EXTRONICS

Hazardous Areas Wireless Buyers Guide 2022

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Introduction

Deploying a successful wireless network in a process industry environment is no easy task!

Not only do you need to design a solution that will work within the parameters of your site or area, but the solution must also consider the nature of each area and what problems must be overcome to satisfy your use case.

Installing wireless devices into a hazardous area is one such scenario which presents a unique set of challenges.

Many companies that operate in the process industries are deploying increased wireless infrastructure as part of a wider digitalisation strategy aimed at improving efficiency, increasing productivity and enhancing worker safety. Markets and Markets 2020 Industrial Internet of Things (IIoT) report states the market was valued at USD 77.3 billion in 2020 and is forecast to grow to USD 110.6 billion by 2025, with demand from Oil & Gas and the Energy sectors contributing approximately a third towards that growth.

As companies push forward with their digitalisation goals it is important to consider what level of protection your chosen wireless devices need when installed in a hazardous area.

Gaining data from within a hazardous area is critical to business operations but it is also the most difficult to obtain.

This eBook is designed to provide a guide to some of the key areas you must consider when installing wireless technology into a hazardous area.

A Note From Our CEO

Firstly, thank you for downloading your copy of our new Wireless Buyers Guide.

Extronics speacialises in developing and manufacturing ATEX, IECEx, and North American-certified equipment for use in hazardous areas. We serve customers around the world in industries such as oil and gas, chemical, pharmaceutical, and mining. Our knowledgeable team of experts have a huge amount of experience in what is required to successfully deploy a range of wireless technologies.

That experience has been gained from working with some of the world's largest companies, including BP, Shell, Cisco, Aruba, Petronas and many more.

It is our aim to ensure that our customers are fully aware of their options, and we offer our expertise to help them navigate what can sometimes be a tricky process.

We recognise that no two facilities are created equal, and that each customer has a particular set of challenges that must be overcome.

It is for these reasons we have developed this Buyers Guide. We hope it serves as a useful resource for anyone looking to further their knowledge about hazardous area wireless, answer any questions they may have about deploying wireless devices into hazardous areas and support those already in the process of installing wireless equipment as part of their digitalisation strategy.

We hope you enjoy reading it!

Thanks,

John Hartley

Defining Hazardous Area Wireless

There are various reasons for deploying wireless technology into a hazardous area. In almost all cases, the goal is to achieve connectivity and gain more visibility within the hazardous area in question.

As businesses operating in these environments strive to achieve their digitalisaton goals, more and more wireless radio devices have entered the market.

Some common use cases for wireless connectivity in hazardous or industrial settings include:

- Personnel or asset tracking
- Automatic mustering in the event of an emergency
- Security / access control
- Condition monitoring
- Remote maintenance using video collaboration
- Inspection and maintenance management
- VoiP or Push to Talk using mobile phones
- Job scheduling
- Incident reporting and management

With the development of Industry 4.0 and the Industrial Internet of Things (IIoT) revolution, the list of use cases continues to grow as all businesses strive to gain a competitive advantage as well as improve the safety across their sites.

This naturally leads to questions about the safety of wireless devices installed in hazardous areas and certification required.

A common misconception among buyers is that standard wireless devices can be easily certified retrospectively. This is rarely the case. Taking an existing device and getting it approved to standards required for hazardous areas is no easy process. It is neither low cost nor quick to do.

What is a Hazardous Area?

Before covering the standards that govern the use of wireless devices in hazardous areas, it is important to first define the different types of hazardous areas.

Industrial facilities may contain hazardous areas where there are flammable gas, vapours or liquids, combustible dust, or even ignitable fibres present. Equipment installed in these areas is subject to additional legal requirements to reduce the risk of explosion.

These hazardous areas can be separated into designated zones dependent on how present the hazards are.

Figure 1. illustrates the different zones for flammable gas and dust environments. Depending on where in the world your hazardous area is located will determine how it is classified. Tables 1 and 2 below define how each classification works. NEC500 (Table 2) is predominantly used in the USA, whereas ATEX and IECEx (Table 1) are widely used everywhere else around the world. The next section talks in more detail about the regional and local bodies that govern the standards.

