White paper

Explosion-protected network cameras

Safety first

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AXIS COMMUNICATIONS

Summary

An explosion-protected network camera has a heavy-duty enclosure, certified for use in hazardous areas where flammable material (liquids, gas, vapor, or dust) may be present. Areas classified as hazardous are often found in critical infrastructure within various industry segments, where the use of surveillance cameras can significantly improve safety and efficiency.

Electrical installations in hazardous areas are subject to rigorous requirements, and compliance is verified through testing to various industry standards. All standards are based on the same criteria, mainly concerning which concentrations of flammable gas or dust that may be present, and their duration.

In the USA, hazardous areas are classified according to the Class/Division system described in the National Electrical Code (NEC). The Class is defined by which type of substance may be present in the area, and the Division further specifies the likelihood of flammable concentrations. Further subdivisions are also made, depending on how flammable the material is and which equipment surface temperatures are allowed.

The rest of the world uses a Zone system described in the IEC 60079 set of standards for the IECEx certification, or national deviations of these standards. The Zone defines the probability that hazardous material will be present in an ignitable concentration in the surrounding atmosphere. Further subdivision is made based on the type of protection used and which substances may be present.

Products that are certified for use in hazardous areas must be labeled to show the type and level of protection applied, as well as details about the certification.

Axis offers several types of explosion-protected network cameras, often combined with video analytics software for efficient detection of risks and monitoring of processes.

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1. Introduction

Network cameras with explosion-protected enclosures provide excellent image quality and flexible integration possibilities in demanding and hazardous environments.

This white paper presents some common types of explosion-protected cameras and their applications, discusses the benefits of using cameras in hazardous areas, as well as the benefits of network cameras over analog cameras in such environments. The paper also covers the basics of explosion and explosion protection, and outlines the applicable industry standards and certifications in place for cameras in hazardous environments. Product marking guides are also provided.

2. Cameras in hazardous environments

2.1 Purposes of explosion-protected cameras

An explosion-protected network camera has a heavy-duty enclosure, or camera housing, usually made from stainless steel or aluminum. The enclosure is certified for use in hazardous environments, where flammable material (liquids, gas, vapor, or dust) may be present.

To determine whether a certain installation requires cameras to be explosion protected, there are several environmental factors to consider. An exhaustive study of the site must generally be performed to determine the location's classification regarding which Class, and Division or Zone it falls under. The classification depends on many factors, such as which type of ignitable material may be present (gas or dust), and in which concentrations. Furthermore, how often will different concentrations be present, and which temperature requirements apply? Which classification system is applicable on the site? More details about these factors are described in Section 4.

Figure 1. A critical infrastructure site.

Many critical infrastructure sites contain areas that are classified as hazardous. The use of network cameras can significantly improve health and safety in such areas, by providing remote monitoring and remote maintenance. This means shorter time inside hazardous areas for service personnel, as well as less operational downtime. Visual inspection can be performed without having a technician on site, and when hands-on maintenance is required, anyone working in a hazardous area can be monitored remotely.

Thanks to their versatility, network cameras provide security from the perimeter all the way to the critical core. Information from explosion-protected cameras monitoring gauges, signals, or smoke detection can be fed into a supervisory control and data acquisition (SCADA) system, basically functioning as a video management system (VMS) for processes.

2.2 Benefits of network cameras

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 for increased safety, easy future-proof installation and integration, remote accessibility and better scalability, flexibility and cost-effectiveness.

2.2.1 Superior image quality

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. In an analog system, on the other hand, images are 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. Wide dynamic range (WDR) technology enables the cameras to handle a greater span between bright and dark areas in the image.

Depending on the surveillance purpose, thermal network cameras can also be used, creating images based on the heat that always radiates from any object, vehicle or person. A thermal camera is less sensitive to problems with light conditions, such as shadows, backlight, darkness, or camouflaged objects.

