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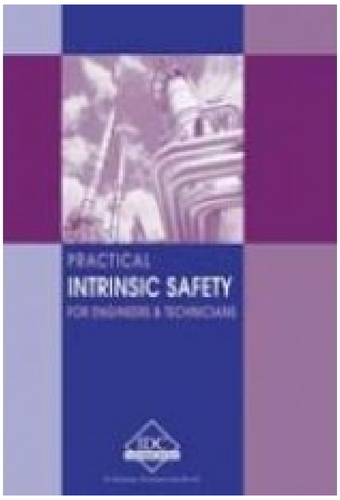
IS-E - Intrinsic Safety



Price: $139.94

Ex Tax: $127.22

Short Description

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This manual covers IS as the preferred technique for instrumentation applied to industrial plant inputs/outputs in hazardous areas. The principles of IS do not change since these are based on the laws of physics, however, the implementation of IS is open to interpretation and causes some conflict as the subject is still seen as a 'black art'.

This manual aims to widen the understanding of this technique by explaining the basic rules within the context of their application. Engineers and technicians working in hazardous process control and instrumentation areas must have an understanding of the close integration between the safety and operational aspects of intrinsic safety as a protection technique in order to specify, design and maintain systems.

This manual is designed to explain the theory of IS and its close integration with operational signal transfer. You will gain a greater understanding of IS loop concepts as a basis for working with measurement and control loops using standard and custom IS solutions. Defining and applying the correct terminology will assist you in communicating and documenting important safety details.

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Practical Intrinsic Safety for Engineers and Technicians

1 Introduction

1.1 General introduction to explosion protection

Intrinsic Safety (IS) is one of a number of explosion protection techniques. Explosion protection (or 'explosion proofing') may be described as the specific treatment of industrial electrical equipment, such that, in the presence of a 'potentially explosive gas atmosphere' and under prescribed conditions, it cannot cause ignition. Equipment so treated is generally referred to as (electrical) 'Apparatus'.

There are considered to be nine different categories or techniques that can be employed by the suppliers of electrical apparatus to meet the industrial needs of users.

The purpose of electrical apparatus designed to minimise the risk of ignition is to allow industry to handle situations where electrical power and signals can be used in hazardous atmospheres. The risk posed is never considered to be totally eliminated as this would be impossible to guarantee. The risk must be lowered to levels that are deemed acceptable by the Law, and all parties interested in safety.

It is the consequences of an industrial explosion that are potentially catastrophic and therefore cannot be ignored.

1.2 Historical background to explosion protection

Explosion Protection concepts were developed in parallel and as a consequence of the mining industry. Coal has been mined for more than 1000 years. Large-scale mining was practised as early as the 18th century in many countries.

Mine ‘safety procedures’ operated from this time when the risks of ‘fire-damp’ were beginning to be understood. The initial way of dealing with the problem was to send ‘fire-men’, younger people covered with wet sacking, down mine ‘roads’, clutching a long lighted taper. The purpose of this was to burn off any residue of methane that had built up before the miners began work. This was an effective but somewhat sacrificial and barbaric practice!

The renowned Davy Safety Lamp was first tested underground at Hebburn Colliery on 9thJanuary 1816. Its invention was as a result of the disaster on 25th May 1815 at Felling Colliery, County Durham, in the UK, where 92 men and boys lost their lives. The scientist, Humphrey Davy, was approached on behalf of the Sunderland Society to try to provide a solution to the problem of firedamp in mines. The Sunderland Society was formed by concerned individuals which included MPs and churchmen who realised that the danger was ever present and that solutions were required.

Over the years, the Davy Safety Lamp must have saved countless lives.

Electrical equipment came into use in mines well before the 1900s. It was not until 1905 that regulations in Britain were introduced to govern the use of electricity. The regulations suggested that equipment installed underground should be designed to minimise the risk of heat or sparks causing ignition. Even before this, equipment had been purposely ‘over-engineered’ in order to withstand the adverse conditions underground. Enclosures and housings were made more substantial than would be otherwise required. The design criteria was that mechanical shock to the equipment, high levels of dust and moisture should not be able to penetrate the casing and render the equipment inoperable or unsafe.

This heavy construction meant that it was also more likely to protect personnel from electrocution. An additional advantage was that the enclosures were found to withstand the effect of an internal explosion if a gas air mixture had seeped inside. It was Humphrey Davy who explained that the enclosure would prevent the internal ignition from reaching the external gas air mixture surrounding it, provided that certain constructional limits were observed. The origins of this method, as one of ‘explosion protection’, undoubtedly came from this realisation. The term ‘Flameproof’ was not used until a British Standard was published in 1924.

More explosions that were thought to be caused by the use of electricity in mines led to the development of British Standards in the early 1900s.

On October 13th 1913 at the Universal Colliery in Senghenydd, Glamorgan in the UK, 439 miners were killed. This was the largest explosion in a UK mine. The government of the day was pressured into appointing two scientists, Wheeler and Thornton, to investigate the cause of the explosion. Their findings, published in 1916, indicated that it was most likely to have been caused by sparks from the electric ‘bare wire bell signalling system’. This was a simple arrangement to aid communication between parties of miners at the coal face (filling coal trucks at one end of a roadway) and the winch operators (at the shaft end) preparing to receive the full trucks. The signalling system was operated from a low voltage and was exempt from the 1905 regulations.

As a result of the two scientists’ work, the spark energy to ignite methane and firedamp was determined. This led to the formal development of explosion protection methods and standards. Crude forms of energy limiting were then used in low voltage circuits to prevent incendive sparks. This method of energy limiting was used for some time and comparatively recently received the name of ‘Intrinsic Safety’. Initial attempts to operate with IS systems at higher power levels than are accepted now were included into British Standard BS4444.

