Infrared Thermography (IR)

1. WHAT IS IR ?

Infrared thermography is the technique of using a non-contact & non-destructive Infrared Scanning Camera to detect invisible Infrared thermal radiation of objects, and recording these pictures as thermal images called "Thermograms" to assist in identifying potential equipment failures.

Infrared radiated energy is emitted by all objects, animate or otherwise, having a temperature above absolute zero.

Amount of energy emitted depends upon how hot the object is and how well it can emit energy.

2. HOW IS IT MEASURED ?

Since Infrared energy is not visible to the human eye, detection requires a physical device to convert the IR to a visible image.

The Thermographic Camera utilizes a system to focus the IR energy onto an IR sensitive detector which is sensitive to radiation within the Infrared Wavelength between 2 - 14 um.

The detector converts the IR energy to a voltage signal, which is in turn, imaged into a TV-like display. These images would then be recorded onto Disk or memory chips.

The Temperature range of a typical Infrared Camera is –15° C to 1500° C in 0.1° C steps.

Analysis of the Thermal Images would be carried out on Computer using specialised software. As a general rule, the following temperature differentials for electrical connections is recommended:

DIFFERENTIAL	PRIORITY RATING	ACTION	MAXIMUM TIME TO REPAIR
5 to 10°C	LOW	Monitor	N.A.
11 to 20°C	MEDIUM	As soon as possible	Next scheduled shutdown (but < 12 mths.)
21 to 29°C	URGENT	Urgent	1 Month
>30°C	SEVERE	Immediately	Immediately

3. WHY USE IR ?

Infrared Thermographic scanning is a very effective tool for predictive maintenance.

Equipment failure is usually preceded by an abnormal temperature pattern, and this temperature rise is easily detected by an Infrared Thermographic inspection.

The biggest advantage of this method is the ability to detect faults in time without the necessity to shut down Plant.

Some of the **APPLICATIONS** are:

ELECTRICAL	Overheated connections owing to loose joints & excessive overloading. Uneven phase loading. Hot motor bearings. Loose Battery connections. Eddy Current heating.
AIRCONDITIONING & REFRIGERATION	Cooling leaks.
MECHANICAL PLANT	Overheated Bearings Misaligned couplings Slipping fan belts
STEAM LINES	Leakage.
KILNS/FURNACES	Refractory breakdown. Furnace tube temperatures.
CONCRETE ROOFS/ PANELS	Cracks & thermal insulation breakdown.
ENERGY MANAGEMENT	Heating & Cooling losses.

ADVANTAGES OF IR INSPECTION

REDUCES
- Unplanned down-time
- Maintenance costs
- Overtime

IMPROVES
- Production
- Equipment life
- Plant safety

FROM THE INSURANCE POINT OF VIEW:

Statistics reveal that 20% to 30% of electrical failures are caused by loose connections.

IR Inspection reduces chances of FIRE due to electrical failures resulting in reduced paid claims. This not only reduces property damage, but also the number of work related injuries.

4. WHEN IS IR REQUIRED ?

This is dependent upon
- size and nature of the Installation.
- severe environment
- high loading

Generally, for Plants operating 24Hrs a day, the schedule shall be categorized into the importance of each equipment as follows:

Category	Inspection Interval
Critical	1 to 3 months
Important	6 months
Unimportant	12 months