2.2.2 Video analytics for increased safety

Built-in intelligence enables constant analysis of input to detect an event, and to automatically respond to it with actions such as video recording and alarm notifications. For example, video motion detection analytics enables reliable detection of moving people and objects, and AXIS People Counter adds the ability to count, in real time, the number of people passing under a camera and in which direction, in a restricted area. Other analytics, such as AXIS Perimeter Defender, can be used to reinforce physical access control for high-security locations and critical infrastructure.

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. Advanced gatekeeper automatically moves the camera to a preset position when motion is detected in a predefined area.

See Section 6, Useful links, 'Axis video analytics', for more information on video analytics.

2.2.3 Flexible integration

Network video provides a high level of integration with other equipment and functions, such as network audio and access control. Existing computer networks 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. Any number of network video products can be added without significant and costly changes to the network infrastructure.

Axis access control products can safeguard potentially hazardous areas by monitoring entrances and exits to ensure that only authorized personnel are granted access. All the permissions and exclusions are managed from the VMS – centrally or remotely. Axis network horn speakers or other audio products from Axis can be used for deterrence or to act on alarms, playing prerecorded audio clips or public announcements.

2.2.4 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.

2.3 Types of explosion-protected network cameras

2.3.1 PTZ dome cameras

Apart from providing 360 degrees panoramic awareness and enabling real-time control, an explosion-protected PTZ dome camera also offers high-speed pan and tilt functionalities with guard tour preset positions. A PTZ dome camera has low weight and low profile compared to a positioning camera, making it easier to install and manage. Installing can be done higher up, and the camera is suitable on sites where heavy winds can be challenging, such as on oil rigs. A PTZ dome camera can be installed by one person, whereas two or three people are needed to install a positioning camera.

Figure 2. An explosion-protected PTZ dome camera.

2.3.2 Fixed cameras

Explosion-protected fixed cameras with analytics are versatile and can be used for, for example, monitoring gauges, process monitoring, flare monitoring, motion detection or smoke detection. The analytics algorithms are typically based on visual contrast in the image. For the example of smoke detection, there are obvious benefits of using a camera, which does not need to come into physical contact with smoke. This results in a much earlier detection of potential danger, and a significantly decreased risk of false alarms due to for example, dust or moisture.

Figure 3. An explosion-protected fixed camera.

2.3.3 Positioning cameras

A positioning camera provides 360 degrees panoramic awareness, as well as views above the horizon. It enables real-time control over the unit.

Figure 4. An explosion-protected positioning camera.

2.3.4 Thermal cameras

Thermal technology can be used together with analytics to detect people and objects in restricted areas. It can also be used for applications such as verifying the contents of a tank. A fixed, thermal-technology, explosion-protected camera can monitor a perimeter and detect if a fence or virtual line is breached.

Figure 5. An explosion-protected thermal camera.

2.3.5 Temperature alarm cameras

Temperature alarm cameras provide remote temperature monitoring. Typical industrial applications for a fixed explosion-protected temperature alarm camera includes temperature control and monitoring of equipment, leak detection in pipes, and fire detection. Moreover, the cameras can be valuable for remote assistance of planned maintenance, and for visual assurance that functions and processes are running correctly. They detect object temperatures between -40 °C and 550 °C. See Section 6, Useful links, 'Remote temperature monitoring', for more information on temperature alarm cameras.

Figure 6. An explosion-protected temperature alarm camera.

2.4 Industry segments

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 are usually non-flammable, or slow burning, they may ignite and explode when in dust form.

Figure 7. Typical industry segments for explosion-protected equipment are power plants, onshore and offshore oil and gas industry, and grain handling and storage.

2.4.1 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 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 health, safety, and environment (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.

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.

An explosive atmosphere is defined as a mixture of an oxidizer (often air) and flammable substances in the form of gases, vapors, dusts, or fibers, under atmospheric conditions. 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.

