1st Edition

CBI

EXPLOSIVES INDUSTRY GROUP

GUIDANCE
FOR ELECTRICAL INSTALLATION AND EQUIPMENT WITHIN EXPLOSIVES MANUFACTURING AND STORAGE FACILITIES INCLUDING FIREWORKS

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Health and Safety Executive,
Redgrave Court,
Merton Road,
Bootle, Merseyside, L20 7HS.

and

Confederation of British Industry,
Centre Point,
103 New Oxford Street,
London, WC1A 1DU.

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SECTION 1 FOREWORD

1.1 This Guidance has been produced by a joint working party of the Health and Safety Executive (HSE) and the Explosives Industry Group of the Confederation of British Industry (EIG/CBI). The document contents builds upon earlier work carried out on this topic. It is now provided as a Guide for determining the electrical standards required for explosives manufacturing and storage facilities including fireworks and the corresponding safeguards for each.

1.2 This Guidance represents good practice found within the Explosives Industry. Following it is not compulsory and persons are free to take other action in this operational sphere, as they see fit. However, by following the Guidance, persons would normally be operating in accordance sufficiently to comply with their legal duties. HSE and the EIG/CBI may refer to this Guidance as illustrating good practice.

1.3 A list of current legislation and information is included at Appendix 2 to this document.

1.4 Whilst every effort has been made to cover appropriate legislation and good practice at the time of publication of this Guidance, neither the CBI, HSE nor its servants or agents can accept responsibility for, or liabilities incurred directly or indirectly as a result of, any errors or omissions within this document. Those persons involved in the Explosives Industry are responsible for taking their own legal and other advice as they see fit. Readers are strongly advised to check for any changes in legislation since the publication of this Guidance document.

1.5 Nor do the CBI, its servants and agents make any representation expressed or implied that the products and product ranges or the processes, equipment or materials referred to in this Guidance are suitable, satisfactory or appropriate for the purpose or purported purposes set out or referred to in this Guidance and the CBI, its servants and agents accept no responsibility or liability therefore.

1.6 It is not the intention of this Guidance to be used as a technical manual by those inexperienced in explosives storage and manufacture, to enable them to carry out such activities. Those not experienced in this field should seek expert assistance from qualified and reputable sources.

SECTION 2 INTRODUCTION

2.1 The purpose of this publication is to assist those people who are responsible for the design, selection, installation, operation and maintenance of electrical systems and equipment (including mobile mechanical handling equipment) used within premises which manufacture, handle or store explosives including fireworks. The advice given is generally consistent with current guidance issued by the Ministry of Defence's Explosives and Storage and Transport Committee (ESTC) for military facilities.

2.2 To assist the reader, buildings and locations used for the manufacture, handling and storage of explosives including fireworks will be referred to in the rest of this document as 'explosives buildings'.

Section 3 SCOPE AND APPLICATION

3.1 Previous specific guidance (PM 82), is now in need of updating. This publication is intended to rectify that through practical, broad-based advice. It applies only to premises which manufacture, handle and store explosive materials, either above or below ground level. Its advice is not relevant to administration, workshop, or other buildings within the perimeter of an explosives area when there is no likelihood of explosives being present in those buildings. However, electrical installations and equipment for all these facilities should conform to accepted standards, e.g. BS 7671 (formerly known as the IEE Wiring Regulations).

3.2 This document does not cover requirements for the safety integrity of control systems. BS EN 61508 (Functional safety of electrical/electronic/programmable electronic safety-related systems) specifies the requirements for this topic.

SECTION 4 SITE ELECTRICAL SUPPLIES

4.1 On-site electrical supplies are normally either overhead or underground distribution systems but are occasionally a combination of both. For new installations, underground systems are the preferred option. Guidance on voltage characteristics of electricity supplied by public distribution systems and nominal voltage for low voltage public supply systems can be found in BS EN 50160 and BS 7697 respectively. At premises where there is an incoming supply at a higher voltage 6.6kV or 11kV the low voltage distribution voltage may differ.

4.2 **Overhead line systems**

Where overhead line systems are used, their design should conform to the requirements set out in the Electricity Safety, Quality and Continuity Regulations 2002 as amended (ESQCR). In these locations, lines are likely to operate at 33kV volts and below. The **minimum** ground clearance for the lowest conductor at the maximum likely temperature for the line should be not less than:

(a) 5.8 metres at any point where there is access for vehicular traffic; and

(b) 5.2 metres at any other point.

4.3 It is recommended that all points where overhead lines cross roadways should be clearly marked and suitable measures taken to ensure that vehicles carrying explosive materials do not park at or near these crossings.

4.4 Normal site distribution is at a nominal 400 volts a.c. to the switch rooms in explosives buildings with the internal supplies to explosives buildings being at a nominal voltage not exceeding 230 volts a.c. or d.c. It is recommended that a TN-S system is adopted in accordance with BS 7671. TN-C-S systems shall not be used because of the potential for circulating earth currents. Further guidance on earthing is to be found in BS 7430. It is recommended that appropriate precautions, such as the use of equipment as recommended in Section 6, are taken when there is a requirement for electrical supplies in explosives buildings. It is not advisable to provide direct access from switch rooms to the interior of explosives buildings (see also section 7).

NOTE: the definition of a TN-S system is a system having separate neutral and protective conductors throughout the system.

4.5 Wherever possible avoid overhead lines crossing over, or being terminated on, any explosives building. It is recommended that overhead lines are terminated on poles at least 15 metres from any explosives building, with the final connection being by way of underground cable and appropriate surge protection devices fitted in accordance with BS EN 62305 Part 4.

4.6 Overhead lines owned and operated by electricity supply companies, the National Grid Company, or other authorities are outside the scope of this guidance except where they are located within the explosives site. In this case it is advisable that they comply with the separation requirements set out in paragraphs 4.2 and 4.5. Where the minimum height of the lowest conductor measured at the support position is greater than 15 metres, it is recommended that the separation distance from any explosives building is not less than this actual height. The minimum separation between any overhead line and the nearest explosives building should not be less than the required separation for a private dwelling. Where the overhead line has strategic importance this separation distance should be increased up to 150% of this value. However, the location of such overhead lines and of those outside the site is a matter for agreement between the parties involved.

4.7 Wherever possible route communication cables and telephone wires used in conjunction with alarm systems underground. However, when they are located overhead, the recommendations for overhead lines should be similarly applied.

4.8 **Underground cable systems**

Wherever possible underground cable systems are the preferred options for all new works and where facilities are being upgraded. It is not advisable to lay cables underneath explosives buildings. Cable supplies to several buildings can be safely provided from central distribution points as long as they are located at least 15 metres from any explosives building. There are many proprietary units on the market suitable for this purpose, but they may need to be protected from impact with site traffic.

4.9 It is recommended that all cables are laid so that they are protected from foreseeable mechanical damage. At road crossings it is advisable to lay them in ducts or provide an equivalent level of protection. Suggested minimum depths of burial are:

500 mm for cable voltages up to 1000 volts a.c;

800 mm for cable voltages 1000 to 33 000 volts a.c;

4.10 It is recommended that cables are laid on bedding free of stones and other sharp materials, and the backfill over the cable or protective duct or pipe is free of stones, etc and compacted. It is advisable to use marked plastic tape or similar to mark the cable route with surface markers at suitable intervals.

4.11 It is advisable to route cables owned or operated by other authorities outside the boundary. If this is not possible then consider routing them away from explosives buildings and providing a separation of at least 15 metres. Where possible, clearly mark these cable routes with appropriate cable markers and ownership identification.

4.12 The surge protection system needs to be inspected in accordance with BS EN 62305 part 4 on a regular basis; especially after thunder storms but at least annually.

4.13 Records

It is recommended that records of overhead line and underground cable routes, including all cable joint positions, are kept at the site, including schedules of conductor sizes, earthing resistances and other parameters (See BS7671). It is easiest to do this at the time of installation when systems to record routine inspections and tests of the distribution system can also be established and subsequently kept up to date. It is also advisable to keep route plans of other authorities' overhead lines and cables on site for reference purposes and updating as necessary.

SECTION 5 AREA AND BUILDING ZONING/CATEGORISATION

5.1 Before considering the appropriate electrical systems and equipment for a particular location, it is necessary to assess the type of risks involved. The industry has for many years adopted a classification system based on Ministry of Defence criteria; this criteria is shown as a simple flowchart at Appendix 1 and further explained below:

- **Category A:** Buildings used or which may be used to manufacture, handle or store explosives which may give rise to atmospheres of flammable gases and vapours, but **not** explosive dusts. This category is further subdivided into zones as follows:
  - ***Zone 0*****:** An area in which a flammable gas or vapour and air mixture is continuously present or is present for long periods (in excess of 1000 hours per year);
  - ***Zone 1*****:** An area in which a flammable gas or vapour and air mixture is likely to occur during normal working operations (between 10 and 1000 hours per year);
  - ***Zone 2*****:** An area in which a flammable gas or vapour and air mixture is not likely to occur during normal working operations, and if it does occur it will exist only for a short time (less than 10 hours per year).
- **Category B:** Buildings used or which may be used to manufacture, handle or store explosives in a form which may give rise to atmospheres of explosive dusts, but **not** flammable gases and vapours. This category is further subdivided into zones as follows:
  - ***Zone 20*****:** An area where exposed or other explosives give rise to an atmosphere of explosive dust either continuously or for long periods or during normal working operations;
  - ***Zone 21*****:** An area where exposed or other explosives are likely to give rise to an atmosphere of explosive dust during normal working operations;
  - ***Zone 22:*** An area where exposed or other explosives are **not** likely to give rise to an atmosphere of explosive dust during normal working operations but if it does occur will persist for a short time only.

- **Category C:** Buildings used or which may be used to manufacture, handle or store explosives which do **not** give rise to any atmosphere of either flammable gases, vapours or explosive dusts or give rise to an explosive hazard due to accumulated dust. Examples of Category C buildings are explosives magazines at times, quarries and construction sites where only packaged water-based gels and slurry explosives in closed boxes are held. However, it is the responsibility of the occupier to assess the categorisation, building by building.

- **Category D:** comprises buildings, rooms, etc. where small quantities defined as being less than 1kg of explosives, except H.T 1.1 (See Appendix 3) are stored and in which explosives are not exposed, and do not give rise to flammable vapour or explosives dusts. The Category D standard also applies to some plant rooms but it is not intended to allow storage of explosives in these rooms.

5.2 There are locations not included in this categorisation system where the process gives rise to atmospheres which are a combination of flammable gases or vapours and explosive dusts. These locations need to be clearly identified and dealt with in accordance with section 6 of this guidance.

5.3 When buildings are categorised, it is important to consider the likely changes in the use of the building. It is sensible to specify electrical installation and equipment suitable for the most onerous category, so that a change of process within the building can be made at short notice without the need for extensive modifications. It is recommended that the category for the building is displayed clearly on an appropriate sign positioned outside and close to the building entrance. It is also advisable to place a further sign at entrances to areas within the building or a different category to that displayed at the building entrance, and to keep records and details of the decisions made for each building for future reference.

SECTION 6 SELECTION OF ELECTRICAL EQUIPMENT

6.1 Area Classification of Explosives Facilities

In order to make the selection of equipment from the algorithm at Appendix 1, it is essential to first classify the area/room/building. This process is described within BS EN 60079-10 (Electrical apparatus for explosive gas atmospheres, Classification of hazardous areas) and BS EN 61241; (Electrical apparatus for use in the presence of combustible dust Part 10: Classification of areas where combustible dusts are or may be present). Classification is a process of detailed analysis of the potential for release of explosives dust or vapour; it is not a straightforward empirical process.

6.2 All explosive area/room/buildings where there is potential for explosives vapours, dust or both must be classified in accordance with these standards. The classification must include a documented Hazardous Area Zoning Study that delineates zones of potentially explosive atmosphere and equipment selection from Table 1 must take account of the different zones. It is possible that different zones may occur within one room and even into a plant room or office. If that is the case, it is necessary to take action to limit a zone or provide protected electrical/mechanical equipment to the zone.

6.3 Where very small quantities (grams) of explosives are processed (in a laboratory or research environment) the ability to zone areas of risk may offer the potential to classify only the immediate area around the process with the remainder of the room/area being ‘unclassified’ in terms of Hazardous Areas, thereby permitting Category C standards in the remainder of the room/area. These areas must be clearly defined within the Hazardous Area Zoning Study and clearly marked in the room/area.

6.4 Where other non-electrical equipment may create a potential source of ignition BS EN 13463 may provide helpful advice.