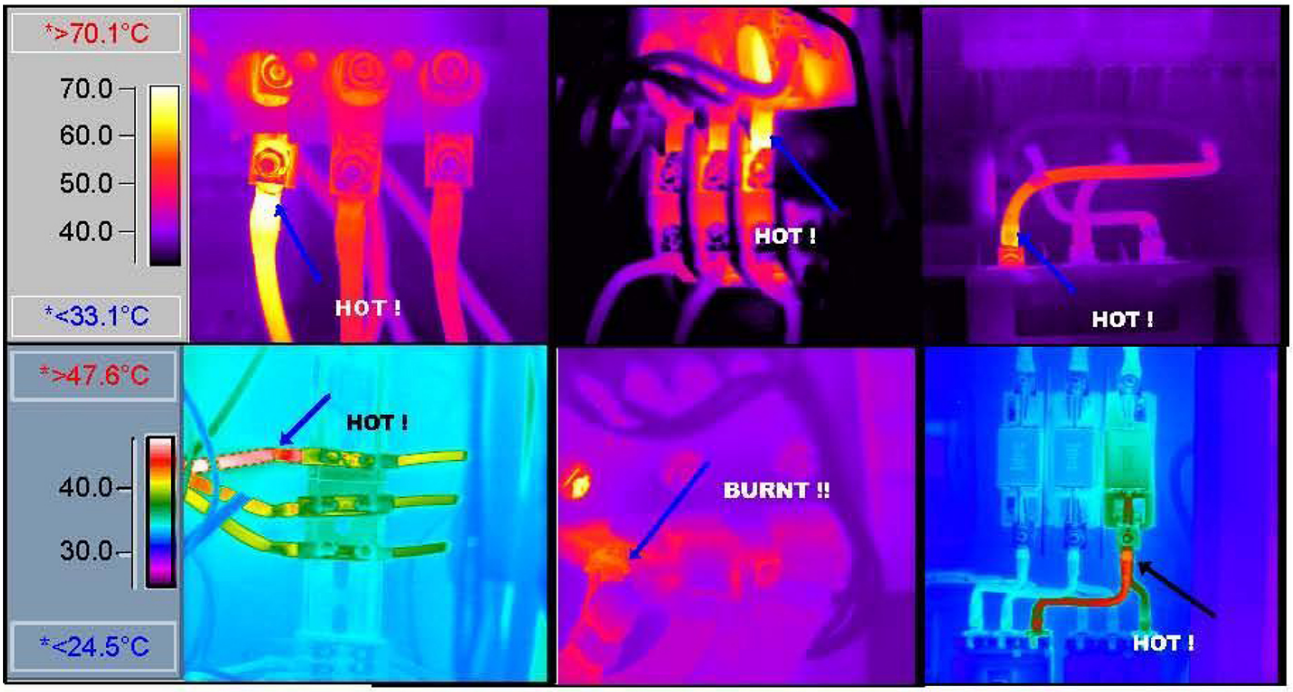
For newly commissioned Installations, inspection should commence:

(i) When loaded to 60% of maximum demand or 2 to 3months after Practical Completion.

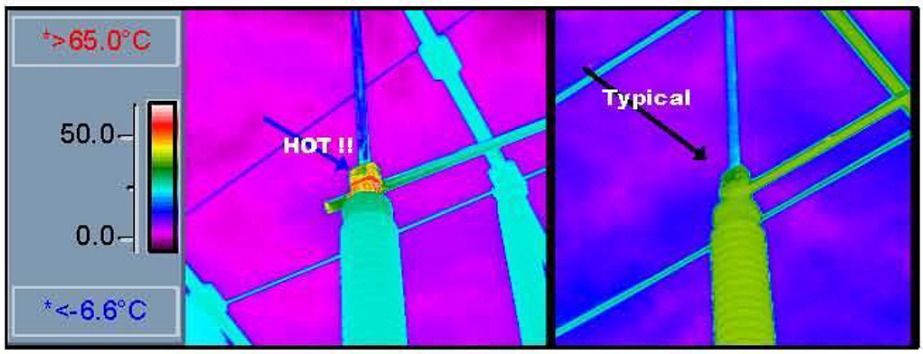
(ii) Just before expiry of equipment warranty.

After rectification of faulty equipment, to ensure that the work had been efficiently and properly completed, it is essential to carry out a re-inspection.

