[INFRARED THERMOGRAPHY]

**Industrial Applications**

*FLIR Systems - The World's Sixth Sense*

FLIR Systems, Inc. designs, develops, manufactures, markets, and distributes technologies that enhance perception and awareness. We bring innovative sensing solutions into daily life through our thermal imaging systems, visible-light imaging systems, locator systems, measurement and diagnostic systems, and advanced threat detection systems. Our products improve the way people interact with the world around them, enhance public safety and well-being, increase energy efficiency, and enable healthy and entertained communities.
CONTENTS
1.0 INFRARED THERMOGRAPHY ................................................................. 2
2.0 Background .................................................................................... 3
3.1 High voltage installations ................................................................. 4
3.2 Low voltage installations ................................................................. 5
3.3 Mechanical Installations ................................................................. 6
3.4 Pipework ....................................................................................... 7
3.5 Refractory and petrochemical installations.......................................... 8
3.6 Seeing through the flames ................................................................. 9
4.0 Other applications ........................................................................ 10
4.1 Flare detection .............................................................................. 10
4.2 Tank level detection ...................................................................... 10
4.3 For Gas Leak Detection and Electrical Inspections ......................... 12
5.0 Why use thermal imaging? .............................................................. 14
1.0 INFRARED THERMOGRAPHY

Galea Curmi Engineering is a dynamic organisation providing complete solutions in the field of infrared thermography and VOC optical gas imaging.

Established in 1996, the company embarked on a programme of continuous research, development of human resources and investment.

For the past 10 years, we have been offering infra-red thermographic surveying services to leading industrial firms in various countries in Europe, Middle East and Africa, using state of the art equipment and backed by qualified and experienced engineers in the field of infra-red thermography and, more recently optical gas imaging.

We have an extensive range of equipment suitable to meet the requirements of any infrared thermography application, including the most advanced optical gas imaging (OGI) technology available on the market. This, together with our engineers’ experience, enables us to provide complete solutions in the field of infrared thermography and gas leak detection.

Galea Curmi Engineering Services Ltd. has also been appointed FLIR Systems Authorised representative for the region comprising Malta and Libya and therefore is capable of providing a full range of services including:

- Camera sales and servicing
- Camera rentals
- Thermographic surveying and image analysis using state of the art equipment and software
- Certified training courses on camera operation, image analysis and interpretation, infrared thermography etc. to ITC (Infrared Training Centre) Level 1.
2.0 BACKGROUND

Thermal imaging cameras for industrial applications are powerful and noninvasive tools for monitoring and diagnosing the condition of electrical and mechanical installations and components. With a thermal imaging camera you can identify problems early, allowing them to be documented and corrected before becoming more serious and more costly to repair.

FLIR thermal imaging cameras:

- Are as easy to use as a camcorder or a digital camera
- Give you a full image of the situation
- Allow you to perform inspections when systems are under load
- Identify and locate the problem
- Measure temperatures
- Store information
- Tell you exactly what needs to be fixed
- Help you find faults before real problems occur
- Save you valuable time and money

FLIR Systems offers a wide range of thermal imaging cameras. Whether you use thermal imaging for an inspection of large industrial installations or for an inspection of a fuse box in a domestic residence, FLIR will have just the right thermal imaging camera for you.

A thermal image that includes accurate temperature data provides the maintenance expert with important information about the condition of the inspected equipment. These inspections can be done with the production process in full operation and in many cases the use of a thermal imaging camera can even help optimize the production process itself.
Thermal imaging cameras are such a valuable and versatile tool that we cannot possibly list all the possible applications. New and innovative ways of using the technology are being developed every day.

3.0 Electrical systems

Thermal imaging cameras are commonly used for inspections of electrical systems and components in all sizes and shapes.

The multitude of possible applications for thermal imaging cameras within the range of electrical systems can be divided into two categories: high voltage and low voltage installations.

3.1 High voltage installations

Heat is an important factor in high voltage installations. When electrical current passes through a resistive element, it generates heat. An increased resistance results in an increase in heat. Over time the resistance of electrical connections will increase, due to loosening and corrosion for instance. The corresponding rise in temperature can cause components to fail, resulting in unplanned outages and even injuries. In addition, the energy spent on generating heat causes unnecessary energy losses. If left unchecked, the heat can even rise to the point where connections melt and break down; as a result, fires may break out.