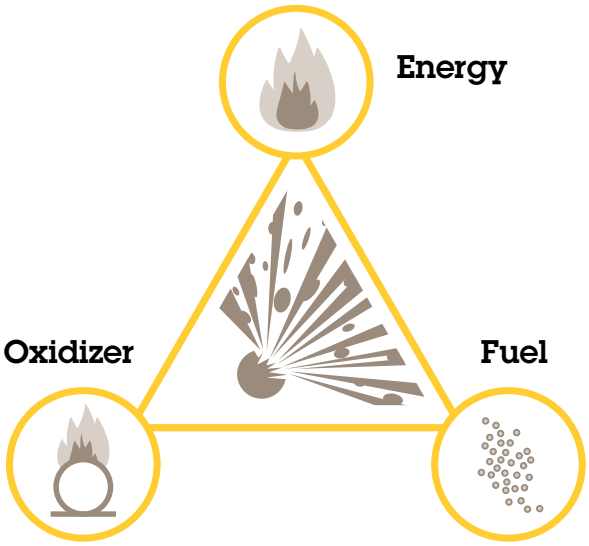

Figure 8. The three components that must be present for an explosion to occur.

3.1 Combustible dusts and fibers

A material can only burn at its surface, where it can react with oxygen. Dusts and fibers have large surface areas compared to their masses, which makes material in dust or fiber 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. In regulations, they may be classified by whether they are conductive or non-conductive, and by the size of the particles. Cotton, rayon, and hemp are examples of combustible fibers.

3.2 Combustible gases

Combustible gases normally require very little energy to react with naturally prevalent oxygen. They are often compounds of hydrogen and carbon.

3.3 Hazardous areas

A hazardous area is an area where flammable liquids, vapors, gases, or combustible dusts and fibers 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 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.

3.4 Safe areas

Explosion-protected network cameras are designed for use in hazardous areas. In non-hazardous areas, also called safe areas, Axis standard product portfolio can be used. This comprises a wide range of versatile, high-quality cameras, video analytics applications, physical access control products and network audio products, for normal and harsh environments.

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:

> Containment
> Prevention
> Segregation

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.

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.

Not all principles may be applicable in all Zones or Divisions.

5. Industry standards and certification

Electrical installations in hazardous areas are subject to rigorous requirements, both on equipment and on the competence of the installer. Compliance to the requirements are verified through testing to various industry standards.

For classification and certification of explosion-protected equipment, the different standards are based on the same criteria. They mainly concern whether an explosive atmosphere will be caused by gas or by dust, which is the concentration of gas or dust, and the duration of this concentration.

In the USA, explosion-protected electrical equipment is classified according to the Class/Division system described in the National Electrical Code (NEC), article 500. The Canadian equivalent is the Canadian Electrical Code (CEC), section 18.

The rest of the world uses a Zone system described in the IEC 60079 set of standards for the IECEx certification, sometimes with national deviations, e.g. ATEX, EAC, or INMETRO. The map in Figure 9 shows the standards applicable in different parts of the world.

Figure 9. Applicable regulations of the world. Note that local variations and exceptions not shown on this map may also apply.

5.1 Class/Division system (used in the USA)

The authority in charge of the applicable regulation in the USA is the Occupational Safety and Health Association (OSHA). OSHA points to the National Electric Code (NEC) of the NFPA 70 (published by National Fire Protection Association), or more specifically the NEC articles 500-506 which regulate the classification. OSHA also supplies a list of test standards in accordance with NEC, for electrical products installed in hazardous areas, as well as a list of notified certification bodies (NCB). Several test standards, such as FM3600, FM3615, and UL1203 (from Underwriters Laboratories), can be used for certification according to the Class/Division system (described in NEC articles 500-503), while the ISA/UL 60079 series of standards can be used for certification according to a Class/Zone system (described in NEC articles 505-506).

The testing according to a specific standard must be performed by a test laboratory that is officially recognized by an NCB for testing against that standard. Examples of laboratories in the list of nationally recognized testing labs (NRTL) include FM, UL, and CSA. While also issuing the test standards, these laboratories are generally approved for testing according to the other laboratories' standards, as well as their own.

5.1.1 Classes

The Classes define the type of explosive or ignitable substances which may be present in the atmosphere.

Class	Substances present
I	Flammable vapor or gas
II	Combustible dust
III	Ignitable fibers or flyings

Table 1. Class definitions in the Class/Division system.

