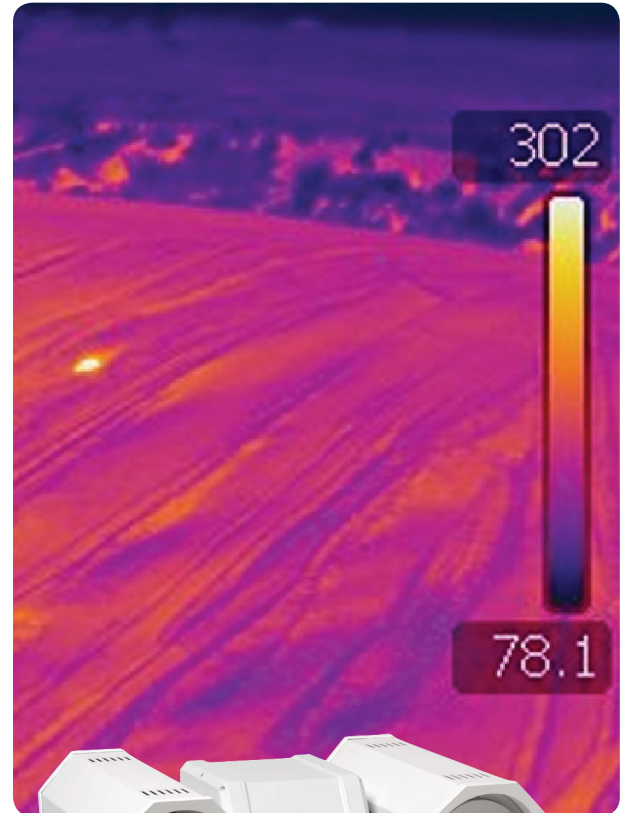


Bulk Material Combustion Warning Systems

Many bulk materials, such as coal and organic wastes, are stored as large piles in open yards where air and moisture promote decomposition and exothermic reactions that raise the pile's temperature. Since self-ignition usually starts within the pile's lower layers, a full-blown fire can develop before it becomes apparent due to smoke and flames. In addition to material loss, these events can cause monetary loss due to equipment and structural damage from fire fighting activities. FLIR's Bulk Material Combustion Warning Systems use an infrared camera to generate a thermographic image of the area being monitored. This clearly shows hot spots on a remote video or PC monitor in real time and triggers an alarm. This application flyer describes how these systems can be designed and used to save hundreds of thousands of dollars by preventing loss before a fire happens.

DETECT DEVELOPING FIRES IN COAL PILES AND OTHER EXOTHERMIC MATERIALS

- Great for monitoring coal stockpiles, compost piles, landfills, scrap bunkers, rail hopper cars, etc.
- Remote monitoring – see high temperatures without onsite personnel
- Connect multiple cameras to a central monitor via Ethernet
- Locates combustion developing below the surface before smoke or flames appear
- Helps prevent material loss and damage to buildings or equipment
- Earliest possible warning with trend analysis software
- Also enhances intrusion security
- Works day or night in any weather – 24/7 operation



This publication is one of the FLIR Solution Series that describes important applications for IR camera systems. This Series is designed to show our customers how FLIR systems can be used to help reduce costs by protecting their assets, improving production automation and machine vision processes, and increasing the value of their predictive/preventative maintenance operations. The images, case histories, and system designs described in this Series are merely examples of the many possibilities available to users of FLIR IR cameras.

Bulk Material Combustion Warning Systems



Spontaneous Combustion

Many bulk materials are stored as large piles in open yards where air and moisture promote decomposition and other exothermic reactions that raise the temperature of the pile. This brings with it the threat of fire, direct monetary loss, and safety issues for personnel. In addition, there is the risk of consequential damages caused by fire, including loss of nearby property, water damage resulting from fire fighting, and production shutdowns. Lack of attention to these risks may also increase insurance premiums.

