



Defence
Safety Authority

DSA 03.OME Part 2 (JSP 482) - Defence Code of Practice (DCOP) and Guidance Notes for In-Service and Operational Safety Management of OME

Defence OME Safety Regulator

DOSR



DSA VISION

Protecting Defence personnel and operational capability through effective and independent HS&EP regulation, assurance, enforcement and investigation.

PREFACE

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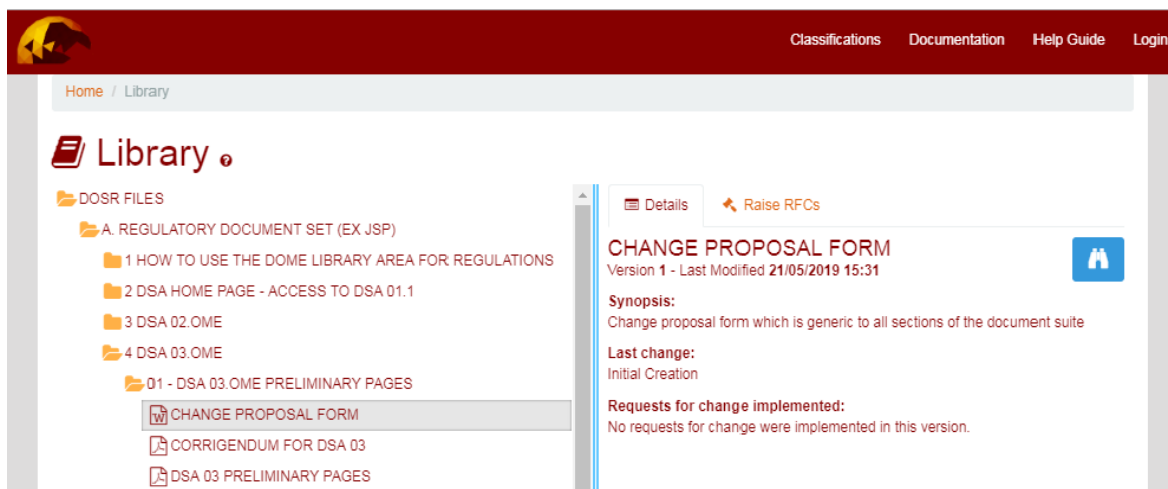


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1. INTRODUCTION

1.1 Scope of Regulations

1.1.1 This Chapter prescribes the regulatory requirements and standards for electrical installations, lightning protection, electrostatic protection and electrical/electronic equipment in above ground and underground sites containing or likely to contain Military Explosives. These sites cover storage, processing and handling buildings and facilities, including airfields.

1.1.2 These regulations do not apply to administrative buildings, workshops or other buildings including non-occupied buildings that do not contain Military Explosives but are nevertheless within an explosives area. The electrical installation and equipment used in such buildings are to comply with statutory requirements and specifications to ensure that they do not endanger explosives facilities.

1.1.3 These regulations are to be read in conjunction with relevant National Regulations, International Standards, British and European Standards and Codes of Practice which are listed at Annex A. This is not an exhaustive list and additional regulations and standards may be required to prove compliance with these regulations and the Health & Safety at Work Act. Attention is drawn specifically to: The Requirements for Electrical installations 'BS 7671 (the Institution of Engineering and Technology (IET) Wiring Regulations)), Electricity at Work Regulations (EWR), the Provision and Use of Work Equipment Regulations (PUWER) and the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) and the Management of Health and Safety at Work Regulations 1999.

1.1.4 MoD Sponsors of Facilities Management (FM) Contractors are reminded of their responsibility to pass this document, along with all associated documents to FM Contractors.

1.1.5 The precautions contained within this chapter are applicable to all personnel who handle and process Ordnance, Munitions and Explosives (OME). If these conditions are not observed, personnel may be at risk from accidental explosion.

1.2 New Buildings and Refurbishments, Responsibilities and Approvals

1.2.1 Duty Holders who have responsibility for new builds, refurbishment or modification programmes, shall comply with the requirements of JSP482 Chapter 5 (Planning and Siting of Explosives Facilities and Alterations to Existing Facilities). A key requirement of that Chapter is that the required electrical category¹ for the explosives licensed building shall be determined in accordance with the flow chart in Fig 1 of this Chapter. This shall be notified to the relevant Inspector of Explosives (IE) and the electrical installation, including equipment installed within the facility shall comply with the requirements of this Chapter with regards to its electrical category.