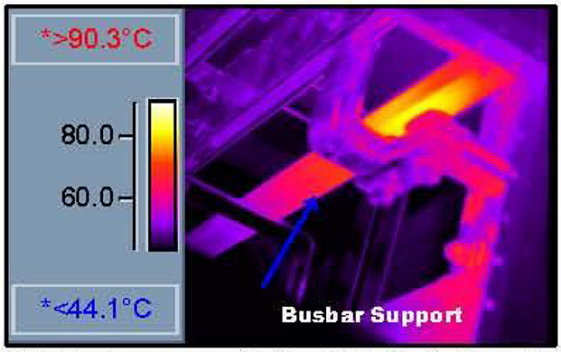
TYPICAL THERMOGRAMS OF HOTSPOTS ON ELECTRICAL EQUIPMENT



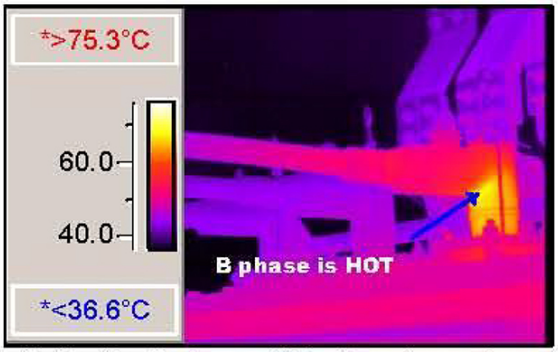
All the above Infrared Scans show Hotspots on Electrical equipment caused by loose connections. Maintenance work can be planned for a scheduled shutdown to carry out the rectification work before failure occurs, thus saving time and money.



On overhead lines, Hotspots can be located with ease. The Thermogram on the right shows a HOT termination compared to the one on the left.



This busbar support in the Main Switchboard is being heated up by the eddy current from the surrounding busbars.



Notice the B phase of this Transformer is HOT when compared to the other phases.

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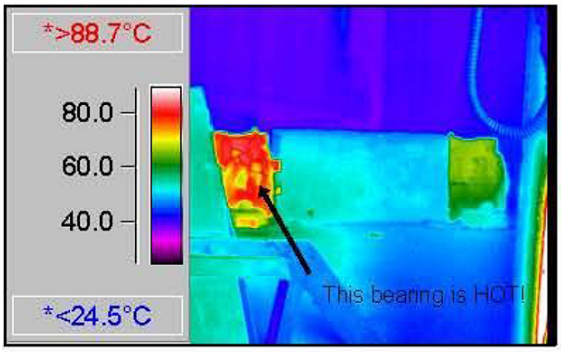
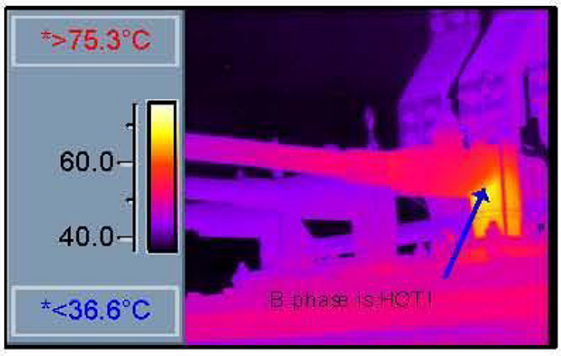
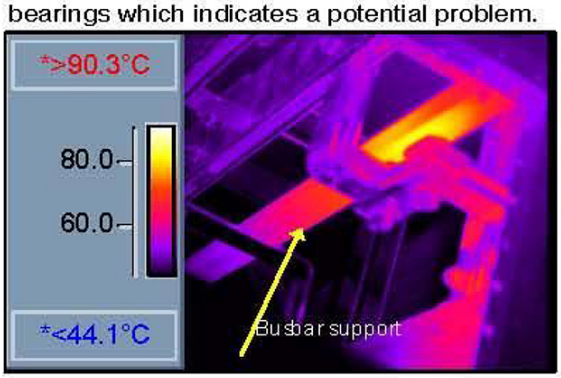
TYPICAL THERMOGRAMS OF HOTSPOTS