Examples of failures in high-voltage installations that can be detected with thermal imaging:

- Oxidation of high voltage switches
- Overheated connections
- Incorrectly secured connections
- Insulator defects

These and other issues can be spotted at an early stage with a thermal imaging camera. A thermal imaging camera will help you to accurately locate the problem, determine the severity of the problem, and establish the time frame in which the equipment should be repaired.
One of the many advantages of thermal imaging is the ability to perform inspections while electrical systems are under load. Since thermal imaging is a non-contact diagnostic method, a thermographer can quickly scan a particular piece of equipment from a safe distance, leave the hazardous area, return to his office and analyze the data without ever putting himself in harm’s way.

Due to the fact that FLIR’s thermal imaging cameras for industrial applications are all handheld and battery operated, they can also be used for outdoor inspections: high voltage substations, switchgear, transformers, and outdoor circuit breakers can be inspected quickly and efficiently with a thermal imaging camera from FLIR Systems.

Continuity is very important to utilities since many people rely on their services. Therefore thermal imaging inspections have become the core of utility predictive maintenance programs throughout the world. FLIR can provide the most advanced thermal imaging solutions to support 24/7 monitoring programs that keep the vital electrical power grid up and running.

### 3.2 Low Voltage Installations

Thermal imaging cameras are used for inspections of electrical systems and components in all sizes and shapes and their use is by no means limited to large high voltage applications alone. Electrical cabinets and motor control centers are regularly scanned with a thermal imaging camera. If left unchecked, heat can rise to a point that connections melt and break down; as a result, fires may break out.
Besides loose connections, electrical systems suffer from load imbalances, corrosion, and increases in impedance to current. Thermal inspections can quickly locate hot spots, determine the severity of the problem, and help establish the time frame in which the equipment should be repaired.

![FIGURE 3 - OVERHEATED CONNECTION](image)

Examples of failures in low voltage equipment that can be detected with thermal imaging:

- High resistance connections
- Corroded connections
- Internal fuse damage
- Internal circuit breaker faults
- Poor connections and internal damage

These and other issues can be spotted at an early stage with a thermal imaging camera. This will help to prevent costly damages and to avoid dangerous situations.

Whether you intend to use thermal imaging cameras for low voltage inspections in production plants, office facilities, hospitals, hotels or domestic residences, FLIR Systems has exactly the right thermal imaging camera for the job.

### 3.3 Mechanical Installations

In many industries, mechanical systems serve as the backbone of operations.

Thermal data collected with a thermal imaging camera can be an invaluable source of complimentary information to vibration studies in mechanical equipment monitoring.

Mechanical systems will heat up if there is a misalignment at some point in the system. Conveyor belts are a good example. If a roller is worn out, it will clearly show in the thermal image so that it can be replaced. Typically, when mechanical components become worn and less efficient, the heat dissipated will increase. Consequently, the temperature of faulty equipment or systems will increase rapidly before failure. By periodically comparing readings from a thermal imaging camera with a machine’s
temperature signature under normal operating conditions, you can detect a multitude of different failures.

Motors can also be inspected with a thermal imaging camera. Motor failures like brush contact-wear and armature shorts typically produce excess heat prior to failure but remain undetected with vibration analysis, since it often causes little to no extra vibration. Thermal imaging gives a full overview and allows you to compare the temperature of different motors. Other mechanical systems monitored with thermal imaging cameras include couplings, gearboxes, bearings, pumps, compressors, belts, blowers and conveyor systems.

Examples of mechanical faults that can be detected with thermal imaging are:

- Lubrication issues
- Misalignments
- Overheated motors
- Suspect rollers
- Overloaded pumps
- Overheated motor axles
- Hot bearings

These and other issues can be spotted at an early stage with a thermal imaging camera. This will help to prevent costly damages and to ensure the continuity of production.

