Emergency signalling in hazardous areas
Neal Porter
E2S Warning Signals

The increasing use of signalling devices to enhance safety in the workplace is to be welcomed. It is particularly important in petro-chemical and oil and gas plants where the potential for serious accidents is far greater than most industrial environments. The author knows this from personal experience: when visiting a site some 15 years ago there was a serious explosion and toxic gas leak. It is at that moment that one realises how tools to warn and control an emergency are absolutely essential.

Hazardous areas are defined as areas where concentrations of flammable gases, vapours or dusts may occur, either constantly (Zones 0 and 20), under normal operating conditions (Zones 1 and 21) or unusually (Zones 2 and 22). A whole series of additional conditions relating to the temperature classification and the auto-ignition temperatures of the type of gas or dust to be found to ensure that any equipment will not initiate an explosion or fire. Products designed for hazardous locations have to meet ever increasing standards and regulations. ATEX is the key requirement for Europe, while in North America, UL standards apply. In other parts of the world, particularly Australia, IECEx is gaining increasing acceptance. As well as these globally recognised standards, there are many local fire approvals that usually have to be met.

Given the variety of different gases or dusts that are potentially present in a hazardous area, detailed standards have evolved to ensure that all eventualities are taken into account when equipment is to be installed and operated in such an environment.

A detailed information bulletin on hazardous areas can be downloaded as a PDF from www.e2s.com/system/hazardous-area-guide. It gives details of gas and dust groups, temperature classifications, common flammable gases, vapours and dust types, ATEX, IECEx and North American protection concepts and many other useful references in a convenient single overview document.

Products for use in hazardous areas

Hazardous area products fall into two categories. They either prevent an explosion by constraining the amount of energy entering the device (intrinsically safe) or have a sufficiently robust housing to contain an internal explosion (explosion proof). In most cases, they offer a robust, weatherproof device capable of operating reliably in the harsh environments in which they are often installed.
It is not the intention to discuss hazardous area standards in this article but to offer some practical guidance on the use of signalling devices and their applications in these locations.

Materials

Four main enclosure materials are available for intrinsically safe and explosion proof products, offering different impact resistance, corrosion resistance and temperature ranges. UL94V-0 flame retardant plastic ABS enclosures for intrinsically safe (IS) units are light weight, impact resistant and corrosion proof. IS sounders and sounder/beacon combinations are also available in marine grade aluminium with a phosphate and powder coat finish housing that offers enhanced mechanical, temperature and UV protection compared with traditional plastic bodied devices.

Explosion proof devices are typically also housed in more robust enclosures, which give the necessary strength to contain an internal explosion. There are three main materials in use today. Aluminium

alloy, glass reinforced plastic (GRP) and stainless steel; the choice is down to customer preference and the environment into which they will be installed.

A recent addition to the choice of materials is polyphenylene sulphide (PPS), an engineering plastic which can be moulded, extruded or machined to high tolerances to give a non-sparking, lightweight, corrosion proof housing suitable for use in Zone 2 and 22 applications.

Intrinsically Safe

Intrinsically safe products will have been designed for Zone 0 (gas) and Zone 20 (dust) and can therefore be used in Zones 1, 2, 21 and 22 as well. They generally use standard moulded enclosures and the protection comes from the electronics which is specially designed to limit the amount of energy required to initiate an explosion. Powered through a Zener barrier or galvanic isolator, they offer a very safe solution which is easy to install, but the limited amount of energy means that IS devices will only ever have lower performance than the same device installed in a safe area. Typically, sounders will have an output between 90dB and 105 dB @ 1m and beacons will use low power LED warning lights rather than ultra-bright Xenon strobes.

This limitation means that while they can be used outdoors in a plant, the sounder outputs are not sufficiently loud to be audible above the background noise. Consequently, IS products are usually best installed indoors in storage facilities, pharmaceutical plants and control rooms and indoor fire alarm systems which cover hazardous areas.

Explosion Proof

The input power to explosion proof products is not limited, so outputs are typically much higher than intrinsically safe devices. Safety is ensured because the devices are housed in rugged enclosures that will contain any potential explosion which may occur inside. This means they are heavier and more difficult to install than their IS equivalents, but they can have significantly higher outputs. For example, alarm sounders can be up to 120 dB @ 1m and beacons can incorporate powerful xenon strobes giving an effective light output up to 500 cd.

A LED intrinsically safe beacon may only warn people within a few metres of its location, but a 21 Joule explosion proof Xenon beacon has an effective warning distance of up to 35 metres. More importantly, the high intensity flash will reflect off any surfaces and will get attention even if one is not looking directly at it, an especially important consideration in a plant environment where personnel will be concentrating on their work and need to know if there is an emergency.

These products are the mainstay of fire alarm, gas detection and PA systems on large petro-chemical installations around the globe where gas is the primary hazard. Increasingly, warning devices are being installed in sugar processing plants, grain storage facilities and other areas where dust, rather than gas, is the main explosive hazard. Obviously, any equipment installed in such areas must be certified for use in Zone 20, 21 or 22 areas.

Increased Safety

Many locations are classified as Zone 2 and it is possible to install alarm devices which have been designed specifically for these areas. This means that high performance products which are easier to install and have a lower purchase cost can be specified. Surprisingly, while there is a strong cost-benefit case to be made for this kind of product, the vast majority of Zone 2 areas are populated by Zone 1 products; it seems that designers adopt a cautious approach when specifying.

