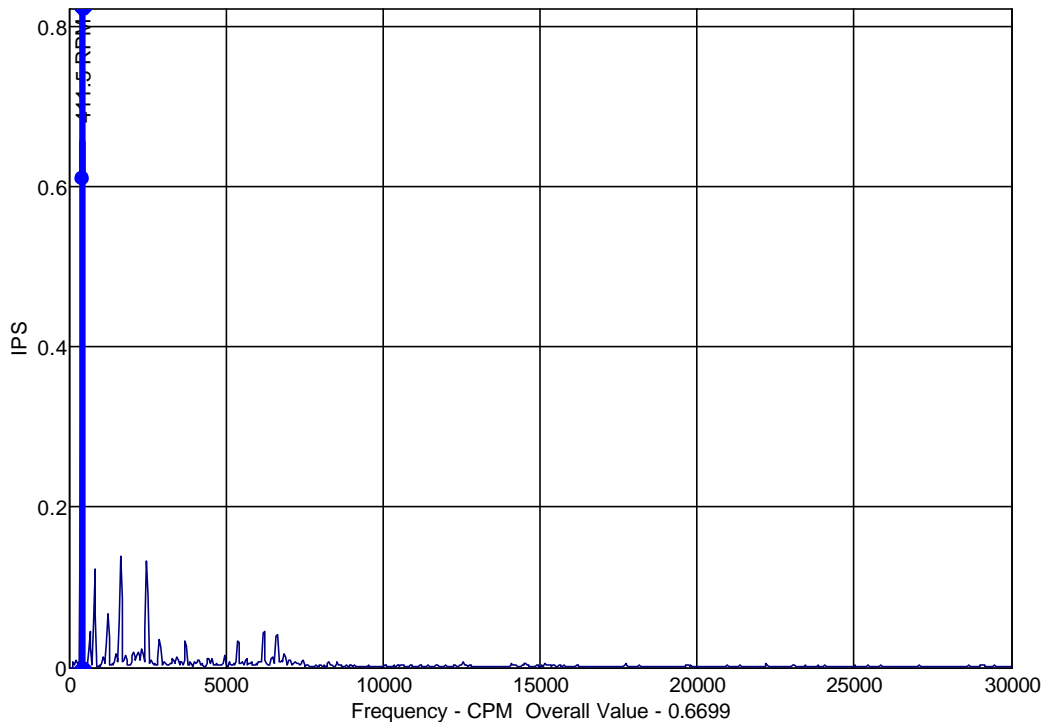
Inspection Date: 06/10/03

Inspection Date: 05/16/03

Unit ID	Level	Description of Problem	Corrective Action	Level	Description of Problem	Corrective Action
Cooler Fan	L	Vibration levels were acceptable at the time of this inspection.	None at this time.	L	Vibration levels were acceptable at the time of this inspection.	None at this time.
Cooler	L	Vibration levels were acceptable at the time of this inspection.	None at this time.	L	Vibration levels were acceptable at the time of this inspection.	None at this time.
Granulator	L	Vibration levels were acceptable at the time of this inspection.	None at this time.	L	Vibration levels were acceptable at the time of this inspection.	None at this time.
#1 Scrubber Fan	C	Overall - 0.66 ips POS - Outboard Fan Horizontal PDF - 0.60 ips @ 412 cpm indicating imbalance.	Clean fan and recheck vibration. Balance if necessary.	L	Vibration levels were acceptable at the time of this inspection.	None at this time.