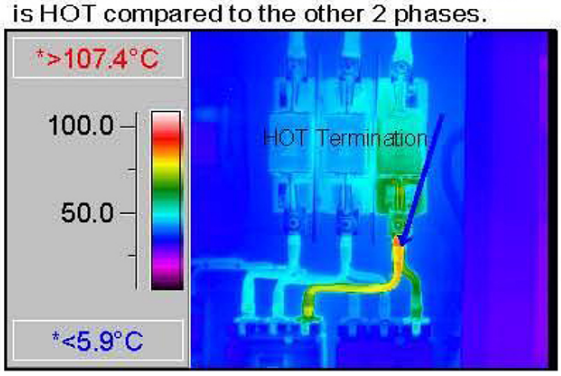
There is a difference in temperature on the bearings which indicates a potential problem.



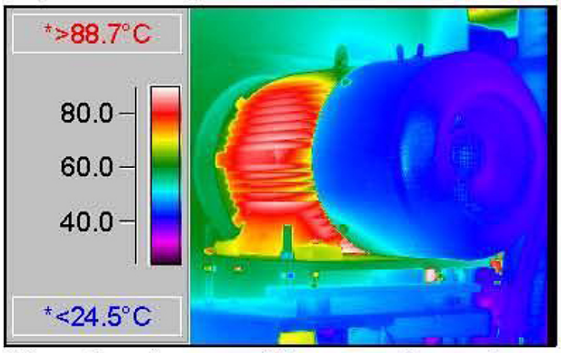
Notice that the B phase of this Transformer is HOT compared to the other 2 phases.

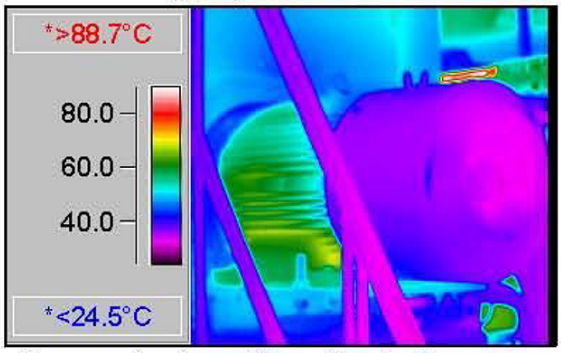


This busbar support in the Main Switchboard is being heated up by the eddy current from adjacent cabling.

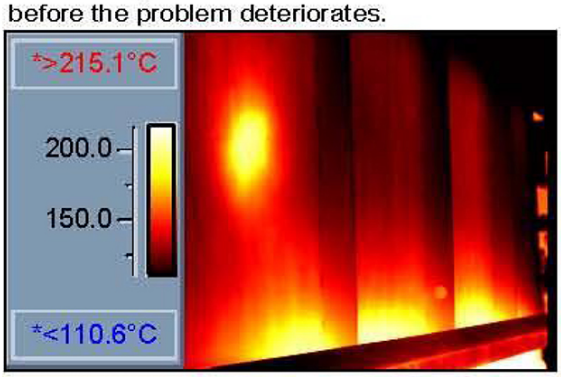


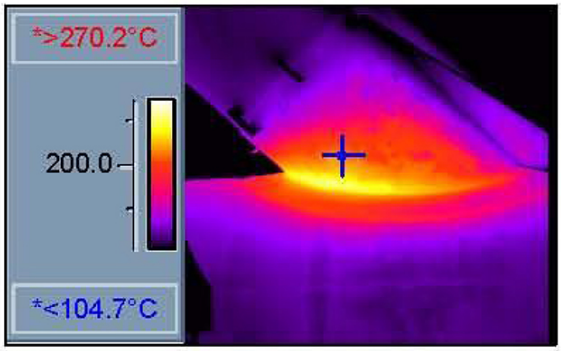
Spot the difference!!! With InfraRed, you can pinpoint a small problem before it becomes a bigger problem.





