

BS 5908-2:2012



BSI Standards Publication

Fire and explosion precautions at premises handling flammable gases, liquids and dusts —

**Part 2: Guide to applicable standards
and regulations**

bsi.

...making excellence a habit.
AVA Documents™
Document Sharing Hub

Publishing and copyright information

The BSI copyright notice displayed in this document indicates when the document was last issued.

© The British Standards Institution 2012

Published by BSI Standards Limited 2012

ISBN 978 0 580 77877 3

ICS 13.220.20; 71.020

The following BSI references relate to the work on this standard:

Committee reference EXL/23

Draft for comment 12/30258581 DC

Publication history

First published as PD 6686, March 2006

First published as BS 5908-2, December 2012

Amendments issued since publication

Date	Text affected
------	---------------

Contents

Foreword *iii*

1	Scope	1
2	Terms and definitions	1
3	Legislative background and the relationship with standards	2
3.1	Introduction	2
3.2	European legislation	2
3.3	UK legislation	3
3.4	Relationship between legislation and standards	3
4	European directives and harmonized standards	3
4.1	Introduction	3
4.2	Conformity assessment	4
4.3	Machinery Directive [15]	4
4.4	ATEX Equipment Directive [1]	5
4.5	Construction Products Directive [17]	6
4.6	Pressure Equipment Directive [16]	7
5	UK legislation	7
5.1	Health and safety	7
5.2	Fire safety legislation [5, 6, 7, 8, 9]	7
5.3	DSEAR [3, 4]	8
5.4	Provision and Use of Work Equipment Regulations 1998 [37]	11
5.5	Health and Safety (Safety Signs and Signals) Regulations 1996 [38]	11
6	Assessment of fire and explosion hazards	12
6.1	Locations of special fire hazard	12
6.2	Toxic hazards of fire effluents	12
6.3	Classification of chemicals with fire hazards	13
6.4	Determining the characteristics of materials	13
6.5	Loss of containment	16
6.6	Controlling hazards	16
6.7	Ignition sources	17
6.8	Control systems	21
6.9	Explosion protection	21
6.10	Fires in machinery and electrical equipment	22
6.11	Combustion plant	23
6.12	Special atmosphere furnaces	23
6.13	Pipework	23
6.14	Spray booths	24
6.15	Solids bulk handling equipment	24
6.16	Battery charging	25
6.17	Hydraulic systems and fluids	25
6.18	Equipment for acetylene use	25
6.19	Equipment for liquid petroleum gas (LPG) services	26
7	Equipment for fire safety	26
7.1	Emergency lighting	26
7.2	Alarm system components and systems	27
7.3	Hand-held fire extinguishing equipment	28
7.4	Mobile fire extinguishers	28
7.5	Fire protection systems	29
7.6	Water supplies, hydrants and equipment for use by the fire brigade	33
	Bibliography	34
	List of figures	
	Figure 1 – Mark of explosion protection	5

List of tables

Table 1 – Explosion protection categories: IEC and ATEX	18
Table 2 – Classification of fire-resistant fluids	25

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 46, an inside back cover and a back cover.

Foreword

Publishing information

This part of BS 5908 is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 December 2012. It was prepared by Technical Committee EXL/23, *Explosion and fire precautions in industrial and chemical plant*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This Part of BS 5908 supersedes PD 6686:2006, which is withdrawn.

Relationship with other publications

This Part of BS 5908 is intended to be read in conjunction with BS 5908-1.

Information about this document

BS 5908-2 constitutes a full revision of what was the content of PD 6686:2006, *Guidance on directives, regulations and standards related to prevention of fire and explosion in the process industries*.

As a guide, this Part of BS 5908 takes the form of guidance and recommendations. It should not be quoted as if it were a specification or a code of practice and claims of compliance cannot be made to it.

Presentational conventions

The provisions in this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This part of BS 5908 gives guidance on the legislation and standards applicable to onshore industrial premises that handle significant quantities of flammable gases, liquids or dusts. It identifies the different strands of legislation that apply to those who supply, transport, store, or use such materials, and those who supply plant and equipment for any of these activities, and provides a guide to relevant standards so that suppliers and users of products that create fire and explosion hazards can identify which might be relevant to their activities.