6.5 **Category A Buildings**

Where it is necessary to install or use electrical equipment within the zoned areas, it is strongly recommended that the guidance given in BS EN 60079 is followed. It is therefore advisable to base the selection of equipment on Table 1 below:

Symbol	Type of Protection	Description of Type	Standard	Use in Cat A Zones	DSEAR Equipment Category
Ex ia	INTRINSIC SAFETY	Limit energy of sparks and limit the temperature but include specified fault conditions	BS EN 60079-25:2007	0, 1 & 2	1G
Ex ib	INTRINSIC SAFETY	Limit energy of sparks and limit the temperature	BS EN 60079-25:2007	1 & 2,	2G
Ex e	INCREASED SAFETY	No arcs, sparks or hot surfaces	BS EN 60079-7:2007	1 & 2	2G
Ex o	OIL IMMERSION	Keep the flammable gas away from any hot surfaces and ignition capable equipment	BS EN 60079-6:2008	1 & 2	2G
Ex m	ENCAPSULATION	Keep the flammable gas away from any hot surfaces and ignition capable equipment	BS EN 60079-18:2004	1 & 2	2G
Ex q	POWDER (QUARTZ/SAND) FILLED	Contain the explosion and quench flames	BS EN 60079-5:2008	1 & 2	2G
Ex p	PRESSURISED APPARATUS	Keep the flammable gas away from any hot surfaces and ignition capable equipment	BS EN 60079-2:2004	1 & 2	2G
Ex d	FLAMEPROOF	Contain the explosion and quench flame	BS EN 60079-1:2007	1 & 2	2G
Ex n	TYPE OF PROTECTION N Includes Ex nA Non sparking Ex nW Enclosed break Ex nL Energy limitation Ex nP Simplified pressurization Ex nR Restricted breathing	A type of protection applied to electrical apparatus such that, in normal operation, it is not capable of igniting a surrounding explosive atmosphere and a fault capable of causing ignition is not likely to occur	BS EN 60079-15:2005	2	3G

Table 1 Category A buildings: Selection of equipment and systems according to zone.

6.6 Equipment certified as conforming to a harmonised European standard is provided with the Ex Distinctive Community Mark. Some equipment ('d', 'ia' / 'ib', 's') may be divided according to the nature of the explosive atmosphere present. These divisions are given in BS EN 60079-0 as IIA, IIB and IIC.

Note: These divisions are not to be confused with explosives building categories A, B and C.

6.7 BS 7671 should be used as a guide to the design of the fixed wiring within these buildings, together with the requirements of the appropriate parts of BS EN 60079.

6.8 **Category B buildings**

Where it is necessary to install or use electrical equipment within the Cat B buildings, it is advisable to follow the guidance given in BS EN 61241-0. In **general** terms the selection of equipment for the appropriate zone is **based on** Table 2 below:

Symbol	Type of Protection	Description of Type	Standard	Use in Cat B Zones	DSEAR Equipment Category
Ex iaD	INTRINSIC SAFETY	Limit energy of sparks and limit the temperature but include specified fault conditions	BS EN 61241-11:2006	20, 21 & 22	1D
Ex ibD	INTRINSIC SAFETY	Limit energy of sparks and limit the temperature	BS EN 61241-11:2006	21 & 22,	2D
Ex mD	ENCAPSULATION	Keep the flammable dust away from any hot surfaces and ignition capable equipment.	BS EN 61241-18:2004	21 & 22	2D
Ex pD	PRESSURISATION	Keep the flammable dust away from any hot surfaces and ignition capable equipment by pressurising the equipment internally.	BS EN 61241-4:2007	21 & 22	2D
Ex tD	ENCLOSURE IP6X	Keep the flammable dust away from any hot surfaces and ignition capable equipment	BS EN 612411:2007	20, 21 & 22	1D
	ENCLOSURE IP5X	Keep the flammable dust away from any hot surfaces and ignition capable equipment.	BS EN 612411:2007	22	3D

Table 2 Category B buildings: Selection of equipment and system according to zone

6.9 Again, BS 7671 should be used as a design guide for the fixed installation in these areas provided that the actual installation meets the requirements of BS EN 61241-0.

6.10 When explosives are exposed, but do not give rise to a hazard created by a flammable or explosive atmosphere and/or hazard created by dust accumulating/settling, they may be processed within Category C explosives buildings.

6.11 **Category C buildings**

Electrical equipment for use in Category C buildings is that which is suitable for Category A buildings, Zones 0, 1 and 2, Category B buildings, Zones 20, 21 and 22, or dust-protected equipment to a level of not less than IP 4X. Design, construction and other detailed requirements can be found in BS EN 61242, BS EN 60079 and BS 4533, section 102.51. Protection against a normal risk of impact damage is recommended. The use of antistatic plastic enclosures, including windows which are flame retardant, is recommended with any transparent parts being positively secured to the main enclosure (*see BS 2782: Part 1 Method 140A: 1992, material classification FH-1).*

6.12 **Category D buildings**

The minimum standard of protection for electrical equipment in category D buildings should be compliant with IP4X.

6.13 **Retail premises with temporary storage**

Where HT3 & 4 articles are stored in their transport cartons within an enclosure, (e.g. a filing cabinet, lockable cupboard, an ISO container.) inside the enclosure shall be considered a Category C zone, and electrical systems present inside the enclosure shall meet the criteria for this zoning. The room or building in which the enclosure is located shall be considered a non-explosives area.

For premises storing explosives on a temporary basis (e.g. seasonal traders of fireworks) that are not stored in an enclosure, the use of any electrical equipment except lighting should be prevented within 1 metres of the explosives. Where practical, electrical isolation at the distribution box is preferred.

For explosives not stored inside an enclosure, a separation distances of 1metre should be applied from any lighting and in the case of incandescent filament lighting, the explosives should not be stored directly beneath the fitting.

6.14 **Building with both flammable gas and explosive dust atmospheres**

Where it is necessary to install electrical equipment in these combination atmospheres, the two hazards ought to be considered separately so that the enclosure needs can meet both requirements. However, this can only be part of

the preventive measures; where the dust is explosive, excellent housekeeping is essential so that the quantities of free dust present can be kept to a minimum. Guidance can be found in BS EN 60079-14.

6.15 Surface temperature limits for electrical equipment

It is important that all electrical equipment for use in the above categories of buildings does not exceed the following surface temperature limits when in use (see also section14).

6.16 For Category A and B zones the maximum surface temperature should be determined by assessment and dependent upon the characteristics of the gas/vapour or dust being processed. For Category C buildings the maximum surface temperature of any electrical equipment shall not be greater than 135˚C.

6.17 Socket-outlets

It is recommended that socket-outlets are only provided where absolutely necessary and then only sockets appropriate to the category and zone shall be used, as well as conducting a suitable and sufficient risk assessment to justify their use. In Category C buildings, socket-outlets complying with BS EN 60309-2 fitted with spring-loaded covers are suitable. Where non-standard supplies are to be provided, use socket-outlets of a distinctive and different design to those used for conventional supplies.

6.18 The IP code symbols

The chart on page 15 illustrates the use of special symbols in the IP classification system. In the "1st digit" column, note the grid-like symbols next to numbers 5 and 6. In the "2nd digit" column numbers 3-8 are symbolised by teardrop shaped symbols, sometimes enclosed in a box or a triangle, sometimes unenclosed. These symbols can be placed on equipment to illustrate the IP protection provided.

6.19 IP explanation and ratings

BS EN 60529 outlines an international classification system for the sealing effectiveness of enclosures of electrical equipment against the intrusion into the equipment of foreign bodies i.e. tools, dust, fingers and moisture. This classification system utilizes the letters "IP" ("Ingress Protection") followed by two digits. (A third digit is sometimes used. An "X" is used for one of the digits if there is only one class of protection; i.e. IP4X which addresses moisture resistance only).

6.20 Degrees of protection – first digit

The first digit of the IP code indicates the degree that persons are protected against contact with moving parts (other than smooth rotating shafts, etc.) and the degree that equipment is protected against solid foreign bodies intruding into an enclosure.

First Digit	
0	No special protection
1	Protection from a large part of the body such as a hand (but no protection from deliberate access); from solid objects greater than 50mm in diameter.
2	Protection against fingers or other object not greater than 80mm in length and 12mm in diameter.
3	Protection from entry by tools, wires, etc., with a diameter of thickness greater than 1.0mm.
4	Protection from entry by solid objects with a diameter or thickness greater than 1.0mm
5	Protection from the amount of dust that would interfere with the operation of the equipment.
6	Dust tight.

Figure 1 Protection requirements against solids

6.21 Degrees of protection – second digit

The second digit indicates the degree of protection of the equipment inside the enclosure against the harmful entry of various forms of moisture (e.g. dripping, spraying, submersion, etc.).

Second Digit	
0	No special protection
1	Protection from dripping water.
2	Protection from vertically dripping water.
3	Protection from sprayed water.
4	Protection from splashed water.
5	Protection from water projected from a nozzle.
6	Protection against heavy seas, or powerful jets of water.
7	Protection against immersion.
8	Protection against complete, continuous submersion in water.

Figure 2 Protection requirements against water

IP54 = IP Letter Code — IP
1st Digit — 5
2nd Digit — 4

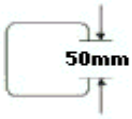
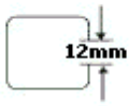
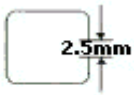
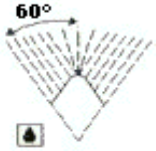
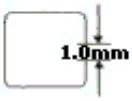
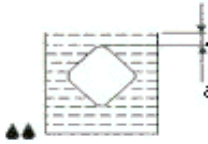
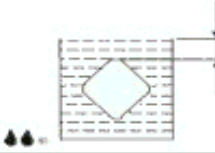
1st Digit	Protection from solid objects	2nd Digit	Protection from moisture
0	Non protected	0	Non protected
1	 Protected against solid objects greater than 50mm	1	 Protected against dripping water
2	 Protected against solid objects greater than 12mm	2	 Protected against dripping water when tilted up to 15°
3	 Protected against solid objects greater than 2.5mmØ	3	 Protected against spraying water
4	 Protected against solid objects greater than 1.0mmØ	4	 Protected against splashing water
5	 Dust protected	5	 Protected against water jets
6	 Dust tight	6	 Protected against heavy seas
Note EN60529 does not specify sealing effectiveness against the following: Mechanical damage of the equipment; the risk of explosions; certain types of moisture conditions, e.g. those that are produced by condensation; corrosive vapours; fungus; vermin.		7	 .15m - 1m Protected against against the effects of immersion
		8	 1m+ Protected against submersion **(see note)**

Figure 3 Diagrammatic showing IP symbols

SECTION 7 SITING OF ELECTRICAL GENERATING AND DISTRIBUTION EQUIPMENT

7.1 Internal Distribution Equipment

Electrical equipment and installations within any explosives building should be confined to that equipment which is essential. Where this is necessary, conformity with the relevant standards is recommended. Switchgear and distribution boards shall not be sited inside a room containing explosives.

7.2 Where electrical equipment is sited on the outside of buildings, appropriate weather protection should be provided that includes adequate ventilation or heating to prevent condensation.

7.3 It is advisable to have a master switch outside each building that is capable of disconnecting and isolating all phase and neutral conductors entering that building. All such switches should be clearly identified. It is recommended that indicator lights are fitted to show that the supply is energised with a duplicate light adjacent to the particular master switch for that supply.

7.4 External Generating Plant & Associated Distribution Equipment

Electrical generating plant and associated distribution equipment whose working voltage exceeds 650V shall be sited not less than 45m from any explosives building. Generating plant and distribution equipment working at 650V, or less, may be sited not less than 10m from any building containing explosives. Such plant should be completely housed in a building or structure which provides complete containment in relation to the buildings containing explosives.

7.5 Electrical generating plant and associated distribution equipment whose working voltage is between 650V and 11kV and which does not contain any flammable insulation fluids may be sited not less than 20m from an explosives buildings provided the loss of the equipment can be tolerated by the whole site.

7.6 It may be necessary to increase distances to comply with the explosives quantity-distances from adjacent explosives buildings or to provide protection by traversing, in order to protect the electrical installation from the explosive risk.

7.7 Electrical installations that contain flammable insulation fluids in sufficient quantity to constitute a significant fire risk shall have drains to allow any fluids to flow into a gravel or shingle filled sump of adequate size to contain all leakage. An area, clear of all combustible material for 5m, shall be maintained around the sump.

7.8 High-Voltage Transformers and Switchgear

It is advisable to separate both high-voltage transformers and switchgear from explosives buildings by at least 45 metres and more if the plant is endangered by the explosion risk. In many cases these units will contain insulating oil which is flammable. It is recommended that a gravel or shingle filled sump of adequate size to contain all leakages is provided so that in the event of any leakage the insulating oil can drain into it. This sump should be sealed to prevent contamination of the surrounding ground or water courses.