These 2 motors are of the same size and operating under the same load conditions. So why is there a temperature difference? Infrared Thermography can locate initial problems on a motor before the problem deteriorates.





On major Mechanical surfaces, InfraRed Thermography can locate Hotspots indicating refractory failure or deteriorating insulation on the equipment. Why shutdown to locate the problem when you can monitor the situation until the next scheduled shutdown.

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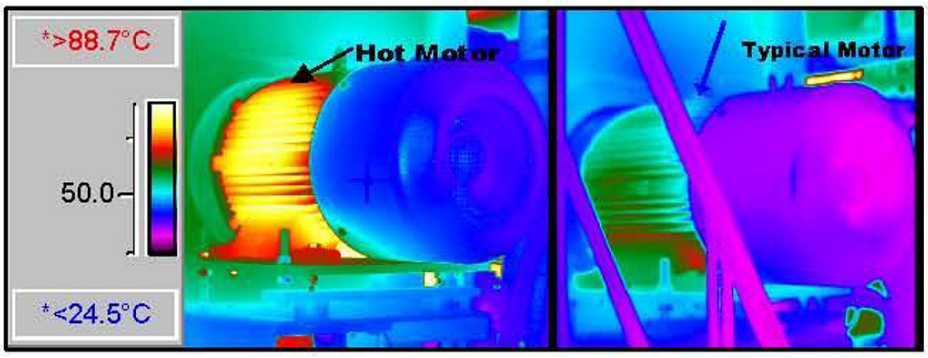
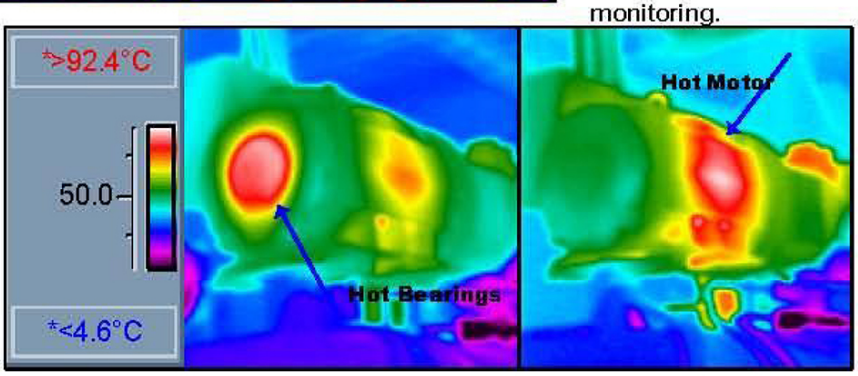
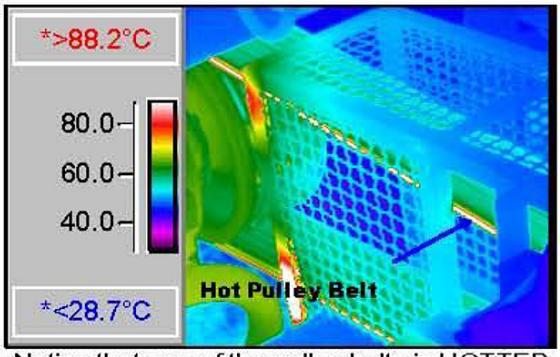
TYPICAL THERMOGRAMS OF HOTSPOTS ON ROTATING MECHANICAL EQUIPMENT



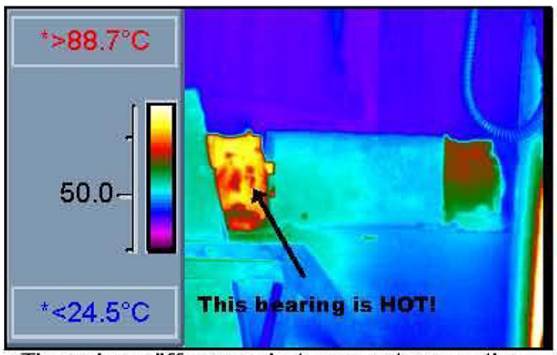
The 2 motors on the left are of the same size and operating under the same load conditions. So why is there a temperature difference? Infrared Thermography can locate problems on a motor even before detection by Vibration monitoring.