**Single Spectrum Plot  
ABC PLANT  
GTSP  
#1 SCRUBBER FAN  
OB FAN H**

Page 1



1: OB FAN H  
Velocity (Acc to Vel) (Peak)  
10-JUN-03 09:51:30

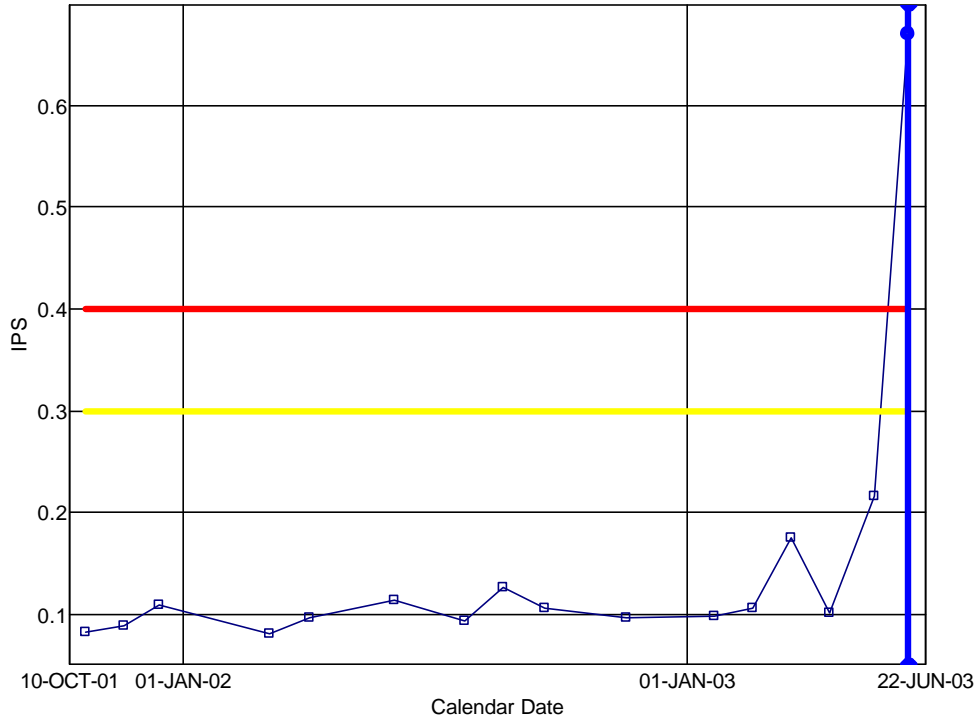
**POINT ID: OB FAN H Desc:outboard fan horizontal**

Machine: #1 SCRUBBER FAN	Window: Hanning	Speed: 411.538 RPM	Overall: 0.670
Date: 10-JUN-03 09:51:30	Lines: 800	Threshold: 0.050000	Sync: 0.664
Freq: 0.0 - 30000.0 CPM	Aver: 4	Units: IPS	SubSync: 0.010
Detect: Peak	Type: FFT		NonSync: 0.086

**Single Value**

CPM 412.5000  
Order 1.0023  
Amp 0.6096

**Overall Value vs. Time Trend**  
**ABC PLANT**  
**GTSP**  
**#1 SCRUBBER FAN**  
**OB FAN H**  
Page 1



1: OB FAN H  
Overall  
10-JUN-03 09:51:30

2: Alert High  
0.3

3: Danger High  
0.4

**POINT ID: OB FAN H Desc:outboard fan horizontal**

Machine: #1 SCRUBBER FAN Alarm Type: Level Danger High: 0.4 Alert Low: ---  
Mean: 0.147752 Std. Dev.: 0.143586 Alert High: 0.3 Danger Low: ---

**Overall Trend Values**

#	Date and Time	Value	#	Date and Time	Value	#	Date and Time	Value
1	22-OCT-01 09:38:09	0.0822	7	24-JUL-02 11:28:45	0.0936	13	17-MAR-03 11:57:57	0.1747
2	19-NOV-01 08:45:30	0.0886	8	21-AUG-02 13:47:49	0.1273	14	14-APR-03 13:54:13	0.1019
3	14-DEC-01 13:58:34	0.1100	9	20-SEP-02 13:18:17	0.1060	15	16-MAY-03 11:30:34	0.2156
4	04-MAR-02 12:57:15	0.0816	10	18-NOV-02 12:38:58	0.0971	16	10-JUN-03 09:51:30	0.6699
5	02-APR-02 09:01:18	0.0972	11	20-JAN-03 09:21:01	0.0984			
6	03-JUN-02 09:57:33	0.1140	12	17-FEB-03 13:57:32	0.1058			

**Single Value**

Date 10-JUN-03 09:51:30  
Amp 0.6699



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## *Lubricant and Oil Analysis*

*A valuable tool for condition monitoring.*

### **Oil Analysis**

*An indicator of equipment and lube condition.*

Monitors wear metals in your equipment's lube to help prevent and predict problems. Detects contaminants in oil, oil additive depletion and to verify proper oil is being used.