3.4 PIWORK

Thermal imaging also gives valuable information about the condition of pipe, tube and valve insulation.
Inspecting the condition of the insulation material surrounding the pipework can be crucial. Heat losses due to failing insulation will show up very clearly in the thermal image, allowing you to quickly repair the lacking insulation and prevent significant energy losses or other damages.

Process valves are another good example of pipework related equipment that is often inspected with thermal imaging cameras. Besides leakage detection a thermal imaging camera can also be used to determine whether the valve is opened or closed, even from a distance.

Examples of pipework faults that can be detected with thermal imaging are:

• Leakage in pumps, pipes and valves
• Insulation breakdowns
• Pipe blockage

All types of leakage, blocked pipes and faulty insulation will clearly show up in the thermal image. And because a thermal image can quickly give you an overview of an entire installation, there is no need to check each pipe individually.

3.5 REFRACTORY AND PETROCHEMICAL INSTALLATIONS

A wide variety of industries rely on furnaces and boilers for manufacturing processes, but the refractory linings for furnaces, boilers, kilns, incinerators, crackers and reactors are prone to degeneration and loss of performance. With a thermal imaging camera damaged refractory material and the corresponding heat loss can be easily located, as the heat transmission will show up clearly on a thermal image.

FLIR thermal imaging cameras will provide rapid and accurate diagnosis for the maintenance of all types of installations that include refractory material.

Thermal imaging cameras are widely used in the petrochemical sector. They provide rapid, accurate diagnosis for furnace maintenance, refractory loss management and condenser fin diagnosis. Heat exchangers can be checked to detect blocked pipes.
FLIR Systems thermal imaging cameras are also used for inspecting cracker installations. Many pipes and tubes in a cracker are insulated with heat resistant refractory stone. Thermal imaging can easily see if the insulation is still intact. But furnace and boiler equipment is also prone to failures from a variety of other mechanisms. These include coking that plugs the inside of tubes and impedes product flow, slag build-up on the outside of tubes, under and overheating, flame impingement on tubes due to burner misalignment, and product leaks that ignite and cause serious damage to the equipment.

3.6 **Seeing through the flames**

To ensure refractory quality of boiler and furnace installations it is not enough to just perform inspections from the outside. The refractory on the inside of the boiler or furnace has to be inspected as well. With conventional methods it is necessary to shut down the installation to be able to inspect the inside. This is extremely costly due to a loss of production during downtime. These losses are not necessary, however, for FLIR Systems also has special thermal imaging cameras that can be used to inspect the inside of the installation during operation.
This is possible due to the flame filter FLIR has included in the design of these thermal imaging cameras. Flames emit infrared radiation at different intensities at different wavelengths and at certain wavelengths in the infrared spectrum flames emit hardly any thermal radiation at all. A flame filter uses that fact to enable the thermal imaging camera to 'see' through the flames.

![Image of thermal imaging camera and flame](image)

The ability of these FLIR thermal imaging cameras to 'see' through flames allows the operator to inspect the boiler or furnace installation during full operation. Not only does this eliminate the need for downtime during inspections, the information gathered with the thermal imaging camera can also be an extremely important control mechanism for safely increasing the production level, which can drastically improve the installation’s yield.

#### 4.0 OTHER APPLICATIONS

Apart from the applications already mentioned there are numerous other applications where thermal imaging technology is being used.

#### 4.1 FLARE DETECTION

During certain production processes gasses are generated which are burned off in flares. The flames generated can be invisible to the human eye. It is important to be sure that the flare is burning. Otherwise, harmful gasses might enter the atmosphere. Thermal imaging can easily see if the flare is burning or not.

#### 4.2 TANK LEVEL DETECTION

Thermal imaging can also easily be used for tank-level detection. Thanks to emissivity effects or to temperature differences the thermal image clearly shows the level of the liquid.
Other applications include:

- Finding hot spots in welding robots
- Inspection of aeronautical material
- Mould inspection
- Checking temperature distribution in asphalt pavements
- Inspections in paper mills

Whether you are interested in inspecting electrical installations, mechanical equipment, tank levels, installations with refractory material, pipe-work, flare burners and many, many more, thermal imaging is the perfect tool for all industrial applications. FLIR Systems offers you the perfect solution for the most demanding industrial applications. From the most affordable to the most advanced thermal imaging camera model, FLIR Systems offers you a full product range so you can choose the thermal imaging camera that best fits your needs.