The Chiller on the right are of the same size and under the same loading. Notice that one has a hot bearing while the other has a hot motor.

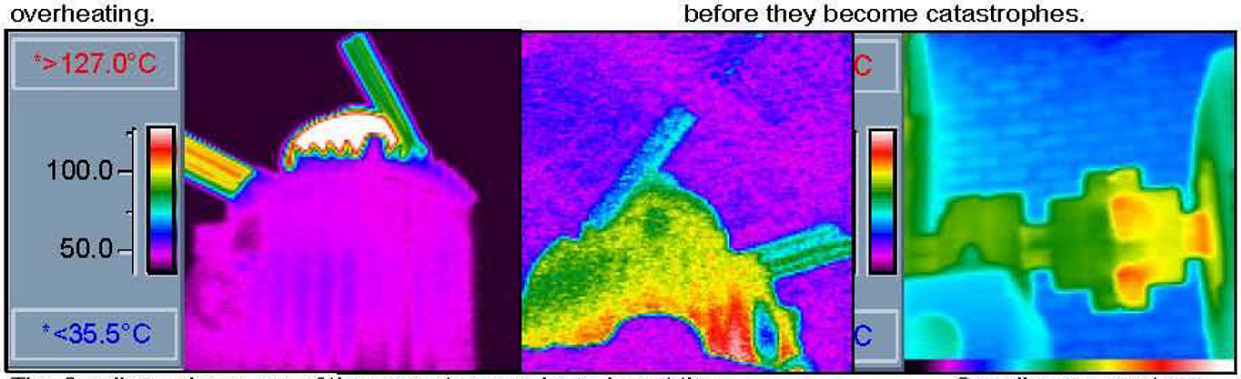




Notice that one of the pulley belts is HOTTER than the other pulley belts. Uneven tension on the pulley belt may cause overheating.



There is a difference in temperature on the bearings, this might indicate a potential . Infrared Thermography finds problems before they become catastrophes.



The 2 pulleys above are of the same type and running at the same speed, but one of the pulleys is much hotter than the other, indicating possible slippage.

Couplings on motors can be scanned to locate misalignment.

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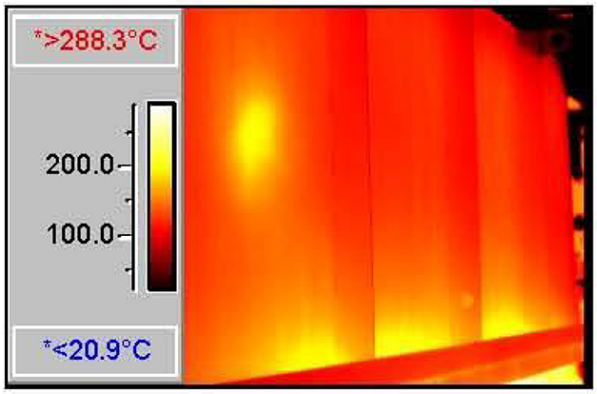
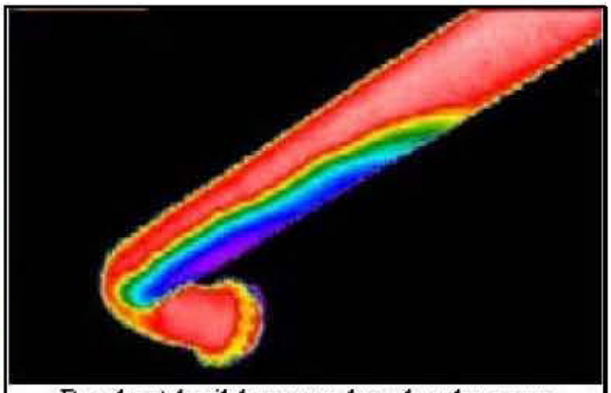
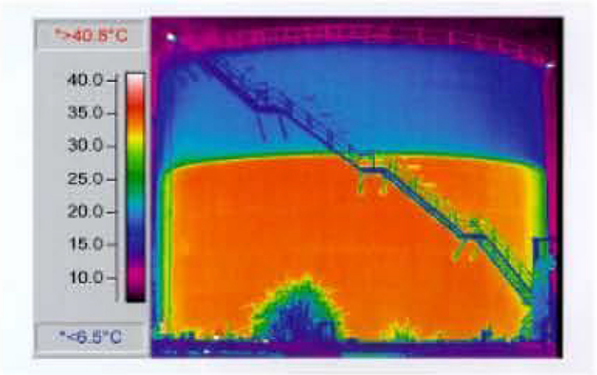
TYPICAL THERMOGRAM OF HOTSPOTS ON SURFACES