This part of BS 5908 does not cover offshore oil and gas production or coal or other mining activities, and only references legislation and standards relevant to the distribution and supply of natural gas where these are also relevant to other activities.

Legislation and standards relevant to the storage and use of liquid fuels and liquefied petroleum gas (LPG) are, however, covered, as in many cases these are also relevant to chemicals with similar hazards which are not specifically used as fuels.

The development of a hydrogen economy, with hydrogen either stored at very high pressure or in liquid form, is at an early stage of development, and this area is also out of scope of this British Standard.

NOTE There is, though, considerable activity within ISO in developing standards on hydrogen applications.

Chemical processes might create fire and explosion hazards that are different from those arising from the chemicals used in the process. The methods associated with assessing those hazards are not in general suitable for standardization as they are too specific to the individual process. The issue of chemical reaction hazards is considered in BS 5908-1.

Some flammable liquids used in pressurized systems, such as hydraulic oils, can form flammable mists from small leaks in hosing or pipework. This scenario is covered in the discussion of the legislation and standards applicable to this situation.

2 Terms and definitions

For the purposes of this British Standard the following terms and definitions apply.

NOTE Definitions are compiled for ATEX standards, except in respect of electrical equipment in BS EN 13237. For electrical equipment intended for use in potentially explosive atmospheres, definitions are provided in BS EN 60079-0. Some terms are set out in the ATEX Equipment Directive 94/9/EC [1].

2.1 equipment

machines, apparatus, fixed or mobile devices, control components and instrumentation thereof and detection, or prevention systems which, separately or jointly, are intended for the generation, transfer, storage, measurement, control and conversion of energy or the processing of material, and which are capable of causing an explosion through their own potential sources of ignition

NOTE This definition effectively excludes items which have no power source or moving parts. The ATEX guidelines [2] give examples of "borderline cases" showing how this is intended to be applied. Hand-operated valves, tanks and hand tools are therefore not within scope.

2.2 explosive atmosphere

mixture with air, under atmospheric conditions, of flammable substances in the form of gases, vapours, mists or dusts in which, after ignition has occurred, combustion spreads to the entire unburned mixture

2.3 potentially explosive atmosphere

atmosphere which could become explosive due to local and operational conditions

NOTE These definitions exclude conditions commonly found in chemical plant, where the system operates under conditions well removed from normal atmospheric temperature and pressure, or the air is excluded and an inert atmosphere is present. The DSEAR Regulations [3, 4], however, require an assessment of the hazards from dangerous substances, in whatever form they might be present. This recognizes that not all explosion hazards can be avoided by correct selection of ATEX equipment. Moreover, it is not practical or necessary to expect manufacturers to design ATEX equipment to be safe under any possible conditions that may occur in a process plant.

2.4 protective systems

design units which are intended to halt incipient explosions immediately and/or to limit the effective range of explosion flames and explosion pressures

NOTE 1 Protective systems may be integrated into equipment or separately placed on the market for use as autonomous systems.

NOTE 2 This definition recognizes that the protective system, perhaps a flame arrester or explosion vent panel, could be made and sold by a manufacturer different from that which supplied the equipment requiring the system. It implies that it needs to be acceptable to sell equipment that is only safe if it is subsequently fitted by the user or installer with a protective system from another supplier.

3 Legislative background and the relationship with standards

3.1 Introduction

Fire and explosion hazards exist wherever dangerous substances or combustible substances are stored, transported, processed or used. Legal requirements are imposed on employers to ensure the safety of workers and others by minimizing the risk of fires and explosions.

Many sites in the chemical and energy sectors have comparatively few employees and are situated away from centres of population. Any fire or explosion might therefore have a low risk of causing death or injury at such sites, but employers still need to prevent incidents which can cause damage to equipment, loss of raw materials or products and, ultimately, a real threat to the viability of their businesses. Accordingly, any package of protective measures should address the risks to both people and property.

3.2 European legislation

Much European legislation is aimed at ensuring the effective operation of a single market. To achieve this, the legislation specifies what is meant by “safe” for a vast range of products: from the comparatively simple, like a fire extinguisher, to the most complex of machines, such as a rotary printing press employing highly flammable gravure inks. National governments can then be satisfied that any such products are safe and can be sold within their countries. The provisions of European Directives are implemented by national legislation in all European Union (EU) member states, e.g. statutory regulations in the UK.