SECTION 8 EARTHING

8.1 Electrical systems must comply with all of the Electricity at Work Regulations; specifically Regulation 8 states:

"Precautions shall be taken, either by earthing or by other suitable means, to prevent danger arising when any conductor (other than a circuit conductor) which may reasonably foreseeable become charged as a result of either the use of a system, or a fault in a system, becomes so charged; and, for the purposes of ensuring compliance with this regulation, a conductor shall be regarded as earthed when it is connected to the general mass of earth by conductors of sufficient strength and current-carrying capability to discharge electrical energy to earth".

8.2 The aim of the regulation is to prevent danger, which includes the prevention of electric shock, through conductors becoming accidentally live, as well as avoiding potential sources of ignition. Since it is the electrical charging of non-circuit conductors that is to be prevented, this should have the effect of preventing electrical sources of ignition from such conductors.

8.3 When an electrical system is introduced into an explosive area compliance with just the Electricity at Work Regulations may not meet the minimum acceptable level of safety. Consideration must be given to all potential ignition sources that might be created by the electrical system, and control measures must be implemented to minimise the risk.

8.4 Earthing and bonding conductors must be suitable for the maximum current which they may carry under fault conditions and be capable of surviving the worst case fault. Their construction and strength must be adequate to withstand likely wear and tear. Where it might otherwise be difficult to ensure the continued effectiveness of earthing and bonding arrangements it may be necessary to provide supplementary protection such as protective path continuity monitoring in accordance with BS 4444 Guide to Electrical Earth Monitoring and Protective Conductor Proving. Refer to section 15 for further guidance.

8.5 All main structural metalwork in and on explosives buildings, the lightning and the antistatic protection systems should be connected to a common system of earthing and equipotential bonding. It is recommended that the earthing installation meets the requirements of BS 7430 (Code of Practice for Earthing) and also BS 7671 (Requirements for Electrical Installations), where protection against shock from electrical equipment is necessary, the resistance of the system to earth being the lowest to comply with the requirements of any one of the systems involved. The lightning protection, equipotential bonding and antistatic protection systems should be connected together only at the incoming mains supply earth bar.

8.6 Metallic enclosures of all electrical switchgear, starters, motors and other electrical appliances should be earthed via a circuit protective conductor. Metallic cable sheaths or armouring, metal projections through walls, for example conduit, pipes, rails, guides etc, should be bonded at their point of entry to buildings to the nearest part of the lightning protection system above the test point. Where such metalwork has straight sections in excess of 15 metres long it is advisable to provide bonding at each end. It is not necessary to bond metal window frames, small ventilators and other small metal fittings which are less than two metres long, provided they are more than 0.3 metres from a lightning conductor. The use of metal service pipes as earth electrodes is not recommended.

8.7 It is important that pipe work which is bonded to earth is electrically continuous and that sections are not isolated due to the use of PTFE or similar insulating thread sealing tape. Where such tape is used, it is essential to individually cross bond all sections of pipe-work, valves etc.

8.8 When processing explosives or explosive munitions that require to be earthed; process equipment/tooling should utilise a single point earth bond to the equipotential system at floor level to prevent unwanted circulating currents from lightning strike or electrical fault conditions.

Note: single point earth will ensure that explosive or explosive munitions are not subjected to harmful electrical currents.

SECTION 9 LIGHTNING PROTECTION

9.1 The purpose of a lightning protection system is to intercept a lightning strike to the building and carry the lightning current safely to earth without causing damage to the building or its contents. To this end buildings can be designed with either an integral or separated lightning protection system, integral meaning attached to the building or utilising parts of the building structure and separated meaning a physically separate lightning protection system which is not fixed to or part of the building structure.

9.2 Lightning Protection Systems (LPS) are classified in BS EN 62305, according to the lightning protection level for which it is designed. There are 4 lightning protection levels and 4 corresponding LPS classes which relate to a probability of physical damage to a protected structure. For example; the highest level of protection is given by a Class 1 LPS for which the probability of physical damage to the structure would be 0.02. At the other extreme a Class IV LPS will give a level of protection that would give a probability of damage to the structure of 0.2.

9.3 “For structures containing solid explosive materials an isolated external LPS is encouraged”, BS EN 62305-3:2006 Annex D paragraph D4 refers. This would suggest either a catenary wire or isolated mast air termination system. To meet the criteria of a Class 1 LPS the design would need to be assessed against the 20 m radius rolling sphere and have an isolation distance from the structure to be protected as calculated in BS EN 62305-3:2006 Section 6 paragraph 6.3. It is recommended that structures containing HT 1, 2 or 3 explosives should have a class 1 LPS.

9.4 The earth termination system shall be a Type B earthing arrangement as defined by BS EN 62305 Part 3.

9.5 For process buildings, the need for lightning protection must be considered as part of the risk assessment; consideration should also be given to explosives in transit that form part of the process.

9.6 All metallic reinforcement, crane and railway rails which enter explosives buildings should be bonded to the nearest point of the lightning protection system.

9.7 Existing steel framed structures with metallic cladding with a steel thickness of at least 4mm may be regarded as self-protecting provided the individual earth resistance of each stanchion, in a stand alone condition, does not exceed ten ohms. The metallic cladding should be bonded to the structure. This may be achieved by the use of suitable metal fixings. Where these conditions cannot be met, a ring electrode should be installed to connect all stanchions together and appropriate measures taken to bond the metallic cladding to the structure.

9.8 To avoid lightning flash-over from structural steel or concrete reinforcing bars a separation distance of >500 mm must be maintained between structural walls and explosives.

9.9 ISO containers of all welded steel construction of at least 4mm plate thickness and where the walls are lined with wood and all panels and doors are electrically bonded using heavy duty bonding straps of at least 50 sq mm, which contain explosives, may be stored in the open without any specific lightning protection provided that the containers have at least two earthing points at opposite corners to connect to driven earth rods. The DC resistance to earth at any point of the ISO container should be less than 10 ohms.

9.10 All lightning protection systems must be inspected and tested by a competent body. Inspections and tests should be conducted at least every 11 months at intervals that ensure the system is tested during every season of the year. These tests should include confirmation of the structural integrity of the LPS.

9.11 If a facility complied with the superseded specification BS 6651, then a building assessment should show that the LPS system complies with BS EN 62305-3:2006.

SECTION 10 STATIC ELECTRICITY

10.1 General

Static electricity, i.e. unbalanced electrical charge, is produced by physical activity, e.g. walking, moving machinery, processing materials. The electrical resistance of man-made materials, e.g. polythene packaging, prevent this hazardous charge escaping. It takes only a few brief, brushing movements for an isolated conductor to reach several thousand volts, e.g. a person leaving their car seat or someone removing an article of clothing. If this energy is released as a spark it can cause an ignition of an explosive, flammable atmosphere or explosive device.

10.2 Charge accumulation must be minimised. This is achieved by providing all large conductors, e.g. people, machinery, etc. with a reliable earth connection, restricting the use of insulating materials and enforcing minimum humidity limits when handling explosives.

10.3 It is essential that this electrostatic control is by expert design and implemented systematically.

10.4 Incorrect cleaning techniques and polishes can adversely affect the electrostatic properties of antistatic or conducting floors. Therefore, the advice of the floor manufacturer must be followed. Additional care must be exercised during maintenance and other work involving electrical equipment within arm's reach of the flooring. This is because the conductivity of the flooring increases the level of shock, making electrocution more likely if contact is made with faulty equipment. The type of flooring used shall be clearly identified at the entrance to the area.

10.5 Staff required to wear conducting footwear and low resistivity clothing must be trained in the correct care and use of this personal protective equipment. Advice can usually be obtained from the manufacturer.

10.6 It is important that pipe work which is connected to earth is continuous and that sections are not isolated due to the use of PTFE or similar insulating thread sealing tape. Where such tape is used, all significant conductive sections of pipe work, valves, etc, must be cross bonded to an earthed section.

10.7 It is recommended that Personal Monitoring Devices with clear operating instructions alongside are installed at the entrances to buildings where conducting floors and conducting shoes are used. Users must be trained and care taken to ensure that these devices are used every time the hazardous area is entered.

10.8 The charge on resistive exterior, i.e. exposed, clothing is a potential source of ignition for very sensitive explosives and flammable atmospheres. Therefore, outer clothing should be made from more conductive materials like cotton. Any charge is relatively innocuous when the clothing is close to the wearer's body and the outer clothing should fit correctly, be correctly fastened and neither be put on nor taken off, within an area designated as safe from ESD.

10.9 Casings, packaging and other enclosures may offer some protection to explosives from electrostatic discharge especially when transporting them outside an area designated as safe from ESD.

10.10 Electrical discharge tests are used to quantify the susceptibility of explosives and explosive devices to electrostatic discharge. The results of these tests are used to categorise them and define appropriate control measures.

10.11 **Comparatively insensitive** - those materials and devices with ignition > 450 mJ. These materials and devices cannot be ignited by static from people but may be susceptible to extreme electrostatic discharge.

Control – Earth all large conductors as required by The Electricity at Work Regulations 1989. Any process capable of producing exceptional high charge levels; e.g. pneumatic transport of insulating powder, must be identified and controlled or kept remote from explosives.

10.12 **Sensitive** - those materials and devices with ignition energies >1 mJ - 450 mJ. Without adequate control measures these materials and devices may be ignited by the static generated.

Control – The measures required for comparative insensitive materials and devices plus people must have a low resistance path, ≥750 kΩ to ≤100 MΩ, to earth. This path will prevent hazardous voltages by allowing dissipation of charge. The use of loose electrical insulators is restricted and no work is permitted in an environment conditioned at a relative humidity below 40%.

10.13 **Very sensitive** - those materials with ignition energies ≤1 mJ. Without stringent control measures these materials and devices are very likely to be ignited by the static generated on people.

Control – The measures required for sensitive materials and devices but people must have a conductive path, <1 MΩ, to earth. This path will ensure the person's potential is below 100 V. The use of loose electrical insulators is prohibited and no work is permitted unless the environment has been conditioned at a relative humidity greater than 65%.

10.14 Detailed guidance is provided within CLC/TR 50404:2003 "Electrostatics – Code of practice for the avoidance of hazards due to static electricity". The minimum control measures required to ensure legal compliance are defined within HSE Manufacture and Storage of Explosives Regulations (MSER) ACOP 2005. The MSER document defines first, intermediate and second degree precautions. To work outside of the above mentioned humidity levels, safeguards must be put in place that can be technically demonstrated to give an equally effective or greater level of protection as required by the above guidance.

10.15 Conductive conditions require additional controls when using mains powered electrical equipment to counter the increased risk of severe shock and electrocution.

10.16 Examples of explosives which are **very** sensitive to static electricity include:

- Conductive compositions;
- All initiatory compositions;
- Many Electro Explosive Devices (EEDs);
- Pyrotechnic delay compositions (gasless) based on boron as fuel and lead dioxide, chromium, bismuth and molybdenum trioxides as oxidant;
- Pyrotechnic igniter and primary compositions based on either zirconium as fuel, with molybdenum and chromium trioxides as oxidant, and/or magnesium as fuel with tungsten trioxide as oxidant;
- Pyrotechnic flame compositions based on titanium as fuel.

SECTION 11 ELECTROMAGNETIC HAZARDS (EMH)

11.1 Radio Frequency Hazards

(a) Hazard to Electro-Explosive Devices (EED)

Signal strengths from even relatively low power transmitters may be sufficient either individually or in combination to activate EED due to pick-up on the leads attached to the EED. Unless the circuit is adequately shielded or filtered these currents can be sufficient to fire an EED in its normal functioning mode. Guidance on this matter is set out in BS 6657 *Guide to prevention of inadvertent initiation of electro-explosive devices by radio-frequency radiation* (**Note**: this standard is due to be superseded by PD CLC/TR 50426:2004). For military systems guidance can be found in DEF STAN 59-114 (previously Pillar Proceeding P101).

Radio frequency transmitters in the local area and those in use on the explosives site therefore need to be assessed to ensure a safe distance is maintained at all times between them and the most sensitive EED used on the site. PD CLC/TR 50426 sets out a method for calculating this distance and although the standard concentrates on specific scenarios the basic calculation method may be applied to any situation. It should be noted that the BS does not mandate the use of a safety margin but suggests users may apply a further safety factor if desired. Historically a minimum safety factor of 12dB below the No Fire Threshold (NFT) has been specified in previous publications and that value is recommended and has been applied to the results shown in table 3 below.

Where radio frequency transmitters are required for the effective operation of an explosive site at which EEDs are stored, handled or used, care must be taken over the choice of and sitting of the transmitters. The use of fixed communication systems, suitable for the particular areas concerned, which provide for two-way communication, is preferred so that the carrying and use of portable units becomes unnecessary. The siting of a fixed transmit antenna should ensure a safe distance between it and the vulnerable EED.