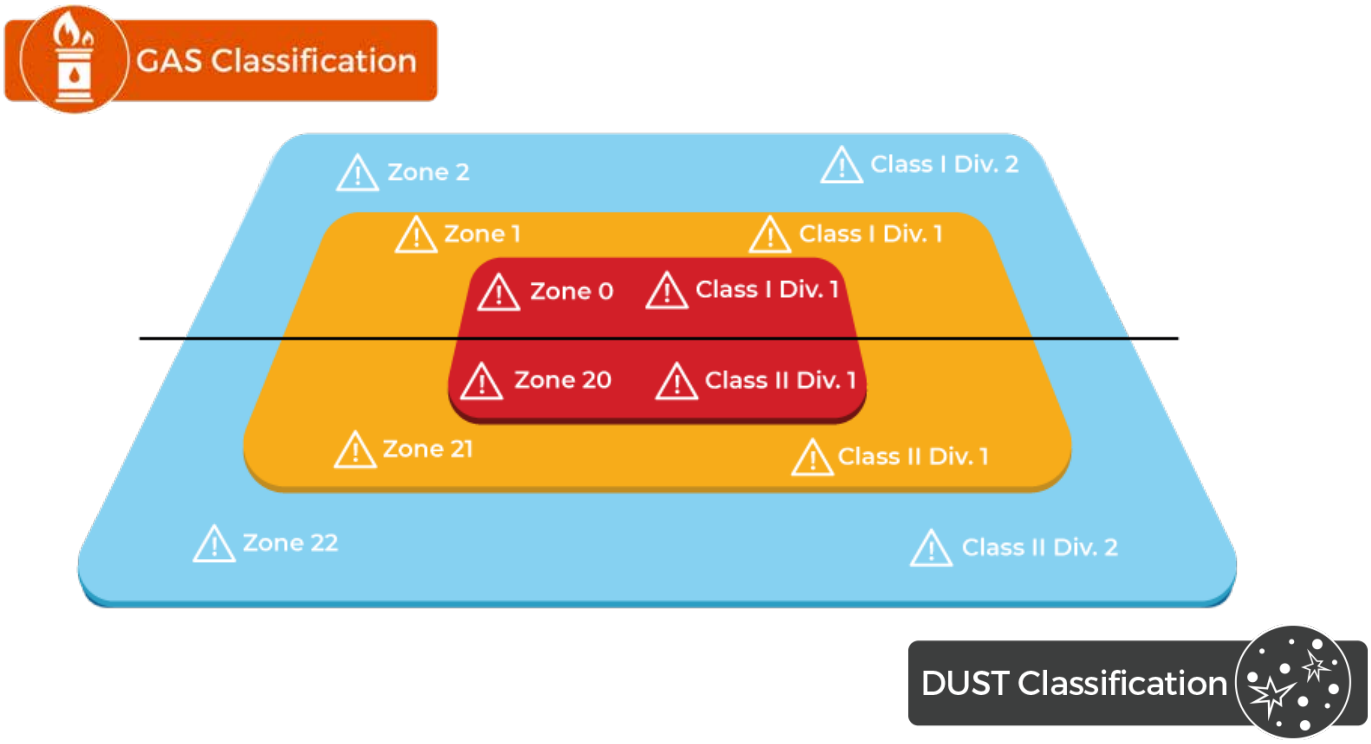

Figure 1: Different flammable gas and dust classification

Hazardous Area Definitions

Table 1:
ATEX, IECEx and NEC505 hazardous area zone definitions.

ATEX, IECEx and NEC505

Gas Zones	Dust Zones	Definitions
0	20	A place in which an explosive atmosphere is continually present.
1	21	A place in which an explosive atmosphere is likely to occur in normal operation occasionally.
2	22	A place where an explosive atmosphere is not likely to occur in normal operation. If an explosive atmosphere does occur it is only likely to be for a short period of time.

Table 2:
US NEC500 hazardous area division and class definitions

US NEC500

Divisions	Definitions
1	A place in which an explosive atmosphere is normally present.
2	A place in which an explosive atmosphere is likely to occur in normal operation occasionally.

Class	
Class I	Gas
Class II	Dust
Class III	Fibres

Standards Governing the Deployment of Wireless Radio Devices Into Hazardous Areas

The main standards for hazardous area equipment globally are ATEX, IECEx and North American NEC 500/505. For ATEX and IECEx, covering most of the world, the IEC 60079 series of standards are typically used for the approval of equipment installed in hazardous areas. Most national or regional domains derive their own standards from the IECEx standards and issue a version, often identical, as their own national or regional standard. The most frequently used electrical equipment protection standards are:

60079-0	General requirements
60079-1	Explosion proof enclosures
60079-7	Increased safety
60079 -11	Intrinsic safety
60079 -15	Non sparking, hermetic sealing and restricted breathing
60079-18	Encapsulation

Who Governs the Standards?

The IEC's standardisation work is organised across 150 Technical Committees (TC) and Subcommittees (SC) with various areas of focus. They are tasked with controlling and creating international standards.

The IEC TC 31 (TC 31) is one such TC, which controls the standards associated with equipment for explosive atmospheres. The IEC TC 31 is tasked with establishing and updating the IEC standard series IEC 60079 (electrical explosion protection) and IEC 80079 (non-electrical explosion protection).

In addition to the ATEX directives, the IEC standards set out the rules all manufacturers of electrical equipment destined for use in hazardous areas must follow.

The TC 31 exists to ensure a uniform set of standards and technical requirements are applicable worldwide in the field of explosion protection. This is intended to reduce the effort spent on certification so the same products can be used globally.

In Europe the ATEX directives ensure that every ATEX certificate must be recognised by a notified body.

IEC standards are also already fully accepted in national standards in some other countries as well. This means one IECEx certificate is currently sufficient for the international sale of explosion-protected equipment in the regions of Australia, New Zealand, Singapore and Israel. No further national certificate is required. In Europe, only an additional ATEX label and the resulting ATEX certificate is required. In the USA and other regions, the IEC standards are applied with some differences.

Most Common Regional Standards

ATEX

ATEX is used mostly within the European Union, but many other countries in the Middle East or Asia Pacific region will also accept them.

UKCA

UKCA is the new mark for product compliance for the UK and also covers the Ex standards. From 2023 all products placed on to the UK market must be approved to this standard. In the meantime ATEX approved products are permitted.

IECEx

IECEx is generally considered a more global standard, but most countries will not accept this standard outright. IECEx is predominantly used for the basis of obtaining the local regional standards.

Although countries such as Australia and Singapore accept these standards without requiring a national version, this also includes all offshore installations in the Gulf of Mexico.

NEC 500 North America

In the USA, all electrical equipment must be approved and certified by a Nationally Recognised Testing Laboratory (NRTL) accredited by Occupational Safety and Health Administration (OSHA).

In Canada, all electrical equipment must be approved by a certification body accredited by the Standards Council of Canada (SCC).

As with ATEX and IECEx, the certification must be displayed on the equipment and a certificate or declaration of compliance alone is not sufficient proof of compliance.

In the USA, The National Electrical Code or NEC, specifically NEC500 or NEC505 stipulates the requirements for the use and installation of electrical equipment in hazardous areas. Workplace safety laws regulate all equipment and ensures that it must be approved / certified by a NRTL accredited by OSHA.

How is Compliance to These Standards Managed?

Certifying the equipment is not the only cost you must consider for your business. There are also the ongoing costs associated with quality assurance. All Ex-product manufacturers must get their Quality Management Systems certified to fully comply. In the case of NRTL approval the manufacturing facility must be certified as well. ATEX requires an Ex manufacturer to complete a Quality Assurance Notification or QAN as it is more commonly known.

The CSA Group define the QAN as follows;

The Quality Assurance Notification is therefore involved with the continued monitoring of systems and processes in relation to those Ex products. It involves periodic audit of the manufacturing process by a qualified auditor. For ATEX certification, this is called a Quality Assurance Notification (QAN)

Source: CSA Group website

For IECEx it is called a Quality Assessment Report (QAR) and for North American Certification they have a requirement for auditing the actual factory where the equipment is manufactured.