### **Benefits**

- **A predictive and preventive tool for equipment condition.**
- **An indicator of lubricant condition.**
- **Reduces maintenance and repair costs.**
- **Reduces production down time losses.**

### **Oil Condition Monitoring Tests**

#### **Spectrographic Analysis**

Detection of wear metals indicating normal or excessive wear, lubricant contamination from inside and outside environment and oil additive presence and/or depletion indicating oil breakdown or lube mixing.

**Viscosity:** *The measurement of resistance to flow at a specific temperature.* Can indicate wrong oil or make up oil added, lube oxidation and contamination of solids, fuel or water.

**Water Contamination:** *Presence of water in oil. (Percent by volume)*

Can compromise lubrication properties, promotes component corrosion and indicates malfunctioning lubricating components.

**Solid Contamination:** *Presence of sediment in oil. (Percent by volume)*

Determines sludge, varnish, gross particle contamination and soot (diesel engines).

**Total Acid Number (TAN):** *Monitors the amount of acidic agents found in the oil.*

An increase indicates lube oxidation or corrosive acid contamination.

**Total Base Number (TBN):** *Monitors the acid neutralizing reserve of the oil.*

A decrease indicates a decrease in lubricants acid fighting ability. This test is usually run on engine and crankcase oil.

**Fuel Contamination:** *Level of fuel contamination in oil. (Percent)*

Can indicate malfunctioning or worn parts on components. This test is usually run on engine and crank case oil.

**Glycol Contamination:** *Presence of absence of ethylene glycol in oil.*

Can be used for detecting leakage into engine lubricants or from other glycol based cooling systems.

Sample ID.: 00086718  
 Equipment Code: A22 051  
 Equipment Name: 2 AGITATOR GEARBOX/GEAR SYSTEM  
 Equipment Area: PAD  
 Lubricant: MEROPA 320  
 Total Hours: 0.0

# CRITICAL

Sampled: 27-APR-04  
 Issued: 03-MAY-04  
 Reported: 03-MAY-04

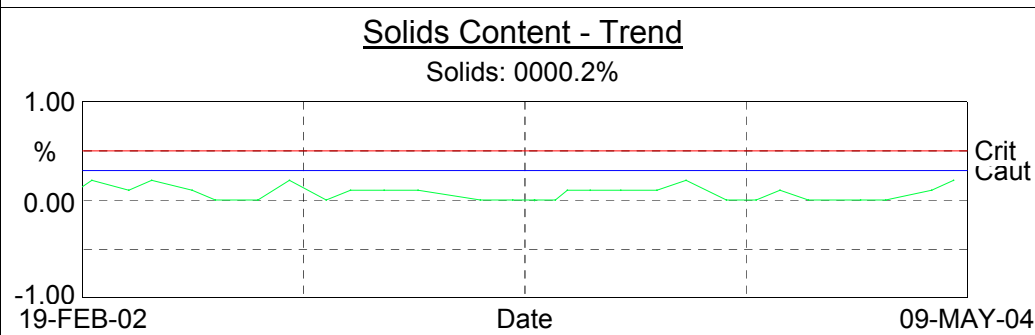
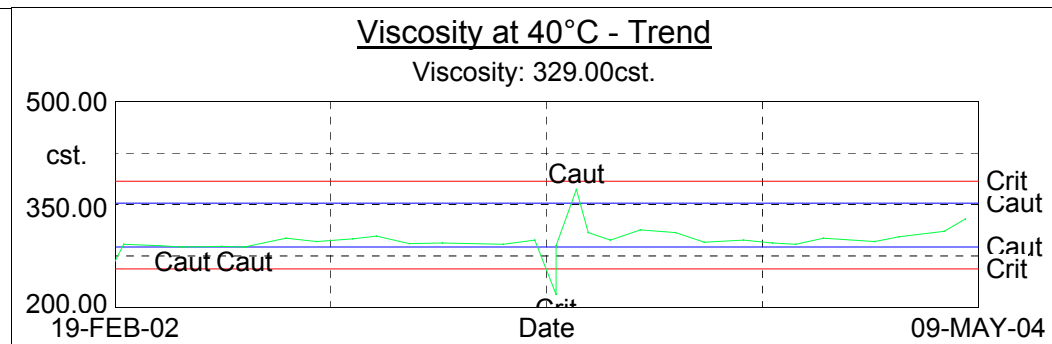
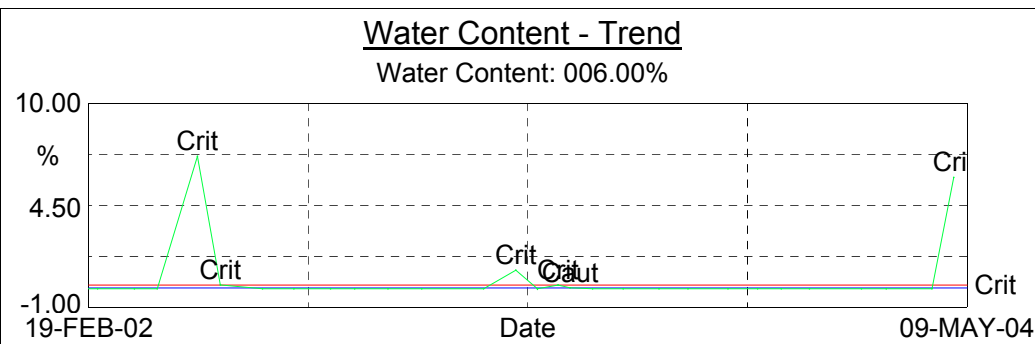
**Sample Comments:**