Where personal communications equipment (such as cell phones and some pagers) has to be used, an assessment of the risks posed by the transmission characteristics of the equipment should be made. Control over where the transmitters may be taken and used may often be required to ensure safety. (**Note**: mobile phones transmit RF when switched on even if not being used. Moreover their RF power output will depend on the signal strength received from the base station mast.) A similar assessment of radio communications equipment used by security, emergency and other similar services should be carried out.

When stores containing an EED are removed from their package, and the associated wiring is unfolded or lengthened (including attachment to a firing line), the susceptibility to electromagnetic radiation pick-up will increase.

This also applies when an EED or its wiring is being handled since the person becomes part of the overall antenna system. Table 1 below gives minimum separation distances from a few common transmitters based on the most sensitive EED specified in PD CLC/TR 50426 (Type 1) with a 1.8m length firing line and a no-fire threshold of 32 mW and using a 12 dB safety margin. For other EEDs and transmitters not conforming to the assumptions given in Table 3 reference should be made to PD CLC/TR 50426 or DEF STAN 59-114 (where appropriate).

Transmitter Type	Assumed Maximum Power Output Watts	Assumed Frequency Range of Operation	Minimum Distance metres
Hand Held Mobile Phone	2	900 MHz or 1800 MHz bands	4
Hand Held VHF Radio	5	156 – 163 MHz	15
Hand Held Tetra Radio	3	380 – 470 MHz & 800 – 870 MHz	3
Vehicle Installed Tetra Radio	10	380 – 470 MHz & 800 – 870 MHz	5
High Power Air Traffic Radar (assuming main beam illumination)	5000 (average) (36 dB gain antenna)	2.5 – 3 GHz	500

Table 3 Safe Distances for Typical Transmitters from a 32mW NFT EED

Concern has been expressed about vehicles fitted with CB radios, tracking devices or similar devices being admitted to sites. The best advice is that where such vehicles require access, the communications system should be switched off before the vehicle is allowed on site.

(b) Hazard to Flammable Atmospheres.

In facilities where a flammable atmosphere may exist (as defined by Section 5) special consideration must be given to the use of RF transmitters.

Guidance on dealing with these matters is set out in two British Standards: BS 6656 *Guide to prevention of inadvertent ignition of flammable atmospheres by radio-frequency radiation. (**Note**; this standard is due to be superseded by PD CLC/TR 50427:2004).*

It is important to consider all potential sources of radio-frequency radiation including all forms of portable communications equipment. This is a separate consideration to the need to use appropriately ATEX certified radios/transmitters in flammable atmosphere zones due to possible ignition sources arising from the batteries and circuitry of such equipment.

11.2 Electromagnetic Compatibility (EMC).

The Electromagnetic Compatibility (EMC) performance of electrical equipment in explosive buildings shall meet the requirements of the EC EMC Directive 2004/108/EC as promulgated by SI 3418/2006.

Installed and portable equipment shall meet the EMC emission requirements for Light Industrial and Residential equipments as defined in BS EN specification 61000-6-3 or relevant product specific standard. Equipment which has been designed and manufactured specifically for defence purposes should normally be tested to the EN standards but exemptions to use a relevant military standard may have been granted.

Mechanical Handling Equipment (MHE) shall meet the EMC requirements of BS EN12895.

In addition since the above tests do not specifically address electro-explosive hazards the following tests/assessments shall be carried out:

(i) Fixed or portable equipment (and their cables) within the immediate vicinity of an unpackaged explosive item (but not electrically connected to it) shall be specifically checked to ensure their radiated emissions are within the standard limits (see **note** below). The radiated emission levels shall be used to determine the safe operating distance of the equipment from the explosive item (see PD CLC/TR 50426 or DEF STAN 59-114 for guidance).

NOTE: A manufacturer may claim compliance to an EMC standard without necessarily having conducted any or all the tests in that standard. Since there are safety issues involved with explosive items, users should request copies of test results.

(ii) Where fixed or portable electrical equipments are directly connected to an explosive item (e.g. under test) or where the item is directly powered from the electrical supply, an assessment and/or test shall be carried out to ensure unintended initiation is not possible. This may require instrumentation of the explosive item (including the EEDs) to allow monitoring of the energy being induced. The assessment shall consider the possibility of RF energy and transients being coupled into the EED wiring either through cable to cable coupling or via earths and the possibility of mains transients causing an unsafe upset in the test equipment or the explosive item itself. See para (c) below.

11.3 Transient Testing

Transient energy can initiate EEDs. It is thus important that any transients produced by a circuit intended to initiate EEDs or to test them cannot cause accidental initiation.

Transients can be wireborne or can be induced from adjacent wiring or capacitive coupling. It must be shown that the firing lines to EEDs within a system do not contain hazardous energy that could cause inadvertent operation. The source of such transients could be on power supply lines external to the system or on actual fire lines. Power supply transients can reach EEDs through circuits internal to the system, earths, 0v and screens. It is also possible by capacitive coupling within the system.

The presence and control of transients is determined by circumstances peculiar to the situation encountered. The nature and proximity of facility and site plant (and the switching thereof), the type of explosive item/article, the type of test equipment in use and transient protection already installed will all have a bearing on how significant the residual transient hazard will be. With this in mind guidance is not a simple matter and as such assessments must be made based on specific situations. The most vulnerable situation is when the explosive item is under test. The following gives some basic guidance for minimising transient hazards:

(i) The inclusion of surge protection on all incoming mains supplies.

(ii) Fitting of transient filters between the mains and the input to the test equipment.

(iii) Ensure cables supplying high inductive loads are not routed in close proximity to EEDs and test cables.

(iv) Ensure adequate earthing and screening of equipment and cables.

Note: In some circumstances it may be necessary to conduct an instrumented test to determine the energy induced into the EED(s). In these circumstances a safety margin of at least 12dB below the NFT shall be applied.

SECTION 12 PORTABLE ELECTRICAL EQUIPMENT

12.1 Portable electrical equipment is defined as equipment that is moved while in operation or that can easily be moved from one place to another while connected to the supply. Portable electrical equipment can be divided into two types, mains and battery powered.

12.2 Mains powered portable equipment should be avoided if possible but where mains-powered equipment is used, the equipment shall be suitable for the environment in which it is used (see Section 6 Selection of Electrical Equipment and HSG 85).

12.3 The following general requirements are applicable to all types of portable electrical equipment:

- Electrical equipment for general use must be CE marked; any specifically designed electrical equipment must be to at least this standard.
- Drop and impact performance, i.e. equipment must be able to withstand a 1m drop or credible impact without the enclosure being compromised and exposing live terminals or battery connections.
- If the equipment is designed to interface or directly test an explosive item then the additional requirements given in Sections 11 and 17 must be followed.
- Equipment shall not be left powered on when not in use and preferably removed from the explosives area.

12.4 The following additional restrictions apply to portable battery powered equipment used in explosives areas:

- Only batteries of the type recommended by the manufacturer of the equipment shall be used.
- Self contained safety torches and hand lamps shall comply with the requirements of this guidance.
- The battery compartment must be secured to prevent access without the use of a tool.
- Changing or charging of batteries must be undertaken outside the explosives area.

12.5 The following additional restrictions apply to portable mains powered equipment used in explosives areas:

- Protection using one or more of the following systems is to be provided:
  - Reduced voltage (110 volts AC or less). BS EN 61558.
  - Separated Extra Low Voltage (SELV – 50 volts AC or less) to BS 7671.
  - Double Insulated (Class II) to BS EN 60417.
  - Residual Current Device (RCD) to BS EN 61008-1 or BS EN 61009-1.

  - Earth Monitoring and Protective Conductor Proving to BS 4444.
- When portable mains powered electrical equipment is used in an explosive facilities with conducting floors:
  - It should be Separated Extra Low Voltage (SELV) or Double Insulated (Class II) equipment.
  - The use of RCD protection is essential (maximum trip current of 30mA).

12.6 Portable electrical equipment should be the subject of a maintenance regime to maintain the equipment's safety and reliability. The following guidance for safe maintenance of portable electrical equipment should be followed:

- Inspection, calibration and repair of portable equipment must be undertaken outside the explosives area.
- Maintenance must be conducted in accordance with HSG 85. If maintenance must be carried out on portable mains powered electrical equipment in situ, then appropriate precautions shall be used, including the use of an insulating mat to BS 921 used to provide protection against electrocution, especially when a conducting floor is present.
- Flexible mains leads must be subject to a visual inspection prior to use and a 12 monthly Portable Appliance Test (PAT). Records of such tests shall be kept.
- Any flexible mains lead or equipment observed to be damaged or faulty during use must be removed from the explosives area immediately.
- All portable equipment shall be maintained by a suitably competent person / body in accordance with the manufacturer’s instructions.

12.7 Further general guidance is available in HSE Guidance note HSG 107 – Maintaining Portable and Transportable Electrical equipment.

SECTION 13 POWERED MECHANICAL HANDLING EQUIPMENT

13.1 Power operated vehicles, Powered Mechanical Handling Equipment (MHE) and cranes present a risk of fire or explosion. When the plant is within or around explosives buildings the hazard is increased. The guidance in this section is to be applied in addition to that mentioned in section 6 – Selection of Electrical Equipment.

13.2 Vehicles and MHE used in explosives facilities should be specified, equipped and marked in accordance BS EN 1755, BS EN 1175, ATEX Directives and this guidance.

13.3 Electrically operated vehicles for use in explosives facilities are preferable from a safety viewpoint to those operated by internal combustion engines. The surface temperature limitations specified for electrical equipment apply equally to mechanical items such as transmissions; brakes and exhaust systems of vehicles.

13.4 Petrol-engine vehicles are **NOT** permitted in explosives areas. Diesel engines that have petrol starting systems and vehicles powered by liquid petroleum gas, butane or propane are to be treated as petrol engines and are therefore not permitted.

13.5 Section 5 of this guidance categorises a building containing explosives according to the nature of the explosives stored, handled or processed in the building. The same categorisation is used to determine the protection to be afforded to vehicles and MHE permitted inside buildings containing explosives. Table 4 below shows the types of powered MHE and vehicles permitted in Explosives buildings:

Building Category	Zone	Truck Classification (see ATEX)	Permitted
A	0	1G	No
A	1	2G	YES – only if para 13.7 is complied with
A	2	3G	
B	20	1D	No
B	21	2D	YES – only if para 13.8 is complied with
B	22	3D	
C	N/A	N/A	YES – only if para 13.9 is complied with
D	N/A	N/A	No Special Requirements

Table 4 Power Type of MHE Permitted in Explosives Buildings.

13.6 Vehicles and powered mobile MHE authorised for use within an explosives building should conform, as a minimum, to the standards set out in paragraphs 13.7 to 13.9. It should not be assumed that a vehicle compliant with paragraph 13.7 is suitable for use within a Cat B environment and visa versa. However, it can be assumed that a vehicle suitable for a Cat A or Cat B environment is suitable for any Cat C environment. In addition to these standards the following criteria are to be observed:

- Identification of MHE - Mobile MHE, including Cranes, should be clearly identified by sign writing, plating or other suitable means to define the areas in an explosives facility in which it is cleared for use.
- Internal Combustion Engines - Internal combustion engines are to be Compression Ignition (CI) engines. Cold starting fluids should only be used in a permanently installed system that injects fluid into the inlet air manifold downstream of the inlet flame arrestor. The length and bore dimensions of any cold start fluid injection jet are to be proportioned such that the jet is flameproof. Cold starting fluids should not to be used in conjunction with any electrical starting aids.
- Fuel - Diesel fuel should have a flash point of not less than 55°C. Other fuels may be used in diesel operated internal combustion engines provided that it has a flash point of not less than 38°C and the ambient temperature of the area in which the vehicle is working is at least 5°C below the flash point of the fuel. Due allowance is to be made for solar heat gain where vehicles are working in strong sunlight. The auto-ignition temperature of either fuel should not be less than 250°C. When fuels are used with additives (i.e. for cold climates) flash point and auto-ignition temperature will normally be reduced. Fuel and cold starting aid fluid should only to be carried in a fixed tank. No provision is to be made for the carriage of spare fuel or starting fluid.
- Tyres - The tyre of at least one road wheel should be electrically conducting in accordance with the requirements of BS ISO 2878:2005. Vehicles designated for use in CAT C storage, marshalling and transit environments are not required to be fitted with electrically conducting tyres. All wheels on any one axle are to be fitted with tyres of the same type.
- Ancillaries - Ancillary items in use with vehicles and powered mobile MHE should comply with the equivalent standards as the main equipment with which they are utilised.
- Electromagnetic Compatibility - All vehicles and powered mobile Mechanical Handling Equipment should be compliant with the requirements of BS EN 12895:2000. **Note**: Equipment may be CE marked and the manufacturer states it meets the requirements of a relevant EN EMC standard without an EMC test having been conducted. Those purchasing equipment should therefore obtain test results for the equipment from the supplier/manufacturer to demonstrate compliance.
- Maintenance - Vehicles and powered MHE are to be maintained and periodically tested in accordance with the standards contained in BS EN 1755. Following any maintenance to the exhaust system it must be reassembled with new gaskets and tested for leaks before the MHE is put back into service. Exhaust system flame emission tests are not required during routine maintenance.

