

## Thermal predictive maintenance strategies for the power-generation industry

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While many people in the power generation industry are familiar with the traditional basic uses of infrared thermography, some electric generating stations have recognized infrared thermography as a cornerstone of their condition monitoring program.

In power generation, the following summarize the importance of infrared thermography in three categories important in power generation.

1. Power delivery to the customer
2. Efficient electricity production
3. Preventive and Predictive Maintenance of production equipment

Electric utilities are charged with the unique responsibility in the United States, as a monopoly, to provide the highest quality product to the public at the lowest possible cost, and simultaneously as publicly owned companies to generate a return on investment for their shareholders. There is a fiduciary responsibility to operate efficiently, and infrared thermography is an absolutely essential component in fulfilling this responsibility.

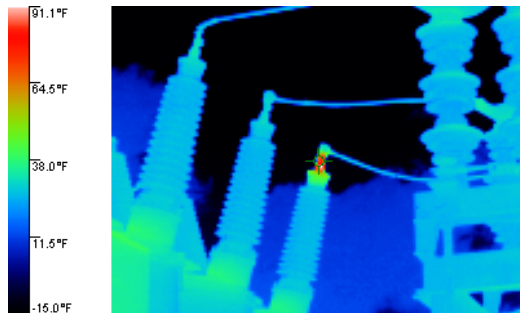
### Power delivery applications in power generation



Delivering electricity to the customers is the highest priority. When the power delivery system fails and your lights flicker and go out, we all suffer. We have become extremely dependent on our electricity always being on, always being available.

For this reason, the primary use of infrared thermography in the power generation

industry is the regular monitoring of the power distribution equipment. The 2300V and 4160V breakers and transformers are inspected to identify problems prior to scheduled maintenance outages.



<< examining a problem on the south phase connection of an oil filled circuit breaker >>

Switchyard inspections are normally performed during the pre-dawn hours in order to avoid solar reflections and effects from wind. During pre-dawn, the load is lighter but the air is usually calm,

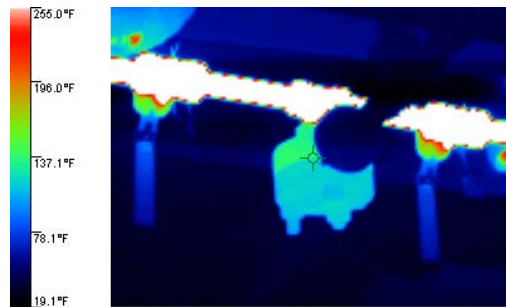
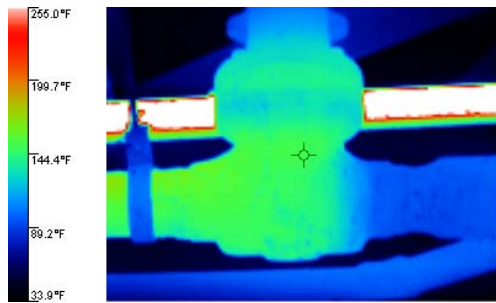
so any problems that are observed are certain to be significant, as they will be much hotter during the period of peak load. Traditionally, these inspections would be performed during periods of maximum load, however locally the wind and ambient conditions can mask serious problems so

experience and training have led many power generation thermographers to modify the practice for better results.

### Thermographic power production applications

While delivery of electricity is essential, efficient production is equally important. In coal fired stations, electricity is produced from steam driven turbines, and the steam produced from coal fired boilers. Efficient management of energy for power generation is critical in keeping the costs down for the customers and profits up for the shareholders.

When steam valves leak or fail, high energy content steam or water blows through to the condenser. This represents significant money literally down the drain! Infrared thermography enables efficient identification of these problems, thus helping control the cost of electricity production.