INCREASED GEAR AND/OR BEARING METALS.  
 GEAR WEAR WITHIN LIMITS.  
 SOLIDS CONTAMINATION IS ABNORMAL.  
 WATER IN OIL; DRAIN; FLUSH; REPLACE OIL.



**Spectrography (ppm.) - Table**

Sample	Date	Hours	Fe	Cr	Mo	Al	Cu	Pb	Sn	Ni	V	Ti	Si	Na	B	Mg	Ca	Ba	P	Zn
00086718	27-APR-04	0.0	50.0	0.0	0.0	0.0	66.0	0.0	0.0	0.0	0.0	0.0	11.0	0.0	13.0	1.0	10.0	0.0	225.0	34.0
00086290	07-APR-04	0.0	10.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	18.0	1.0	10.0	0.0	202.0	12.0
00085226	25-FEB-04	0.0	6.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	13.0	0.0	0.0	0.0	204.0	11.0
00084819	02-FEB-04	0.0	4.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.0	0.0	0.0	0.0	189.0	5.0
00083921	16-DEC-03	0.0	5.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.0	0.0	0.0	0.0	178.0	3.0
00083318	20-NOV-03	0.0	62.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	9.0	0.0	10.0	1.0	15.0	0.0	234.0	14.0



**Abbreviations**

Fe - Iron	Sn - Tin	B - Boron
Cr - Chromium	Ni - Nickel	Mg - Magnesium
Mo - Molybdenum	V - Vanadium	Ca - Calcium
Al - Aluminum	Ti - Titanium	Ba - Barium
Cu - Copper	Si - Silicon	P - Phosphorous
Pb - Lead	Na - Sodium	Zn - Zinc

# Thermography

Thermography is the use of an infrared imaging and measurement camera to “see” and “measure” thermal energy emitted from an object.

Thermal, or infrared energy, is light that is not visible because its wavelength is too long to be detected by the human eye; it's the part of the electromagnetic spectrum that we perceive as heat. Unlike visible light, in the infrared world, everything with a temperature above absolute zero emits heat. Even very cold objects, like ice cubes, emit infrared. The higher the object's temperature, the greater the IR radiation emitted. Infrared allows us to see what our eyes cannot.

Infrared thermography cameras produce images of invisible infrared or “heat” radiation and provided precise non-contact temperature measurement capabilities. Nearly everything gets hot before it fails.