In addition, a Certificate of Conformity (CoC) is required. The IECEx CoC comprises of two elements. The first element is the assessment of product samples against relevant standards. The second element requires an assessment of the manufacturer's quality systems based on parts of ISO 9001:2008 and ISO/IEC 80079-34:2011.

It is also worth noting that certification aims to verify a compliant design, it is not intended to be the initial determination of compliance. Therefore, redesign or re-engineering is almost always required for products that were never originally intended for hazardous area use, further adding to the time and cost before certification can be assessed.

The certification process can cost upward of $50,000 to get approvals covering ATEX, IECEx and North American certification and require significant changes to your existing quality processes. As a business you are subject to a yearly audit at an additional cost to maintain your certification. For North American certified products, audits are required four times a year at a much higher cost to the business.

Typical Wireless Technology Used in Hazardous Areas

Often when we talk about wireless technology in the process industries, it is said in the context of the Industrial Internet of Things (IIoT) or industry 4.0.

As the digital transformation of process industries has evolved, the number of wireless devices being added has increased and forced companies to rethink their wireless network strategy.

There are several wireless technologies used for a whole variety of use cases associated with hazardous and harsh industrial environments typically seen throughout the process industries.

The fact is, deploying wireless in an industrial setting is not nearly as simple as deploying it in an office or factory environment. Heavy industrial environments pose unique challenges and conditions, including dense metalic infrastructure and hazardous environments such as potentially explosive atmospheres

Here we look at some of the most common wireless technologies used and consider some of the pros and cons of each.

The IIoT market was valued at USD 77.3 billion in 2020 and is forecast to grow to USD 110.6 billion by 2025, with demand from Oil & Gas and the Energy sectors contributing approx. a third towards that growth.

Source: Market Research Report, 2020 - https://www.marketsandmarkets.com/Market-Reports/industrial-internet-of-things-market-129733727.html

WiFi

Probably the most common and well known wireless technology used globally. WiFi is a wireless network standard designed to allow mobile devices to communicate with each other or servers to access and exchange data using IP connectivity. WiFi operates in the ISM bands at 2.4GHz and the 5GHz band. With this technology being so mature there are a lot of hazardous area certified devices available compared with some of the newer wireless standards.

Cellular Network's (3G, 4G, 5G and LTE)

Cellular networks are commonplace in everyday life providing wide area network connectivity and voice communications for mobile phones. More recently versions of the standards are available that allow IoT applications with the advent of NBIoT and LTE-M protocols. This then allows low cost, low power communications over long distances for battery powered sensors.

Some sites are now opting for private LTE networks. There has traditionally been two ways of providing this to customers by the Mobile Network Operators (MNO) that own the radio spectrum. The easiest option is to use the existing network infrastructure that is normally used for the general public. They offer a segregated part of the bandwidth on the closest cell tower to the site that is only available to that particular customer. This is often not a practical solution because the location of process plants is not usually in an area where the cellular coverage is good across the site. Another option is the MNO can install a dedicated cell tower/base station just for that site. This usually costs a lot more and will require the customer to commit to payment plans running into many years so that the MNO can get the return on the capital investment of the site-specific equipment.

It is worth noting that complete site coverage is difficult to achieve with LTE networks inside the process areas due to the dense metallic infrastructure. The way to overcome this challenge is to install Pico Cells in hazardous area wireless enclosure systems in these locations to allow full site wide coverage to be achieved.

A recent development with LTE and 5G networks is the advent of private LTE/5G that can be deployed in much the same way as a WiFi network is by the end user, without the need to go to an MNO. In the USA this type of private LTE is called Citizens Band Radio Service (CBRS) and is also being made possible in other parts of the world. First conceived by the FCC in 2012 and launched in 2017, this new possibility is being made available in many countries around the world. Although gaining in popularity it is important to note that the free to access spectrum is different in most countries which will mean the number of mobile devices that are available will be limited for some time and especially hazardous area approved devices.

LTE/5G is acknowledged to provide a higher degree of security and deterministic latency compared to WiFi and has a much greater coverage. Typically, coverage outdoors is 10 x and indoors 4 x that of WiFi.

BLE

Bluetooth Low Energy (BLE) is a short-range wireless technology, although later iterations of the standard such as BLE 5 have a much longer-range capability of over 1Km in certain use cases. BLE operates in the 2.4 GHz ISM band and consumes very little power compared to traditional Bluetooth. BLE is typically used to tether devices together, location tracking or IoT connectivity.

UWB

Ultra-Wide Band (UWB) is a low energy radio technology for short-range, high-bandwidth communications over a wide range of frequencies.

UWB is also capable of transmitting data at very high rates meaning it is well suited for short range high bandwidth wireless data transfer. UWB has more typically been used as a Real Time Location System (RTLS) solution for personnel and asset tracking in industrial settings because of its accuracy and low power consumption.

Passive RFID

RFID tags are generally passive devices which when energized by a reader transmit their ID. They are typically used in asset tracking and identification applications and are available in three different frequency ranges: LF (125KHz), HF (13.5MHz) and UHF (900MHz)

LoRaWAN®

LoRaWAN® is a low power, wide area network protocol used for wireless connectivity of devices to internet networks. It is designed as a low power, low bandwidth technology especially for battery powered sensors. It was originally available in the sub GHz bands but more recently a new 2.4GHz version is being launched which has less range but much higher bandwidth. The new 2.4GHz band is in it's infancy and is not part of the LoRaWAN alliance. As such there are few products available at the moment. Typical line of sight range for the sub GHz band is over 10Km, which means only a few gateways are required to cover a large process plant.

WiHART/ISA100.11a

WiHART and ISA100.11a are two different protocols typically used for connection of battery powered sensors. Unlike LoRa it is much shorter range but running on 802.15.4 radio technology provides a higher degree of reliability as each device forms part of a self-healing MESH network. This wireless technology is almost exclusively used in battery powered process instrumentation devices.

Other Radio Technology

There are a lot of proprietary radio technologies on the market that use both the unlicensed and licensed spectrums. These include DECT for cordless phones, VHF/UHF walkie talkies, most commonly known as TETRA in the digital version, as well as long distance high bandwidth wireless links or short distance ultrahigh bandwidth wireless links that transmit in the tens of GHz range.