Class I locations are those in which flammable vapors and gases may be present. Class II locations are those in which combustible dust may be found. Class III locations are those which are hazardous because of the presence of easily ignitable fibers or flyings.

5.1.2 Divisions

Each of the three Classes is further subdivided into Division 1 or Division 2. The Division defines the likelihood of the hazardous material being present in a flammable concentration. Equipment approved for Division 1 can also be used in Division 2 within the same Class.

Division	Definition
1	In which ignitable concentrations of hazards exists under normal operation conditions and/or where hazard is caused by frequent maintenance or repair work or frequent equipment failure.
2	In which ignitable concentrations of hazards are handled, processed or used, but which are normally in closed containers or closed systems from which they can only escape through accidental rupture or breakdown of such containers or systems.

Table 2. Division definitions in the Class/Division system.

Figure 10 shows an example of an industry facility where different areas have been classified in Divisions.

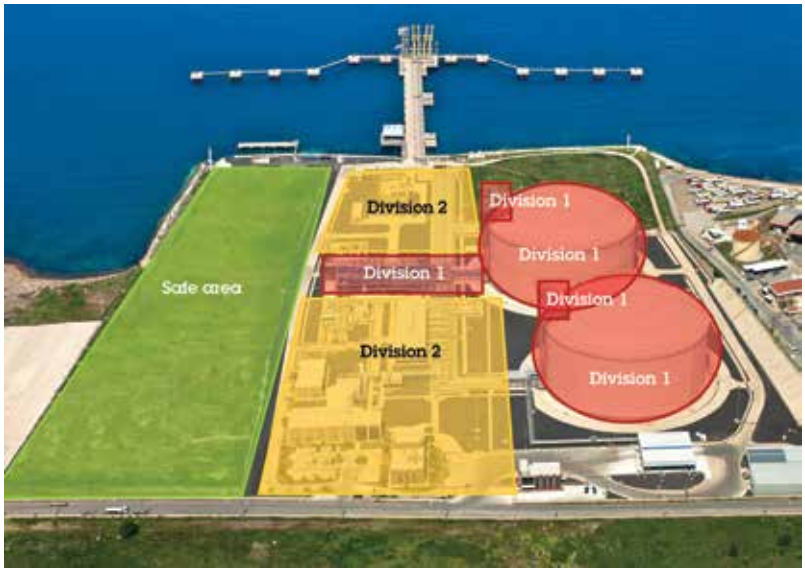

Figure 10. An industry facility with areas classified in Divisions.

A large part of the area will be defined as Division 2 (which corresponds to Zone 2 in the rest of the world, see section 5.2.1). In a Division 2 area, an explosive atmosphere is present under abnormal conditions between 1 and 10 hours per year.

In a Division 1 area, explosive atmospheres will occur continuously or intermittent periodically more than 10 hours per year. This is typically inside tanks filled with flammable liquids, and in the proximity of valves.

5.1.3 Groups

Class I and Class II are also subdivided into Groups of hazardous materials. The Groups define substances by rating how flammable they are, based on, among other things, maximum explosion pressures. Table below shows typical flammable material of each Group, representing certain ignition energies, for which the equipment is safe.

Group	Flammable material (examples)
A	Acetylene
B	Hydrogen
C	Ethylene
D	Propane
E	Metal dusts
F	Carbonaceous dusts
G	Combustible dusts

Table 3. Groups of flammable substances in the Class/Division system.

5.1.4 Temperature classes

The temperature classes are used to designate the maximum temperatures on the surface of the equipment which should not exceed the ignition temperature of the surrounding atmosphere. Ignition temperature is the minimum temperature required, at normal atmospheric pressure in the absence of a spark or flame, to set afire or cause self-sustained combustion independently of the heating or heated element.

Class I temperature marking shall not exceed the ignition temperature of the specific gas or vapor to be encountered as specified in NEC section 500-5(d).