- Battery - Use dry batteries wherever possible. If this is not possible, battery enclosures must be capable of withstanding an exploding battery and containing the debris.
- Battery Charging - The batteries of electrically powered vehicles should be maintained and charged at locations external to the explosive facilities that are well ventilated outside the explosive area - HSE leaflet INDG139 gives further guidance.
- Fire Fighting Equipment - Vehicles and powered MHE should carry fire extinguishers that are of a type suitable for the fuel used and which will also tackle electrical fires. Additional means of fire fighting should be available at garages, refuelling points and battery charging facilities.
- Parking - Vehicles and powered mobile MHE should not be left unattended in an explosives building. Vehicles and mobile MHE shall only be parked in designated areas within the explosives storage area, each site shall determine suitable parking areas.
- Emergency Stop - An emergency switch shall be fitted that is:
    - Readily accessible to the driver.
    - As close as possible to the battery connector.
    - Incapable of being reset without a key that is not available to the driver.
    - Capable of isolating all supplies from the battery under full load current.
    - If a button is used, it should be shrouded to prevent inadvertent operation.

13.7 Vehicles and Powered MHE Appropriate for Cat A Zone 1 and Zone 2 Explosives Buildings

Diesel powered vehicles, diesel powered mobile MHE, electrically powered vehicles and electrically powered mobile MHE are authorised to enter a Cat A Zone 1 explosives building (for Category 2G vehicles) and CAT A Zone 2 Potential Explosives Store (for Category 2G and 3G vehicles) subject to the restrictions detailed in this paragraph. Diesel powered vehicles, diesel powered mobile MHE, electrically powered vehicles and electrically powered mobile MHE should comply with the following requirements and the applicable standards in Table 5 below.

BS EN 1127-1: 1998	Explosive atmospheres – Explosion prevention and protection – basic concepts and methodology
BS EN 1175: 1998	Safety of industrial trucks – electrical requirements
EN 1755: 2000	Safety of industrial trucks – operation in potentially explosive atmospheres – use in flammable gas, vapour, mist and dust
BS EN 1834-1: 2000	Reciprocating internal combustion engines - Safety requirements for design and construction of engines for use in potentially explosive atmospheres - Part 1: Group II engines for use in flammable gas and vapour atmospheres
BS EN 60079: 2006	Series of standards covering electrical apparatus for use in explosive gas atmospheres
BS EN 12895:2000	EMC

Table 5 – Standards for vehicles and powered mobile MHE for use in a Cat A Zone 1 Explosives Building and CAT A Zone 2 Explosives Building.

- The maximum surface temperature of any part of the vehicle or powered mobile MHE is to be specified for the potentially explosive atmosphere that is anticipated but must not exceed T4 135°C.
- It is strongly recommended that battery-operated vehicles are to at least BS EN 1755 specification.
- Compliance with BS EN 1755 is recommended for the battery and its container, as is the fitting of a suitable temperature sensor to equipment which is liable to exceed the maximum permitted temperature.
- The use of double pole wiring and isolation is recommended.

NOTE*:* It is inadvisable to use diesel engine vehicles in Category A Zone 1 locations due to the potential danger of induction of a flammable atmosphere into the engine air intake.

13.8 Vehicles and Powered MHE Appropriate for Cat B Zone 21 and Zone 22 Explosives Building

Diesel powered vehicles, diesel powered mobile MHE, electrically powered vehicles and electrically powered mobile MHE maybe authorised to enter a Cat B Zone 21 explosives building (Category 2D vehicles only) and Cat B Zone 22 (Category 2D and 3D vehicles only) subject to the restrictions detailed within this paragraph. Diesel powered vehicles, diesel powered mobile MHE, electrically powered vehicles and electrically powered mobile MHE should comply with the following requirements and the applicable standards in Table 6 below.

BS EN 1127-1 : 1998	Explosive atmospheres – Explosion prevention and protection – basic concepts and methodology
BS EN 1175: 1998	Safety of industrial trucks – electrical requirements
EN 1755: 2000	Safety of industrial trucks – operation in potentially explosive atmospheres – use in flammable gas, vapour, mist and dust
BS EN 1834-3: 2000	Reciprocating internal combustion engines - Safety requirements for design and construction of engines for use in potentially explosive atmospheres - Part 1: Group II engines for use in flammable dust atmospheres
BS EN 61241: 2006	Series of standards covering electrical apparatus for use in the presence of combustible dust
EN12895:2000	EMC

Table 6 Standards for vehicles and powered mobile MHE for use in a Cat B Explosives Building Zones 21 and 22

- The maximum surface temperature of any part of the vehicle or powered mobile MHE is to be specified for the potentially explosive atmosphere that is anticipated but must not exceed T4 135°C.

13.9 Vehicles and Powered MHE Appropriate for a Cat C Explosives Building

Diesel powered vehicles, diesel powered mobile MHE, electrically powered vehicles and electrically powered mobile MHE maybe permitted to enter a Cat C explosives building provided that they comply with the following as a minimum:

- An approved spark arrestor should be fitted to the exhaust system of diesel powered vehicles.
- The maximum temperature of the exposed surfaces of the vehicle or powered mobile MHE should not exceed 135°C. This requirement may be met by shielding which is designed to prevent explosives coming into contact with any surface whose temperature exceeds 135°C.
- The surface temperatures of components under the covers of the powered mobile MHE in its normal operating condition is to be as low as practicable and must not exceed 200°C.

- The air intake system should be fitted with a dry air cleaner.
- If a cold starting aid, which ignites fuel in the air intake manifold, is fitted, an approved flame trap is to be fitted between the air cleaner and the cold start device.
- Electrical equipment enclosures that are accessible when the MHE is in its normal operating condition are to provide protection against the ingress of solids and liquids to comply with the requirements of BS EN 60529, IP44.
- Electrical equipment enclosures are to withstand an external impact of one joule, with the exception of light emitting parts with guards which are to withstand an impact of 0.7 joules when tested without the guard.
- The covers of the MHE in the normal operating condition may be regarded as a satisfactory enclosure if:

    - They provide protection, from the top and the sides, against contact with live or moving parts inside by tools, wires or such objects of a thickness greater than 1mm.
    - They cannot be opened without keys or tools which are not normally available to the operator. Such keys or tools may be kept in a sealed container on the MHE to allow access in an emergency.
    - Electrical equipment under the covers is protected so that a 5mm diameter metal sphere cannot cause a short circuit in or between equipment or between equipment and the frame of the MHE.
    - Components which may overheat should be fitted with a sensor arranged to warn the driver or to disconnect the relevant circuit when the maximum permissible temperature is being approached.
    - Wiring should consist of single or multi-core sheathed cable, or harness; conductors are to be multi-stranded. Conductor insulation should resist chemical attack by engine fuel, lubricating oils and hydraulic and electrolytic fluids. The wiring system may be enclosed by the structure of the MHE in its normal operating condition provided cable entries into electrical equipment enclosures maintain the degree of protection of the enclosure.
    - Diesel engines should be fitted with oil pressure loss, and high coolant temperatures warning devices, or an automatic shut down device.
    - MHE shall be fitted with an emergency stop device which shall isolate all electrics.
    - EMC performance to BS EN12895:2000.

SECTION 14 HEATING APPLIANCES

14.1 **Note** the following points:

- All heating and air conditioning equipment shall be permanently installed. Portable equipment should not be used in explosives buildings. All fixed heating equipment shall comply with the electrical category of the area it is installed in.
- All appliances are subject to the maximum surface temperature limits prescribed in section 6.
- It is recommended that all heating appliances are permanently installed and portable heaters are not used; unless electrically heated water/oil-filled radiators carry suitable third party certification to demonstrate a limitation of their maximum surface temperature.
- The heater shall be fitted with a guard or positioned so as to prevent physical contact with it, and any guard shall not allow explosives to be laid upon it by having an angled top surface.
- A thermal cut-out, which is not self-resetting with falling temperature, shall be fitted to the hottest part of each heater to ensure compliance with the maximum surface temperature limits. This requirement may be waived (but only within Category C and D areas), when a temperature class e.g. T5, is defined as a part of the certification, by a recognised authority for an appliance. Provision of such a cut-out shall not invalidate any certification of the appliance.
- **Note**: Water and oil filled electrically heated radiators shall have a high temperature cut-out set to T6 (85°C); see table for all T class max surface temperatures.
- Equipment used for heating explosives shall be fitted with an additional thermostatic regulator that will override all other controls and limit the temperature to a safe level, normally not exceeding 100°C. The setting device shall be tamperproof and its operation shall be frequently tested. The equipment shall be fitted with an indicator light to show when the heater is energised.
- Electrically heated air re-circulating systems are not permitted in Category A or B buildings, or in heating appliances containing exposed explosives e.g. conditioning chambers. Electrically heated floors and ceilings are not permitted in any explosives building.

T Class	T1	T2	T3	T4	T5	T6
Max. Surface Temperature (C^o)	450	300	200	135	100	85

Table 7 Maximum surface temperature for each T Class.

SECTION 15 WIRING SYSTEMS

15.1 It is recommended that:

- Metal conduit systems or mineral insulated metal covered (MIMC) cables are used in category A and B explosives areas. Conduit systems and gland arrangements should be selected to meet the requirements of the equipment category for the specific area sub-zones.
- The types of cable system to be used in explosives buildings should be of fire retardant low smoke/fume emission plastic materials. Cables within category A and B areas should also comply with the requirements of BS EN 60079-14. Cables with a single strand conductor are not to be used.
- In conduit and trunking systems, power cables should comply with BS 6007, BS 6004, BS 7211 or BS 7889, the conductor cross-sectional area being at least 1.5mm^2. Communications and alarm system cables should meet BS 6500 and have conductor cross-sectional areas of at least 0.35mm^2.
- Metal black enamel coated conduits are only suitable for use in Category C and D areas and should comply with BS 4568, BS 4607 or BS EN 61386-1:2004, running couplers are not used in Category A and B areas and the use of flexible conduit is kept to a minimum.
- Metallic trunking, non-metallic trunking, and rigid PVC conduit complying with BS 4607 may be used in Category C and D areas.
- An earth continuity conductor is enclosed throughout all conduit or trunking systems.
- Metal conduit is to be bonded to the earth system.

Note: All auxiliary building equipment i.e. alarms and fire systems should have the same standard of wiring as described above.

SECTION16 MAINTENANCE AND TESTING OF ELECTRICAL SYSTEMS AND EQUIPMENT

16.1 It is necessary to maintain all systems and equipment periodically to ensure that they remain in a safe condition for use. This requires visual inspections of systems and equipment accompanied in some cases by testing to verify, for example, the integrity of insulation and earth paths. The precise nature of such inspections needs to be set out by the management for the area concerned, taking account of the environment and the likely use and abuse of systems and equipment etc.

16.2 It is advisable to set out the testing requirements in detail for each area or building. The precise nature of tests should reflect the needs of the types of system and equipment involved. Records of inspections and tests are useful in showing such matters as trends of deterioration and for establishing appropriate renewal or refurbishment policies and therefore must be retained.

16.3 BS 7671 sets out requirements for the initial verification of fixed installations and subsequent periodic testing. There is also additional guidance on inspection and testing available from BS EN 60079-17 and BS EN 61241-17. Other guidance may be found in BS 7430 and BS EN 62305 in relation to earthing and lightning protection respectively.

Test Requirement	Cat A & Cat B max	Cat C max	Cat D max
Visual Inspection	**6 Months**	**12 Months**	**12 Months**
Electrical Inspection and Test to BS7671 Guidance Note 3 & BS EN 60079-17	**12/36 Months***	**24 Months**	**24 Months**
Conducting and Antistatic Floors	**11 or 12 Months**	**11 or 12 Months**	**N/A**
RCDs	**12 Months**	**12 Months**	**12 Months**
LPS	**11 Months**	**11 Months**	**11 Months**

Table 8 Frequency of Inspection

* For Category A and B Buildings BS EN 60079-17 requires three levels of inspection; visual, close and detailed. Close and detailed inspections should be carried out at 12 monthly and 36 monthly intervals respectively.

