

## CHASING VACUUM LEAKS

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*itc* Thermal Imaging Course  
Moderator

One really handy application for thermal imaging is in locating vacuum leaks. There are many processes that utilize or result in vacuums. In short, whenever a vessel has a pressure inside that is lower than normal air pressure, a partial vacuum is created. The production of semiconductor crystals, paper and electric power generation as well as many other uses result in vacuums.

### Power Plants

Detecting these leaks with an infrared camera is a challenge but certainly not impossible. In 1984 I purchased an Inframetrics 525 for just this purpose. As an engineer tasked with improving the thermal performance of a nuclear plant (i.e. get more Megawatts out by increasing efficiency on the non-nuclear side), I looked for any technology I could find. At the time I read an article about infrared thermography and knew I wanted one. I was very successful in identifying valve leaks, bad steam traps and what I am explaining here – vacuum leaks.

Steam plants heat water a variety of ways until it turns into steam. To be useful this steam must be at high temperatures and high pressure. The steam is passed through turbine blades and just like a fan would the turbine turns. These turbines are connected to a generator and generate electricity so engineers can turn on their laptop computers and write technical articles for monthly newsletters. I think electricity has one or two other uses as well... Anyway, as the steam passes



through a series of fixed and rotating blades it transfers some of its energy. Eventually most of the usable energy has been utilized and the steam is “recycled” by condensing it back into water for reheating back into steam.

The condensing process reduces the volume of steam by a factor of about 300:1. This means 300 cubic feet of steam is condensed into 1 cubic foot of water. This results in a pressure drop below atmospheric pressure. In fact many plants have a pressure inside the condenser of around 1 psia where the air we breath is 14.7 psia. Therefore any leaks are from the outside to the inside.

Air leaking into a steam system causes two major problems. First, the oxygen in the air contributes to the buildup of corrosion byproducts which has to be removed chemically in many cases. Second, the air is non-condensable and has to be removed as too much air can inhibit the free flow of steam. If the condenser cannot draw the steam through the turbine, there is less power delivered to the shaft and generator: less Megawatts! There is always some acceptable level of in-leakage but plant operators try to maintain the plant at optimum minimum levels.

### It's Convection

There are other methods of leak detection – ultrasonics, trace gas, soap bubbles – and all have value and some may work better than IR in certain cases. However, many leaks are more quickly found with an IR camera.

There are certain conditions necessary for a successful vacuum leak hunt: a warm

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LEAKS (CONTD.)

(Continued from page 1)

surface of high emissivity, a system under vacuum, at least one other method to confirm the leak (I like ultrasonics) and a patient and very thorough thermographer.

Convection heat transfer is very complicated as everyone knows. However, in the case of vacuum leaks its complexity helps us. We show in our training classes that air flow affects heated surfaces. This is what you look for when hunting vacuum leaks.

Small changes in air flow across a surface cause small changes in the surface temperature. Many times this temperature change is rapid and looking at suspected locations we can see the surface changing temperature.

Other times the leak is large enough that the temperature doesn't change, as in the bolt in the condenser picture.

In all cases IR can produce some false positives so rely on at least one other confirming test method before taking any corrective actions.

**What Leaks Where?**

There are many locations that can produce a vacuum leak. These include flanges, access covers, valve

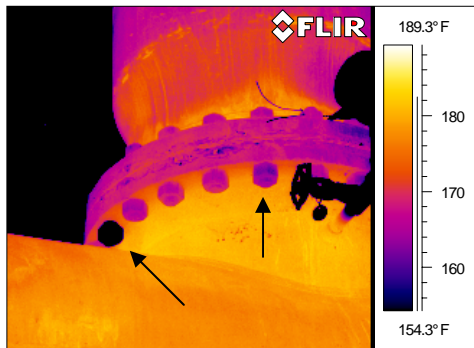


Figure 1. Flange at neck of condenser showing vacuum leak

stems & packing stuffers, turbine shell, rupture diaphragms, instrument line fittings and other mechanical joints, literally thousands of possible locations within a small plant.

**Examples**

In power plants we look for leaks above the water level and below. In general those above the water level are large and easily detected by ultrasonics and trace gas technology. Figure 1 shows

a flange at the neck of the condenser between a steam driven pump and the condenser. There is a 14 °F difference between the bolt that is the source of the leak and bolts not leaking. This bolt was loose and the air was being sucked past the bolt threads.

An example from below the water level is shown in Figure 2. Such leaks are harder to find with tracer gas technology but ultrasonics works well.