Temperature class	Permissible surface temperature of electrical equipment	
	°C	°F
T1	450	842
T2	300	572
T2A	280	536
T2B	260	500
T2C	230	446
T2D	215	419
T3	200	392
T3A	180	356
T3B	165	329
T3C	160	320
T4	135	275
T4A	120	248
T5	100	212
T6	85	185

Table 4. Temperature classes in the Class/Division system.

5.1.5 Product marking

In North America, explosion-protected products must be equipped with a marking label that specifies the manufacturer, the certificate issuer and file number, and the marking according to NEC 500-506.

The example label in Figure 5 is for a product marked "Class I Division 1 Group B,C,D T6" according to NEC 500, and "Class I, Zone 1, IIB+H2, T6" according to NEC 505.

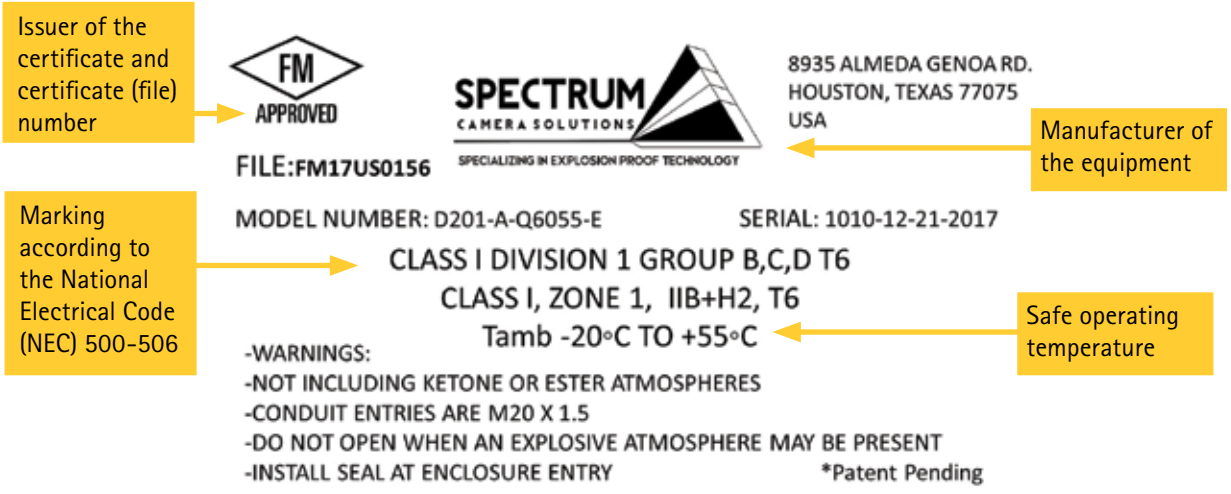

Figure 11. A product marking label, with added explanations, showing certification according to NEC.

Figure 12 and Figure 13 provide quick guides to product marking in the USA.

Class I, Division 1, Group B, C, D, T6

Explosive atmosphere	Area classification	Gas/dust group	Temperature code
Class I: Gas/Vapor **Class II:** Dust **Class III:** Flyings	**Division 1** Division 2	**A:** Acetylene **B: Hydrogen** **C: Ethylene** **D: Propane** **E:** Metal dusts **F:** Carbonaceous dusts **G:** Combustible dusts	T1 - T6 **T6: 85° C** *Maximum surface temperature of equipment*

Figure 12. A quick guide to product marking according to the Class/Division system (as described in NEC article 500), exemplified by a product marked "Class I, Division 1, Group B, C, D, T6".

Class I, Zone 1, IIB + H2, T6

Explosive atmosphere	Area classification	Gas/dust group	Temperature code
Class I: Gas/Vapor *For dust environments, the class of the hazard (Class II) shall not be mentioned in the marking*	Zone 0 (Gas) **Zone 1 (Gas)** Zone 2 (Gas) Zone 20 (Dust) Zone 21 (Dust) Zone 22 (Dust)	**IIA:** Propane **IIB: Ethylene** **IIC:** Acetylene + **Hydrogen, H2** **IIIA:** Combustible flyings **IIIB:** Non-conductive dusts **IIIC:** Conductive dusts	**Gas: T1-T6** **T6: 85° C** *Maximum surface temperature of equipment*

Figure 13. A quick guide to product marking according to the Zone system in USA (as described in NEC article 505), exemplified by a product marked "Class I, Zone 1, IIB + H2, T6".