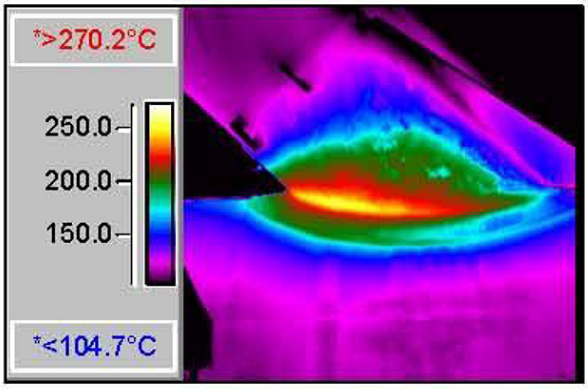
Hotspots on Furnace surface indicate refractory failure



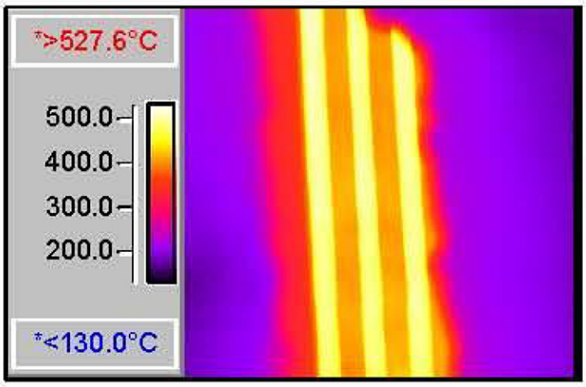
Product buildup can be clearly seen as the cold area on the bottom of the pipe



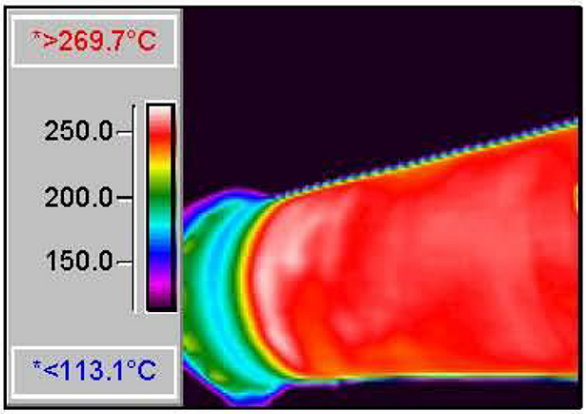
Tank liquid level easily detected



Hotspot at Y pipe connection shows impending failure



Check Furnace tubes to locate coaking problems.



Surface of the Kiln shows uneven temperature distribution.

