White paper

Explosion Protected Network Cameras

Combining technologies

AXIS COMMUNICATIONS

Table of contents

Introduction

Explosion protected network cameras provide great image quality and flexible integration possibilities for demanding and hazardous environments. Intelligent image processing, together with excellent streaming performance and high resolution, gives image quality rarely seen in explosion protected cameras before.

Explosion protected network cameras are heavy-duty enclosures containing networked Internet Protocol (IP) cameras. The enclosure is a stainless steel housing that is certified for use in hazardous environments. The housing works as a container, stopping any sparks from escaping and starting an explosion by igniting vapors, gases, dust, or fibers in the air surrounding it.

Explosion protected network cameras used in a hazardous environment can be integrated with a system of network cameras for safe areas already in place on an existing computer network, extending the usability of the cameras with video analytics, video streaming and video storage.

1. Application areas

Explosion protected network cameras can be used for a wide variety of purposes in hazardous areas, promoting health, safety and environment (HSE). They offer detection, verification and identification to ensure security, safety and process reliability. Integrated in a physical access control system, they can provide identity management to improve security. To enhance and maintain process reliability, they can be used for visual verification of processes.

In industrial control systems, network cameras give eyes to the sensors, which means shorter time inside hazardous areas for service personnel, as well as less downtime. For the purpose of safety, they can be used for the surveillance of plants and transportation systems. Thanks to their versatility, network cameras provide security from the perimeter all the way to the critical center.

There is a vast number of industry segments where equipment needs to be explosion protected. Explosion protected network cameras are aimed especially for hazardous areas in onshore, offshore, marine and heavy industrial environments. These segments include oil and gas refineries, offshore platform rigs, gas pipelines and distribution centers, gas stations and chemical processing plants. Other, perhaps less obvious industry segments are printing, paper and textile industries, sugar refineries, grain handling and storage facilities, woodworking areas, waste treatment and premises used for metal surface grinding (especially aluminum dusts and particles). Even though the materials used in these segments usually are considered to be non-flammable, or slow burning, they may be ignited and explode when in dust form.

Figure 1. Typical industry segments for explosion protected equipment are onshore and offshore oil and gas industry, grain handling and storage.

1.1 The oil and gas industry

There are issues that are quite unique to the oil and gas industry, apart from the risk of explosions in hazardous areas. In the oil and gas industry, production takes place in largely remote areas. The oil transport system is global, including super tankers and continent crossing pipelines. Oil products are moved by ship, barge, truck, rail and pipeline.

Oil and gas companies must regularly collect critical data from remote well sites, offshore drilling platforms and outlying production locations, as well as from Supervisory Control and Data Acquisition (SCADA) systems set up to monitor facilities, such as storage tanks, pumping stations or pipelines. Some well sites are far away from the closest monitoring facilities, making on-site data collection a costly and time-consuming operation. Establishing the required broadband network links between multiple locations can be extremely difficult, given that these activities generally occur where wire line links are not practical. By means of network video surveillance systems, several of these issues can be addressed.

Remote monitoring and control allow users to control remote facilities in response to changing system demands. Network video surveillance systems can be used for process monitoring of critical zones and processes, such as drilling, pumping, compressor stations, tanks, pipelines and refineries.

Despite the issues with remote facilities and the challenges they bring, the main concern of oil and gas companies must be HSE. Of course, it is necessary to respect safety instructions and environment policies, and using the right tools and protective equipment is essential. Network video surveillance systems can, apart from the advantages mentioned earlier, reduce risk levels by monitoring emergency procedures and crowd flows.

2. Why use network cameras in hazardous areas?

A network video surveillance system provides benefits and advanced functionalities that cannot be provided by an analog video surveillance system. The advantages include superior image quality, built-in video analytics, increased safety, easy future-proof installation and integration, remote accessibility and better scalability, flexibility and cost-effectiveness.

2.1 Superior image quality

Network cameras can provide full HDTV resolution with exceptional image quality and color fidelity at a high frame rate. Motorized optical zoom and autofocus allow the cameras to cover great distances providing both wide overviews and detailed images for identification purposes.

In a network video surveillance system, images from a network camera are digitized once and they stay digital without any unnecessary conversions or image degradation due to distance traveled over a network. In an analog system, on the other hand, images have to be converted several times on their way from the camera to the operator.