5.2 Zone system (used in the rest of the world)

The International Electrotechnical Commission (IEC) issues the IEC 60079 set of standards about electrical equipment in explosive atmospheres. National deviations of these standards are used throughout the world.

In the European Union, equipment must comply with the essential requirements of EU Directive 2014/34/EU, also known as the ATEX Directive, describing what equipment and work environment is allowed in an area with an explosive atmosphere.

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 IEC's system for certification to standards relating to equipment for use in explosive atmospheres.

5.2.1 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.

Zone		Hours per year of flammable gas-air mixture or dust clouds present
Gas	Dust	
0	20	1000 or more hours/year (10%)
1	21	10 < hours/year < 1000 (0.1% - 10%)
2	22	1 < hour/year < 10 (0.01% -0.1%)

Table 5. Hazardous area zones.

For gases, Zone 0 is an area in which an explosive gas-air mixture is continuously or frequently present, or present for lengthy 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 does occur, it will exist only for a very short time due to abnormal conditions.

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. Products certified for Zone 0 (20) can be used in Zones 0, 1, and 2 (20, 21, and 22). Zone 1-certified (21) products can be used in Zones 1 and 2 (21 and 22).

Figure 14 shows an example of zone classifications of different areas of an industry facility.

Figure 14. An industry facility with areas classified into different Zones.

5.2.2 Types of protection

Electrical equipment used in hazardous areas can be protected from explosions in several ways. Table 6 lists the types of protection that can be used in different Zones.

Designation	Type of protection	Zone
Ex d	Flameproof (explosion-protected) enclosure	1, 2
Ex e	Increased safety	1, 2
Ex i	Intrinsically safe	0, 1, 2, 20, 21, 22
Ex o	Oil immersion	1, 2
Ex p	Pressurized (purged) apparatus	1, 2, 21, 22
Ex q	Powder (sand) filling	1, 2
Ex m	Encapsulation	0, 1, 2, 20, 21, 22
Ex n	Non-incentive and/or normally no sparking circuits	2
Ex t	Enclosure	20, 21, 22

Table 6. Types of protection.

Axis explosion-protected cameras belong to the protection category Ex d or Ex t, while some accessories belong to Ex e. For equipment designated Ex d, an explosion-protected housing should prevent any inner explosion from spreading to the surrounding gas mixture. Ex t is an explosion protection method where the enclosure restricts the surface temperature and keeps ignitable dust out from the electronics. Ex e, increased safety, is an explosion protection method for gas environments that prohibits arcs, sparks or hot surfaces.

5.2.3 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.

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

Table 7. Groups of apparatus according to the Zone system.

IIC is the highest class for a gaseous atmosphere, and products certified for IIC can also be used in IIB and IIA. Similarly, IIB products can be used in IIB and IIA. For dust environments, the case is similar, with the highest class being IIIC.

5.2.4 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 is tested for maximum temperature ratings by approval agencies. Tested equipment receives a temperature code indicating the maximum surface temperature, as listed in Table 8.

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

Table 8. Temperature codes according to the Zone system.

Note that the ambient temperature also affects which temperature code is applicable. For example, if the product by itself generates 10 °C (or, for example, 10 °F), but is used in an ambient temperature of maximum 80 °C (or 180 °F), the maximum surface temperature will be 90 °C (or 190 °F), and the product must be classified as T5. Products that are classified as T6 are allowed for use in areas that require T5-classified equipment, and so on, while T5 equipment cannot be used in areas that require T6-classified products.

5.2.5 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 notified body that monitors the quality system of the manufacturer. The CE mark is complemented with the ATEX Ex symbol, followed by the Group, Category and, if Group II equipment, whether the marking relates to gases (G) or dust (D). The marking further specifies the type of protection, the group of apparatus, the temperature category, and the equipment protection level.