Above: IR image of a leaking closed steam valve

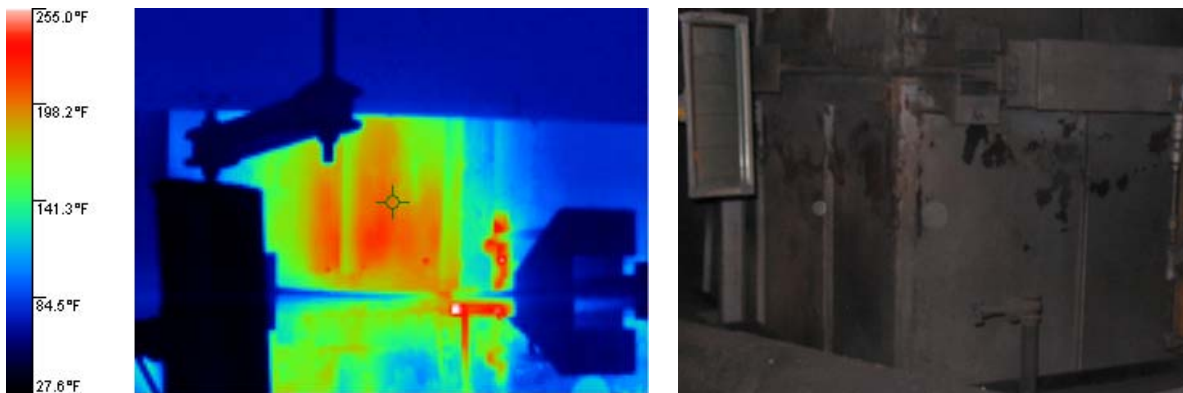
IR image of failed steam valves

Below: Inspecting boiler drain lines

Matching photo for above, steam line valves



Energy losses are not limited to the steam lines. Infrared thermography is used to inspect the boilers to identify areas of insulation breakdown.



Hot areas on the boiler walls indicate areas of worn insulation and significant energy losses. Infrared thermography helps identify these areas so they can be repaired during the next maintenance outage.

Whether you are examining steam lines or boiler walls, the comparative analysis is very straightforward. Training and experience is essential, but you do not need to be a Level II thermographer to gain significant benefits from using infrared cameras to identify problems.

#### **Predictive Maintenance Basics**

Predictive maintenance is especially important to power-generation facilities because so many are running past their original design lives. Preventing unplanned downtime while operating aging equipment on a fixed budget doesn't leave too many options.

Predictive maintenance (PdM) involves monitoring equipment over time for conditions that indicate impending failure, determining whether corrective action is required, and, if necessary, taking that action before the equipment fails. The goal is to avoid unplanned downtime and repair equipment when needed and scheduled.

PdM technicians identify critical production assets, determine how often they need to be monitored, set up an inspection route and schedule, and regularly measure key indicators. Then, they compare those measurements over time, looking for changes in operating conditions that indicate potential breakdowns. Available monitoring and measuring methods include infrared (IR) temperature measurement, vibration analysis, oil analysis, ultrasonic testing, electrical measurement, power quality, insulation resistance, and thermal imaging.

The benefits include significantly reduced downtime, maximized uptime, stocking an optimum number of spare parts, and lower labor costs for maintenance. Overall, PdM programs increase capacity or productivity using existing equipment. Some power generation facilities find that the data collected for predictive maintenance is also useful for meeting environmental documentation requirements.

#### **New technology in thermography**

Thermal imaging cameras have historically been very expensive. The latest technology offers a new generation of infrared cameras with uncooled 160x120 element detectors. These systems

offer a tremendous price/performance value to the power generation industry. These versatile tools are becoming indispensable for power generation facilities.

Generating stations that use professional infrared service providers can now economically react to trouble and do their own follow-up on repairs. Plus, these tools allow relative novices with basic infrared thermography training to perform qualitative infrared inspections of much of the plant equipment.