The excellent light sensitivity of network cameras makes them able to record scenes in high detail even in low-light conditions, without any extra illumination equipment. The Wide Dynamic Range (WDR) technology enables the cameras to handle a greater span between bright and dark areas in the image.

See Section 8, Useful links, 'Image quality: Usability is the real issue', for more information on image quality.

2.2 Video analytics and increased safety

Built-in intelligence such as Video Motion Detection, Cross Line Detection or Active Tampering Alarm enables constant analysis of input to detect an event, and to automatically respond to it with actions such as video recording and alarm notifications.

Video Motion Detection enables reliable detection of moving people and objects, whereas Cross Line Detection works as a virtual trip wire. It detects moving objects that cross a virtual line set up by the user across the field of view of the camera, making it possible to automatically trigger an event. Active Tampering Alarm can detect if a camera has been redirected, obscured or tampered with, and can send alarms to an operator. This is especially useful in installations in demanding or hazardous environments where keeping track of the proper functioning of cameras is associated with difficulties. Pixel Counter assures that the pixel resolution of an object fulfills any regulatory or specific customer requirements for identification purposes, and Advanced Gatekeeper automatically moves the camera to a preset position when motion is detected in a predefined area. All these video analytics applications contribute to increased safety, which is never more essential than in hazardous areas.

Thanks to the superb image quality and excellent light sensitivity of network cameras, the video analytics applications work in variable lighting conditions for both indoor and outdoor installations.

See Section 8, Useful links, 'Axis Video Analytics', for more information on video analytics.

2.3 Flexible integration

Network video provides a high level of integration with other equipment and functions. Existing computer networks, such as Local Area Networks (LAN) and the Internet, can be used for video streaming and video storage. Unlike an analog system, a fully integrated network video system can be used for a multitude of applications simultaneously, such as access control, building management, fire alarms and intruder and visitor management. To monitor temperatures remotely, it is easy to add a temperature alarm camera to a system of network cameras.

See Section 8, Useful links, 'Remote temperature monitoring', for more information on temperature alarm cameras.

A network video system can grow with the user's needs — one camera at a time — while analog systems often can only grow in steps of four or 16 at a time. In a network video system, any number of network video products can be added without significant and costly changes to the network infrastructure. In an analog video system, on the other hand, a dedicated coaxial cable must run directly from each camera to a viewing/recording station. Using standard PC server hardware rather than proprietary equipment such as Network Video Recorders (NVR) radically reduces management and equipment costs. Video encoders make it possible to integrate an existing analog Closed-circuit Television (CCTV) video surveillance system with a network video system, taking advantage of existing cameras and infrastructure and combining them with state-of-the-art network camera technology.

2.4 Remote accessibility

In a network video surveillance system, users can access real-time video at any time, from any authorized computer, anywhere in the world. Video can be stored at remote locations for convenience and security, and the information can be distributed over any existing IP-based networks such as LANs or the Internet.

Network cameras can be used both for remote monitoring and to facilitate remote maintenance. An initial, visual inspection can be performed without having a technician on site. When hands-on maintenance is required, anyone working in a hazardous area can be monitored remotely.

See Section 8, Useful links, 'Ten reasons to buy a network camera', for more information on the advantages of network cameras.

3. Basics of explosion

An explosion is a rapid process that releases energy and gives rise to a shock wave. For an explosion to occur, three components must be present: fuel, an oxidizer and energy. If one or more of these components is removed, no explosion will take place.

Fuel is mixed with some form of oxidizer, usually air, to form an explosive atmosphere. An explosive atmosphere is defined as a mixture of an oxidizer and flammable substances in the form of gases, vapors, mists or dusts, under atmospheric conditions. Thermal or electrical energy is required to ignite the combustible mixture, and after ignition the combustion spreads to the entire unburned mixture. The source of an ignition can be lightning strikes, open flames, mechanically generated impact or friction sparks, electric sparks, radiation, electrostatic discharge, high surface temperature or shock waves. An area where there is a risk for explosions is called a hazardous area.