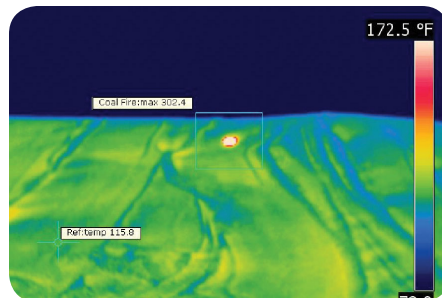
Storage piles that are especially prone to spontaneous combustion include coal, organic wastes (compost, etc.), scrap paper for recycling, wood, and various inorganic chemicals, such as cement and chlorine hydrates. Some metals, such as aluminum, can react with certain liquid wastes, creating gases that are easily ignited. Even in the absence of spontaneous combustion, many bulk materials like plastics pose a fire hazard due to sparks or other external ignition sources. Since self-ignition usually starts within the lower layers of a pile, a full-blown fire can develop before it becomes apparent to observers due to smoke and flames. Therefore, an early warning system is needed to monitor the surface and reveal hot spots at an early stage, so measures can be taken to prevent a major fire from breaking out.

Cost-effective Early Warning

FLIR's Bulk Material Combustion Warning Systems use an infrared camera to generate a thermographic image of the area being monitored. This clearly reveals hot spots on a remote video or PC monitor in real time. In addition, this "Smart Camera" can be programmed to set the temperature at which an alarm signal is generated, and multiple target spots and alarms can be used. The alarm output can be wired directly to an alarm device, annunciator, programmable logic controller (PLC), or PC-based monitoring and control system. When an alarm occurs, personnel can then go to the visual monitor to verify the problem and its exact location.

Why Infrared is So Effective

All objects emit thermal radiation in the infrared spectrum that is not seen by the human eye. IR cameras convert that radiation to a visual image that is calibrated to a temperature scale. This non-contact temperature data can be displayed on a monitor, and can also be sent to a digital storage device for analysis. Measurement accuracy is typically $\pm 2^{\circ}\text{C}$.



In our Bulk Material Combustion Warning Systems FLIR IR video cameras produce the visual images and non-contact temperature data. Unlike visible image cameras that may detect smoke, IR video cameras do not require lighting to produce their images, and can see hot

spots well before smoke or flames appear. They can be mounted in all-weather housings and placed on pan/tilt drive mechanisms to survey extensive storage piles. With different focal length lenses, they can be placed wherever required. Therefore, they support 24/7 monitoring in all environments and locations.



Industries and Applications

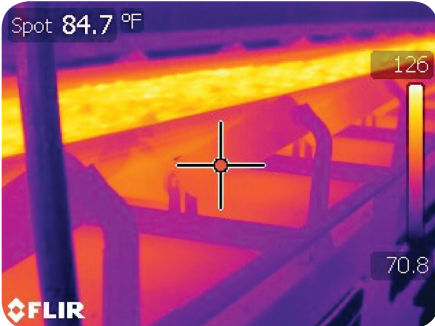
Businesses adopting IR monitoring have found that they receive an excellent return on their investment in the form of reduced loss, lower insurance premiums, and more timely maintenance. In addition to storage pile monitoring, typical applications include:

- Rail hopper cars arriving at coal-fired power plants
- Conveyors in coal prep plants associated with mining
- Ship holds in marine transport
- Steel mill coking plants
- Coal gasification and liquefaction plants
- Scrap processing yards
- Active and inactive landfills

As always, fire prevention or early detection is less expensive than fighting one after a full breakout. The same goes for early detection of maintenance problems, such as damage to conveyor belts due to hot inclusions, grinder or shredder bearings running hot due to contamination, or impaired infrastructure because of high temperatures.

Bulk Material Combustion Warning Systems

In many cases, low temperatures can also cause problems, which IR monitoring helps prevent. For example, in winter weather the lumps of coal stored in a bunker can freeze together, making it difficult to remove and handle. One solution is to spray the coal with



antifreeze before it enters the bunker. However, antifreeze is expensive, and may not be needed if the coal going in is warm enough. An IR camera can provide non-contact temperature measurements to resolve this issue and save cost in the long run.