The EU has developed worker protection legislation, which has as an objective, first, to ensure a reasonable minimum level of safety in the workplace, and, second, to prevent migration of manufacturing industry across the EU, to places where safety standards are poor. Again, these Directives have been implemented in the UK by statutory regulations.

3.3 UK legislation

Traditionally, fire safety legislation as it applied to those in control of buildings in the UK was seen as separate from health and safety, and was very fragmented. The EU influence drew no such distinction, and the current UK fire safety legislation [5, 6, 7, 8, 9] (see Clause 5) essentially implements general EU health and safety legislation as it applies to fire hazards in a broad range of premises.

NOTE Almost all of this legislation has been separately implemented in Northern Ireland. Where necessary this can be obtained from the UK office of public sector information at www.opsi.gov.uk

Fire hazards are also covered by the Building Act and Regulations [10, 11, 12, 13, 14]. The provisions are not uniform across the UK, with differences between England and Wales, Scotland and Northern Ireland, but the equipment and products used in buildings are subject to EU single market legislation, so, for example, a fire door as a stand-alone item or a fire alarm sounder still has to conform to European regulations and standards.

3.4 Relationship between legislation and standards

It is impractical to write into legislation all the technical details that relate to safety and, to a large extent, this work has been taken up by standards making bodies, such as ISO, CEN/CENELEC and BSI.

It is also impractical for those in charge of premises in the process industries to check every detail of equipment they buy. For them, standards supply a route to ensuring that the equipment they procure is safe for the intended purpose. It is expected that this document will help users locate appropriate standards when purchasing equipment, and also when installing and operating it. It should also be useful to manufacturers of equipment, particularly where there are standards that supply different levels of technical detail or where there is no very specific standard that applies to their products.

4 European directives and harmonized standards

4.1 Introduction

European directives containing provisions relevant to fire and explosion safety of products include the Machinery Directive [15], the ATEX Equipment Directive [1], the Pressure Equipment Directive [16] and the Construction Products Directive [17]. These directives contain high-level requirements, and CEN/CENELEC have provided detailed technical standards for meeting these.

Normally, these European Standards are “harmonized”, which means formally adopted by the EU as meeting the requirements of the relevant directives. If a product meets the requirements of the applicable standard, there is an automatic presumption that it meets the corresponding directive. The official lists of harmonized standards are on the EU commission main website: http://ec.europa.eu/enterprise/mobile/topics/policies/european-standards/harmonised-standards-legislation/index_en.htm

Some products fall outside the scope of particular standards. In these cases, manufacturers have to work to the less specific requirements of the directives.

4.2 Conformity assessment

Conformity assessment is the system by which a manufacturer demonstrates that they have applied the applicable standard(s) in designing and manufacturing a product, giving the user confidence that the product meets the legal requirements. At its simplest, the manufacturer draws up a “declaration of conformity” which lists standards used in the design, and fixes a “CE mark” to the equipment, which is a legal claim of conformity to all the relevant directives. In support of this there has to be a technical file, collecting together all the relevant design details, supporting tests and records, but this is not routinely available to the customer.

For the equipment that creates the highest risks, the design, testing and quality assurance during manufacture require independent input from a specialist test house. These are designated by member states as being competent to make independent judgments as to whether a product conforms to the essential requirements of a directive(s), and are notified to the EU commission. They are then “notified bodies”. Some are notified only for a single directive, others for more than one. There are different systems for ensuring adequate quality, depending on whether many identical products are made (series manufacture) or the products are made in very small numbers so that each individual unit can be fully tested.

Under ATEX [1] (see 4.4), an additional process not applicable to other directives is in place for products with an intermediate level of risk. Here, a technical file is lodged with a notified body prior to products being sold, but the notified body is not responsible for its contents.

4.3 Machinery Directive [15]

The Machinery Directive [15] is implemented in the UK by the Supply of Machinery (Safety) Regulations 2008 [18]. The definition of machinery is very broad and includes essentially anything that has moving parts and a source of power. In respect of fire and explosion hazards, the Machinery Directive [15] requirements are very simple: “machines must be designed to avoid any risk of fire, overheating or explosions caused by the substances produced or used by the machine”. Depending on the hazards, some machines might also require built-in fire extinguishing systems.