Ex Solutions for Deploying Wireless and What to Consider

If you want to deploy wireless devices into hazardous areas, you have two options:

1

Buy a wireless device that has been fully certified by the manufacturer to relevant Ex standards

2

Buy a pre-certified Ex wireless enclosure solution to house your preferred hardware

The likelihood is that your chosen wireless device does not hold the required hazardous area certification. This is typically because it is a specialised market and new technology is not often made available as a hazardous area version when it is first introduced to the market. Furthermore, technology companies rarely develop a hazardous area version of their devices because the market size is too small for their business model.

The most likely option for end users is to use an Ex certified enclosure system. Without this solution you will not be able to install the wireless technology in your hazardous areas on site.

It is worth knowing a little more about the different Ex protection options available and which hazardous zones they are suitable for as this will help you make an informed decision when choosing your wireless enclosure system supplier.

Firstly, when you are considering Ex protection concepts for your wireless device there are several concepts available:

- Protection by encapsulation (containing an explosion)
- Protection by keeping a flammable gas or dust out
- Quenching a flame
- Limiting energy (to avoid spark or thermal ignition
- Installing the wireless device in a safe area and an Ex rated antenna in the hazardous area

There are various protection types that cover all the above, but the most common seen in industrial and process industry settings for wireless devices are Ex d and Ex n.

Ex d – IEC 60079-1

Typical Zone: 1, 2, 21, 22 and Division 1

An Ex d enclosure is designed to contain an explosion and stop any flames, sparks and hot gases from escaping into the surrounding atmosphere should an internal explosion occur. In addition, an Ex d enclosure protects the fitted equipment against external moisture, dirt, dust or water.

Electrical equipment, such as a wireless radio device, has the potential to operate with potentially hot surfaces, which could cause an explosion if not housed correctly with the relevant Ex protection.

Often referred to as 'flameproof' or "explosion-proof", an Ex d enclosure also includes what is known as a flame path. The flame path design can vary depending on the construction of the Ex d enclosure system.

A flame path is a gap within the enclosure that, if an internal explosion occurs, ensures that by the time the flame has reached the end of the flame path it has been starved of oxygen or cooled down to such an extent that nothing, but air propagates from the explosion. The flame never escapes the enclosure and so cannot ignite an ambient gas.

Some flameproof boxes have flame paths that operate surface to surface, like a flange touching a joint, whereas others like a typical IIC gas group enclosure have a lid that screws into the body of the enclosure. In these enclosures, the flame path is in the thread, forcing the flame to move in and out of the thread quenching the flame.

Ex d enclosures are usually heavy and bulky due to the requirements of the Ex standard.

Ex nR - IEC 60079-15

Typical Zone: 2, 22 and Division 2

An Ex nR or restricted breathing enclosure removes the fuel element of an explosion by stopping any flammable gasses entering inside the enclosure. In doing so, potentially explosive gases never meet hot surfaces or an ignition source potentially present inside the enclosure.

Restrictive breathing enclosures are only certified to Zone 2 hazardous areas, where the area is considered safe in normal operation with flammable gases only present in fault conditions.

A Ex nR enclosure typically has the following characteristics:

- Lightweight metallic or non-metallic construction
- Designed to prevent flammable gases entering
- High ingress protection levels
- Tightly sealed

Ex i – IEC60079-11

The Ex i intrinsically safe protection concept is not available as an enclosure, it is designed into the electrical equipment so that the finished certified device is safe in its own right. This is achieved by limiting the amount of power fed into a circuit to avoid ignition by hot surfaces as well as limiting the amount of energy storage which could lead to spark ignition. This concept is specifically used in the context of Ex wireless enclosure systems as a method of protecting the RF output of the radio equipment rather than the radio device itself.
Installing the radio equipment in a safe area and the antenna in a hazardous area is the lowest cost solution as it does not require the use of a certified enclosure. If connecting the antenna to an uncertified radio you must consider that AC or DC could pass through the radio under a fault condition. If this was fed into a standard antenna this could lead to an unsafe condition.

Therefore, there are two distinct options for this use case. Option one uses an intrinsically safe RF isolator between the antenna and the radio, see Figure 2, which limits any hazardous fault current that could pass into the hazardous area mounted antenna. This method of protection allows the use of standard antennas in most types of hazardous area. Option two is to use an Ex antenna where the antenna is designed and certified to the Ex standards. This would typically be Ex d or in some cases Ex e (Increased Safety).

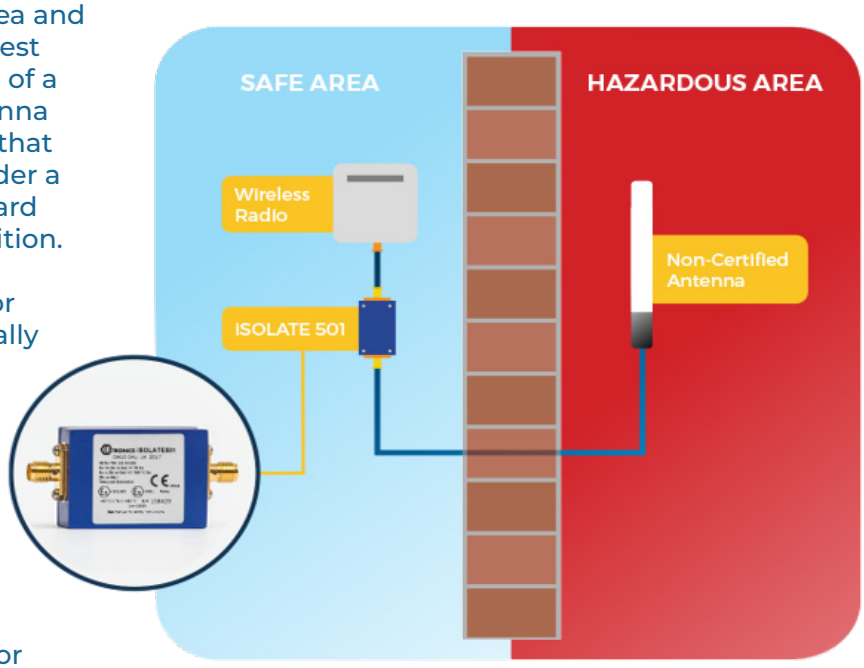

Figure 2: Typical safe area installation

Hazardous Area Certified Antennas

Whilst it is technically possible to use certified antennas, they are often expensive and available in very few form factors, frequency ranges and antenna patterns. For this reason, intrinsically safe RF protection and the use of standard passive antennas is now becoming the dominant and favoured solution due to the significant advantages they offer over specifically certified antennas.