Flexible System Configurations

The cost of an automated temperature monitoring system using infrared cameras is a modest and worthwhile investment for many types of bulk material storage and handling applications. System design can take many forms, customized for specific applications. In all cases the cameras are configured to generate an alarm output when user-defined maximum temperature thresholds are exceeded. Audible and visual alarms in a control room draw the operator's attention to a potential fire threat, or equipment problem. Various types of software have been developed to isolate trouble spots and display temperature data for each one.

Although these systems can provide a signal directly to an audible or visual alarm device, they can also be combined with a PLC or PC controller to create

a monitoring system with advanced features. With FLIR's IR camera firmware, or PC-based software, these features can include:

- **High, low, and average temperatures in an image**
- **Temperature set-point alarms**
- **Multiple target spots and alarms**
- **Delays to ignore temporary temperature increases due to vehicles in the area**
- **Temperature trend analysis to reveal problems before a set-point is reached**
- **Ethernet connections to a central controller**
- **Connecting multiple cameras to a central monitor**
- **Alarm messages and images via Ethernet, email, or ftp**

Camera Features Fill Many Needs

The features of the FLIR A310 allow this one camera system to satisfy many different requirements in bulk material monitoring and handling. A great example is a commercial coking operation that uses FLIR cameras to assist in filling rail cars, where coke is dumped out of bins into the car. This environment is very dusty and the inside of the rail car is often obscured by steam as it is being filled. The spectral response of the camera allows the operator of the coke



loader to "see" through steam using a thermographic image on a PC monitor, which avoids under or over filling the rail car. Cameras are cabled to the operator's

PC with an Ethernet connection, and get their operating voltage directly from that connection via POE (Power Over Ethernet). The area where they are used is classified as hazardous due to the presence of volatile hydrocarbon vapors, so the cameras are mounted in a special housing. The housing has a germanium window that is transparent to the wavelengths of the camera's IR detector. The housing also has an air purge system that blows air across the window to help keep it clear.