A very large number of standards are needed to cover the requirements for all types of machinery covered by this Directive, and, in order to achieve a consistent format, these have been written at three levels.

- Type A standards describe general principles and deal with basic methodology and philosophy. There are comparatively few Type A standards, the most important example being BS EN ISO 12100.
- Type B standards deal with one safety aspect, or one type of safety device. These can be used across a wide range of machinery, and are normally cross-referenced in Type C standards. Type B standards particularly relevant to fire and explosion hazards are BS EN 1127-1 and BS EN 13478.
- A Type C standard specifies detailed safety requirements for one type of machine, or group of machines, normally covering all the relevant aspects from the Directive.

The manufacturer of machinery is generally responsible for ensuring their product meets the safety requirements. This is achieved by drawing up a technical file, which is not normally supplied to the customer, applying the CE mark to the machine itself, and a declaration of conformity, which has to be passed to the customer.

4.4 ATEX Equipment Directive [1]

4.4.1 Equipment covered by the Directive

The ATEX Equipment Directive [1] applies to equipment and protective systems intended for use in potentially explosive atmospheres, and is implemented in the UK by the Equipment and Protective Systems for Use in Potentially Explosive Atmospheres Regulations [19, 20]. The Directive [1] covers a large range of specially-designed electrical equipment, for which standards have been developed over the last 50 years, mechanical equipment that creates a potential ignition source, where no standards existed before 1994, and the items of equipment that comprise one of various types of protective system, using the techniques outlined in BS EN 1127-1. These include flame arrestors, explosion vent panels, explosion suppression systems and explosion isolation devices, as used in dust-handling plants (see 6.9).

Many ATEX products are also machines, and in these cases the more specific requirements of ATEX are taken to demonstrate conformity with the high-level requirements of the Machinery Directive [15].

The ATEX Equipment Directive [1] introduced a comparatively complex system of conformity assessment, with products categorized according to intended use.

- Category 1: products intended for use where the risk of explosion is highest require independent (third party) conformity assessment by a notified body.
- Category 2: electrical products intended for use where a medium level of risk exists also have to be assessed by a notified body. Mechanical equipment does not require independent assessment, but a technical file has to be lodged with a notified body.
- Category 3: products used where there is a low risk of explosion do not require the involvement of a notified body, and the manufacturer issues their own declaration of conformity.

In each case ATEX equipment has to be provided with the CE mark, the mark of explosion protection (see Figure 1), and a declaration of conformity supplied to the customer.

Explosion protective systems are not subdivided into categories, and all require independent certification by a notified body.

Figure 1 Mark of explosion protection



In addition, as many aspects of explosion protection require some measurement of material properties, many test methods for such properties have been adopted as European standards. Prior to ATEX [1], the electrical equipment standards published by the IEC also required test methods for materials, and these have been published as IEC standards (see 6.7).

For electrical goods intended for use in potentially explosive atmospheres that are sold outside the European market, an international scheme of independent conformity assessment, known as the IEC Ex scheme, has been established. Adoption by a manufacturer is voluntary, but the scheme is steadily increasing. Standards for electrical equipment intended for use in potentially explosive atmospheres are now almost all international in origin, adopted as European standards and harmonized by the EU Commission.

Standards for ATEX mechanical equipment have been written over the last ten years at European level, and harmonized. These are now being transferred to the international level, and will in due course appear as parts of ISO 80079.

4.4.2 Protective systems

The ATEX Directive [1] also covers protective systems, some of which, like explosion vent panels, are clearly products that can be tested in their own right, while others, like suppression systems, are sold as an “add on” package for other equipment, or a section of a process. The former are subject to mandatory independent conformity assessment, similar to Category 1 equipment (see 4.4.1). The standard for suppression systems, BS EN 14373, cannot give the individual design checks for every application, and only indicates how parts of a suppression system can be separately assessed and sets out common design tools.

4.5 Construction Products Directive [17]

The definition of a construction product includes anything intended for permanent incorporation into a building or structure, but not a complete building. The Construction Products Directive (CPD) [17] sets out essential performance requirements under six broad headings, one of which is safety in case of fire.