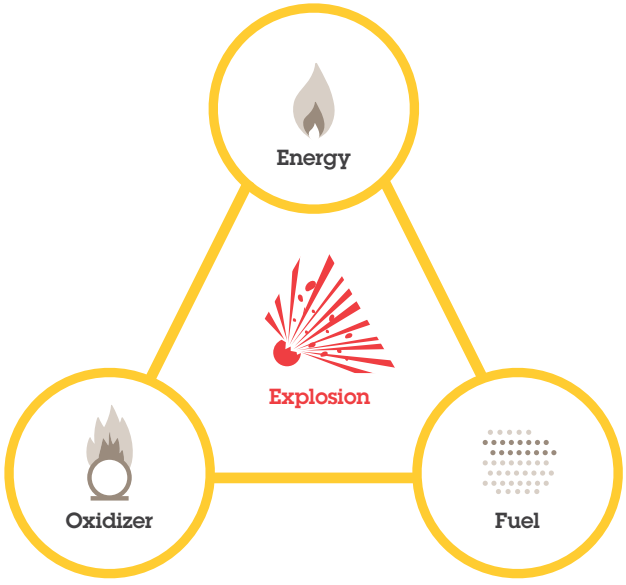

Figure 2. The three components that must be present for an explosion to occur.

3.1 Combustible dusts

A material can only burn at its surface, where it can react with oxygen. Dust has a large surface area compared to its mass, which makes material in dust form much more flammable than the same material in a bulk form. Because the particles are very small, they need much less energy to catch fire than the bulk material, since no energy is lost through thermal conduction within the material. Coal, sawdust, aluminum dust, starch, pollen, sugar and flour are examples of combustible dusts.

3.2 Hazardous areas

A hazardous area is an area where flammable liquids, vapors, gases or combustible dusts are likely to occur in quantities sufficient to cause a fire or explosion. Such areas include oil refineries, rigs and processing plants, gas pipelines, automotive and aircraft refueling stations, but also hospital operating theatres, sewerage treatment plants, woodworking areas and places where grain is handled and stored.

Other names for hazardous areas are Ex areas, classified areas, explosive areas or hazardous locations, also known as HAZLOCs.

3.3 Safe areas

Explosion protected network cameras are designed for use in hazardous areas. Non-hazardous areas are called safe areas. In safe areas, Axis standard product portfolio can be used, giving the user access to a wide range of versatile, high-quality cameras and intelligent video analytics applications, such as Cross Line Detection and Active Tampering Alarm. In safe areas, other network products, such as physical access control and network audio, can also be used.

4. Principles of explosion protection

Equipment used in hazardous areas must be designed to be explosion protected. There are three basic principles for explosion protection:

1. Prevention
2. Segregation
3. Containment

When prevention is used, the electrical and thermal energy is limited to safe levels, both during normal operation and if a fault should occur. Equipment that are intrinsically safe use this principle.

When segregation is used, the electrical parts or hot surfaces are physically separated from the explosive atmosphere. Segregation can be accomplished by various techniques, such as pressurization and encapsulation.

Containment means that if an explosion should occur, it will be confined to a well-defined area, preventing it from propagating to the surrounding atmosphere. Flameproof or explosion protected enclosures take advantage of this principle.

5. Industry standards and certification

Different industry standards for explosion protected equipment apply in different parts of the world, see Figure 3. All standards concern equipment used under normal atmospheric conditions, that is, normal atmospheric pressure (0.8–1.1 bar), normal oxygen level (21%) and normal atmospheric ambient temperature (-20 °C to 40 °C/-4 °F to 104 °F).

Figure 3. The geographical distribution of different certifications.

5.1 The ATEX system

In the EU, equipment must comply with the essential requirements of EU Directive 94/9/EC (that will be replaced by 2014/34/EU after 20 April 2016), also known as the ATEX[1] Directive. The ATEX Directive consists of two EU directives describing what equipment and work environment is allowed in an environment with an explosive atmosphere. The ATEX Directive is the most international of all standards.

1 *Appareils destinés à être utilisés en ATmosphères Explosives (ATEX)*

5.1.1 Zones

Hazardous areas are divided into zones. The zone defines the probability that hazardous material will be present in an ignitable concentration in the surrounding atmosphere. For gases, Zone 0 is an area in which an explosive gas-air mixture is continuously or frequently present, or present for long periods. Zone 1 is an area in which an explosive gas-air mixture is likely to occur for short periods during normal operation. In Zone 2, an explosive gas-air mixture is not likely to occur. If it occurs, it will only exist for a very short time due to an abnormal condition. For clouds of combustible or conductive dusts, the equivalent zones are 20, 21 and 22. Zones 1 and 2 (or 21 and 22 for dust) are the most common classifications, whereas Zone 0 (or 20 for dust) is restricted to small, inaccessible areas or areas inside technical equipment.