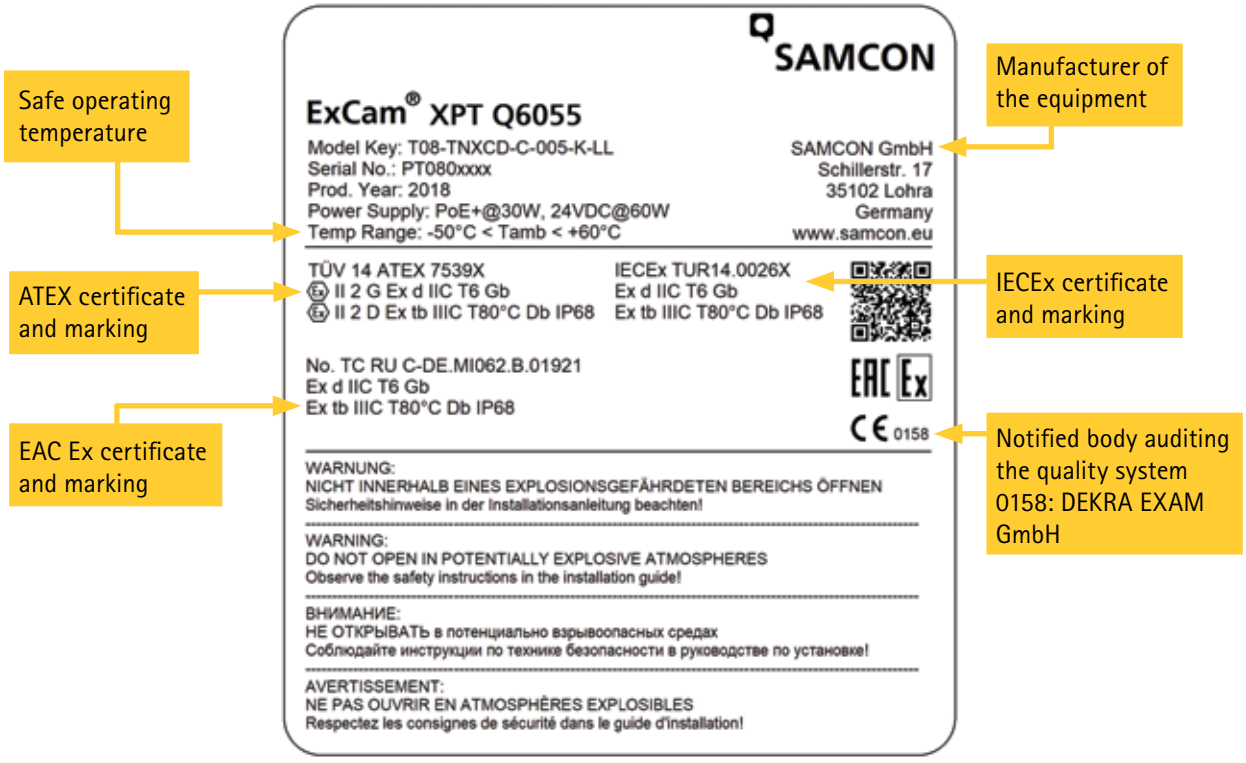

Figure 15. A product marking label, with explanations added, showing ATEX, IECEx, and EAC specifications.

Figure 16 and Figure 17 provide quick guides to product marking according to the ATEX standard.

Equipment group	Equipment category	Surrounding atmosphere	Explosion protected
I: Mines II: Surface industry	1: Zone 0 (or 20) 2: Zone 1 (or 21) 3: Zone 2 (or 22)	G: Gas D: Dust	

Type of protection	Gas group	Temperature code	Equipment protection level
d: Flameproof enclosure	IIA: Methane IIB: Ethylene IIC: Hydrogen	Gas: T1–T6 T6: 85 °C	G: Gas b: Zone 1

Figure 16. A quick guide to product marking, in relation to gas, according to the Zone system (as described in the ATEX standard).