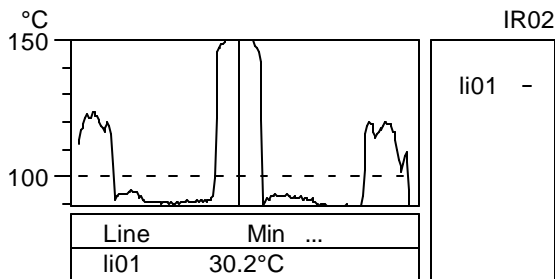
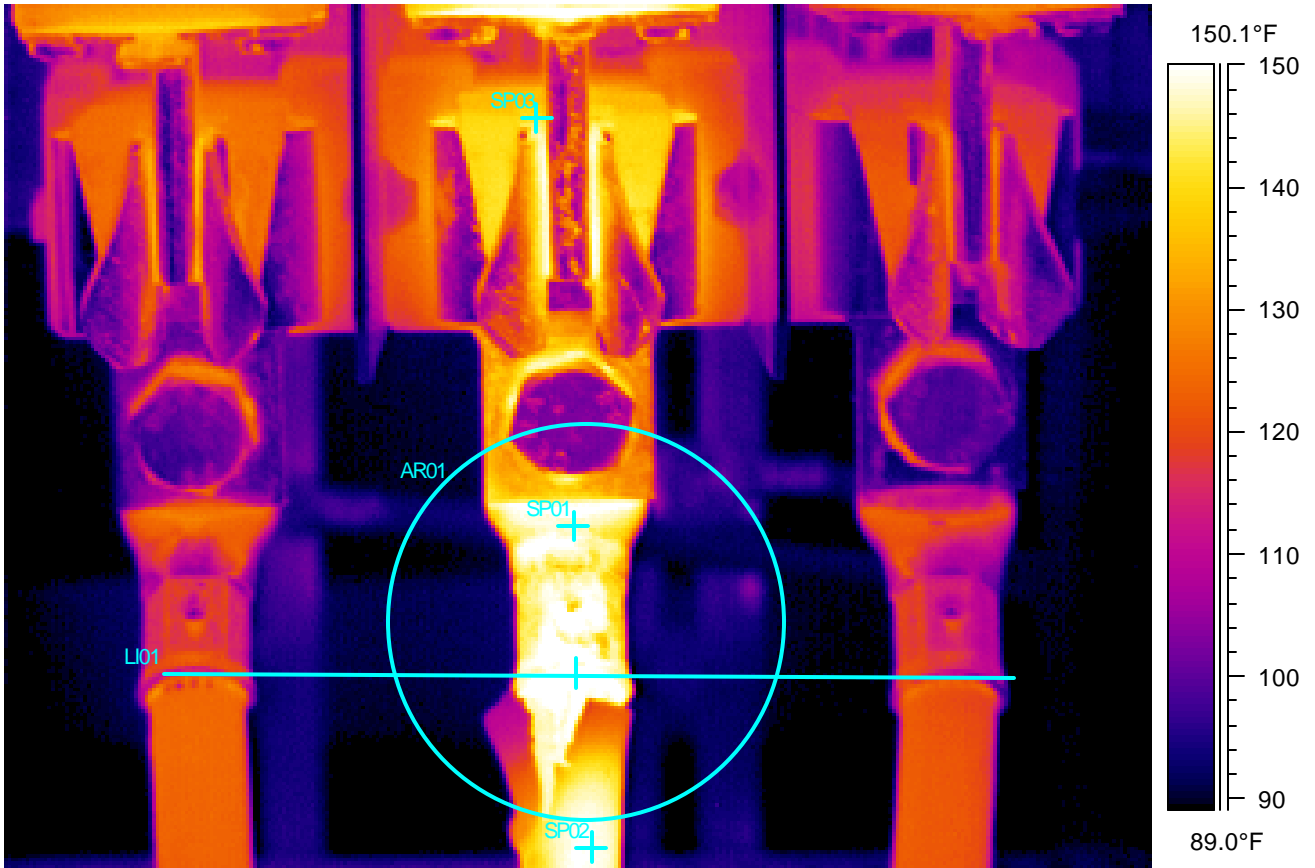
## Ideal Technology

Infrared Thermography (IR) operates by measuring the infrared energy of any object's surface and producing a detailed visual image showing its temperature profiles. Since IR operates without physical contact, it offers building operators a safe, on-line and cost effective means to evaluate the electrical operation of any property. While many border line problems areas typically remain undetected during an off-line physical inspection, they can be easily pinpointed using IR.