16.4 **Conducting / Antistatic Floors**

When first installed all conducting and antistatic flooring should be inspected every 3 monthly for the first year that the flooring is laid.

16.5 **Hazardous Areas (Cat A / B)**

Three types of inspection for installations in hazardous zoned areas: Visual, Close & Detailed. BS EN 60079-17:2007 gives guidance on inspection frequencies and gives informative guidance on applying an alternative risk assessment approach.

16.6 Inspections are required at commissioning then subsequently at periodic intervals or by continuous supervision by a skilled person. Essentially inspection periods are determined by the maintainer based on visual inspections, sample testing, complexity of facility, age etc.

SECTION 17 ELECTRICAL EQUIPMENT FOR TESTING EXPLOSIVES AND ELECTRO-EXPLOSIVES DEVICES (EEDs)

17.1 Electrical equipment for testing EEDs shall not be brought into use unless it has been approved by the appropriate authority. See ***Note** below.

17.2 Equipment intended for testing EEDs and firing circuits fitted with live EEDs shall be designed such that:

(a) No single fault of any nature can result in initiation or the degradation of an EED.
(b) Connection to the system under test will not degrade the EMC of the system within the specified environment.
(c) Safety under test conditions shall not be solely dependent on procedures.

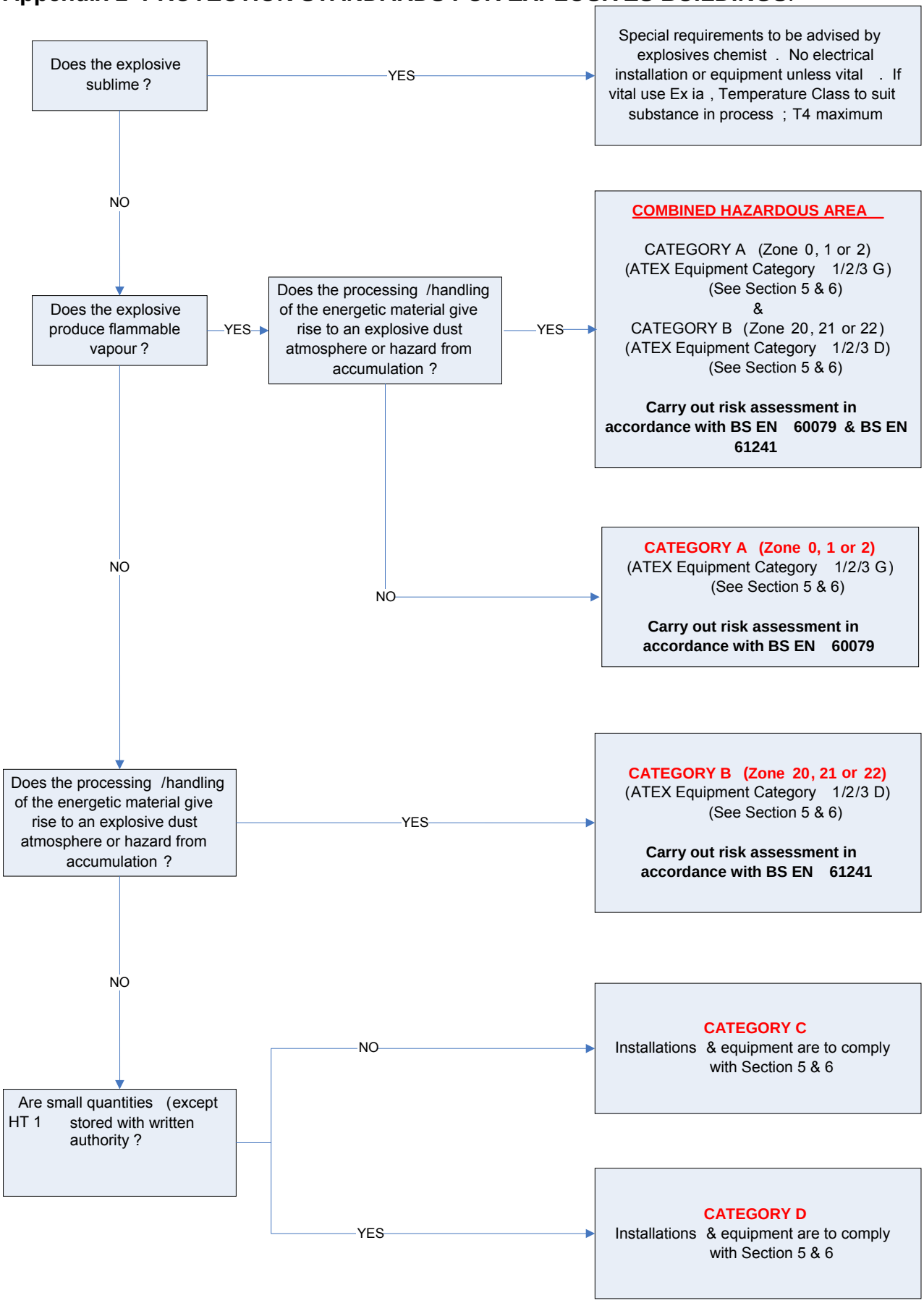
17.3 Equipment, (general purpose and dedicated) designed to the above principles should meet the safety requirements relevant to the category of explosives building and area, as defined in Section 5, for the safe measurement of resistance, continuity, isolation and levels of spurious alternating and direct voltages which may be induced in firing circuits incorporating the most sensitive EEDs. Similar principles must be applied to equipment for testing the performance of sub-systems that incorporate EEDs and explosives.

17.4 General electrical equipment for testing EEDs must comply with all EU Directives and be CE marked as an indication of compliance; specifically designed electrical equipment for testing must be to at least this standard. Test equipment should therefore meet the same EMC requirements and Standards as specified in Section 11.

17.5 For very sensitive EEDs and sub-systems and where the limits as defined in the above referenced Standards are considered insufficient then manufacturers of electrical test equipment should provide the results of testing or make provision for independent testing and evaluation.

***Note**: 'Appropriate Authority' being suitably qualified and experienced person or persons who can competently assess the suitability and compliance against Standards, for the electrical test equipment and the explosives hazards associated with its use.

Appendix 1 PROTECTION STANDARDS FOR EXPLOSIVES BUILDINGS.



Appendix 2 LEGISLATIVE REQUIREMENTS.

The aim of this section is to provide a general overview of the key health and safety requirements that apply to explosives manufacture. Many regulations has an associated Approved Code of Practice (ACOP) which have a special legal status in that if not followed; then the onus is on the company to demonstrate equally effective measures.

There is a considerable amount of health and safety legislation, which has a bearing on the manufacture and storage of explosives. The list below is the principal legislation dealing with activities relating to manufacture and storage of explosives:

A2.1 Manufacture and Storage of Explosives Regulations 2005 (MSER).

MSER requires that, with certain exceptions, explosives may only be manufactured in a facility licensed under the regulations**,** and only be kept at a licensed facility or premises registered under the regulations. All licenses and the conditions of registration of premises specify the locations where explosives may be stored and manufactured, and the maximum quantities and types of explosives, which may be present at each location. The regulations also require that any person who disposes of explosives shall ensure, so far as is reasonably practicable, that they are disposed of safely and that any person who decontaminates explosive-contaminated items shall ensure, so far as is reasonably practicable, that they are decontaminated safely.

The MSER ACOP paragraphs 66-73 also requires that all personnel working with explosives should have the necessary training and competence for the work they undertake.

A2.2 The Explosives Act 1875.

Most of the provisions of the EA 1875 have been repealed or amended. Details of most of the sections of the act that have been repealed or amended by MSER are detailed within schedule 5 to MSER 2005.

The most relevant of the remaining, albeit amended, provisions under the act are the requirements under Section 23 of the Act and the requirements under Order of Secretary of State 11 (3). Section 23 requires the occupier of every premises at which explosives are manufactured or stored to take all due precaution for preventing unauthorised persons having access to the premises or to the gunpowder therein. Order of Secretary of State 11 (3) requires persons not to deposit explosives in receptacles or places appropriated for refuse and states that explosives shall not to be handed or forwarded to persons or vehicles employed or appropriated for the removal or conveyance of refuse.

A2.3 Health and Safety at Work etc Act 1974 (HSWA).

This Act covers the health and safety of people through work activities. It has a number of objectives, primarily to secure the health, safety and welfare of persons at work. It applies to all persons at work irrespective of the work done or the premises where it is done.

Under Section 2, employers are required to ensure, so far as is reasonably practicable, the health and safety at work of their employees.

Duties placed on employers and the self-employed under Section 3 of HSWA are relevant to persons who are not employees, for example contractors. The Act also protects people other than those at work (i.e. the general public) against risks to their health and safety arising out of work activities.

The Act imposes duties on everyone concerned with work activities ranging from employers, employees, self-employed, manufacturers, designers, suppliers and importers, people in control of premises and even extends to members of the public.

A2.4 Classification and Labelling of Explosives Regulations 1983 (CLER)

CLER specifies that with certain exceptions, an explosive substance may not be imported or conveyed unless it has been classified by the UK competent Authority and it complies with specified labelling requirements. There is Health and Safety Executive guidance on these Regulations.

A2.5 Electricity at Work Regulations 1989

These regulations place duties on employers, the self-employed and employees and apply to all workplaces. In the context of this guide, their requirements will need to be complied with in relation to any item of electrical equipment, which forms part of the workplace.

Amongst the areas that the Regulations address, there are two that are especially important in relation to equipment in explosives working areas. Regulation 6 deals with adverse or hazardous environments, and requires inter alia that electrical equipment which may reasonably foreseeably be exposed to any flammable or explosive substance including dusts, vapours or gases shall be of such construction or, as necessary, protected to prevent, so far as is reasonably practicable, danger arising from such exposure.

Regulation 4 requires that electrical systems shall at all times be of such construction as to prevent danger.

Regulation 8 deals with earthing or other suitable precautions. There is general Health and Safety Guidance on these regulations.

Regulation 16 requires persons are to be competent to prevent danger and injury.

A2.6 Control of Explosives Regulations 1991 (COER).

These regulations include requirements that an explosives certificate issued by the chief officer of police is required to acquire or keep certain explosives, and that records of explosives possessed are to be maintained.

A2.7 Manual Handling Operations Regulations 1992 (MHOR).

The requirements of these Regulations need to be considered for any activity involving manual handling. There is Health and Safety Executive guidance on these Regulations. This includes tools for the conducting of manual handling risk assessments which are available at www.hse.gov.uk/msd/mac.

A2.8 Workplace (Health, Safety and Welfare) Regulations 1992.

The requirements of these regulations need to be met to ensure that workplace facilities meet certain standards. There is Health and Safety Executive guidance on these Regulations.

A2.9 Personal Protective Equipment at Work Regulations 2002.

MHSWR requires employers to identify and assess risks to health and safety in the workplace. The risks should then be reduced to an acceptable level by the most appropriate means. Engineering controls or safe systems of work should be considered

first in the hierarchy of controls. PPE should be regarded as the last resort to protect against risks. However given the nature of most disposal operations there is likely to be a requirement for some kind of PPE at some stage of the process.

When PPE is necessary, it only protects the person wearing it, theoretical maximum levels of protection are seldom achieved and PPE often restricts the wearer by limiting mobility or visibility. It is therefore essential that appropriate PPE and training in its use is provided when there is a risk to health and safety that cannot be adequately controlled by other means.

The regulations place requirements on employers to provide PPE that is suitable for the purpose, which is maintained or replaced as necessary, which is provided with suitable accommodation when not in use and that suitable information, instruction and training is given in its use.

The regulations also place duties on employees to make full and proper use of PPE when it is provided. Employees also have a duty to report any loss or defect.

Further guidance on the use of PPE in an explosives environment can be found in Fire Protective Clothing, CBI EIG Guide, ISBN 0852015135 and Head and Eye Protection, CBI EIG Guide.

A2.10 Placing on the Market and Supervision of Transfers of Explosives Regulations 1993 (POMSTER).

These regulations include requirements for certain explosives to undergo testing and meet certain essential safety requirements before they are placed on the market. They also require that certain security controls be complied with.

A2.11 Provision and Use of Work Equipment Regulations 1998 (PUWER 98)

PUWER 98 applies to the provision and use of all work equipment, including mobile and lifting equipment, and to all workplaces and work situations where HSWA applies.

The Regulations define work equipment as “any machinery, appliance, apparatus, tool or installation for use at work (whether exclusively or not)”.

Regulation 4 deals with the suitability of work equipment. In Regulation 5 there is a requirement that work equipment is maintained in an efficient state, in efficient working order, and in good repair. Regulation 6 deals with inspection, including inspection of equipment after installation or reinstallation, before it is put into service and inspection of equipment such as complex automated equipment where the safe operation is critically dependent on its condition in use and deterioration would lead to a significant risk to the operator or other worker. This Regulation also requires that a record of the latest inspection is kept until the next inspection has been recorded.