1.2.2 All MoD Explosives sites with Cat A or Cat B facilities and facilities with DSEAR² zones, as defined in Section 2 shall ensure that at least one member of MoD staff is competent in the requirements of DSEAR. On sites where this is not practical, access to a competent person shall be made available. This person shall be responsible for ensuring that area classification, selection of equipment, Explosion Protection Document³ upkeep, and correct maintenance standards for electrical systems within the explosive licensed area are performed. This is to be achieved through consultation with respective IE staffs.

¹ See Section 2 for details of explosives buildings categories and corresponding electrical equipment.

² Dangerous Substances and Explosive Atmospheres Regulations 2002 (SI 2002/2776).

³ ATEX-Directive 1999/92/EC mandates that an Explosion Protection Document shall be maintained for places of work where flammable dusts, vapours and mists may be present. For details see Para 2.5.

1.3 Project Teams (PTs) Duty of Care

1.3.1 PTs supplying equipment/systems to be fitted or used in explosives facilities are to ensure that such equipment complies with these regulations for the electrical category of the building, as well as associated National Regulations. Failure to comply with this requirement could result in the equipment being prohibited for use within an explosives environment.

1.3.2 In addition PTs are responsible for specifying the requirements for the type of controlled environment (e.g. electrostatic protected area (EPA)) to be employed and identifying the precise point(s) during handling/processing when the specific environment(s) is/are to be applied to explosives substances and articles for which they are responsible.

1.4 Maintenance Staff Duty of Care

1.4.1 The requirements of this Chapter are equally applicable to maintenance contractors and MoD staff responsible for maintenance of licensed explosives facilities. Such personnel shall ensure that maintenance, designs and installation replacements or modifications fully comply with this Chapter.

1.4.2 Maintenance contractors and their equipment shall be controlled in accordance with JSP482 Chapter 18 and Section 18 of this Chapter.

1.5 Non-Compliance of Infrastructure

1.5.1 Where shortfalls against this Chapter exist which relate specifically to the licensing of explosives buildings, e.g. electrical installation, lightning protection system (LPS), electrostatic protected areas (EPA), test and inspection etc., the Duty Holder eg HoE, is directed to Chapter 9 in the first instance and shall notify the relevant IE.

1.5.2 Where shortfalls against this Chapter relate to other areas, not specifically related to licensing the HoE is directed to refer to JSP482 Chapter 1.

1.6 Maintenance Periodicity

1.6.1 In accordance with Chapter 3, facilities, equipment and plant that are unserviceable or overdue for statutory or MoD Mandatory test are not to be used and unauthorised use shall be prevented.

1.7 Approvals of Electrical Equipment

1.7.1 Electrical equipment which is to be taken into an explosives facility for purposes related to the storage or processing of explosives shall be formally assessed against the requirements of this Chapter by a competent person. Evidence of compliance shall be kept within the Potential Explosion Site (PES) logbook. Where the required equipment is essential but is not deemed to fully comply with this Chapter and an alternative compliant version is not available the IE shall be contacted to arrange assessment by a competent person. Form 2256 (Annex H) may be used capture the relevant information for the assessment. Where risks can be mitigated to as low as is reasonably practical (ALARP) as described in JSP482 Chapter 1 the equipment may be approved. Such approvals should detail any caveats or controls which are required to maintain OME safety and this shall be logged within the PES logbook and copied to the relevant IE.

1.7.2 Fixed electrical equipment is to have its EMC formally assessed, to ensure that it complies with Paragraph 6.6 of this Chapter in order to confirm that it does not pose a risk to other installed equipment and OME under test.

1.8 Retrospective Action

1.8.1 It is not intended that works services action should always be undertaken immediately to modify existing installations to achieve conformance with any amendments to this Chapter. Neither is it normally necessary to carry out surveys to establish the extent to which existing installations fail to meet the latest standards.

1.8.2 Such work and surveys should only be considered when they are necessary and arise for other reasons. For example:

- (1) When there has been a change to UK or EU electro-technical legislation which has a direct or indirect impact to the safety adopted at the installation which is intolerable and requires retrospective action.
- (2) When CIE MOD directs improvements on safety grounds.
- (3) When building refurbishment or modification is being carried out.
- (4) When the installation fails to pass the periodic inspection or test and it is more economic to replace all or part of the installation than to rectify the defects.
- (5) When the installation is inadequate for meeting the purpose for which the building is being used due to insufficient power capacity or illumination levels.
- (6) When the installation has reached the end of its economic life.
- (7) Where it has been highlighted through a near miss or realised event.

