Recommendations

RC30

for the selection of electrical and non-electrical equipment for use in atmospheres containing flammable and explosive gases or vapours

FPA
Fire Protection Association

InFiReS

LOSS PREVENTION RECOMMENDATIONS

These Recommendations are part of a series of insurer documents developed under the Insurers' Fire Research Strategy Funding Scheme (InFiReS) and published by the FPA. InFiReS membership comprises a group of UK insurers that actively support a number of expert working groups developing and promulgating best practice for the protection of property and business from loss due to fire and other risks. The technical expertise for the Recommendations is provided by the Technical Directorate of the FPA and experts from the Insurance Industry who together form the InFiReS Risk Control Steering Group.

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Printed by Modern Colour Solutions 1.0/01.05

SCOPE

This document gives guidance on the selection, installation and maintenance of electrical and non-electrical equipment for use in potentially flammable/explosive atmospheres involving gas or vapour. (It should be noted that atmospheres containing dust or powder in air may also be flammable or explosive. These are not discussed here but advice on the prevention and control of dust explosions is given in RC12 (ref.1).) The Recommendations do not apply to mines.

Sparks from electrical equipment can ignite flammable/explosive mixtures of gases and vapours in the atmosphere and the energy required for ignition can be very low. The moving parts of mechanical, non-electrical equipment may be ignition sources. Such hazards are typically found at chemical works, paint spraying workshops and petrol filling stations.

INTRODUCTION

Flammable gas or vapour explosions in the workplace cause injury and loss of life. In addition, explosions and subsequent fires cause substantial damage to property and loss of production. Measures to prevent such explosions and restrict their effects are an essential part of modern risk management.

Statutory requirements: The life safety issues have been recognised in a European Directive (ref. 2). In the UK this Directive is implemented through the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) (ref. 3). These Regulations require that where a dangerous substance, such as an explosive atmosphere, is present or likely to be present a formal risk assessment should be carried out and that measures be implemented to mitigate against risks identified by such an assessment. Many of these measures are also relevant to property protection.

DSEAR also requires an employer to eliminate or reduce the risks arising from the presence of flammable or explosive atmospheres. Among the methods specifically mentioned by DSEAR is the avoidance of ignition sources. Electrical and non-electrical equipment is a potential ignition source and the control of such equipment will form part of the management of this risk. It will be expected as part of the mitigation plan arising from the risk assessment. This document outlines the background to the control and classification of such equipment for use in the presence of flammable/explosive mixtures of gases and vapours that enable this ignition risk to be controlled or eliminated.

It should be remembered that all equipment within an area should be assessed. Thus items such as fire and intruder detection systems, clocks, radios, and hand held torches must be included.

Classification of hazardous places where the hazard arises from the presence of flammable or explosive atmospheres is defined by DSEAR (Schedule 2). These are:

- Zone 0 – A place in which an explosive atmosphere consisting of a mixture with air of dangerous substances in the form of gas, vapour or mist in air is present continuously, or for long periods of time or frequently.
- Zone 1 - A place in which an explosive atmosphere consisting of a mixture with air of dangerous substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally.
- Zone 2 - A place in which an explosive atmosphere consisting of a mixture with air of dangerous substances in the form of gas, vapour or mist in air is not likely to occur but, if it does, will be present for a short period only.

'Normal operation' means the operation of equipment within its design parameters.

Labelling: Where necessary, areas classified as zones 0, 1 or 2 should be marked at their entrance points by the sign prescribed in Schedule 4 of DSEAR. See Fig. 1. (Similar definitions are used for dust/air mixtures. See RC12 (ref. 1).)

Fig. 1. Sign for use at entrance points to areas classified as zones 0, 1 or 2.

It is important to remember that the most effective way of controlling potential ignition sources is to remove them from the hazardous area. Consideration should always be given locating or relocating electrical and mechanical equipment outside the hazardous areas. This may also lead to savings in installation and maintenance costs and an improvement in overall safety. Examples of this are remotely-sited lighting and switchgear.

Where it is not possible to locate the equipment outside the hazardous area (i.e. areas where one of the classification zones applies) the equipment should be designed to be safe for use in such areas. It is a statutory requirement (under DSEAR) that all equipment supplied for such use after 30 June 2003 should meet the essential safety requirements described in the Equipment and Protective Systems for Use in Potentially Explosive Atmospheres Regulations 1996 (as amended) (ref. 4) (EPS Regulations).

Equipment suitable for the various zones is described in the following sections.