Whilst installing the radio in the safe area is an attractive option it does have its limitations. It is typically restricted to applications where there are a small number of hazardous areas that are often in segregated rooms.

This use case can typically be found in batch processing industries that produce chemicals, paints and adhesives for example. It is more common to install the complete radio with the antennas directly in the hazardous area. This is generally because of the operational challenges, for example the distance between the hazardous area and safe area. There is also a limit on how long the RF cabling can be before excessive losses are experienced rendering the wireless signal unusable.

In certain scenarios, the entire facility can be classed as a hazardous area, such as those found in large petrochemical plants and refineries or offshore platforms.

Extronics has performed a simple apparatus assessment on a range of standard non-hazardous area antennas. This means that when using the Extronics RF iSOLATE device, customers can pick from a wider range of lower cost antenna options.

Example of Simple Apparatus Assessment

Equipment Type: iANT221 Antenna
Directional Dual Band 2x2 MIMO Antenna
This document assesses the equipment as simple apparatus only when connected to an Intrinsically Safe RF Source.

Standards and Specifications used:

IEC 60079-0:2018	Explosive atmospheres – Part 0: Equipment – General requirements
IEC 60079-11:2012	Explosive atmospheres – Part 11: Equipment protection by intrinsic safety “i”
IEC 60079-14:2014	Explosive atmospheres – Part 14: Electrical installations design, selection, and erection
Doc No. 413569	Extronics iSOLATE501 Operating Manual

Assessment Summary:

11:2012 clause 5.7 simple apparatus	The iANT221 Antenna is a purely passive device and contains no energy storage, current limiting, or voltage enhancement components. It does not require separate power to operate.

60079- 0:2018 clause 8 Exposed metals	The iANT221 Antenna is consisting of a white Polycarbonate, UV stable radome with an aluminum backplate and a Nickle Plated Brass N-Type connector. There are mild steel bolts protruding from the for securing the antenna to the optional MNT-22 mounting bracket. The aluminum rear plate will be considered externally exposed for the purpose of this clause, and the high aluminum content of the alloy used means that this antenna does not comply with the criteria for equipment to be rated EPL Ma, Mb (Mining) or EPL Ga (Gas Zone 0) Overall, the chemical composition of the exposed metallic elements detailed above, are individually each below 7.5% by mass of metals magnesium, titanium, and zirconium. There are no copper elements exposed which means the requirements of 8.5 in relation to copper content for Gas Group IIC applications has also been met. In summary, this means that the requirements of this clause for EPL Gb and Gc (Gas Zone 1 and 2) and EPL Da, Db and Dc (Dust Zone 20, 21 and 22) have all been satisfied.

0:2018 - Clause 8 - Exposed Metals							
Group I - Mining			Group II - Surface Gas			Group III - Surface Dust	
EPL Ma	EPL Mb	EPL Ga	EPL Gb	EPL Gc	EPL Da	EPL Db	EPL Dc
FAIL	FAIL	FAIL	PASS	PASS	PASS	PASS	PASS

Environmental Challenges

Now let's consider the installation of a non-certified wireless device into a hazardous area and look at the key considerations:

- Materials of Construction
- IP Rating
- Ambient Temperature
- Solar Loading
- Metallic Environments and the Effects of Multipath Interference

Materials of Construction

Often hazardous areas are also subject to extreme weather conditions or corrosive substances. It is therefore extremely important that the materials of construction used in any Ex enclosure be carefully considered to ensure the product can withstand the extreme condition long term.

For instance, when installing an Ex wireless enclosure into a marine environment the material of the enclosure becomes paramount for a successful installation. When we think about marine environments in the process industries, we often think about offshore platforms, but the same material consideration must be given to process plants by the coast in a hot humid environment. In a hot humid environment, the saline atmosphere can be very corrosive and if the correct materials are not used the equipment will soon become corroded and eventually fail.

Typically, a high-grade marine aluminum with special coatings should be selected or stainless steel constructed enclosures. In some cases, nonmetallic enclosures that use glass reinforced polyester can also provide a high degree of environmental protection. It's very important to ensure the enclosure is designed for these extreme environments otherwise what looks good when first installed will soon be a liability to the owner.

IP Rating

The minimum level of IP rating for an outdoor Ex enclosure is IP54, but this level of protection is not suitable for extreme outdoor environments. In these environments the minimum level of protection that should be considered is IP65. IP66 provides a higher level of protection in applications that are exposed to high volumes of liquid for clean downs or deluges such as on an offshore platform or ship.

Ambient Temperature

When installing a wireless radio device into your hazardous area it is important to consider the operating temperature. Most standard indoor wireless radio devices will likely only have a 0°C to 40°C operating temperature range and would be unsuitable for extreme hot or cold environments. A truly industrial Ex wireless device must have an operating temperature range of -40°C to over +50°C to provide reliable performance in the most extreme environments.

It is also important to consider the heat rise that your chosen wireless device will be subject to by being installed in an Ex enclosure. It is not uncommon to see a heat rise of 0.5°C per Watt of power dissipated. For example, a 25W WiFi access point could generate a 12.5°C heat rise. This heat rise must be added to the upper temperature limit. If your enclosure is subject to extreme cold, then enclosures can be fitted with heaters to ensure that the lowest temperature the wireless device is exposed to is within its normal operating temperature range.

For example, if an indoor rated WiFi access point (AP) is only rated up to 40°C and there is a 10°C temperature rise within the enclosure, the enclosure should be installed in an area that would not exceed 30°C, otherwise the WiFi AP will be exposed to temperatures outside of its rated range.

For this reason, it may be better to fit outdoor or industrial indoor AP's inside the enclosure because they typically offer a wider range of operating temperatures.

Solar Loading

Solar loading is often overlooked but can cause significant operating issues if not addressed. The heating effects of the sun can be considerable, especially in hot climates. If not properly protected the surface temperature can rise to considerably dangerous levels, especially if the enclosure is dark in colour. When specifying your enclosure, be sure to understand the potential solar loading effects for the area where the enclosure will be installed.