Regulation 7 addresses cases where the use of work equipment is likely to involve a specific risk to health or safety. In such cases, this Regulation requires that equipment is only allowed to be used by those whose task it is to use it, and that repairs, modifications etc shall only be carried out by a specifically designated person (who could also be the operator of the equipment). Regulation 8 deals with information and instruction and Regulation 9 with training. Regulation 10 covers the conformity of work equipment with legislation, which brings into effect the requirements of EC Directives on product safety, such as the Supply of Machinery (Safety) Regulations 1992 as amended.

Regulations 11 to 24 of PUWER 98 deal with the physical aspects of work equipment. They cover for example, the guarding of dangerous parts of work equipment, the provision of appropriate controls and suitable warning markings or devices.

There is an approved code of practice and guidance for PUWER 98.

A2.12 Lifting Operations and Lifting Equipment Regulations 1998 (LOLER)

Although PUWER 98 applies to all lifting equipment, LOLER applies over and above the general requirements of PUWER 98 with regard to specific hazards and risks associated with lifting equipment and lifting operations. There is an approved code of practice and guidance for these regulations.

A2.13 Management of Health and Safety at Work Regulations 1999 (MHSWR)

An important requirement of these regulations is for an employer to make a suitable and sufficient assessment of the risks to the health and safety of employees and other persons arising from the employer's undertaking in order to identify the measures the employer needs to take to comply with health and safety legislation. Similar duties are placed on the self-employed. These regulations also (in Schedule 1) lay down a set of principles to be followed in identifying the appropriate protective measures to control the risks identified by the risk assessment. There is an approved code of practice and guidance for these regulations.

A2.14 Control of Major Accident Hazards (Amendment) Regulations 2005 (COMAH)

These regulations apply to any establishment, which has, or anticipates having, any substance specified in Schedule 1 to COMAH above the qualifying quantity. The qualifying quantities of explosives for the application of COMAH are such that currently there are relatively few sites licensed under the Manufacture and Storage of Explosives Regulations 2005 which are subject to COMAH. At establishments where COMAH does apply, advice in the guide will be relevant to various aspects of the general duty under the regulations for the operator of the establishment to take all measures necessary to prevent major accidents and limit their consequences to people and the environment. It should be emphasised however that the protection of the environment per se is out with the scope of this publication. There is Health and Safety Guidance on these regulations.

A2.15 Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR)

These regulations apply to all dangerous substances at nearly every business in Great Britain. They set minimum requirements for the protection of workers from fire, explosion and similar (energy releasing) events, which are caused by dangerous substances and potentially explosive atmospheres. The regulations are complementary to the general duty to manage risks under the Management of Health and Safety at Work Regulations 1999.

The main requirements are that employers and the self-employed must:

- Carry out a risk assessment of work activities involving dangerous substances
- Provide technical and organisational measures to eliminate or reduce as far as is reasonably practicable the identified risks
- Provide equipment and procedures to deal with accidents and emergencies
- Provide information and training to employees

- Classify places where explosive atmospheres may occur into zones, and mark the zones where necessary.

There are approved codes of practice for these Regulations.

A2.16 Chemicals (Hazard Information and Packaging for Supply Regulations) 2002 (CHIP 3)

CHIP 3 applies to suppliers of dangerous chemicals. Its purpose is to protect people and the environment from the effects of these chemicals by requiring suppliers to give information and to package them safely. The idea is that when people know about the dangers of a chemical, and what they can do to avoid them, they will be less likely to harm themselves, others or the environment.

CHIP applies to most chemicals. The exceptions, which are identified in regulation 3(1), are specialised chemicals such as cosmetics, medicines, wastes and several others all of which are covered by other regulations.

It is a fundamental requirement for suppliers to decide, using a set of rules, whether a chemical is dangerous or not. If the supplier decides that the chemical is dangerous (i.e. ‘classified’) then a number of further requirements are triggered.

HSE is of the view that any finished and closed munitions or other explosive articles (which have no exposed explosive composition) should be generically considered complete articles, rather than substances or preparations, and, therefore, are outside the scope of the current CHIP regulations. If work causes composition to become exposed as part of an action by users etc. then there will be duties under the HSWA to provide necessary information for ensuring health and safety with respect to any chemical hazard.

There is an Approved Code of Practice and further guidance for these Regulations.

A2.17 Construction (Design and Management) Regulations 2007

The construction industry covers a wide range of activities, hazards, materials, techniques, employment patterns and contractual arrangements. In these circumstances, good management of construction projects from concept through to demolition is essential to maintain health and safety standards.

CDM is intended to protect the health and safety of people working in construction, and others who may be affected by their activities. The Regulations require the systematic management of projects from concept to completion: hazards must be identified and eliminated where possible, and the remaining risks reduced and controlled. This approach reduces risks during construction work and throughout the life cycle of a structure (including eventual demolition).

There is Health and Safety Executive guidance on these regulations.

A2.18. Fire Precautions (Workplace) Regulations 1997 (as amended 1999/2003)

These regulations make requirements for fire fighting, fire detection, emergency routes and exists, maintenance of the workplace and safety devices, risk assessment, health & safety arrangements, health & safety assistance, information for employees, coordination and co-operation and persons working in host employers' undertakings.

A2.19. Regulatory Reform (Fire Safety) Order 2005

Fire safety within the UK is currently undergoing a major change. The Regulatory Reform (Fire Safety) Order is set to change the emphasis from fire certification to the fire risk assessment goal-based principle and self-regulation.

The aim is to create one fire safety regime that applies to all workplaces and other non-domestic premises. The current system of fire safety in the UK involves over 100 pieces of fire legislation.

The RRO will be risk assessment based with responsibility for fire safety of occupants of a building, and those who may be affected by a fire, resting on the responsible person. (The employer).

The Fire Precautions (Workplace) Regulations 1997 (as amended) and the Dangerous Substances and Explosive Atmosphere Regulations 2002 are the basis for the Fire Safety Order.

Fire authorities will continue to inspect premises and enforce the regulations. The HSE will continue to be the enforcing authority for fire safety where they license explosives factories and magazines.

APPENDIX 3 SUPPLEMENTARY INFORMATION CONCERNING HAZARDS FROM EXPLOSIVES

A3.1 High Explosives In recent years, UK licences for explosives factories and magazines have referred to HTs and not the UN HDs where the classification is assigned to explosives which are packaged for transport according to the UN Recommendations. The nature of packaging (or lack of it), the quantity and arrangement in storage can have a significant affect on the hazard presented in non-transport situations. HTs have been defined in the terms of the licence by descriptions similar to those for the UN HDs employed in the classification of explosives (see Table below).

Hazard Type 1	**An explosive which has a mass explosion hazard. (*a mass explosion is one in which the entire body of explosives explodes as one);***
Hazard Type 2	**An explosive which has a serious projectile hazard but does not have a mass explosion hazard;**
Hazard Type 3	**An explosive which has a fire hazard and either a minor blast hazard or a minor projection hazard, or both, but does not have a mass explosion hazard (i.e. *those explosives which give rise to considerable radiant heat or which burn to produce a minor blast or projection hazard);***
Hazard Type 4	**An explosive which has a fire or slight explosion hazard, or both, with only local effect (i.e. *those explosives which present only a low hazard in the event of ignition or initiation, where no significant blast or projection of fragments of appreciable size or range is expected*).**

Table 9 Description of Hazard Type

A3.2 Determining Hazard Type For those explosives being kept as packaged for carriage, and that have been classified, there will generally be a direct correlation between the UN Hazard Division assigned them on classification for transport and the Hazard Type they should be allocated for manufacture and storage, i.e.:

UN HD 1.1 = HT1

UN HD 1.2 = HT2

UN HD 1.3 = HT3

UN HD 1.4 = HT4

NOTE: Any explosives classified in the hazard divisions UN HD 1.5 and UN HD 1.6 need to be assessed on a case by case basis to assign the appropriate hazard type.

A3.3 However, the classification is assigned to the explosives as they are packaged for transport according to the UN Recommendations, and the nature of packaging (or lack of it, and the quantity and arrangement in storage) can have a significant effect on the hazard presented in non-transport situations. Therefore an assessment must be made of the hazards presented by explosives throughout the course of their manufacture, storage and handling to ensure that the correct Hazard Type is used under all conditions.

A3.4 This assessment may require tests and trials to be undertaken to determine how an explosive behaves in particular circumstances, and the hazard type may vary as conditions change. For example:

(a) propellants classified as UN HD 1.3 would under normal circumstances be regarded as Hazard Type 3. However, under specific circumstances these propellants can be Hazard Type 1. Such circumstances include confinement during processing at elevated pressure and/or temperature, and the critical diameter and bed depth of the material. Examples of where these circumstances may occur are:

(i) within an extrusion press (where the critical considerations are critical diameter, confinement, pressure and, with certain pressing operations, elevated temperature; and
(ii) within a hopper in a cartridge-filling operation (where the critical considerations are propellant depth and confinement);

(b) some detonators classified as UN Hazard Division 1.4 for transport can also present an HT1 hazard when outside their packaging and stored together. Other explosives and explosive articles can present a change of hazard type depending upon on the packaging used.

A3.5 It is good practice to keep the amount of explosives in boxes or other containers to the minimum practicable and to make arrangements to prevent propagation from one box or some other container to another. For example, an explosion in a box where a large number of percussion caps are kept loose will result in the explosion of the majority of the caps in the box. However, if the same caps are kept in trays where they are separated from one another, the initiation of one cap will not result in the initiation of the rest of them.

A3.6 The principal explosion hazards associated with HT1 explosives result from blast waves and fragments that may arise from any container or adjacent structure. A full quantification of these effects is outside the scope of this document, but some indication of the potential involved is given by considering the effects of explosions of small quantities of high explosives inside a small single storey (6m x 6m) building:-

1g of Explosive:

- any person holding the explosive could receive serious injury.

10g of Explosive:

- any person close to this quantity of explosive at the time of initiation would receive very serious injuries. 1% of persons at a distance of 1.5 metres away are also liable to ear-drum rupture.

100g of Explosive:

- 50% of windows in room likely to be blown out.
- 1 % ear-drum rupture at distance of 3.5m.
- 50% ear-drum rupture at distance of 1.5m.
- persons in very close proximity to explosion (e.g. holding the explosive) almost certainly killed.

500g of Explosive:

- complete structural collapse of brick-built building is most likely.
- steel or concrete framed building would probably survive.
- persons very close to blast almost certainly killed.
- persons close to blast will be seriously injured by lung and hearing damage, fragmentation effects, and from being thrown bodily.
- almost all persons within the room will sustain perforated ear-drums.

A3.7 Pyrotechnics

The burning characteristics of pyrotechnic substances generally range from slow to very violent burning. Under certain conditions some high energy pyrotechnic substances can detonate. Specific legislation controlling the manufacture of pyrotechnics requires individual manufacturers to assign their pyrotechnic compositions, semi-finished products and finished articles into five groups according to their sensitiveness and burning characteristics. At the slow burning end of the range, Group 5, the compositions burn slowly and articles either burn or explode singly. At the opposite end, Group 1, the compositions burn very violently and even without confinement small quantities can explode. Also they are mechanically and thermally very sensitive and Group 1 articles are capable of mass explosion. Examples of both composition and article assignments are as follows:-

GROUP 1:

Compositions: (burn very violently)
Chlorate and metal perchlorate report or whistling compositions.
Dry non-gelatinised cellulose nitrates.
Barium peroxide/Zirconium compositions.

Articles: (mass explosion risk)
Flash shells (maroons).
Casings containing flash compositions.
Sealed hail preventing rockets.

GROUP 2:

Compositions: (burn violently)
Nitrate/metal/sulphur compositions.
Compositions with >65% chlorate.
Black powder.
Nitrate/boron compositions.

Articles: (accelerating single-item explosions)
Large firework shells.
Fuse unprotected signal flares.
Non-pressed report bullets (bird scarer).
Report cartridges, unpacked.
Black matches, uncovered.

GROUP 3:

Compositions: (burn fast)
Nitrate/Metal compositions without sulphur.
Compositions with up to 35-65% chlorate.
Compositions with black powder.
Lead oxide/silicon with >60% lead oxides.
Perchlorate/metal compositions other than report.

Articles: (burn very violently with single-item explosions)
Large firework shells.
Fuse protected signal flares.
Pressed report cartridges in primary packaging.
Quick matches in transport packaging.
Waterfalls; Silver wheels; Volcanoes.
Black powder delays.