Figure 2. Another leak that shows up well in IR but is harder to find with tracer gas techniques

**Vacuum Pumps**

Common in many industries are vacuum pumps. The pump in Figure 3 is one of many drawing a vacuum used in the papermaking process. In this case the bolt that is leaking is very evident.

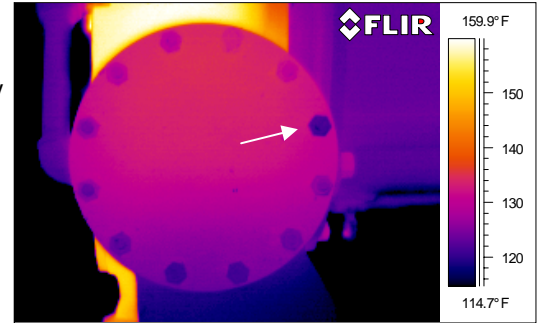


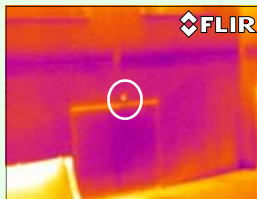
Figure 3. The leaking bolt in this vacuum pump is easy to spot

**Conclusion**

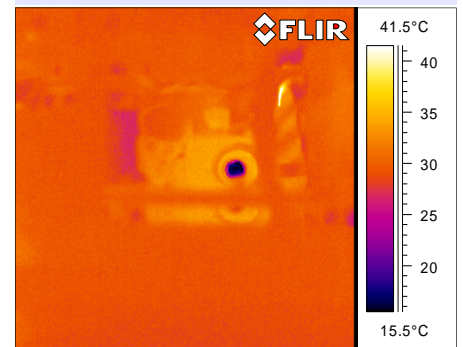
The examples shown above should be confirmed with another technology before any maintenance is planned. Occasionally there is a reason the bolts look different – usually due to emissivity differences. All of the above are probably large leaks. The smaller leaks may indicate an 0.1 °F temperature difference and usually are best observed and diagnosed as live, rather than static images. Good Hunting! ♦

**LAST MONTH'S BRAINTEASER**

Nobody was even close on April's Brainteaser. But that's okay, it was a hard one. The hot spot is a fly resting on the wall. ♦



**BRAINTEASER OF THE MONTH**



Here is this month's brainteaser. First reader to email me with the correct explanation wins \$20 in Infrabucks. Please put "Brainteaser" as the subject of the message. ♦



Mailto: [Gary.Orlove@infraredtraining.com](mailto:Gary.Orlove@infraredtraining.com)



# Infrared Thermography

## ***Level I certification course***

The Infrared Training Center is holding a series of infrared training courses and would like to invite you to attend!

The Level I course is geared to the new IR camera user and focuses on its use for a variety of applications.

Attendees completing course requirements and a field assignment will receive a Level I Thermography Certification.

### COURSE HIGHLIGHTS

- Introduction to thermal imaging and measurement systems for predictive maintenance applications. No experience in thermography is necessary!
- Collect quality data, accurate temperature readings, and account for measurement effects such as distance and emissivity using IR cameras.
- Interpret thermograms and make informed decisions using heat transfer concepts to analyze images, and see the latest in report generation and database software.
- Avoid costly mistakes — distinguish between hot spots and reflections, direct vs. indirect readings and qualitative vs. quantitative thermography.

### TUITION

A registration fee of \$1550 includes 4-day seminar cost, breakfast/lunch and all course materials.

### TIME & PLACE

**DATE:** May 20-23, 2002  
**TIME:** 7 A.M. TO 3:30 P.M.  
**WHERE:** Los Angeles Dept. of Water & Power  
11781 Truesdale St.  
Sun Valley, CA 91352  
(213) 367-7046 Contact: Louise

Hotels in the area are:  
Ramada Inn, 2900 N. San Fernando Blvd.  
Burbank, CA phone: (818) 843-3463  
Rate: \$78.40 + Tax (Ask for Natalia)  
Hilton, 2500 N. Hollywood Way  
Burbank, CA phone: (818) 843-6000  
Rate: \$144 + Tax

### REGISTRATION

If you have any questions or to confirm registration, please contact Laurie Kelley:  
(978) 901-8291 or toll free at 1-866 TRAINIR.

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# Infrared Thermography

## *Level II certification course*

The Infrared Training Center is holding a series of infrared training courses and would like to invite you to attend!

The Level II course is geared to the new IR camera user and focuses on its use for a variety of applications.

Attendees completing course requirements and a field assignment will receive a Level II Thermography Certification.