Enclosures designed for outdoor high ambient temperature environments will have been thermally engineered. The use of light colours helps reflect the suns heating rays and minimizes the amount of heat conducted into the enclosure (see Figure 4). It is also possible to provide sunshades if the heating effect is deemed to be too large (see Figure 5). When using a sunshade, consideration should be given to the material of construction as it may affect the RF propagation and thus the wireless performance. It is also important to ensure the shade is made from an anti-static material. This is because the large surface area of the shade could become an electrostatic ignition hazard.

Figure 4: iWAP XN3 thermally engineered design

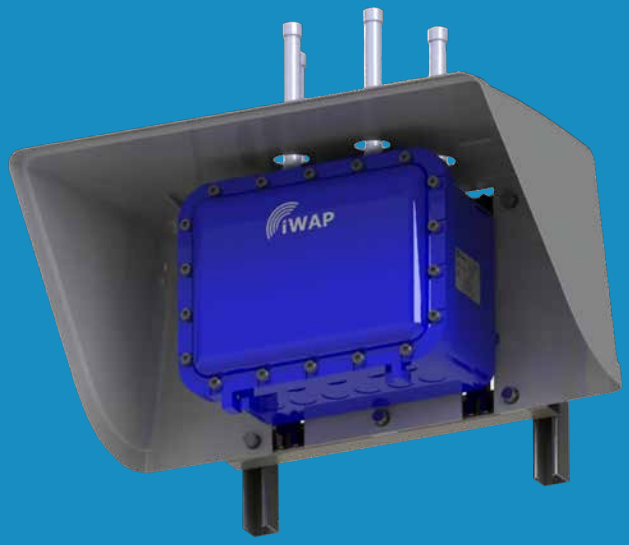

Figure 5: iWAP107 with sunshade installed

Metallic Environments and the Effects of Multipath Interference

One of the most common challenges seen in almost all process industry sites is the effect metallic structures have on the wireless signal. It is essential you chose a device and enclosure system capable of operating in a dense metallic environment. These tend to be on large process plants such as refineries, but they can also exist in smaller chemical plants or on offshore platforms and FPSO's.

Typical communication wireless signals will not penetrate metal, so the complete signal is attenuated and therefore no communication link is possible. Many of these areas include metal rooms or walkways with bulkheads, scaffolding and pipes, making it very difficult to obtain a strong signal. When designing wireless networks for these dense metallic environments you must consider the position of your wireless enclosures and the density you need to obtain the required performance levels.

Another phenomenon that must be considered is the effect of RF multipath interference (see Figure 7).

Figure 6: Metallic process industry environment

Radio signals will bounce off metallic structures and this causes the wireless signal to be received multiple times by a receiver. This can mean signals are received out of phase and cancel each other out. This results in a poor or no communication link.

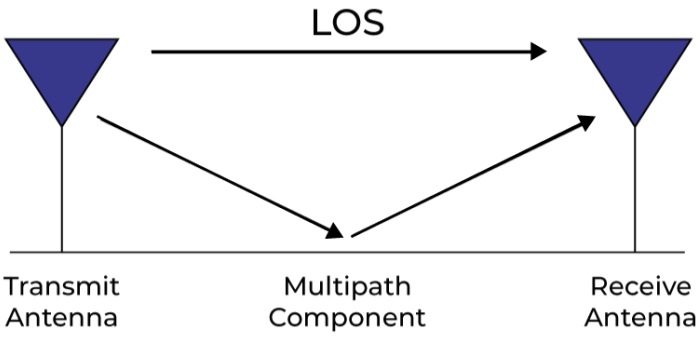

Figure 7: multipath interference diagram

Certain radio technologies have evolved to be tolerant to this and use multipath interference to increase the bandwidth. For instance, MIMO radios have become common place nowadays.

Technology, such as 802.11b/g WiFi was fine in line-of-sight applications but became useless as soon as it was deployed in heavy metallic environments with severe multipath interference. This was one of the main reasons that held up the deployment of WiFi in the process industries. The advent of 802.11n WiFi was a game changer in that it was the first WiFi standard to utilise this radio technology. It made it as practical to use in a refinery processing unit as it did in an office.

Design and Installation Considerations

There are a few important steps to go through when determining the suitability of an Ex certified wireless enclosure system for the chosen wireless device.

It is important to ensure it is still compliant to the Ex certification, does not invalidate other product certification such as product safety and make sure that the wireless device performs as the original manufacturer intended, especially from the RF signal perspective.

The key points you must go through when installing an Ex wireless solution into a hazardous area are summarized below:

1

Does the wireless device meet the typical parameters set out by the Ex certification requirements?

- Operating voltage
- Regulatory compliance, such as product safety e.g. EN62368
- Maximum power dissipation allowed in the enclosure
- Cross sectional area and volume stipulations for Ex d explosion proof certified enclosures.

2

Will the wireless device fit in the enclosure?

It is important that size is taken into consideration to ensure any future maintenance is trouble free. It is critical to avoid compromising the routing of the RF cables to the external antenna ports and tight bend radiuses of the internal RF cables to ensure RF performance is not affected.

It is also worth noting that in the US you cannot buy an empty enclosure and install your choice of wireless device yourself. This would invalidate the manufacturing facility and process audits required for all Ex-manufacturers. In the US, all installations must be checked and signed off by an Authority Having Jurisdiction (AHJ) appointed by the state to ensure OSHA rules are applied correctly.

3

If the Ex Certification is for North America the notified bodies stipulate that any equipment inside the enclosure must be certified to an appropriate UL safety standard by an NRTL. This can often be a challenge because many wireless devices will have been tested for product safety to a standard such as IEC62368, but they were not done by an NRTL.

They can still be sold in the North American market without concern because they are classed as low power equipment so don't need to have an NRTL safety approval, however, for Ex certification under the NEC500 or NEC505 it is a requirement. This can present a serious challenge and restrict the possibility of installing the chosen device in a hazardous area. Extronics wireless enclosures have been designed to overcome this issue and our internal processes and protective components allow such devices to be installed.