It has proved a slow process to harmonize standards for many aspects of construction products, and the process is incomplete. Alongside formal European standards, European Technical Approvals are issued by independent test houses (notified bodies), and many British Standards remain current.

Because the CPD [17] has proved difficult to implement, it has been repealed by the Construction Products Regulation (305/2011) [21]. This has a transition period up to July 2013, but it sets out the conditions for CE marking which demonstrates that construction products have been assessed against a harmonized European standard and can be accepted onto the market anywhere in the European Economic Area (EEA). One of the consequences is that a wider range of products will be CE-marked in future. The Regulation is directly applicable to the UK, and does not therefore need to be implemented by national statutory regulations.

Relevant areas covered by harmonized standards include components for fire detection and fire alarm systems (BS EN 54), space heating equipment (BS EN 416 and BS EN 777), fixed firefighting systems (BS EN 12094), smoke and heat control systems (BS EN 12101), sprinkler systems (BS EN 12259) and tank overfill prevention devices (BS EN 13616).

Alongside harmonized standards, there are Eurocodes which set out common design principles for various structures, but allow individual countries to incorporate their own values of particular parameters. Of relevance is BS EN 1991-4, which gives recommendations for the protection of silos from dust explosions.

4.6 Pressure Equipment Directive [16]

Many flammable products are stored or processed in closed systems that operate at pressures above atmospheric. The Pressure Equipment Directive [16] applies to systems operating at pressures above 0.5 bar, and related safety accessories, with some complex exemptions. The system of conformity assessment is graded according to the risk, in this case operating pressure and size or volume of the equipment and the intended contents. The Directive is implemented in the UK by the Pressure Equipment Regulations [22].

Many fire extinguishers are covered by this Directive.

5 UK legislation

5.1 Health and safety

The Health and Safety at Work etc. Act 1974 [23] sets out the general responsibilities of employers, employees and those who supply products and substances used at work. It also established the Health and Safety Executive (HSE) to enforce its requirements. In Northern Ireland the equivalent requirements are found in the Health and Safety at Work (Northern Ireland) Order 1978 [24].

The explicit requirement for a risk assessment of work activities is set out in the Management of Health and Safety at Work Regulations 1999 [25] (and the Management of Health and Safety at Work (Northern Ireland) Regulations 2000 [26]), which implement the EU Framework Directive [27]. The Framework Directive [27] makes no distinction between fire and any other type of workplace hazard, and includes requirements for the evacuation of premises and contact with emergency services that were traditionally enforced in the UK by the fire services.

Fire hazards controlled by “process fire precautions” are enforced by the HSE. These are largely covered by DSEAR [3, 4] (see 5.3).

5.2 Fire safety legislation [5, 6, 7, 8, 9]

In England and Wales, the Regulatory Reform (Fire Safety) Order [5] implements in part the requirements of the Framework Directive [27] and requires a risk assessment to be carried out by the employer (and others deemed the “responsible person”) to determine the necessary preventive and protective measures to safeguard people from fire. However, the assessment has to cover not only employees, but all who might be lawfully present on the premises. In many situations the main risk is not just to employees. The equivalent legislation elsewhere in the UK is the Fire (Scotland) Act 2005 [6], the Fire Safety (Scotland) Regulations 2006 [7], the Fire Safety (Northern Ireland) Regulations 2010 [8] and the Fire and Rescue Services (Northern Ireland) Order 2006 [9].

For industrial premises, this legislation applies not only to buildings, but also other places where there might be a fire hazard, e.g. from storage of high fire hazard products in a tank farm or open-air drum store.

Particular requirements relate to means of escape, fire alarm systems, provision of hand-held fire extinguishers, emergency lighting, provision of fire safety information, and training on the actions required in case of fire. Enforcement is by the fire services, with the following exceptions.

Premises	Enforcement body
Construction sites not part of some larger premises	HSE
Military premises	Ministry of Defence fire services
Other crown premises	Fire inspector appointed by the government or one of the devolved administrations

The fire safety legislation is referenced in BS 9999, a comprehensive code of practice for fire safety in the design, management and use of buildings. Much of this is targeted at premises very different from industrial buildings, where the numbers of people are low and no sleeping accommodation is provided, but it does include advice specifically relevant to means of escape from process plant buildings and open-air structures (Annex F), and hot work (Annex U). It does not, however, cover the circumstances in which flammable materials can give rise to a risk of explosion and the issues that surround the preparation of process plant ahead of hot work.