Choosing an effective alarm

Safety Integrity Level, SIL

Safety Integrity Level, SIL, is a measure of safety system performance expressed in terms of probability of failure on demand (PFD). In the oil and gas industry, particularly in the fire and gas detection systems where safety integrity is crucial to ensuring the safety of the plant, personnel, production and the environment, SIL 2 is becoming a common standard across systems. To meet the growing demand in the oil & gas industry, fault monitoring technology to give SIL compatibility is becoming increasingly common in explosion proof sounders and beacons from leading manufacturers such as E2S Warning Signals.

In large petro-chemical installations safety-critical warning devices are installed over large distances, so central monitoring is a key requirement. While fire and gas detection systems continually monitor the integrity of the cabling, the warning devices themselves are not checked continuously and physical inspections must be arranged to ensure these work properly. The new SIL 2 functionality in sounders and beacons means that each single device can be remotely checked and an alert sent to the control panel in case of fault.

A smart combination of software and hardware removes the need for time-consuming inspections and test of each individual warning device by intelligently reading the sound output of the sounder or the light emitted by the beacon to check it is working properly.

Beacons and Status Lights

There are a number of different ways that can be used to generate light and for emergency signalling: it is important to know the advantages and disadvantages of each type to make the right choice. Rotating mirror beacons are by far the most effective, and are still used extensively today, particular for vehicles and moving machinery. Their high output light reflects off everything but the use of halogen lamps (around 200 hours of working life) and a mechanical drive system mean they need regular maintenance and are generally not suited to hazardous areas, especially where maintenance rules requires the system to be powered down each time work needs doing.

Xenon strobes, especially the higher power versions, have a working life beyond 2,000 hours and create an effect almost as good as the rotating mirror beacons which means they are the preferred choice for critical alarm systems such as fire, gas and PA.

There is a lot of interest in LED technology at the moment and the benefit of long life and the low maintenance and life costs they bring. Even the brightest units fall well below the outputs of a xenon strobe and so they are best used as status lights. They are particularly beneficial when used as “system good” green indicators, which are often working 24/7. The steady light, low power consumption and long working life are real benefits.

Alarm Sounders

These form the main backbone of most alarm systems, and many countries have national alert tones for fire alarm which are a legal requirement. France for example has the AFNOR tone, Germany the DIN tone and there are the PFEER tones for the offshore industry.

The choice of tone is very important. Continuous tones can very quickly blend into the background noise of motors, compressors and steam and do not grab your attention in the way a changing frequency tone does. The German DIN tone, which is also one of the PFEER tones, is particularly

effective. It sweeps from 1200Hz down to 500Hz every 1 second and can be heard at far greater distances than many other tones.

Electronic sounders can often generate up to 64 alarm tones, and many devices allow the use of three or four different stages of alarm, meaning that there can be a fire, toxic gas or any other kind of alarm from a single device. This allows greater functionality from each device and saves money on cabling and installation.

Typically, hazardous area alarm sounders have outputs of between 110 and 120 dB @ 1m. To create effective warning, the sound level needs to be at least 5 dB above the background noise and together with a choice of suitable tones, an effective alarm is created. When using several different signals for different alarms, it is important that the two or three tones selected are different and can be readily distinguished by plant personal as a quick response in an emergency is vital.

As well as electronic alarm tones, there are the traditional electro-mechanical products such as bells, buzzers and sirens, which are rich in harmonic content, very effective and easily recognisable. While widely used for more than 100 years, the reliability, performance, maintenance and running costs of electro-mechanical devices has always been a concern, particularly now that more efficient alternatives are available. Compared with solid state technology, electro-mechanical devices suffer from high inrush current on start up, require higher operating currents when running while being less efficient in terms of converting electrical to acoustic energy and will fail far sooner than an electronic alternative. Fortunately, digital electronics can now replicate these tones with complete fidelity and often with outputs that are higher than the originals. Solid state electronics ensure greater reliability and, most importantly, they are available in both heavy duty weatherproof and Ex versions.

Disaster Sirens

It is becoming more and more common for large industrial sites to extend their warning systems to cover car parks and storage facilities to provide a disaster siren for major emergencies and toxic gas release. This can be to warn both people on-site and also people living and working in the neighbouring areas adjacent to the plant. Sometimes the requirements are for a short distance (200 to 400 metres) and for others it is for far greater distances, possibly up to 2 km or more.

Typical solutions now have battery back-up, silent test and options for various communication methods including TCP/IP, Radio Control, GSM and RS485 which means a siren can be installed and managed remotely from the control room without significant expense.

Disaster sirens require high power inputs for operation, and so they are usually installed in the safe areas. However, it is possible to have the electronics installed in an Ex d enclosure and mount the speakers at 15 metres which is usually classed as safe area, giving the best of both worlds.

High quality voice reproduction can also be achieved using these products, giving the option of extending the site PA systems to cover other areas.

Temporary Alarms

As well as the usual requirements for fixed safety warning devices on an established plant, there is increasing use as temporary alarms, especially during the construction phase of a new or extended plant. Radio control makes this an easy to implement solution, and with only a small ac power supply required or powered from solar panels, it can be up and running quickly and then moved to another site once the construction phase is complete.

This gives the construction engineers the option of a full fire alarm and/or emergency management system which can be activated from almost anywhere in the plant without any cabling, providing a temporary solution which is as effective as a fixed installation.