Infrared Thermography is ideally suited for detecting faults in electrical panels, breakers, switchgear, splices, insulators, starters, contractors, wiring, distribution systems, disconnects and transformers, etc. With a lesser degree of reliability, IR can locate water leakage in roofs trap malfunctions, ineffective HVAC air distribution pattern, motor and bearing defects, building energy loss, pipe blockages and underground pipe leakage – providing a visual representation of the heat generated or lost in almost any physical application.



Inspected By:	Date:	
Location: <b>Sample - Electrical</b>		
Equipment Name:	Equipment #	



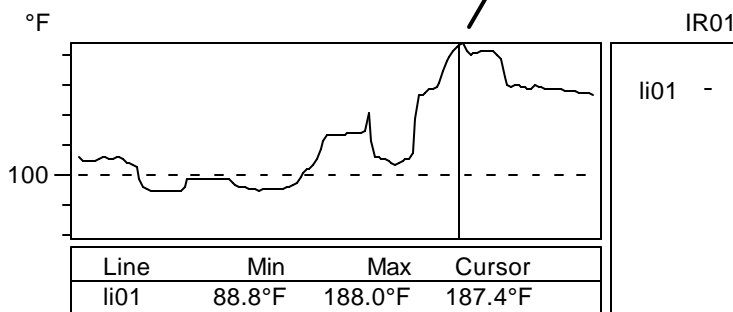
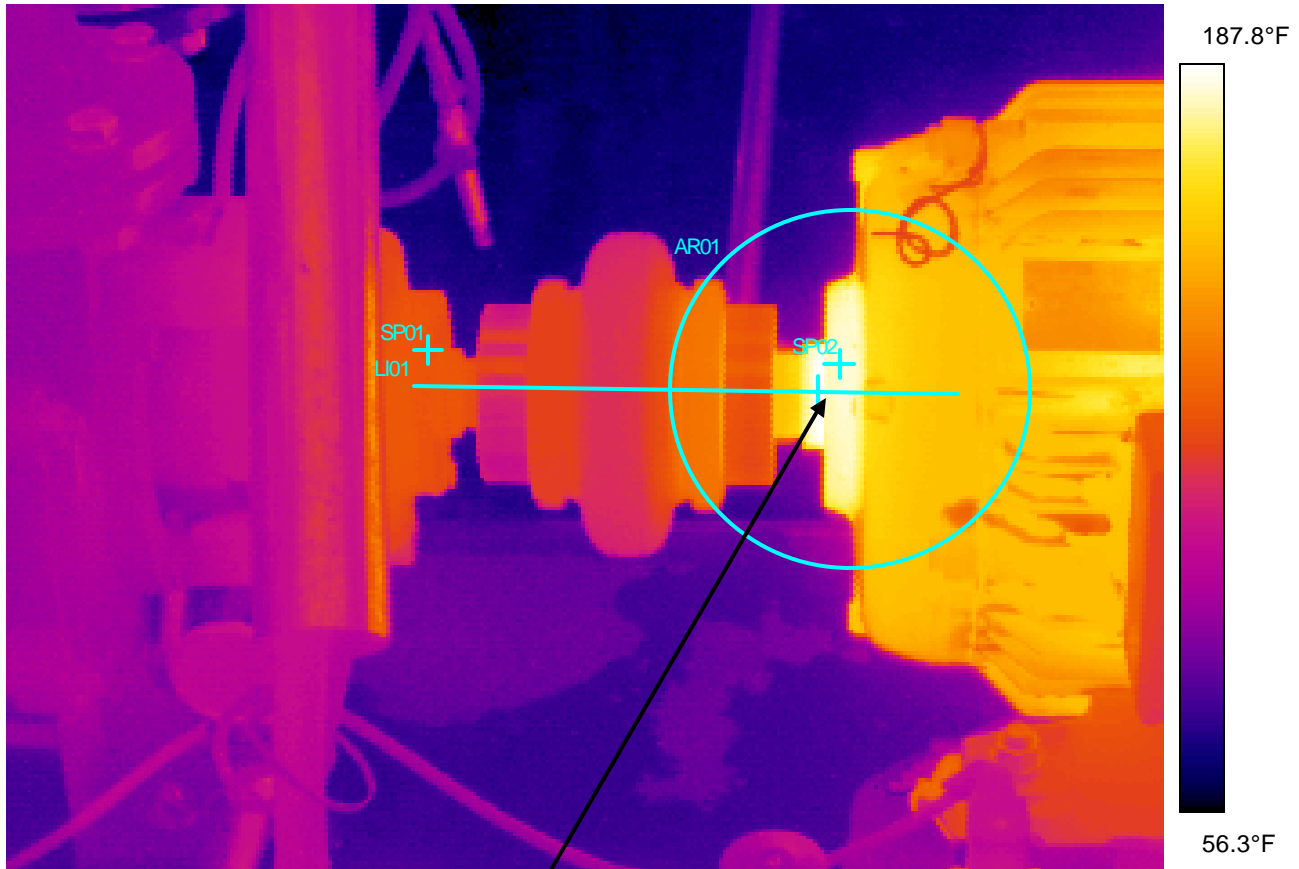
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Zoom factor	1.00
Object parameter	Value
Emissivity	1.00
Object distance	3.3 ft
Ambient temperature	73.4°F
Label	Value
SP01	64.6°C
SP02	65.5°C
SP03	60.4°C
LI01 : cursor	67.9°C
LI01 : max	69.0°C
LI01 : min	30.2°C
AR01 : max	69.1°C
AR01 : min	30.2°C

