Being frequently involved in area classification studies as the so-called expert, the
author wishes to share, from personal experience, some principles that can be
applied by owners and managers in their quest to make their plants safer places of
work. In addition, the aim is to create greater awareness among plant owners, their
insurers and safety facilitators, their electrical and instrumentation contractors, and
safety inspectorates of regulatory and other bodies.

**Hazardous area classifications**

(SANS 10 108)

by Dr. Johannes G Auret, Exproblabs

Area classification (in South Africa better known as the classification of hazardous
locations) plays a pivotal role in explosion prevention - i.e. the technology of preventing
explosions due to flammable gases, vapours, mists, dusts and fibres in surface
industry and mines. Area classification can be defined in several ways, for example:
- part of major hazardous installation risk analysis;
- a quantification of the probability that an explosive atmosphere will occur, or
- determining the appropriate zones and zone geometries associated with
  sources of release (see Fig. 1), as well as the properties of the explosive
  atmosphere including gas group and temperature class that can occur in
  these zones.

The concept of area classification has remained the same over the years, but the
application has grown in detail requiring the classifier to be in command of a certain
knowledge and skills base. Area classification is no longer a part-time activity
for an engineer - it has become a team-based job facilitated by an expert. This
brings with it certain disadvantages, but also leads to safer plants in hazardous locations
and to cost savings.

**Hazardous locations commonly found in industry**

Hazardous locations occur in all underground coal mines. In industry, it is
estimated that more than 50% of goods and materials produced in this country are
manufactured in facilities with hazardous locations. If the knock-on effect is included,
it becomes clear that the manufacturing industry in a country such as South Africa
will grind to a halt were it not for explosion prevention and in particular for area
classification as one of its main pillars.

A review of typically found hazardous locations is given below.

**Factories**

There are various industries in which the presence of flammable gases, vapours and
dusts in certain places at certain times is inevitable and where the area classification
must be determined. These include:
- chemical and petrochemical;
- food and beverage;
- pharmaceutical;
- paints and inks.

Fig. 1: Typical area classification of a surface plant where explosive vapours are present.
Mines

Although coal mines are traditionally the prime focus for explosion prevention due to the flammability of coal and of methane dust carried by the coal, hard rock mines such as gold and platinum mines in South Africa have reported the presence of flammable gases (hydrocarbons and hydrogen) on a regular basis in recent years, accompanied by a series of destructive explosions that has led to the strict application of explosion risk analysis and explosion prevention in this mining sector.

Surface-based processing plants associated with mines

These plants are categorised separately because of their legal status as being controlled by the Mine Health and Safety Act and cover a wide range of petrochemical and minerals processing plants, including refineries and platinum concentrators.

Many of the improved modern-day reagents used in platinum concentrators are unstable and decompose into flammable products, as a result of which explosion prevention has been introduced in reagent-handling plants. Recent incidents in concentrators have shown clearly that, although safety and explosion prevention procedures have been developed, these must be improved further.

In coal mining, surface crushing plants, coal storage silos, coal beneficiation plants and petrochemical and minerals processing plants are associated with mines. These plants are categorised separately because of their legal status as being controlled by the Mine Health and Safety Act and cover a wide range of petrochemical and minerals processing plants, including refineries and platinum concentrators.

Act

| Occupation Health and Safety Act (Act 85 of 1993) | EIR 4(1) EMR 8(1) | SANS 10108 Plant management |

EIR = Electrical Installation Regulations  EMR = Electrical Machinery Regulations

Provided that items of an electrical installation not covered by such safety standard and the conductors between the point of supply and the point of control shall be installed in accordance with the by-laws or regulations of the supplier concerned.

EMR 8(1) No person may use electrical machinery in locations where there is danger of fire or explosion owing to the presence, occurrence or development of explosive or flammable articles, or where explosive articles are manufactured, handled or stored, unless such electrical machinery, with regard to its construction relating to the classification of the hazardous locations in which it is to be used, meets the requirements of a safety standard incorporated for this purpose in these regulations under Section 36 of the Act.

R 21.17.1.1 The manager shall identify and define any hazardous area referred to in regulation 1(1A)(ii) in or on a mine or at a works and record it on a plan or in a register provided for that purpose.

Organizing a decent classification (the Do’s and Don’ts)

We know that legally the plant or mine owner carries the can for area classification. How does he achieve this in practice?

Role of owner

It is fine if the owner wants to carry out his own area classification, as long as the availability of in-house competence can be demonstrated, if necessary in a court of law. Practically, once a plant is commissioned, explosion prevention is often left in the care of maintenance staff that have an imperfect understanding of the concept. Management, on the other hand, is even less well informed and is not able to constructively support these maintenance efforts. The result is that bad practices abound and that the statutory requirements are seldom complied with, including area classification.

EIR 4(1) No person shall install or permit or require the installation of an electrical installation, other than in accordance with a safety standard incorporated into these regulations under section 36 of the Act, provided that items of an electrical installation not covered by such safety standard and the conductors between the point of supply and the point of control shall be installed in accordance with the by-laws or regulations of the supplier concerned.

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protection may be involved and will introduce an MIE to the scene.

MIEs are sometimes their own worst enemies. Having been exposed to SANS 10108, the national standard that provides the basis for area classification, an MIE often assumes the role of expert in matters of area classification as well, and often carries out the little task single-handedly! Unfortunately he does not realize that he is exposing himself to severe legal consequences if a mistake is made. In addition, the position of being judge and jury at the same time (he will also normally specify the apparatus that must be purchased as a result of his classification) causes major anti-trust issues and the project ends up as a tug-of-war between the MIE who is belatedly trying to ensure a safe plant at the expense of a nice profit margin and the owner who has lost some faith in the MIE and is trying to cut costs.