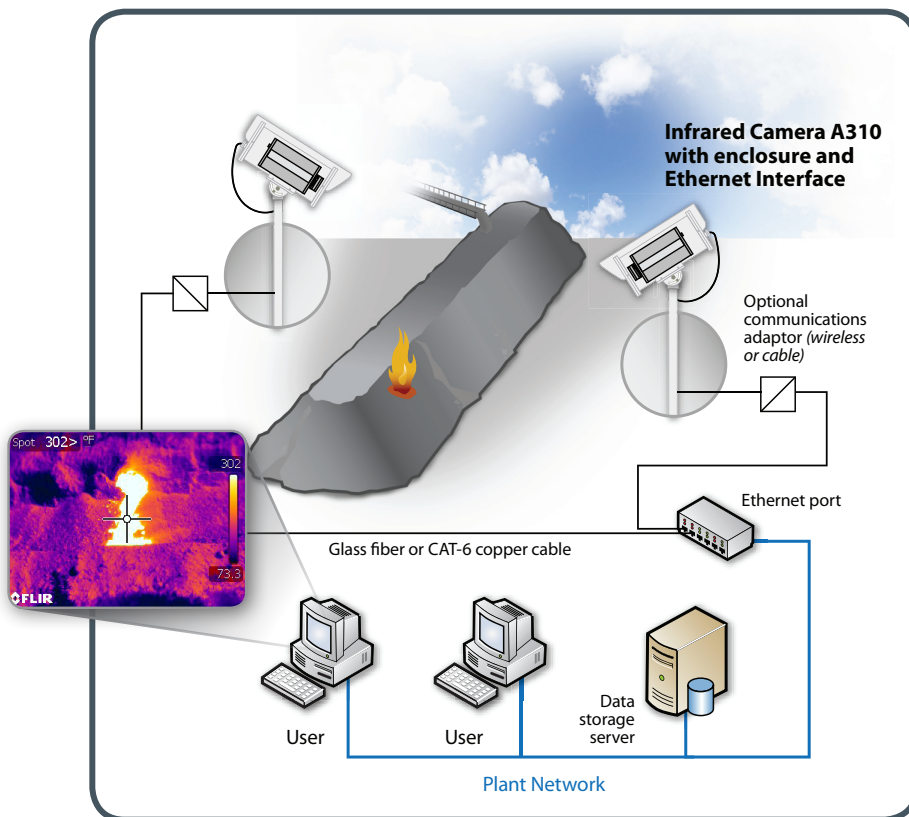
System Connections and Variations

The diagram on the following page depicts connections for a few of the possible system variations, based on the FLIR A310 Camera. Although analog video and digital I/O outputs allow this camera to operate as a standalone smart sensor, many bulk material applications also use its digital data stream, sent over Ethernet lines to a PLC or PC controller. When used in this manner, the temperature data is one of the primary inputs to the PLC or PC controller, which is part of a broader facility monitoring and control system. In conjunction with its alarm setpoint capabilities, the A310's Ethernet communication can supply a digital compression of the camera's analog video signal to virtually anywhere a PC is running monitoring software. FLIR'S software allows a PC to display up to nine camera images at a time, and switch between additional camera groups as needed. In addition to viewing thermographic images, temperature data can be stored and analyzed to produce a trend analysis.

Field Survey

Contact IMC for a survey of your storage area and our recommendations for a Bulk Material Combustion Warning System.

Bulk Material Combustion Warning Systems



Camera Specifications

Detector	320x240 pixel uncooled microbolometer focal plane array
IR Spectral Band	7.5 – 13µm
Object Temperature Range (Selectable)	-20°C to +120°C or 0°C to +350°C
Accuracy	±2% or 2°C of reading
Sensitivity	0.07°C at 30°C
Field of View (FOV)	25°(horz) × 18.8°(vert.)
Focus	Auto and manual with electronic zoom
Min. Focus Dist.	0.4m
Spatial Resolution (Instantaneous FOV)	1.36mrad
Image Update Rate (Selectable)	9 or 30 frames per second
A/D Converter	14-bit
Interfaces	NTSC/PAL video, Ethernet, and Digital I/O (10-30VDC)
Electrical	12/24VDC power
Physical	170x70x70mm, 0.7kg
Mounting	Tripod (UNC ¼"x20) or 2xM4 threaded holes
Environmental	-15°C to +50°C operating range; 2g vib./ 25g shock per IEC 60068-2-6/29
Optional Accessories	Lenses with different focal lengths and FOVs, various housings, and mounting options (consult factory)
Included Software	Allows easy camera setup, alarm configuration, thermal image and temperature data capture, trend analysis, and remote monitoring via Ethernet, ftp, and email.

WE KNOW INFRARED. LIKE NOBODY ELSE.

FLIR invented the infrared camera industry as we now know it. We brought the first commercial IR camera to market in the 1960s and have piled up more industry firsts in thermal imaging than anyone. Today we are the only global company totally dedicated to finding and fixing thermal problems through IR imaging systems. Our company's mission is to provide the most innovative systems available, with the highest possible quality, and show thermography practitioners how to get the most out of them. Our goals, now and in the future, are to provide greater insight into all types of thermal phenomena, and help our customers save money by applying this knowledge. This is supported by the most comprehensive and respected training courses in the industry.

FLIR's 'smart' IR cameras are used in basic research, non-destructive testing, product development, factory automation, equipment and building maintenance, asset protection, medical diagnostics, public safety, national defense, and a host of other applications. No other company offers the breadth of thermal imaging/temperature monitoring products supplied by FLIR, and none is as dedicated to technical excellence as our 350+ engineers. Within the past three years alone, FLIR has spent more than \$230 million on R&D. Our customers are the primary beneficiaries of this investment, enjoying an ROI that amounts to millions of dollars a year in direct savings from operating efficiencies and loss avoidance. As a result of this leadership, FLIR is the most trusted name in the industry.

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