**SUMMARY:** Loose connector and connection in middle leg. Also burnt insulation.

**RECOMMENDATION:** Cut wire back to good insulation, replace connector, tighten bolt to specification.



Inspected By:	Date:
Location: Sample - Mechanical	
Additional:	

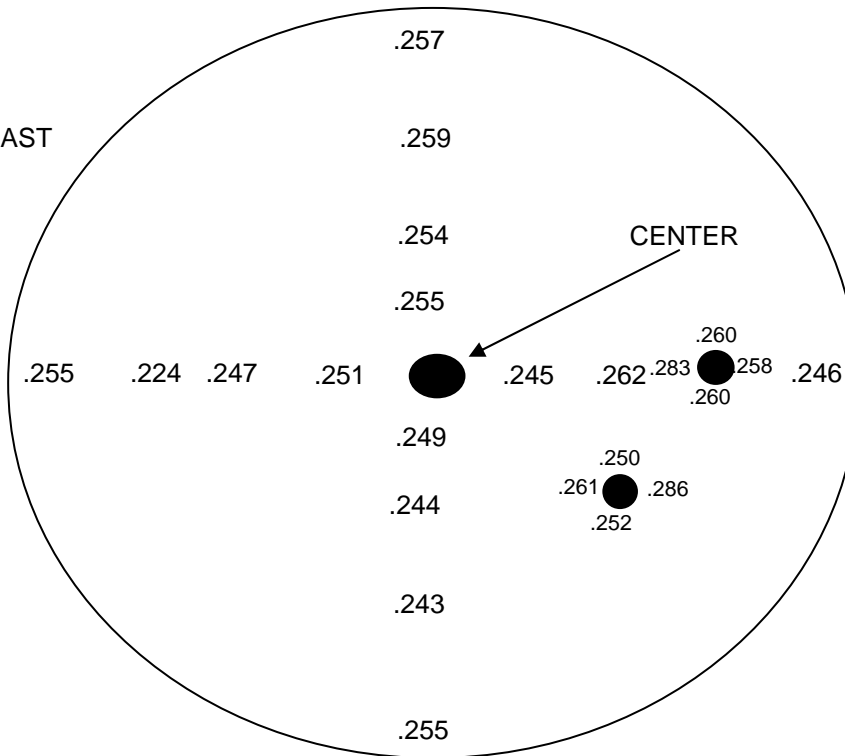
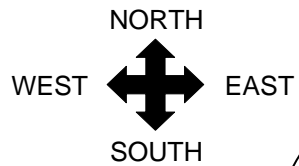
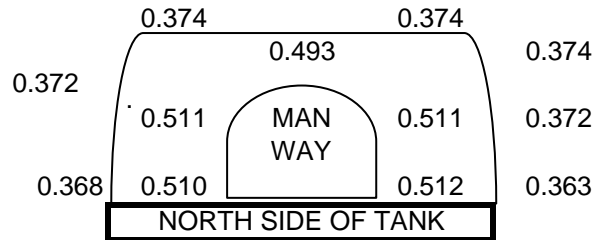
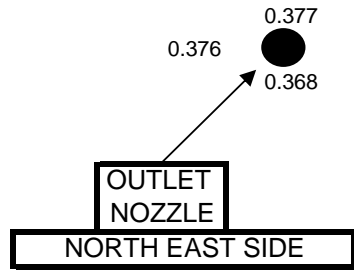
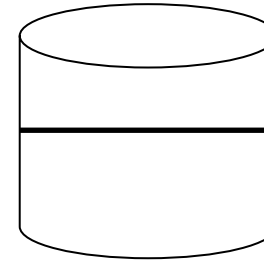