5.3 DSEAR [3, 4]

5.3.1 General

The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) [3] draw their requirements from two separate directives (Chemical Agents Directive [28] and ATEX 137 [29]), and in consequence contain provisions based on a risk assessment approach and others which are more prescriptive. These set minimum requirements, some of which are relatively specific, for the protection of workers from fire and explosion hazards arising from the presence of dangerous substances and potentially explosive atmospheres in the work place. For Northern Ireland the equivalent provisions are set out in the Dangerous Substances and Explosive Atmospheres Regulations (Northern Ireland) 2003 [4].

The employer is required to carry out an assessment of the risks arising from the presence of dangerous substances on site, and adopt measures to control those risks.

DSEAR [3, 4] requires control measures to be adopted in the following order of priority.

- Reduce the quantities of dangerous substances present.
- Avoid or minimize the release of a dangerous substance (D-S).
- Control any release of D-S at source.
- Prevention the formation of an explosive atmosphere.
- Collect and remove any D-S that is released.
- Avoid ignition sources.
- Segregate incompatible D-S.

Specific requirements of DSEAR [3, 4] include the following.

- Identification of any hazardous areas where explosive atmospheres might be

present and their division into zones according to the probability that an explosive atmosphere is present (see 5.3.3).

- Selection of equipment to be located within a hazardous area from the categories set out in the ATEX Directive [1] according to the following.

	Zone 0	Zone 1	Zone 2
Equipment category	1	1 or 2	1,2 or 3
Category number is followed by G, D or G,D for gas, dust or atmospheres containing both			

- Assessment of the explosion safety measures by a competent person before any new equipment or process is brought into use.
- Marking of access points into hazardous areas with an Ex sign where necessary.
- Marking of containers and pipes holding or carrying hazardous materials to indicate their contents.
- Provision of information and training to employees about the hazardous materials present in the workplace.
- Procedures to deal with accidents, incidents and emergencies arising from the presence of dangerous substances.

The HSE has published Approved Codes of Practice and Guidance to the Regulations, e.g. L133, L134, L135, L136, L137 and L138 [30, 31, 32, 33, 34, 35].

5.3.2 Explosion hazards

Fire hazards can occur where flammable gases, liquids or dusts are present, but explosion hazards might also occur and these need to be considered.

Explosions can be the consequence of:

- heating of a closed container that is not provided with protection;
- ignition of a gas/air, vapour/air or mist/air mixture inside a closed system;
- ignition of a dense suspension of dust in air inside a closed system, usually requiring an internal means of creating and maintaining the dust cloud; and
- a chemical reaction inside a closed system which generates large volumes of gas.

Explosions that occur outside an enclosed or semi-enclosed system are possible, but generally much larger quantities of materials are required, and not all flammable materials create this risk.

Closed containers take many forms, for example pressurized gas cylinders, sealed drums for flammable liquids, silos for storing powders, chemical process vessels, complete buildings, or rooms within a building and combustion plant. Systems do not have to be completely closed; risk arises from any sudden release of gas or energy that produces a rapid pressure rise causing the enclosure to fail.

Some explosion hazards can only be controlled by protecting the system from external fire (see 6.6).

Dust explosions are controlled by special technical measures described in 6.7.5.

Particular examples of protection against explosions in other process plant are given in 6.4.2.

5.3.3 Hazardous areas

The development of equipment designed to be safe in the presence of an explosive atmosphere necessitates a methodology for determining what type of equipment is appropriate for particular locations.

The requirement for a hazardous area classification study long predates specific legislation, but the definitions of hazardous areas for gases, liquids and dusts are now set out in DSEAR [3, 4].

For gases and vapours:

- **Zone 0** is an area in which an explosive atmosphere is present for long periods, or frequently, e.g. above the liquid level of a container used for highly flammable liquids, or inside some enclosed processes.
- **Zone 1** is an area in which an explosive atmosphere can form in normal operation, e.g. where highly flammable liquids are poured from one container to another, or very close to the nozzle of a spray gun.
- **Zone 2** is an area in which explosive atmospheres are not likely to occur in normal operation and, if they do occur, persist for a short period only, e.g. where perhaps a spillage is possible, or controls on some item of equipment are faulty, provided in both cases that the problem is detected reasonably promptly.