The classification team approach is a self-regulating one as external expertise can be brought in; the interests of all parties are considered; proper records are generated and it is legally defensible as the reasonable-man approach.

Standards - the technical base for classifications, but are they user-friendly?

This subject is included because the variety of standards and different interpretations of these standards has caused many plant owners to consider area classification as a black art or a free-for-all.

The technical rules for classification standards for area classification have been available for many years. Some of the best work has always been forthcoming from the chemical and especially petrochemical industries, initially from large individual companies (e.g. the thenICI) and later from national technical organizations and eventually national, regional and international standards writing bodies.

Initially the scientific foundation for zone sizes and geometries in particular was somewhat instinctive and based on practical experience, but current standards are pretty solidly based on facts and figures.

Examples of the old approach

One is the 180 m distance from the working face allocated for compulsory hazardous locations in an underground coal mine. Apparently the main reason lies in the typical maximum length of power cables, i.e. this figure allowed switchgear to be placed just outside of the hazardous location. The same thumb-suck lies probably in the 20% of LEL cut-off concentration for operating explosion-protected apparatus.

And who will believe that an LPG pump, a hexane pump and a CO fuel gas fan create the same hazardous radius - the hazardous radius being the primary horizontal dimensions of the zone? Nevertheless, in several standards including SABS 0108 of 1974 this approach was entrenched.

There was also the interesting conviction that a Zone 1 is always accompanied by a Zone 2. Practically this is of course true of sources of release such as storage tank vents, but can certainly not be generalized.

O ther issue that left room for improvement were the lack of attention to smaller higher grade zones, typically those associated with sampling and drain points and instrumentation vents. The location of these sources of release can of course only be pinpointed after installation, and the necessary classification review after the initial paper-based classification by the engineering firm was probably only conducted in exceptional cases.

In the same league falls distinguishing between sources of release based on their frequency of use. In other words, a sampling point used only during startup of a plant could result in a Zone 2 (explosive atmospheres only forming under “abnormal” i.e. other than normal operational conditions) while one used daily will give rise to a Zone 1.

The above should not be seen as criticism, except if so-called classification experts do not give attention to the more precise modern practices.

How do old and new classification standards compare? Why are the results different? These are fair questions whose answers lie in the correct interpretation of the standards involved.

For example, the zone sizes specified in a standard depends on:

- How conservative the approach is that was taken. This goes hand-in-hand with the age of the standard (older standards tending to be more conservative).
- Another age-related factor is that modern technologies produce cleaner plants with fewer and smaller releases, due to better sealing systems, restrictions on emissions and more reliable equipment requiring less maintenance.
- How general the application of the standard is (the more general, the more conservative the approach tends to be).
- An example is the classification in the old SABS 089:2.1965 (now obsolete) compared to UK IP Code Part 15 Edition 1 for a pump/tank containing petrol (15 m versus 15/3 to 1.5 m).

Newer standards tend to be more specific. Compare the 2 m/5 m approach of SABS 0108:1974 to the differentiation of petroleum products into four fluid categories, e.g. LPG or any other flammable liquid handled under conditions that will produce at least 40% vaporization instantly upon release, liquids that will boil off when released, liquids released above their flash point or as a mist, and gases.

Some current classification standards are listed above.
As one of these so-called experts, the author has identified the following problem. Until quite recently, a technically skilled person could read a classification standard and could come up with a decent classification standard if he put his mind to it. In the author’s opinion, this possibility has become history with the publication of the leading standard for classification of flammable liquids and gases, Edition 2 of the Area Classification Code for Petroleum Installations, published by the UK Institute of Petroleum. This publication has a misleading title as it can be applied to most flammable fluids, provided they are “similar in physical characteristics to those occurring in the petroleum, petrochemical, and allied industries.”

This standard still uses three main classification concepts i.e. Direct Example; Point Source or Source of Release; and First-principle Calculations (dispersion modeling). However, it provided specifically for ultrahigh pressure installations; “leak hole size” and “release level” must be determined; the sealing system plays a pivotal role.

Quite frankly, only a team approach will allow this standard to be applied successfully, as inputs from various disciplines are essential. Secondly, to apply the principles contained in this standard for determining the hazard radius properly, an expert must be used!

It must be stressed that the standard is an excellent document worthy of its status. A concern exists however that certain potential users of the document will not be able to apply the information to the full – a situation fraught with dangers. Should plant owners and other users wish to do “their own thing”, my well-meant advice would be to use a less complex standard (even the first edition of said IP code), on the basis that any inaccuracies would be more acceptable thana completely incorrect conclusion! The word “errors” would be too strong in this context, as the difference between the two codes would only involve typically a 10-20% variation in hazard radius, excluding extreme processing conditions of course.

Conclusions
The principles of area classification are simple. However, effective application of current classification standards requires full-time involvement in the field, as firstly, the application of the standards has become more scientifically based and therefore more complex, and secondly, a structured and well-managed approach has to be followed to create a sound database.

No doubt the near future will bring training programmes and accreditation of specialists. However, it will pay handsome dividends to have the members of classification teams also trained in the classification concept to improve their effectiveness.

The good news is that classification is now even more a scientifically founded process than before. Growing awareness among roleplayers is leading to progressively better and safer classifications.

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