IR information	Value
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Zoom factor	1.00
Object parameter	Value
Emissivity	0.92
Object distance	4.9 ft
Ambient temperature	66.7°F
Label	Value
SP02	182.5°F
SP01	109.3°F
LI01 : cursor	187.4°F
LI01 : max	188.0°F
LI01 : min	88.8°F
AR01 : max	188.3°F
AR01 : min	63.1°F
AR01 : avg	132.3°F

**SUMMARY:** Motor bearing (SPO2) 73.2 degree hotter than same spot on pump bearing (SPO1). Also 115.8 above ambient temperature.  
**RECOMMEND:** Check bearing lubrication/condition.

SOUTH SULFURIC STORAGE TANK - 05/07/03

	N	NE	E	SE	S	SW	W	NW
15'10"	0.346	0.338	0.340	0.339	0.346	0.363	0.352	0.346
12"	0.366	0.364	0.359	0.365	0.364	0.369	0.367	0.366
8'2"	0.359	0.359	0.361	0.360	0.353	0.361	0.354	0.356
7'10"	0.364	0.366	0.356	0.364	0.354	0.363	0.359	0.368
4'	0.378	0.379	0.372	0.374	0.375	0.374	0.372	0.379
6"	0.372	0.368	0.369	0.370	Obstr	0.368	0.366	0.368
2"	0.346	0.366	0.362	0.367	Obstr	0.345	0.364	0.364



TOP OF TANK = 8' RADIUS

READINGS FROM CENTER

1'

4'

6'

7'6"



**THE INSULTECH GROUP  
PLANT SERVICES DIVISION**

ABC Company  
Rotary Equipment Inspection Report  
Unit ID: Oil Coating Drum West, 0064-38-021 Loading: \_\_\_\_\_ Amp Draw: 24  
Inspection Date: 07/11/03 Inspector: \_\_\_\_\_

Area	Appearance / Wear Patterns / Condition	Action Needed	Action Taken
General Position/Training	Motor temperature is 112°. Gearbox temperature is 138°. Vessel is running in a floating position.	Unable to check bearing temperatures and discharge trunnions because of new guards. Product covering all bearings.	
Feed End Tire	Flat spots all the way around tire; however, tire may be improving.	Resurface tire. Continue to monitor.	
Feed End Trunnions	Lots of build-up around trunnions and bearings.	Clean build-up from around trunnions.	
Feed Side Thrust Roller	Good condition; However, build up around thrust roller.	Clean around thrust roller.	
Feed End Tire Chair Pads	Good condition.	None at this time.	
Feed End Tire Keeper Blocks	Good condition.	None at this time.	
Feed End Tire Lubrication	Poor.	Need to install graphite block and support frame.	
Discharge Tire	In acceptable running condition; however, has developed flat spots.	Continue to monitor.	
Discharge Tire Trunnions	Lots of build-up around trunnions.	Clean build-up from around trunnions.	

**THE INSULTECH GROUP  
PLANT SERVICES DIVISION**

ABC Company  
Rotary Equipment Inspection Report  
Unit ID: Oil Coating Drum West, 0064-38-021 Loading: \_\_\_\_\_ Amp Draw: 24  
Inspection Date: 07/11/03 Inspector: \_\_\_\_\_

Area	Appearance / Wear Patterns / Condition	Action Needed	Action Taken
Discharge Side Thrust Roller	Good Condition.	None at this time.	
Discharge Tire Chair Pads	Good Condition.	None at this time.	
Discharge Tire Keeper Blocks	Good condition.	None at this time.	
Discharge Tire Lubrication	Poor condition.	Install graphite block and support frame.	
Bull Gear	Good Condition.	None at this time.	
Plant/Weather Condition	Hot		