### COURSE HIGHLIGHTS

- Introduction to thermal imaging and measurement systems for predictive maintenance applications. No experience in thermography is necessary!
- Collect quality data, accurate temperature readings, and account for measurement effects such as distance and emissivity using IR cameras.
- Interpret thermograms and make informed decisions using heat transfer concepts to analyze images, and see the latest in report generation and database software.
- Avoid costly mistakes — distinguish between hot spots and reflections, direct vs. indirect readings and qualitative vs. quantitative thermography.

### TUITION

A registration fee of \$1550 includes 4-day seminar cost, breakfast/lunch and all course materials.

### TIME & PLACE

**DATE:** June 10-13, 2002  
**TIME:** 8 A.M. TO 5 P.M.  
**WHERE:** Days Inn Airport Indianapolis  
5860 Fortune Circle Drive - West  
Indianapolis, IN 46241  
**CONTACT:** 317-248-0621

The Days Inn Airport offers shuttle service to and from the International airport. Shuttle begins each morning 4:00 a.m. - 12:00 midnight. The Days Inn is located 1/2 mile from the International Airport.  
**ROOMS:** FLIR Systems Room Rate: \$58.00 + tax

Hotel info: <http://www.the.daysinn.com/indianapolis05568/hotelhome/?sid=AAAsrACwAAABrfAAL>

### REGISTRATION

If you have any questions or to confirm registration, please contact Laurie Kelley:  
(978) 901-8291 or toll free at 1-866 TRAINIR.

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**About the Infrared Training Center**

The Infrared Training Center offers training and certification in all aspects of infrared thermography use. Our world-class training facilities are located near Boston, Massachusetts, USA and Stockholm, Sweden and have the world's most extensive hands on laboratories for infrared applications. Please join us in exploring the fascinating world of infrared!

Your comments and suggestions about this newsletter are welcomed and encouraged. If you have an interesting application or case study to share, we encourage you to submit it for publication.

Please e-mail

mailto:[Gary.Orlove@infraredtraining.com](mailto:Gary.Orlove@infraredtraining.com) or regular mail to the USA office

*"Delivering world-class training and knowledge about thermography"*



**ite INFRAMATION** - Editor / Designer: Gary Orlove

**Upcoming Classes - Americas**

Remember we also teach customer site training courses at your convenience. Please contact us for more information.

**May 2002**

- 4/29-3 – Level I – Boston, MA
- 7-10 – Level III – Boston, MA
- 20-23 - Level I Montreal, Canada
- 20-23 - Level I - Los Angeles, CA
- 21-24 – Level I – Lake Charles, LA
- 27-31 – Level I – Brazil

**June 2002**

- 3-6 - Level II - Miami, FL
- 3-7 – Level I – Boston, MA
- 10-14 – Level II – Boston, MA
- 10-13 – Level II – Indianapolis, IN
- 18-21 - Level I - Puerto Rico
- 24-27 – Level I – Las Vegas, NV
- 24-28 - Level I - Trinidad

**July 2002**

- 15-19 – Level I – Boston, MA
- 15-18 – Level I – Portland, OR
- 15-19 – Level I – Venezuela
- 22-25 – Level I – Nashville, TN
- 29-8/1 – Level I – Detroit, MI

**August 2002**

- 5-9 – Level I – Boston, MA
- 6-9 – Level I – Chicago, IL
- 6-9 – Level I – Denver, CO
- 12-15 – Level II – Chicago, IL
- 13-16 – Level I – San Francisco, CA
- 26-29 - Level I - Honolulu, HI

**Upcoming Classes - International****May 2002**

- 13-17 - Level I - Indonesia
- 20-24 - Level I - Japan

**June 2002**

- 3-7 - Level I
- 10-14 - Level II - South Africa
- 17-21 - Level II - UK
- 24-28 - Level I

**July 2002**

- 1-5 - Level I - Italy
- 1-5 - Level I - South Africa (ABB)

**August 2002**

- No Courses

**Upcoming Classes - Germany****May 2002**

- 14-16 - Operator CM
- 14-16 - Level I EN 473 (part 1)
- 22-24 - Level I EN 473 (part 2)

**June 2002**

- 24-26 - Operator CM
- 24-29 - Level I EN 473

**July 2002**

- 9-11 - R&D
- 22-24 - Operator CM
- 22-27 - Level I EN 473

**August 2002**

- No Courses

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**Upcoming Classes - France****May 2002**

- 27-29 - Operator CM

**June 2002**

- 10-12 - Operator CM