5.1.2 Types of protection

Electrical equipment used in hazardous areas can be protected from explosions in several ways. Table 1 lists the different types of protection, their designation and in which zones they apply.

Table 1. Types of protection

Designation	Type of protection	Zone
Ex d	Flameproof (explosion protected) enclosure	1, 2
Ex e	Increased safety	1, 2
Ex ia	Intrinsically safe	0, 1, 2
Ex ib	Intrinsically safe	1, 2
Ex o	Oil immersion	2
Ex p	Pressurized (purged) apparatus	1, 2
Ex q	Powder (sand) filling	2
Ex m	Encapsulation	1,2
Ex n ir Ex N	Non-incentive and/or normally no sparking circuits	2

Equipment certified for Zone 0 must not constitute an ignition source even if two independent faults should occur. Equipment for Zone 1 must not constitute an ignition source if a fault should occur, or it should be designed to prevent faults or explosion by preventing the combustible gas mixture to reach the ignition source. An inner explosion should be prevented from spreading to the surrounding gas mixture (by an explosion protected housing). There should be no ignition source and measures should be taken to prevent an ignition source to occur at a fault. Equipment for Zone 2 must not constitute an ignition source during normal operation.

5.1.3 Groups of apparatus

For the certification of explosion protected equipment, all types of apparatus are divided into three groups, as listed in Table 2. Group I covers equipment used in mines and Groups II and III cover all other applications.

Table 2. Groups of apparatus

Application	Group	Sub group	Concerns applications where hazards due to the following substance(s) may exist:
Mining	I		Methane
Explosive gases	II	A	Propane, methane and similar gases
		B	Ethylene and other such industrial gases
		C	Acetylene, hydrogen and other very easily ignited gases
Combustible dusts	III	A	Flammable particles
		B	Non-conductive dust
		C	Conductive dust

5.1.4 Temperature classes

A mixture of air and hazardous gases may ignite by coming in contact with a hot surface. Whether an ignition will occur depends on the temperature of the surface area and the concentration of the gas. The ignition temperature, or auto-ignition temperature (AIT), is the lowest temperature of a substance, whether solid, liquid or gaseous, to initiate a self-sustaining combustion. Apparatus used in any hazardous area must not have any surface whose temperature exceeds the AIT, neither during normal nor abnormal operation.

The maximum temperature of a piece of equipment must always be lower than the AIT of the gas, vapor or air mixture in which it is placed. Certified equipment are tested for maximum temperature ratings by approval agencies. Tested equipment receives a temperature code indicating the maximum surface temperature, as listed in Table 3.

Table 3. Temperature codes

Temperature code	Max. surface temperature (°C)	Max. surface temperature (°F)
T1	450	842
T2	300	572
T3	200	392
T4	135	275
T5	100	212
T6	85	185

5.1.5 Product marking

All electrical equipment certified for use in hazardous areas must be labeled to show the type and level of protection applied. In Europe, the label must show the CE mark and the code number of the certifying body. The CE mark is complemented with the Ex mark, followed by the Group, Category and, if Group II equipment, whether the marking relates to gases (G) or dust (D).

An example: **Ex II 1 G**
This means that the product is explosion protected, the group is II (not mining equipment), the category 1 (very high level of protection), and that the indication relates to gas.

In addition, the normative marking will be able to establish the specific type or types of protection being used.

An example: **Ex ia IIC T4**
This means that the type is ia (intrinsically safe), the group IIC (gases), and the temperature category 4 (max. surface temperature 135 °C/275 °F).

5.2 IECEx

The voluntary IECEx Equipment Certification Scheme can facilitate acceptance of equipment for use in an explosive atmosphere in other major jurisdictions around the world. IECEx is the International Electrotechnical Commission (IEC) system for certification to standards relating to equipment for use in explosive atmospheres. Although similar in scope and intent, the ATEX directive components and the IECEx scheme encompass different requirements and utilize different assessment approaches.

5.3 The U.S. and Canada

In the U.S. and Canada, the applicable standards are issued by Underwriters Laboratories (UL) and the Canadian Standards Association (CSA). The suitability of equipment for specific hazardous areas in the ANSI/NFPA(NEC)[2] regulated market, that is the U.S. and Canada, must be tested by a Nationally Recognized Testing Laboratory (NRTL). Such institutes are UL or FM. Evaluation can also be performed

2 *American National Standards Institute (ANSI), National Fire Protection Association (NFPA), National Electrical Code (NEC)*

by accredited laboratories, such as LabTest Certification (LC) that approves according to the applicable CSA and UL standards.