GROUP 4:

Compositions: (low/medium speed burning)
Coloured smoke compositions.
White smoke compositions (except those in Group 5)
Compositions with <35% chlorate.
Thermite compositions.
Aluminium/phosphorous pesticide compositions.

Articles: (single-item ignitions/explosions)
Large firework shells without flash compositions in transport packaging.
Signal ammunition without flash compositions, up to 40g of composition.
Small fireworks, fuse protected (except volcanoes and silver wheels).

GROUP 5:

Compositions: (burn slowly)
Slow burning heating compositions.
White smoke compositions based on hexachloroethane with zinc, zinc oxide and <5% of aluminium, or <10% of calcium silicon.

Articles: (slow single-item ignitions/explosions)
Small fireworks in primary packaging.
Signal ammunition in transport packaging.
Delays without black powder.
Coloured smoke devices.
Sealed table bombs.
White smoke devices unpacked (see Group 5 composition).

A3.8 For each type of processing or storage activity, and for each type of pyrotechnic, specific regulations prescribe how the pyrotechnic should be handled, including maximum quantity per room and number of occupants. The greatest restrictions are placed upon Group 1 explosives and articles. To reproduce here lists of groupings for specific formulations and articles, together with the corresponding restrictions that apply in Germany, would occupy several pages and probably not accord completely with UK products. The examples given here of the groupings are useful though both in demonstrating the vast range in burning behaviour of these materials, and an indication of the likely behaviour of generic types.

A3.9 It is important to understand the possible behaviour of small quantities of pyrotechnic substances or a single article, and the possible effects of self-confinement. Bundles of pyrotechnic articles (e.g. fireworks) may burn much more vigorously and even violently (with sufficient numbers of items) than single items. If any doubts exist about the way a particular substance will behave, in the quantities and configuration that it is intended to work, it will be necessary to either use a remote manufacturing facility, or arrange for full-scale remote trials to be conducted to demonstrate “safe” behaviour.

A3.10 An estimate of the size of fireball from a “fast” burning pyrotechnic, high explosive or propellant is given by the expression:

$$D=3.77Q^{1/3}$$

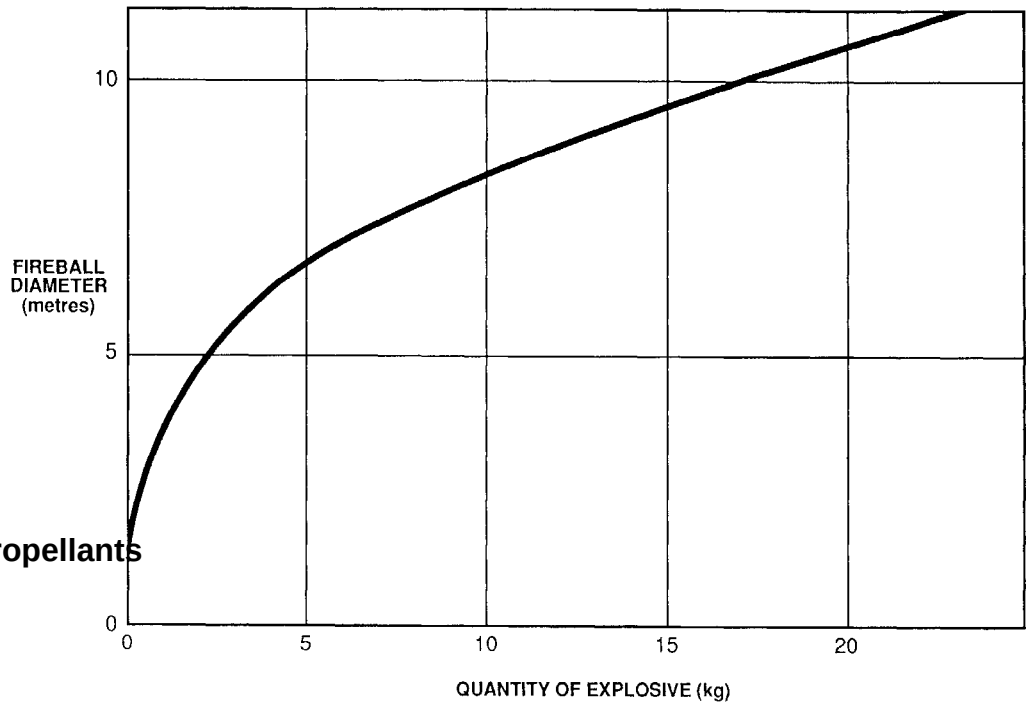
D is diameter of fireball in metres.
Q is weight of substance in kilograms.

A3.11 Thus 2kg of pyrotechnic composition might be expected to give a fireball of diameter 5m. A graph showing quantity (kg) of explosive versus fireball diameter (m) is given below.

A3.12 Persons engulfed within a fireball and not wearing fire resistant protective clothing are likely to receive very serious bums. Persons in close proximity to the fireball are also vulnerable, depending upon size and duration of the event. Methodologies are available for estimating likely burn injuries.

A3.13 The potential hazards from propellants are generally very similar to those from pyrotechnics, i.e. vigorous burning and fireball effects are typical; - see previous paragraph for fireball diameter estimates. Confinement, however, has the effect of increasing the burning velocity of propellant materials and with sufficient confinement, detonation occurs on initiation. Situations in practice that might encourage this transition from burning to detonation might be where propellant is processed in relatively large quantities and in equipment which provides significant confinement.

FIGURE 4 Diameter of fireball versus quantity of explosive



Propellants

ABBREVIATIONS

CDM	Construction (Design and Management) Regulations
COMAH	Control of Major Accident Hazards Regulations
DSEAR	Dangerous Substances and Explosive Atmospheres Regulations
EA 1875	Explosives Act
HSWA	Health and Safety at Work etc Act
MHSWR	Management of Health and Safety at Work Regulations
MSER	Manufacture and Storage of Explosives Regulations
PUWER	Provision and Use of Work Equipment Regulations

a.c.	Alternating Current
AFT	All Fire Threshold
ATEX	Explosive Atmosphere
BS EN	British Standards European Norm
CB	Citizen Band
CBI	Confederation of British Industry
CE	Conformite Europeene
dB	Decibel
d.c.	Direct Current
EED	Electro-Explosive Device
EIG	Explosives Industry Group
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
ESQCR	Electricity Safety, Quality and Continuity Regulations
ESTC	Explosives Storage and Transport Committee
EU	European Union
HD	Hazard Division
HSE	Health and Safety Executive
HT	Hazard Type
IExpE	Institute of Explosives Engineers
IP	Ingress Protection
ISO	International Standards Organisation
kg	Kilogram
LABSET	Laboratory Scale Explosiveness Test
LPS	Lightning Protection System
MHE	Mechanical Handling Equipment
MIMC	Mineral Insulated Metal Covered
mm	Millimetre
MoD	Ministry of Defence
NFT	No Fire Threshold
OB	Ordnance Board
PAT	Portable Appliance Test
PPE	Personal Protection Equipment
PTFE	Polytetrafluoroethylene
PVC	Polyvinyl Chloride
QD	Quantity Distance / Separation Distance
RCD	Residual Current Device

RF	Radio Frequency
RMS	Root Mean Square
RRO	Regulatory Reform Order
SELV	Separated Extra Low voltage
TN-S	Terre Neutral Separate
UN	United Nations

REFERENCES

1	BS 638:Part 4: 1996	Arc welding power sources, equipment and accessories: Specification for welding cable.
2	BS 921:1976	Rubber mats for electrical purposes.
3	BS 2050:1978	Replaced by BS ISO 2878: 2005.
4	BS 2782-0:2004	Methods of testing plastics.
5	BS 2782:Part 1: Method 140A:1992	Determination of the burning behaviour of horizontal and vertical specimens in contact with a small flame ignition source.
6	BS 4293	Replaced by BS EN 61008-1:2004 and BS EN 61009-1:2004 Specification for residual current-operated circuit-breakers.
7	BS 4343:1992	Replaced by BS EN 60309-2: 1992.
8	BS 4444:1989	Guide to electrical earth monitoring and protective conductor proving.
9	BS 4533–102.51: 1986	Luminaires. Particular requirements. Specification for luminaires with type of protection N. Specification withdrawn.
10	BS 4568-1:1970	Specification for steel conduit and fittings with metric threads of ISO form for electrical installations. Steel conduit, bends and couplers.
11	BS 4607:1984	Non-metallic conduits and fittings for electrical installations (Four parts).
12	BS 5345:Part 1	Replaced by BS EN 60079-14:1997.
13	BS 5501:Part 1	Replaced by BS EN 60079-0: 2006.
14	BS 5958: Part 1 1991	Code of practice for control of undesirable static electricity: General considerations. BS 5958: Part 2: 1991 Control of undesirable static electricity: Recommendations for particular industrial situations. Replaced by PD CLC/TR 50404.
15	BS 6004:2000	Specification for PVC-insulated cables (non-armoured) for electric power and lighting.
16	BS 6007:2006	Electric cables. Single core unsheathed heat resisting cables for voltages up to and including 450/750 V, for internal wiring.
17	BS 6467:Part 1	Replaced by BS EN 60079-17: 2007.
18	BS 6467:Part 2	Replaced by BS EN 60079-17: 2007.
19	BS 6500:2000	Specification for insulated flexible cords and cables.
20	BS 6651	Replaced by BS EN 62305-1:2006.
21	BS 6656	Replaced by PD CLC/TR 50427:2004.
22	BS 6657	Replaced by PD CLC/TR 50426:2004.
23	BS 6941	Replaced by BS EN 60079-15:2005.
24	BS 7211:1998	Electric cables. Thermosetting insulated, non-armoured cables for voltages up to and including 450/750 V, for electric power, lighting and internal wiring, and having low emission of smoke and corrosive gases when affected by fire.
25	BS 7430:1998	Code of practice for earthing.
26	BS 7671:2008	Requirements for electrical installations IEE Wiring Regulations 17th edition.

27	BS 7697:1993	Nominal voltages for low voltage public electricity supply systems.
28	BS 7889:1997	Electric cables. Thermosetting insulated, unarmoured cables for a voltage of 600/1000 V.
29	BS EN 1127-1: 1998	Explosive atmospheres – Explosion prevention and protection – basic concepts and methodology.
30	BS EN 1175 -3: 1998	(3 parts) Safety of industrial trucks- Electrical requirements.
31	BS EN 1755:2000	Safety of industrial trucks. Operation in potentially explosive atmospheres. Use in flammable gas, vapour, mist and dust.
32	BS EN 1834–1: 2000	Reciprocating internal combustion engines - Safety requirements for design and construction of engines for use in potentially explosive atmospheres - Part 1: Group II engines for use in flammable dust atmospheres.
33	BS EN 12895: 2000	Industrial trucks. Electromagnetic compatibility.
34	BS EN 13463-1: 2001	Non-electrical equipment for potentially explosive atmospheres. Basic method and requirements.
35	BS EN 50014	Replaced by BS EN 60079-0:2006.
36	BS EN 50160: 2007	Voltage characteristics of electricity supplied by public distribution networks.
37	BS EN 60079-0: 2006	Electrical apparatus for explosive gas atmospheres. General requirements.
38	BS EN 60079-14:2003	Electrical apparatus for explosive gas atmospheres. Electrical installations in hazardous areas.
39	BS EN 60079-15: 2005	Electrical apparatus for explosive gas atmospheres. Construction, test and marking of type of protection "n" electrical apparatus.
40	BS EN 60079-17: 2007	Explosive atmospheres. Electrical installations inspection and maintenance.
41	BS EN 60309-2: 1999	Plugs, socket-outlets and couplers for industrial purposes. Dimensional interchangeability requirements for pin and contact-tube accessories.
42	BS EN 60417	Specification withdrawn.
43	BS EN 60529: 1992	Specification for degrees of protection provided by enclosures (IP code).
44	BS EN 61000: 2007	Electromagnetic compatibility (EMC).
45	BS EN 61008-1: 2004	Residual current operated circuit-breakers without integral overcurrent protection for household and similar used (RCCBs)
46	BS EN 61009-1: 2004	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs)
47	BS EN 61241-0:	Electrical apparatus for use in the presence of combustible dust.

	2006	General requirements.
48	BS EN 61241-14: 2004	Electrical apparatus for use in the presence of combustible dust. Selection and installation.
49	BS EN 61242: 1998	Electrical accessories. Cable reels for household and similar purposes.
50	BS EN 61386: 2008	Conduit systems for cable management. General requirements.
51	BS EN 61508: 2002 (Part 1-7)	Functional safety of electrical/electronic/programmable electronic safety-related systems.
52	BS EN 61588: 2005	Safety of power transformers, power supplies, reactors and similar products. General requirements and tests.
53	BS EN 62035: 2000	Discharge lamps (excluding fluorescent lamps). Safety specifications.
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