1.8.3 Provided installations pass periodic inspections and tests and comply with the version of this document or regulations that were in force at the time of installation, it is considered that they are adequate for continued use and not unsafe. However, any extensive work on the electrical system or Lightning Protection System (LPS) should warrant an upgrade to the latest standard.

1.8.4 Any such work carried out on a PES shall require a Siting Board, as per JSP482 Chapter 5, to ensure that all relevant parties, including the appropriate Technical Advisors have the opportunity to express their concerns/opinions.

1.9 Small Quantities of Explosives for Research And Development

1.9.1 Research and Development sites may, out of necessity, have to perform processes that involve small quantities of explosive and potentially explosive substances. The nature of these processes may make it impracticable to comply fully with the requirements of this Chapter⁴.

1.9.2 In such cases it is often impractical to assign an electrical category to these facilities covering the entire room or work area as much of the associated laboratory equipment is not available to explosives category standards. In such circumstances a risk assessment should be made of the processes undertaken and local explosive category zoning implemented by a competent person. These areas should then be kept clear of unnecessary electrical equipment, lighting and sockets unless it meets

⁴ See Section 2 (Electrical Categories and Standards of Building, Areas, Installations and Equipment)

explosive category requirements or is subject to a local approved safety management arrangement. If processing gives rise to flammable atmospheres (vapours, mists, dusts etc.) the requirements of DSEAR shall be invoked. Refer to Paragraph 2 for further information.

1.9.3 Where it can be demonstrated to the IE that suitable and sufficient the necessary Hazard Surveys and Risk Assessments have been completed, and that controls and procedures are in place to minimise the risks as required by law⁵, and appropriate measures are in place to prevent and limit the spread of fire and explosion⁶, then the IE can detail a lesser electrical standard to be applied. Equally, the IE can withdraw these exemptions (in total or in part) at any time and require that full the standards shall be applied in full.

2. ELECTRICAL CATEGORIES AND STANDARDS OF EXPLOSIVES BUILDINGS, AREAS, INSTALLATIONS AND EQUIPMENT

2.1 Introduction

2.1.1 The standard of electrical installations and equipment in explosives buildings is determined according to the explosive hazard which is likely to be encountered, such as the quantity and nature of the explosives present and the atmospheres that may occur during the processes undertaken.

2.1.2 There are 4 broad standards or categories of electrical installation which are defined within this Chapter and these are denoted by the following letters, A, B, C and D, which are selected based on the algorithm of Fig 1 – Electrical Category Selection Algorithm.

2.1.3 When specifying the type of installation to be provided it is prudent to consider all aspects:

- (1) The possibility of any change of use that may require a different classification.
- (2) Special compatibility problems associated with substances other than explosives e.g. liquid fuels, special cleaning materials and processes that may splash water onto electrical systems.

2.1.4 Special considerations are necessary when explosives are liable to sublime⁷. Electrical equipment shall in this case not be installed in the building unless it is absolutely essential. In circumstances where they are necessary suitable standards shall be specified in conjunction with the explosives chemist who will need to advise on the properties of the explosive in the process.

2.2 Signage

2.2.1 The Electrical Category of an area or building shall be displayed adjacent to the entrance; example templates for the signage can be found at Annex G.

2.2.2 Where more than one Category exists, this shall be indicated on the sign fixed at the entrance to the facility.

⁵ Required by the Management of Health and Safety at Work Regulations (MHSWR) 1999.

⁶ Manufacture and Storage of Explosives Regulations (MSER), Regulation 4.

⁷ Certain explosives natures change directly from a solid to a vapour state when heated and on cooling reform to a "sublimate". The sublimate may form on any cool surface.