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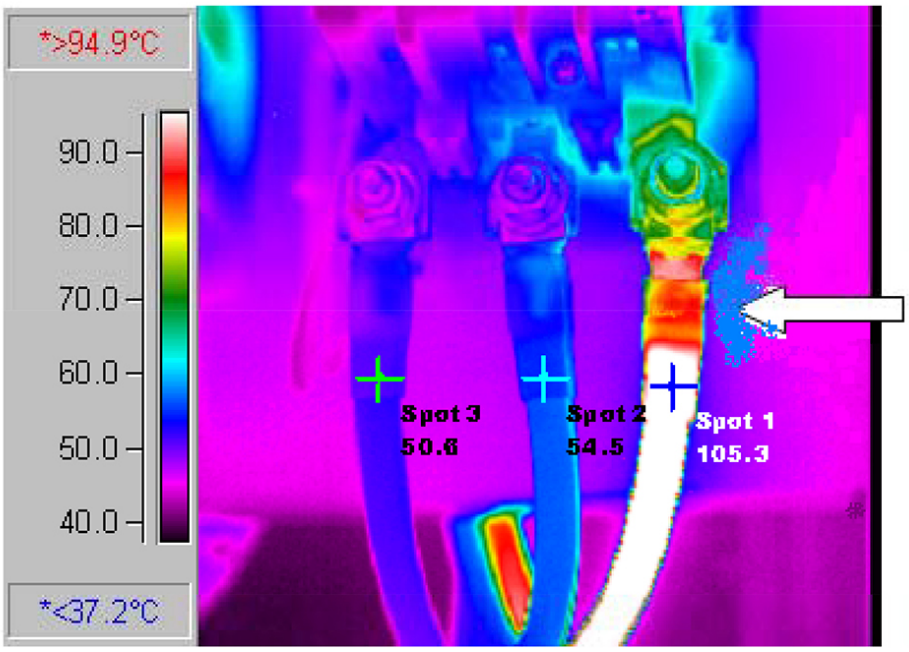
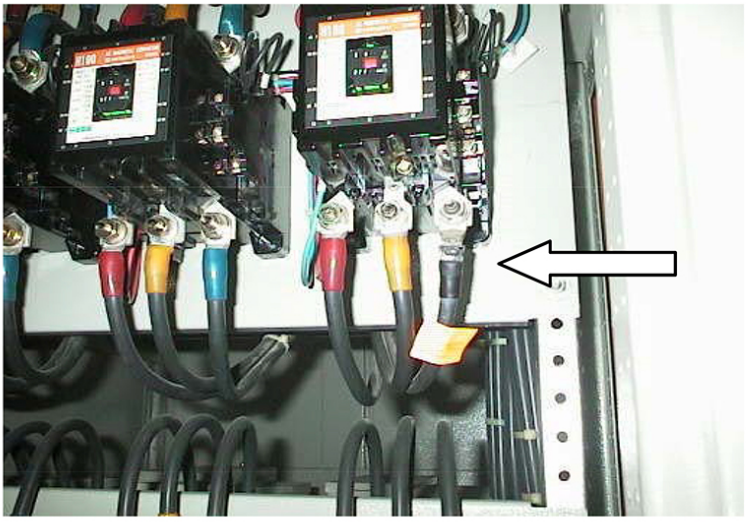
TYPICAL REPORT FORMAT

ACE ENGINEERING SDN BHD



Date: January 16, 2000
Time: 12:32 PM
Emissivity: 0.8
Amb.temp.: 29.0°C
Distance: 1.00m



THERMOGRAM: ACE1A05
LOCATION: MAIN SWITCHROOM
EQUIPMENT: Main Switchboard No.1
COMPONENT: P1 - 10X50 KVAR Capacitor Bank, Capacitor Step 5, Contactor B ph Bottom - HOT

REMARKS:

Exception Spot 1	105.3 °C	B ph
Reference Spot 2	54.5 °C	Yph
Difference	50.8 °C	

Repair priority rating: ****

ACTION: To reduce exception temperature IMMEDIATELY per N.E.T.A. recommendations. Possible loose lug connection. To replace the lug and cable. To clean and tighten the termination.

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