4

The RF path is very important to achieve the same level of performance from the standard wireless device when installed in an enclosure.

High quality low loss RF cables and connectors with a minimum bend radius are essential to obtain maximum performance. If using intrinsically safe RF barriers standard antennas can be used - ensure that these have a low insertion loss.

Finally, when direct mounting antennas to the enclosure it is important to ensure that the antenna ports are optimally spaced for the radio frequency concerned when using devices that have multiple antennas such as MIMO radios. If the antennas are installed too close or even too far apart this can affect the RF performance. These key considerations should be carefully addressed to ensure the standard wireless device will provide the required level of performance when installed in a hazardous area certified wireless enclosure system.

5

In more recent times, it has become common place to install multiple wireless devices into the same enclosure system. This is often done to cater for specific use cases or to utilise the best wireless technology available from different manufacturers. For example, combining WiFi with WiHART or WiFi with LTE are quite common use cases across the process industry.

Ensuring that the antenna port spacing provides suitable RF isolation between the two radios is essential as they can interfere with each other. This only applies in applications where the antenna is directly mounted to the wireless enclosure. A typical value of isolation required to prevent a transmitting radio saturating the receiver of the other radio is 30dB to 40dB.

The wireless devices can even interfere with each other when working on different frequencies. Ideally, the devices would be spaced more than a metre apart but that is not possible when installed inside the same enclosure. There are two practical options available in this scenario. Firstly, one antenna can be remotely mounted to create the required distance. If remote mounting is not an option, then mounting one radios antenna on the top of the enclosure and the other on the bottom will usually provide the appropriate level of isolation.

6

Antenna port spacing on the enclosure is important when using MIMO radios. MIMO radios typically have 3 or 4 antennas per radio. The spacing of these ports from one to the other is important to ensure optimal performance when omni directional antennas are mounted directly on to the enclosure.

WiFi Use Case: Enclosure Design and Configuration

WiFi devices are still some of the most common deployments in the process industry. Although many other wireless technologies are becoming more popular and regularly being deployed, for the purposes of this guide we will use the deployment of an uncertified WiFi Access Point into a hazardous area as an example.

Firstly, it is important to clarify with the end customer what the hazardous area classification is, Zone/ Division, Gas Group and Temperature Class.

Example Customer Specification

- Zone 1 IIB T3 hazardous area
- Ambient temperature range of -10°C to +40°C
- WiFi Access Point Specification - indoor IP20 rated 4 x RF port 802.11AC device

Wireless Device Specification

- POE power input
- Power consumption of 25W
- Dimensions are 220 x 220 x 67 mm
- Operating temperature range of -20°C to +50°C
- Maximum RF power output of 23 dBm (200 mW)

Customer Requirements

The Access Point will be installed in a location on the plant that is too far away from a network switch to use copper ethernet cabling and PoE power. For this reason, fibre ethernet and 230 VAC power supply is required. Antenna pattern required is omni directional and direct mounted antennas would be preferable. The maximum ambient temperature is 40°C.

Solution

It is recommended that the customer use the Extronics iWAP107 Zone 1 hazardous area wireless enclosure with direct mounted iANT216 antennas.

Once it has been determined the wireless device will fit inside the enclosure, a check of the maximum power disipation is assessed along with any other stipulations regarding product safety approvals that may be required, such as compliance to EN62368 for example. It's also a requirement to check that the max RF power output at the antenna ports does not exceed the allowed limits for the specific hazardous area where the device is being installed. In this case it is a IIB area meaning up to 3.5W is allowed and therefore well under the safe limits.

The maximum allowed ambient temperature must be calculated to ensure that the internal heat rise in the enclosure does not exceed the wireless device's maximum operating temperature. In this example the wireless device has a maximum power consumption of 25W. The majority of this will be disipated inside the enclosure. Therefore, the maximum ambient operating temperature will be less than the standard wireless device due to internal heat rise. Extronics has profiled the power disipation and the effects of heat rise on all iWAP enclosures. In this example, the heat rise will be approximately 10°C meaning the iWAP maximum ambient temperature will be reduced to 40°C to ensure that the wireless device is operating within its standard operating parameters.

As all the Ex parameters are within the limits of the certification it is now confirmed that this WiFi Access Point is suitable for installation inside the iWAP107 enclosure system.

Extronics has over 15 years experience of developing and manufacturing hazardous area wireless enclosure systems. During this period we have delivered a wide range of wireless configurations all over the world. There is a high degree of possibility that we have already delivered an identical system you may be looking for. This means that the compliance checks, production process and procedures will have been completed, making it even easier for you to purchase.

If it is a new wireless device then we must check a number of safety parameters that are stipluated in our notified body type approval for the enclosure system. The first thing to check is to make sure that the Access Point fits into the permissable area detailed in the notified body type approval. For instance there can be limits on how close to the wall of the enclosure that heat generating parts can be mounted as this could affect the T class of the enclosure by increasing the surface temperature. In respect to Ex d explosion proof enclosures there are rules about the amount of free space that needs to be in the enclosure both dimensionally and volumetrically.

Ex Installation Considerations

How you install the enclosure should be at the forefront of any hazardous area installation planning. Firstly, you must decide how the wireless enclosure will be mounted in the plant. The iWAP range of enclosures has standard fixing points for mounting to a wall or a frame. Alternatively, you may wish to mount the enclosure to a pole using a standard pole mounting bracket available for the iWAP enclosure range.

The next step is to look at the field cabling requirements. For instance, the AC power cable in this example will need to be mechanically protected. This is a mandatory requirement stipulated in the IEC60069-14 Electrical installations design, selection and erection standard. There are typically two approaches to meet this requirement:

Option 1:
the cable selected has an armoured sheath, which can be in the form of a metal tape or braid compliant with the standard

Option 2:
the cable must be mechanically protected by other means such as installing it in a metal conduit or cable tray system

When the cable type has been selected a suitable Ex cable gland must be selected to match the cable and the hazardous area classification. Extronics can offer advice on selecting the suitable cable glands and can supply these as a separate item as part of the kit of parts to complete the installation in compliance with the standards.