RECOMMENDATIONS

1. Equipment

Equipment to be used in areas classified according to the zones described above should be of the appropriate category. These are prescribed in Schedule 3 of DSEAR and are:

- Zone 0 - category 1,
- Zone 1 - category 1 or 2,
- Zone 2 - category 1, 2 or 3.

(The requirements for the three categories are given in Schedule 4 of the EPS Regulations. and discussed in BS EN 60079-10: 2003 (ref. 5).)

1.1 *Identification of equipment*

Equipment certified to meet the relevant requirements of each category will be marked with the explosion protection symbol shown in Fig. 2. It will also be marked with the equipment category (1, 2 or 3) and a 'G' to indicate suitability for gaseous hazards.

('D' is used to designate suitability of equipment for use in atmospheres where there is a dust hazard and such equipment should not be used in zones with gaseous hazards - see RC12 (ref. 1).)

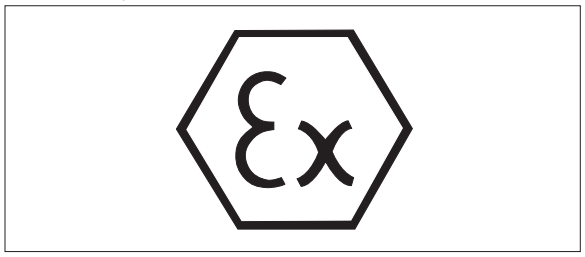

Fig. 2. Explosion protection symbol

Other information such as the temperature rating and gas group may also be included in the marking and safety information. See sections 4 and 5.

These markings apply to both electrical and mechanical equipment but at the time of publication the 'Ex' mark has not been used on any mechanical equipment as there are no harmonised European standards for categories 1 and 2. (Category 3, mechanical equipment, can be tested to BS EN 13463-1 (ref. 6).)

1.2. *Selection of equipment*

Equipment for use in zoned areas should normally comply with the requirements listed at the start of section 1. However, the results of the risk assessment should take into account the types of gases likely to form the explosive atmosphere and their ignition temperatures. This may allow less onerous requirements based on the temperature rating and gas group equipment. See sections 5 and 6. (The phrase 'unless the risk assessment finds otherwise' in Schedule 3 of DSEAR allows for this variation.)

Further guidance on the selection of electrical equipment for explosive atmospheres is given in BS EN 60079-14 (ref. 7).

2 Electrical equipment

There are various ways of achieving the requirements for electrical equipment to be used in hazardous areas. The generic term 'ex-proof' is used to cover all of the apparatus types. The terms given below for ex-proof apparatus are those generally recognised but some minor differences in terminology may be found in various documents. It is necessary to specify the temperature classification and gas group for which the apparatus is suitable. It is important to recognise that a further risk assessment would need to be carried out if process arrangements or materials change.

The design features of the various apparatus types are as follows:

- Intrinsic safety, 'ia' and 'ib': Intrinsically safe equipment is physically unable to ignite a flammable/explosive mixture. Due to the very low ignition energy of most flammable/explosive mixtures, this category consists of some specialised instruments incapable of producing a significant temperature rise or incendive sparks.

  To ensure that devices do not receive an excess current, they are normally linked to a semiconductor current barrier.

- Flameproof, 'd': This category consists of equipment which is not intrinsically safe or non-sparking but is designed so that the exposed parts do not become hot enough to ignite a flammable/explosive mixture, even under fault conditions. Flames cannot be propagated from inside the casing because flame traps or labyrinths are incorporated to remove heat from any emerging flame.

  It is often possible to distinguish flameproof equipment by sight. The casings are usually heavier and appear more robust; fasteners may be shrouded or have non-standard heads (i.e. incorporate triangular rather than hexagonal bolt heads).

- Ventilation or purging, 'p': If the enclosure is ventilated with fresh air or an inert gas, it is impossible for a flammable/explosive mixture to accumulate and also there may be a cooling effect. Precautions have to be taken to ensure that the supply of air or purge-gas does not fail while the equipment is energised.

- Filling or separating: powder-filled, 'q' and oil-filled, 'o': In these categories the casing is filled with an inert material or the live parts are encapsulated to prevent a flammable/explosive mixture being in contact with the live parts.

- Non-sparking, 'n' or 'N': This category covers equipment which, by nature of its construction,

cannot produce an incendive spark. This is not the same as being intrinsically safe and precautions have to be taken to ensure that temperature rises to the ignition point cannot occur. Extra or increased safety 'e' is also a form of non-sparking apparatus.

- Encapsulation, 'm': This category of equipment has its electrical components fully encapsulated in an approved material, so that its potential ignition sources are segregated from any explosive atmosphere.