![FIGURE 10 - THESE THERMAL IMAGES CLEARLY SHOW THE LEVEL OF LIQUIDS IN THE STORAGE TANKS.](image-url)
4.3 FOR GAS LEAK DETECTION AND ELECTRICAL INSPECTIONS

The FLIR infrared camera is a preventative maintenance solution to spot leaks in piping, flanges and connections in petrochemical operations. The infrared camera can rapidly scan large areas and pinpoint leaks in real time. It is ideal for monitoring plants that are difficult to reach with contact measurement tools.

KEY FEATURES

- Visualize gas leaks in real time
- Fully calibrated for temperature measurement applications
- Embedded GPS data in reporting
- Inspect without interruption of process
- Considerably reduce inspection time
- Trace leaks to source
- Spot leaks close by or meters away
- Verification of repair

MAKES REPORTING EASY

Images from FLIR GF-Series infrared cameras are recordable to any off-the-shelf video recorder for easy archiving and documentation

GASES DETECTED AND MINIMUM DETECTED LEAK RATE (MDLR)

Independent laboratory (third party) testing confirms that the GasFindIR cameras can see the following gases at the minimum detected leak rate (MDLR):

<table>
<thead>
<tr>
<th>Gas</th>
<th>MDLR (g/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Pentene</td>
<td>5.6</td>
</tr>
<tr>
<td>Benzene</td>
<td>3.5</td>
</tr>
<tr>
<td>Butane</td>
<td>-0.4</td>
</tr>
<tr>
<td>Ethane</td>
<td>0.6</td>
</tr>
<tr>
<td>Ethanol</td>
<td>0.7</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>1.5</td>
</tr>
<tr>
<td>Ethylene</td>
<td>4.4</td>
</tr>
<tr>
<td>Heptane</td>
<td>1.8</td>
</tr>
<tr>
<td>Hexane</td>
<td>1.7</td>
</tr>
<tr>
<td>Isoprene</td>
<td>8.1</td>
</tr>
<tr>
<td>MEK</td>
<td>3.5</td>
</tr>
<tr>
<td>Methane</td>
<td>0.8</td>
</tr>
<tr>
<td>Methanol</td>
<td>3.8</td>
</tr>
<tr>
<td>MIBK</td>
<td>2.1</td>
</tr>
<tr>
<td>Octane</td>
<td>1.2</td>
</tr>
<tr>
<td>Pentane</td>
<td>3.0</td>
</tr>
<tr>
<td>Propane</td>
<td>0.4</td>
</tr>
<tr>
<td>Propylene</td>
<td>2.9</td>
</tr>
<tr>
<td>Toluene</td>
<td>3.8</td>
</tr>
<tr>
<td>Xylene</td>
<td>1.9</td>
</tr>
</tbody>
</table>

The following services with are offered respect to Optical Gas Imaging (OGI):
- OGI Surveying services using our in-house FLIR GF320 camera
- Camera sales and service
- Training in Advanced Gas Detection courses using OGI techniques. This course is carried out under the umbrella of FLIR’s Infra-Red Training Centre (ITC). In fact, our licensed ITC instructor has carried out numerous such courses over the past 7 years in the EMEA region for several major players in the oil and gas industry.
5.0 **WHY USE THERMAL IMAGING?**

Producing faster, better, more efficiently and at a lower cost. In order to reach these goals, industrial plants need to be running continuously: 24 hours a day, 365 days a year. No costly breakdowns, no waste of time.

So, when you are in charge of plant predictive maintenance you really have a lot of responsibility on your shoulders. If you could only see when components are about to fail, you could accurately decide the best time to take corrective action.

Unfortunately the worst problems remain hidden until it is too late.

Thermal imaging cameras are the perfect tool for predicting failures because they make the invisible visible. On a thermal image problems seem to jump right out at you. To keep plants operational at all times many industries have combined their predictive maintenance programs with the most valuable diagnostic tools for industrial applications on the market: thermal imaging cameras.