IP-rating of the enclosure

Explosive atmosphere	Equipment category	Surrounding atmosphere	Explosion protected
I: Mines II: Surface industry	1: Zone 0 (or 20) 2: Zone 1 (or 21) 3: Zone 2 (or 22)	G: Gas D: Dust	

Type of protection	Dust group	Max. surface temperature	Equipment protection level
t: By enclosure b: Zone 21	IIIA: Combustible flyings IIIB: Non-conducive dust IIIC: Conducive dust	80 °C	D: Dust b: Zone 21

Figure 17. A quick guide to product marking, in relation to dust, according to the Zone system (as described in the ATEX standard).

5.3 Comparisons between Class/Division system and Zone system

This section displays tables for easy comparison between the systems.

Zone 0	Zone 1	Zone 2
Where ignitable concentrations of flammable gases, vapors, or liquids are present continuously or for long periods of time under normal operating conditions.	Where ignitable concentrations of flammable gases, vapors or liquids: - Are likely to exist under normal operating conditions - May exist frequently because of repair, maintenance operations, or leakage	Where ignitable concentrations of flammable gases, vapors or liquids: - Are not likely to exist under normal operating conditions - Occur for only a short period of time - Become hazardous only in case of an accident or some unusual operating condition

Division 1	Division 2
Where ignitable concentrations of flammable gases, vapors or liquids: - Are likely to exist under normal operating conditions - Exist frequently because of maintenance/repair work or frequent equipment failure	Where ignitable concentrations of flammable gases, vapors or liquids: - Are not likely to exist under normal operating conditions - Are normally in closed containers where the hazard can only escape through accidental rupture or breakdown of such containers or in case of abnormal operation of equipment

Table 9. Class I area classification comparison.

Zone	Class/Division
IIC - Acetylene and Hydrogen	A - Acetylene
	B - Hydrogen
IIB - Ethylene	C - Ethylene
IIA - Propane	D - Propane

Table 10. Class I group comparison.

Zone 0, 1 and 2	Division 1 and 2	Maximum temperature
T1	T2	450°C (842°F)
T2	T2	300°C (572°F)
	T2A	280°C (536°F)
	T2B	260°C (500°F)
	T2C	230°C (446°F)
	T2D	215°C (419°F)
T3	T2	200°C (392°F)
	T3A	180°C (356°F)
	T3B	165°C (329°F)
	T3C	160°C (320°F)
T4	T4	135°C (275°F)
	T4A	120°C (248°F)
T5	T5	100°C (212°F)
T6	T6	85°C (185°F)

Table 11. Class I temperature class comparison.

6. Acronyms and abbreviations

AIT	Auto-ignition temperature
ATEX	ATmosphere EXplosibles
CCoE	Chief Controller of Explosives
CEC	Canadian Electrical Code
CNEX	Nanyang Explosion Protected Electrical Apparatus Research Institute
CSA	Canadian Standards Association
EAC	Eurasian conformity (certification marking)
FM	Factory Mutual Insurance Company (testing/certification service issuing the FM mark)
HAZLOC	Hazardous location
HSE	Health, safety, and environment
IEC	International Electrotechnical Commission
INMETRO	National Institute of Metrology, Quality and Technology (Brazil)
IP	Internet Protocol
ISA	International Society of Automation
LAN	Local area network
NCB	Notified certification body
NEC	National Electrical Code
NFPA	National Fire Protection Association
NRTL	Nationally recognized testing laboratory
OSHA	Occupational Safety and Health Association
PTZ	Pan-tilt-zoom
SCADA	Supervisory control and data acquisition
UL	Underwriters Laboratories
VMS	Video management system
WDR	Wide dynamic range

7. Useful links

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_1602_hi.pdf

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Axis enables a smarter and safer world by creating network solutions that provide insights for improving security and new ways of doing business. As the industry leader in network video, Axis offers products and services for video surveillance and analytics, access control, and audio systems. Axis has more than 3,000 dedicated employees in over 50 countries and collaborates with partners worldwide to deliver customer solutions. Axis was founded in 1984 and has its headquarters in Lund, Sweden.

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