Some of these methods are assessed by various parts of the BS EN 60079 series of standards. For example, see reference 7.

3 Non-electrical equipment

This is a relatively new issue arising from the European ATEX Directive implemented in the UK by the EPS regs. The intention is to produce harmonised European standards to allow testing and certification of such equipment. To date only one such standard (BS EN 13463-1) (ref. 6) has been published. This covers category 3 for mechanical equipment only.

It is therefore important to consider mechanical ignition sources in the risk assessment.

4 Temperature classification

Since ignition temperatures of gas/air mixtures vary, it may not be necessary to provide as high a degree of protection for one substance as for another. This has led to classification schemes being adopted, relating to ignition temperature and explosion properties of the substances likely to be encountered. Six temperature classes have been defined:

T class	Maximum surface temperature °C
T1	450
T2	300
T3	200
T4	135
T5	100
T6	85

It should be noted that North American practice differs slightly from European practice. Although the same hazardous zone classifications are used and the marking information is much the same, reference is made to American National Standards and there are more temperature categories. More information is available at *http://www.medc.com/guide.html* and *http://www.fmglobal.com/approvals.*

5 Gas grouping

Individual flammable materials require particular levels of energy for ignition and ex-proof equipment is type-tested and certified as being suitable for particular groups of substances. Gases and vapours are classified into Group I for mining (not applicable to these recommendations) and Group II (with sub-groups) for non-mining applications:

Group	Description
I (mining only)	methane (firedamp)
IIA	least readily ignited, e.g. propane, benzene
IIB	more readily ignited, e.g. ethylene, diethyl ether
IIC	most readily ignited, e.g. hydrogen, acetylene

6 Suitability for hazardous area zones

Hazardous area zones are determined by considering the nature of the combustible substance and the extent of the potential exposure (see ref. 5). The standard of protection must achieve a level of reliability appropriate to the risk and, in practice, the following types of apparatus are normally suitable for flammable vapours:

Intrinsically safe 'ia' equipment is the only type suitable for Zone 0 areas. The use of equipment with other protection methods will depend upon the standard to which the equipment has been tested and certified. EU Directives now require this information to be marked on the equipment by the manufacturer. See Fig. 3.

Note. The term 's' protection is also used and refers to individual pieces of equipment which have been specifically designed for use within one or more zones. Care is required to ensure that the apparatus is specifically certified for the intended zone of use.

Marking symbol	E	Ex	ia	IIC	T5
Meaning	European standard	Explosion protection	Type of protection	Gas group	Temperature classification

Marking symbol	CE0000	⟨Ex⟩	2	0	G
Meaning	CE mark and identification number of notified body	Type of protection	Equipment category	Zone classification for which equipment is suitable	Type of atmosphere (gas or dust)

Fig. 3. Information required to be marked on equipment

Zone	Equipment category (defined in DSEAR)	Type of protection
0	1	ia
1	1 or 2	ia, ib, d, e, p, m o and q
2	1, 2 or 3	As Zones 0 and 1 plus 'n'

7 IP rating

When identifying equipment for use in explosive atmospheres, confusion may arise when equipment is also marked or designated with an IP rating. The 'IP' number is the 'index of protection' and describes the resistance of the enclosure round the equipment to the ingress of dust and water. Each is assessed on a scale of 0 to 6, or 0 to 8, respectively. It is a measure of the robustness of the physical integrity of the equipment housing and has no direct bearing on the ex-proof nature of the apparatus. It is common for specifications and standards to call for an IP rating in addition to the ex-proof criteria. An IP rating alone does not impart any ex-proof qualities to a piece of equipment.

8 Maintenance

It is essential that ex-proof apparatus is regularly inspected and maintained by a specialist electrician. A written record of all inspections, tests, maintenance and repairs of ex-proof equipment should be kept. In general inspections should be carried out annually unless the risk assessment indicates more frequent inspections are necessary. Inspection intervals may be specified by legislation in particular circumstances.

9 Wiring and cables

Wiring and cables which may be exposed to flammable atmospheres should be suitable for their location. Further guidance on the selection of electrical equipment for explosive atmospheres is given in reference 7. In general, suitable wiring systems include cables drawn into screwed, solid drawn or seam-welded steel conduit, or cables that are otherwise protected against mechanical damage.

Cabling for Zone 0 requires special protection.

10 Further information

Approved Codes of Practice supporting the DSEAR are published by the Health and Safety Executive, in particular *Control and Mitigation Measures* (ref. 8) and *Dangerous Substances and Explosive Atmospheres* (ref. 9).

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