5.3.1 The Class/Division system

In the U.S. and Canada, the Class/Division system is used for explosion protected electrical equipment, instead of the ATEX system. In the Class/Division system, equipment for hazardous areas is marked in accordance to the area that the equipment is classified to use, whereas in the ATEX system equipment is marked in accordance with the type of protection it uses.

5.4 South America, the Russian Federation, India, China, and South Africa

In South America, certification bodies must be accredited by the National Institute of Metrology, Quality and Technology (Inmetro) in Brazil. In the Russian Federation, the Federal Agency on Technical Regulating and Metrology (GOST R) is the national standards body. In India, the approval of the Chief Controller of Explosives (CCoE) is mandatory for all electrical equipment installed in potentially explosive atmospheres. In China, it is the Nanyang Explosion Protected Electrical Apparatus Research Institute (CNEX) that verifies explosion protected apparatus. In South Africa, the certification body is the South African National Accreditation System (SANAS).

See Section 8, Useful links, for more information on the national standards bodies.

6. Conclusion

Explosion protected network cameras offer many advantages compared to analog explosion protected cameras. The major ones are superior image quality and a modern, future-proof camera technology. Video analytics increases safety and enables remote accessibility, using any existing IP-based networks or the Internet. An explosion protected network camera must be certified for hazardous areas according to the industry standards applicable in the country where it is to be used.

Axis' portfolio of network cameras for safe areas adds a multitude of functions to systems containing explosion protected network cameras for hazardous areas. Network cameras provide flexible integration options with other equipment and functions, such as access control, fire alarms and intruder management.

7. Acronyms and abbreviations

AIT	Auto-ignition Temperature
ANSI	American National Standards Institute
ATEX	Appareils destinés à être utilisés en ATmosphères EXplosives
CCoE	Chief Controller of Explosives
CCTV	Closed-circuit Television
CNEX	Nanyang Explosion Protected Electrical Apparatus Research Institute
CSA	Canadian Standards Association
GOST R	Federal Agency on Technical Regulating and Metrology
HAZLOC	Hazardous Location
HSE	Health, Safety and Environment
IEC	International Electrotechnical Commission
Inmetro	National Institute of Metrology, Quality and Technology
IP	Internet Protocol
LAN	Local Area network
LC	LabTest Certification
NEC	National Electrical Code
NFPA	National Fire Protection Association
NRTL	Nationally Recognized Testing Laboratory
NVR	Network Video Recorder
SANAS	South African National Accreditation System
SCADA	Supervisory Control and Data Acquisition
UL	Underwriters Laboratories
WDR	Wide Dynamic Range

8. Useful links

For more information, see the following links:

Axis Communications – 'Ten reasons to buy a network camera':
www.axis.com/files/feature_articles/ar_10reasons_34954_en_0903_lo.pdf

Axis Communications – 'Image quality: Usability is the real issue':
www.axis.com/files/feature_articles/ar_image_usability_hoffman_36541_en_0908_lo.pdf

Axis Communications – 'Axis Video Analytics':
www.axis.com/files/whitepaper/wp_video_analytics_65216_en_1509_lo.pdf

Axis Communications – 'Remote temperature monitoring':
www.axis.com/files/whitepaper/wp_remote_temp_monitoring_61431_en_1412_lo.pdf

ANSI: www.ansi.org

CNEX: www.cnex-global.com

CSA: www.csagroup.org

FM Global: www.fmglobal.com/default.aspx

GOST R: www.gost-r.info

IEC: www.iec.ch

IECEx: www.iecex.com

Inmetro: www.inmetro.gov.br/english/index.asp

LC: www.labtestcert.com

NFPA: www.nfpa.org

SANAS: www.home.sanas.co.za

UL: http://ul.com

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About Axis Communications

Axis offers intelligent security solutions that enable a smarter, safer world. As the global market leader in network video, Axis is driving the industry by continually launching innovative network products based on an open platform - delivering high value to customers through a global partner network. Axis has long-term relationships with partners and provides them with knowledge and ground-breaking network products in existing and new markets.

Axis has more than 2,000 dedicated employees in more than 40 countries around the world, supported by a network of over 75,000 partners across 179 countries. Founded in 1984, Axis is a Sweden-based company listed on NASDAQ Stockholm under the ticker AXIS.

For more information about Axis, please visit our website www.axis.com.

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