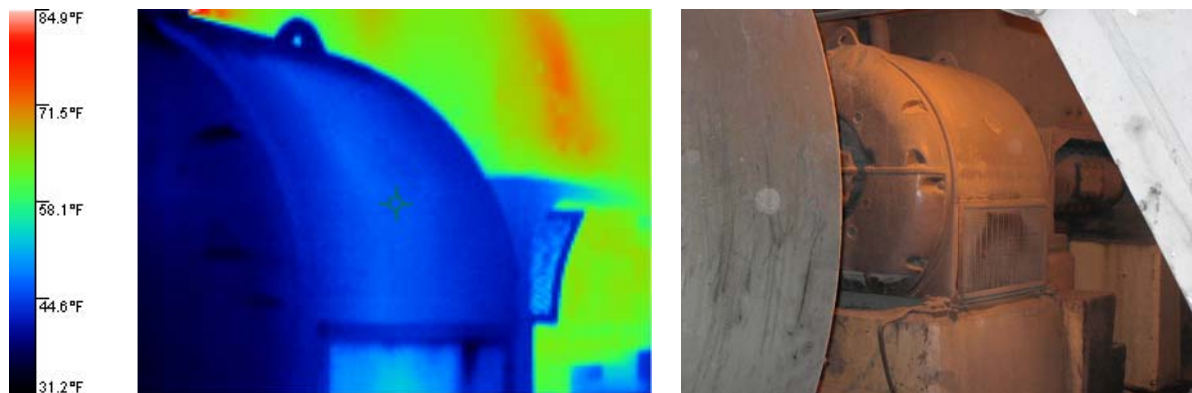
Infrared thermography requires an understanding of heat in terms of conduction, convection and radiation, plus detailed knowledge of the principles of infrared measurement: reflectance, absorbance and transmission. Emissivity is the most difficult issue to understand and deal with in infrared thermography, and requires training and experience.

However, much of the equipment in coal-fired power generating stations can be efficiently inspected with infrared thermography using qualitative and comparative infrared analysis. Most of the metal surfaces in a coal-fired plant are heavily oxidized and coated with fly ash. This means that most of the surfaces of interest generally have an emissivity of about 0.95.

Dirty metal surfaces are the rule in coal fired facilities. They don't often need to analyze the emissivity. When they do need to make more accurate measurements, they often use the thermographer's friend: a piece of black tape on the surface, or a contact temperature probe to allow them to adjust the emissivity until the infrared reading matches the contact probe.

#### **Qualitative & Comparative Infrared Analysis for PdM of Equipment**

In power generation facilities, most of the infrared analysis is qualitative and comparative – examining similar pieces of equipment under similar load. A primary example is the inspection of pulverizer motors. The steam boilers are hungry for coal. Many large 400 to 500 horsepower motors drive the pulverizers which feed the boilers.



Stations usually have a motor casing monitoring program, where we regularly check the case temperature for each motor. Motors all have NEMA temperature ratings on their nameplates, so we know the usual operating temperatures for the motors. The normal apparent temperature is approximately 120 – 140degF, depending on our ambient conditions. As the temperature rise approaches 40 degrees, it usually indicates the need to clean the filters. When the temperature rise exceeds 40 degrees, it indicates that the motor needs to be scheduled for cleaning and reconditioning. Since the motors are all about the same size and operating under similar loads, it is a fairly simple matter to identify “hot” motors comparatively and take corrective actions.

### **Thermography Training**

Infrared cameras are easy to use, and even easier to mis-use. Adequate training is essential to perform quantitative or qualitative infrared inspections. While issues like emissivity are minimized by dirty metal surfaces, other issues like reflections, convective losses due to wind, and other conditions can cause an untrained person to draw erroneous conclusions.

Two days of basic thermography training is essential to orient the novice to the versatility and limitations of infrared imaging so that they can begin to develop their technical skills. As they gain experience, they will undoubtedly have moments when it is not apparent what they see as they analyze problems, and they will begin to understand how much more they will benefit from additional training and knowledge.

### **Prioritizing problems equates to VALUE**

Value is the driving force in business and while we would like to live in a perfect world, the business world is far from perfect. We constantly deal with endless maintenance needs and limited resources.

Infrared thermography helps identify many maintenance needs but prioritizing the problems requires thoughtful evaluation of many factors. The most significant problem is not necessarily the one that has the hottest apparent temperature. Problems and the criticality of the equipment are evaluated to take into account the total cost, with issues like safety taking top priority, followed closely by the need to ensure that our production costs are minimized.

The greatest value is achieved by balancing the load. In thermography in power generation, the load is comprised of trained knowledgeable people, the right tools for the job, and time to get the job done during scheduled outages.

Infrared thermography is a powerful production tool to ensure our customers are receiving electrical power at lowest cost, to keep their lights on and the wheels of business turning.

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