2.2.3 A diagram indicating the different Zones/Categories is to be fixed to the facility notice board (See Annex G).

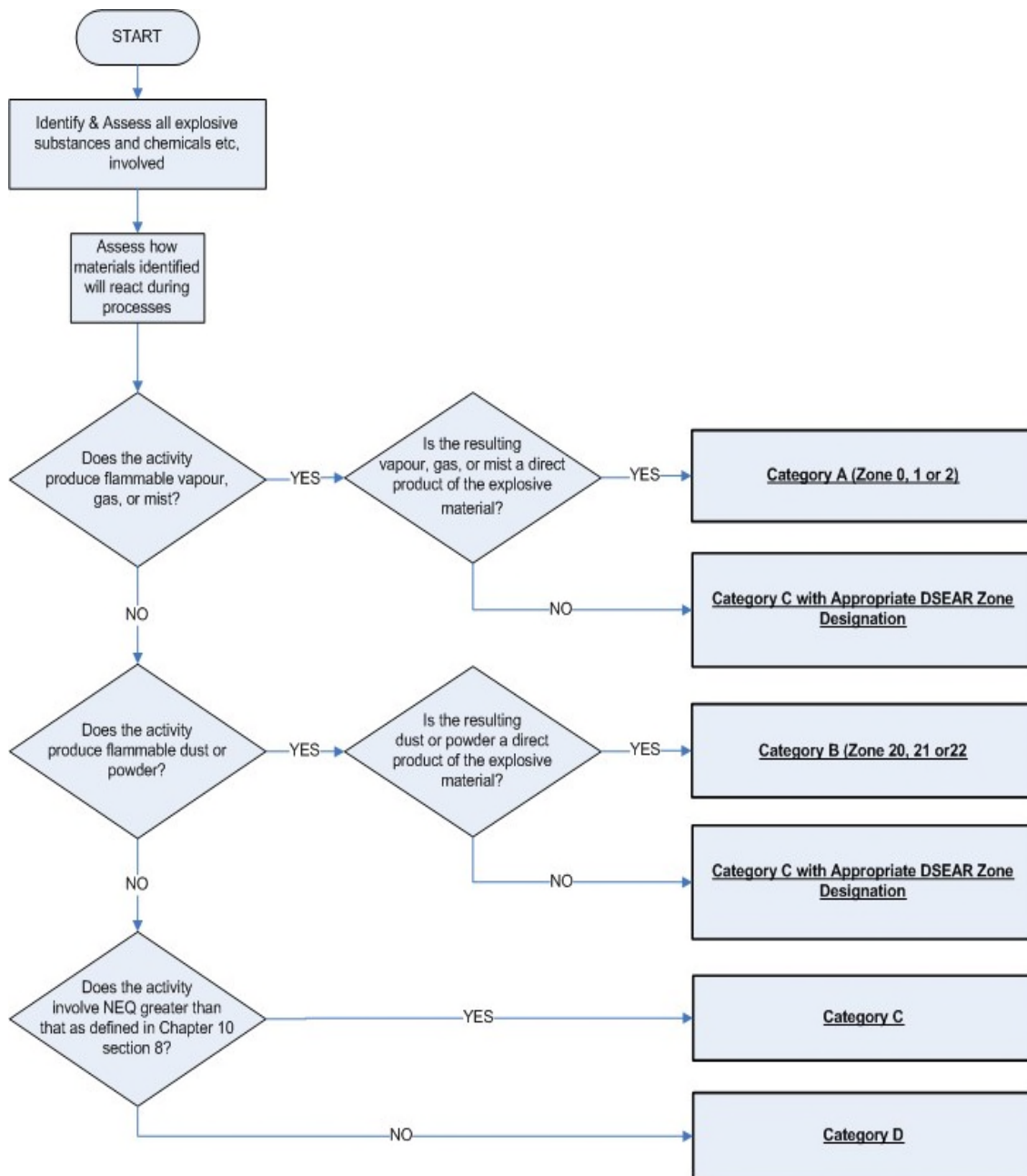


Fig 1 – Electrical Category Selection Algorithm

2.3 Electrical Categories A & B, and DSEAR

2.3.1 The Dangerous Substances and Explosive Atmospheres Regulations are concerned with protection against risks from fire, explosion and similar events arising from dangerous substances used or present in the workplace. They set minimum requirements for the protection of workers from fire and explosion risks related to dangerous substances and potentially explosive atmospheres.

2.3.2 Under regulation 3 of DSEAR the ‘manufacture, handling, use, storage and transport of explosives or chemically unstable substances’ are exempt from regulations 5(4)(c), 7 and 11, which relate to area classification, zoning, equipment selection, signage and duty of co-ordination. Notwithstanding, it should be noted that explosives

are legally only exempt from these specific regulations and are subject to the rest of DSEAR.

2.3.3 As a result of this exemption and in the absence of suitable alternative legislation, the MOD has decreed that the concept of these regulations (5(4)(c), 7 and 11) shall be adopted as follows.

2.3.4 Areas where explosives give rise to an explosive atmosphere are categorised as Category A (Zones 0, 1 or 2 for gas and vapour atmospheres), or Category B (Zones 20, 21, 22) for dust atmospheres respectively. Area classification and zoning is to correspond with the definitions within DSEAR for Zones 0, 1 & 2, and 20, 21 & 22 accordingly.

2.3.5 Due to the absence of Category A & B equipment standards electrical equipment to be used within these areas shall be selected or designed for compliance with DSEAR for the derived zone.