Solar Loading

Consideration should be given to the amount of solar loading the enclosure will be exposed to as this will cause further heat rise inside the enclosure. It's important to check with a manufacturer of enclosure systems what the effect of solar loading is. If it is determined that the solar loading effect will cause heat rise that means the wireless device's operating temperature is exceeded, then a sunshade needs to be fitted to the wireless enclosure system to ensure the heat rise stays within the standard operating temperature for the device.

Location Performance

As with any wireless device it is important to consider where it is mounted from a wireless performance perspective. This will have been determined by undertaking a wireless design survey. It should not be underestimated the importance of carrying out a wireless network design review, which will often include carrying out a physical wireless survey. There are companies that specialise in this type of work. They will also consider interference from other wireless devices that may be deployed in the plant. This is essential to ensure the wireless equipment being installed will perform to the manufacturer's specification and be reliable in operation.

Finally, it must be proven that the maximum RF field at the antennas does not exceed those allowed for the hazardous area classification where the enclosure is installed. In the above example: Max RF power is 23 dBm and the antenna gain is 6 dBi.

Calculation

Max EIRP = Max Radio Power + Antenna Gain – Cable Losses – Connector Losses

Radio frequency power thresholds

Equipment for	Threshold power W	Thermal initation time µs
Group I	6	200
Group IIA	6	100
Group IIB	3,5	80
Group IIC	2	20
Group III	6	200

There is no cable or connector losses because the antennas are directly mounted. Therefore, the maximum power is 29 dBm, which is 794mW and well below the 3.5W allowed for a IIB hazardous area. This means the installation is safe. More details on how to verify if an RF installation is safe can be found on our blog.

Calculating the Max RF Power for a Hazardous Area Wireless Device

Maintenance of Ex Equipment

All Ex equipment needs to be routinely inspected to a standard such as IEC 60079-17:2014 Explosive atmospheres.

This standard stipulates the type of inspections and the frequency they must be carried out. These inspections must be documented and it is only through compliance to this standard that an end user can be assured that they are operating their plant in the safest way possible.

When selecting a wireless enclosure system, it is important to check the details of the Ex certificate for any special conditions of safe use. It is not uncommon for an Ex certificate to have an “X” after its number. The “X Conditions” are clearly stipulated on the certificate and in the installation and maintenance manual of the product.

They cover things such as “mounting in an area that is not of a high risk of mechanical impact” or “a routine pressure test needs to be carried out after installation and annually after that”. These can not only be a burden on an end user but very costly too. For instance, with Type nR protection – restricted breathing, which is suitable for Zone 2 & Division 2 installations, there are certain conditions that stipulate if the enclosure must be pressure tested every year to ensure the method of explosion protection is maintained.

Extronics iWAP hazardous area wireless enclosures are engineered to the highest standard without the need of routine testing in the plant.

Working With a Specialist Can Save Time and Hassle

Whether you are an End User, OEM or System Integrator working with specialists pays dividends in the long term. Reliable operation of the wireless device, the long-term total cost of ownership or the support during the design phase makes a big difference to the total costs.

Extronics is vendor agnostic when it comes to the wireless technology. We work with any wireless vendor or wireless standard. Our mission is to enable non-hazardous area certified wireless devices to be cost effectively installed in hazardous areas with the minimal effort required from our customers.

Being agnostic to one vendor or type of wireless technology means we are not bound by contractual relationships that stipulate you can only offer specific devices. It also means we can support all wireless vendors with our solutions without them being concerned that we favour one or the other.

Our goal is to offer the best solution to suit the customer's application. If the customer has a preferred wireless device, then that is the one we'll use. Equally if a customer comes to us and has no preference, we will offer the solution that best matches their application.

We are wireless experts. We have been involved in wireless technology for deployment in hazardous areas since 2005. There are many companies in the market that sell Ex enclosures to install uncertified electrical equipment, such as low voltage switchgear and they do a great job of this. However, when installing a wireless device in a hazardous area you need specialist knowledge and design considerations in the enclosure to ensure optimal performance.

We don't just offer the enclosure; we develop and manufacture other components to enable wireless equipment to be deployed in hazardous areas cost effectively. For example, the Extronics intrinsically safe RF isolators and antennas. These are available for purchase separately but are extensively used in our wireless enclosure systems and have been optimised for price and performance.

Working With OEMs

If you are an OEM developing wireless devices, Extronics is an ideal partner to work with. We can help you take your wireless equipment to the hazardous area market without the need to take on the task and expense of designing your own Ex compliant enclosure.

Using a Pre-Certified Enclosure

There are several benefits to utilizing pre-certified Ex wireless enclosures. Firstly, the reduced time to market. Typically, an Ex certification process will take up to 12 months but often it can be longer.

If you are an end user or System Integrator and you want to use wireless equipment that you are familiar with, , then you don't have to compromise and try and find a wireless devices that is already certified.

Our wireless enclosures are certified to many standards such as North American, ATEX, IECEx, UKCA, EAC, INMETRO and TIIS. It costs a lot of money to get such a range of Ex certificates as well as the time and the quality control considerations. It's important to note that all Ex manufacturers not only have to obtain a type approval for their product but also need to have the appropriate quality system in place. It is a legal requirement that all Ex manufacturers are audited frequently to ensure the equipment is being manufactured in accordance with the type approval. For example, North American certification requires 4 audits per year. ATEX and IECEx have an annual inspection regime but are typically of much longer duration and may take 2 to 3 days.

Working with a specialist like Extronics removes all the hassle surrounding EX certification.

Extronics – Hazardous Area Wireless Experts

At Extronics, we provide Ex certified wireless enclosures systems for use in hazardous areas. Our vendor agnostic position means we can work with most global wireless devices including most WiFi access points sold on the market.

This approach gives you the flexibility to design your WiFi network in the most efficient way possible, reducing upfront cost, installation cost and cost of ownership into the future.

We do this using our innovative iWAP range of hazardous area wireless enclosures for reliable wireless networking.

Learn more about the iWAP range of hazardous area wireless enclosures

The unique chassis design is purpose built to house most wireless devices and provide intrinsically safe RF outputs using our iSOLATE technology. The iSOLATE technology further drives cost down for the end user by allowing standard non-hazardous area antenna to be used.

iWAP modular chassis system example with AP installed.

Contact Us

Our experienced team is on hand to answer any questions you may have.

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