For dusts:

- **Zone 20** is an area in which an explosive atmosphere in the form of a cloud of combustible dust in air is present continuously for long periods or frequently. This is only likely to occur inside the containment system for the process, and might not apply where dust is stored for long periods but the activities which create a cloud occur only infrequently.
- **Zone 21** is an area in which an explosive atmosphere in the form of a cloud of combustible dust in air is likely to occur in normal operation occasionally. This is normally inside the containment system for a dusty product, but could exist locally to a transfer point where dust is tipped in a system which is not completely enclosed from one container to another.
- **Zone 22** is an area in which an explosive atmosphere is not likely to occur in normal operation, but if it does occur persists for short periods only.

Layers, deposits and heaps of dust should be treated as any other source which can form an explosive atmosphere. Effectively, this requires assessment of the risk that a dust layer that might exist regularly can be raised into a cloud that is dense enough to create an explosion risk.

BS EN 60079-10-1 sets out a methodology for assigning hazardous areas where gases and vapours are present, and BS EN 60079-10-2 does the same for dusts. These standards offer relatively high-level guidance, and more detailed codes for particular industries are discussed in BS 5908-1.

5.3.4 Self-heating

DSEAR [3, 4] also covers the fire hazards that arise due to spontaneous combustion of materials, i.e. where there is no external source of ignition. This occurs with certain materials when they are either stored for long periods in bulk, such as in a silo or large store, or used in smaller quantities but at relatively high temperatures. BS EN 15188 details the material test method and how the test results can be applied to full-scale scenarios on the site to enable safe storage and operating parameters to be set, e.g. safe ambient temperatures, volumes and storage times. The requirement to assess the risks from self-heating also falls under the fire safety legislation [5, 6, 7, 8, 9] (see also 6.4.2).

Materials liable to undergo self-heating that require transport need to be tested under the *Recommendations on the Transport of Dangerous Goods: Model Regulations* (Volumes 1 and 2) [36]. Substances liable to self-heating are classed as Division 4.2 substances and different packing groups apply depending on the test results of the material that restrict the package volumes that can be used (see also 6.3).

5.3.5 Personal protective equipment

Personal protective equipment of many kinds is used to protect individuals from exposure to chemicals, by direct contact or inhalation. Clothing has been developed that provides some protection from fire, either because it is non-combustible, difficult to ignite, not prone to absorb liquids, or provides some degree of thermal insulation. This is commonly used by firefighters, but is not generally required by those working with flammable chemicals, and its adoption is the last of the protective measures listed in DSEAR [3, 4].

Clothing for protection against spatter (small splashes of molten metal), short contact time with flame, radiant heat from arc, and electrical shock by short-term, accidental contact with live electrical conductors in normal conditions of welding and allied processes is specified in BS EN ISO 11611. Such clothing might also be of benefit where grinding of metals is regularly carried out.

See 6.7.3 for antistatic PPE.

5.4 Provision and Use of Work Equipment Regulations 1998 [37]

The Provision and Use of Work Equipment Regulations [37] impose a general obligation on employers to provide equipment for use at work that is fit for the intended purpose, properly maintained and, where necessary, periodically inspected.

A specific requirement of these Regulations is that the equipment has to conform to the requirements of any applicable product directive. This, however, is not applicable retrospectively, so that old machines, pressure vessels or ATEX equipment can be used indefinitely, provided they are "fit for purpose".

5.5 Health and Safety (Safety Signs and Signals) Regulations 1996 [38]

The identification of fire exits, location of fire equipment, places of assembly and other information needed to help ensure safety in case of fire are specified by the fire safety legislation [5, 6, 7, 8, 9]. DSEAR [3, 4] extends these by specifying the use of an Ex sign to mark hazardous areas, where this is necessary, and the distinctive marking of pipelines carrying hazardous products (e.g. gas or a flammable liquid). Provisions for signs and their designs are set out in the Health and Safety (Safety Signs and Signals) Regulations 1996 [38]. More detailed recommendations for their use are given in the various parts of BS 5499. Requirements for the actual signs, including performance and durability, are specified in ISO 17398, BS ISO 7010 and ISO 3864-4.