1.3 Scope of protection systems

It is important to realise that modern explosion protection methods and standards are only in place to minimise the risk of electricity causing ignition of a flammable atmosphere.

Use of these standards does not enable the equipment to continue to work when fire or explosions have been caused. This is a general misconception of the term. Systems which are designed to continue to operate even though some disaster has been caused are the subject of separate engineering consideration. Fail-Safety concepts are discussed in this manual because they form an important part of the safety strategy for instrumentation and control applications.

There are many other safety issues that must be taken into account and must operate in parallel with Explosion Protection and IS. These techniques can and do operate in a complementary way and one technique does not necessarily alter the strategy of the other.

1.4 Responsibility

The requirement placed upon industry to operate in a safe way is contained in the laws of most countries.

A ‘duty’ is placed on the owners of ‘places of work’, to provide conditions that minimise risks to such an extent as is ‘reasonably practicable’. This legal precedent is followed to encapsulate the level of responsibility needed by industrial management for the definition of this duty.

It is clearly necessary to safeguard life and limb. It is also in the interest of the general public that property, investment, livelihood and social structures are similarly protected. Owners of industrial premises must be aware of all aspects of general safety and must take precautions to minimise risks to ‘acceptable levels’. The term, ‘acceptable levels’ is not easy to define and is based on a matter of judgement. This may vary in definition from one country to another and so it is up to the laws of those countries to balance the probability according to their interpretation.

An obvious question to ask is whether it is absolutely necessary to site a piece of electrical equipment in a position where it has an increased risk of causing ignition. If it is possible to design out this requirement then the risks are inevitably reduced. This is the responsibility of the plant design body.

General electrical safety is just one of many aspects of safety that need to be considered by the plant owner in an industrial situation.

The consequences of equipment and system failures causing accidents that include explosions must be considered by the factory owner. The location of a plant and the impact of an explosion on the surrounding location must be assessed. It is reasonable to take extra precautions if the factory is located in the middle of a city, but does not mean that safety can be relaxed if it is located in the middle of nowhere.

Risk assessment is the art of judging the likely causes of disasters and balancing them against measures taken to prevent the occurrence of such a disaster. It must take the view that nothing is completely safe. It should be realised that explosion protection is just one tool which can be used in an industrial situation to minimise the risk of electricity causing ignition to an acceptable level.

1.5 Explosion of protection and certification

The expense and inconvenience of safety testing each item of electrical equipment in each individual plant situation is impractical. A system has evolved to facilitate the selection of equipment for use in plants which utilise potentially flammable materials.

The principle of the system is based on the matching of two sets of criteria that are defined under a common set of rules. These criteria are:

- The classification of a plant
- The classification of electrical equipment used in the plant.

The common set of rules comes from national and international Standards and Codes of Practice. These have been developed over the years and describe acceptable ways of building equipment in such a way as to prevent electricity from causing ignition in certain hazards. The standards expect that the hazards into which the equipment is to be placed have been categorised and defined by these same common rules and so the hazard and equipment may be directly compared for suitability.

The certification process merely states conformance with the standard to which equipment has been assessed. It does not imply that the equipment is safe.

The classification rules will be discussed in some detail in this manual. These have led to an almost internationally accepted set of markings that are used to identify Explosion Protection (Ex) equipment. The benefit of this system is that it helps both equipment manufacturers and users to design, select, install and maintain equipment in a more practical and cost effective fashion.

Documentation of all criteria applied to safety is required by Law and by the Standards. The classification system makes documentation easier. In this way it may be said to contribute to the overall plant safety. A set of documents collected and collated by the management of any plant is fundamental in communicating the appropriate information on safety issues. It is referred to as “Plant Safety Documentation”. Its content will be discussed during the course.

1.6 Legality

The present legal situation in the UK may be taken as an example of the way the Law relates to the responsibilities of factory owners. The law does not state how the owner must make his factory safe. It merely states that the owner must be able to demonstrate that he has taken all reasonably practicable steps to assure safety.

The use of national or internationally agreed standards to which equipment has been tested/certified and which forms part of an overall scheme of safety, as recorded in the Plant Safety Documentation, is accepted as proof that adequate care has been taken.

In the UK, as yet, it is not illegal, if certified equipment has not been used. In this case, the owner would be responsible for proving that the equipment on his plant was safe if an explosion were to have occurred. This burden of proof could only be satisfied if the owner maintained records demonstrating that the equipment used on the plant was selected from that which had a proven track record of safety.

Note: The situation described above will remain true in Europe until the European 'ATEX' Directive, known as Article 100a, came into force on 1st July 2003. Thereafter, all equipment, of whatever origin, sold into and installed throughout Europe, must have been assessed for safe use and marked accordingly. This covers both electrical and mechanical equipment. It is discussed further in the section on Standards and Certification.

In other countries, Standards may be cited by in the Law of the country as to how to proceed on these matters.

1.7 The role of standards and certification

The local and national standards for the design and implementation of explosion protection systems are now converging into the International Electrotechnical Committee Standard series IEC79.

Since the first publication of the IEC documents in the mid-1980s, there has been an escalation of effort to complete the series and maintain its technical content.

Many countries have now adopted IEC79.

It is therefore logical that where contracts to design and supply industrial processes requiring safety in operation are now global, safety standards are accepted across the world.

This workshop therefore uses the international standards as the basis for training. Where localised experience can augment, explain or clarify the IEC Standards it is used to give examples of common practice methods.