2.3.6 Category C & D facilities are also subject to DSEAR if activities taking place within give rise to explosive/flammable atmospheres which are not a direct product of explosive materials.

2.3.7 Hazardous area risk assessments shall only be carried out by competent personnel.

2.4 Area Classification of Category A & B Facilities, and Facilities with DSEAR Zones

2.4.1 In order to make the selection of equipment from the algorithm at Fig 1 – Electrical Category Selection Algorithm it is essential to first classify the area. This process is described within BS EN 60079-10-1 (Explosives atmospheres: Classification of areas – Explosives gas atmospheres) and BS EN 60079-10-2 (Explosives atmospheres: Classification of areas – Combustible dust atmosphere). Classification is a process of detailed analysis of the potential for release of explosives dust or vapour; it is not a straightforward empirical process.

2.4.2 Area classification shall take account of all processes involved in the licensed area which could generate an explosive atmosphere e.g. use of solvents or paint spraying which may attract a DSEAR zone & signage.

2.4.3 All explosives areas where there is the potential for flammable/explosives vapours, mists or dusts shall be classified in accordance with the above standards. The classification shall include a documented Hazardous Area Zoning Study that delineates zones⁸ of potentially explosive atmosphere. Subsequent equipment selection from Fig 1 shall take account of the different zones. It is possible that different zones may occur within one room; it is also possible that zones may extend outside of a room and even into a plant room or office. In such cases it shall be necessary to limit the zone or provide protected electrical/mechanical equipment appropriate to the zone.

2.4.4 Where small quantity processing/handling of explosives occurs it is often in the form of particles/powder or solutions which may lead to a Category A or B environment around the process being carried out. Any such processes should be reviewed to confine these processes to the minimum area possible within the room. The room as a whole should then be zoned in accordance with the requirements of DSEAR. Consideration should also be given to any solvents or other hazardous chemicals used as part of the process.

⁸ Cat A and B Zones are defined in Para 2.5 and 2.7 respectively.

2.4.5 The above process requires a zoning committee to be convened. This should include all of the specialists involved in the design and operation of the processes and the personnel responsible for the design, maintenance and operation of the room. The output from this committee would be the production of an Explosion Protection Document (EPD) which would document the decisions of the zoning committee and provide an audit trail for the decisions made.

2.4.6 The EPD shall demonstrate:

- (1) that the explosion risks have been determined and assessed.
- (2) that adequate measures will be taken to attain the aims of the Directive.
- (3) those places which have been classified into zones.
- (4) those places where the minimum requirements will apply.
- (5) that the workplace and work equipment, including warning devices, are designed, operated and maintained with due regard for safety.
- (6) that arrangements have been made for the safe use of work equipment.

2.4.7 The explosion protection document shall be drawn up prior to the commencement of work and be revised when the workplace, work equipment or organisation of the work undergoes significant changes, extensions or conversions.

2.4.8 Providing this process is sufficiently robust this zoning activity may negate the need for blanket Category A or B classification and zoning across the whole facility and limit Category A and B areas to much smaller zones where the actual processes are carried out.

2.4.9 All zoned areas within the facility or room shall be clearly identified and their boundaries marked.

2.4.10 A plan of the facility or room shall be produced clearly identifying all zoned areas where explosives or hazardous materials are handled and made aware to all personnel working or visiting the area. This plan shall be displayed at the entrance to the appropriate area.

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

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

2.5 Category A – Zone Determination

2.5.1 Cat A areas are sub divided into three zones, as shown in Table 1 Classification for Explosives Gas/Vapour Risks, that recognise the differing degrees with which explosive concentrations of gases/ mists/vapours may arise in terms of both the frequency of occurrence and the probable duration of existence on each occasion.

2.5.2 Equipment procured for use in explosives gas/vapour atmospheres shall be certified and marked in accordance with DSEAR standards as discussed in Paragraph 2.6 below.

MoD Category	DSEAR Zone	DSEAR Description	Equipment Category
Cat A Zone 0	Zone 0	"A place in which an explosive atmosphere consisting of a mixture with air or dangerous substances in the form of gas, vapour or mist is present continuously or for long periods frequently."	1G
Cat A Zone 1	Zone 1	"A place in which an explosive atmosphere consisting of a mixture with air of dangerous substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally."	2G
Cat A Zone 2	Zone 2	"A place in which an explosive atmosphere consisting of a mixture with air of dangerous substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only."	3G

Table 1 Classification for Explosives Gas/Vapour Risks

2.6 Category A – Standard of Installations/Equipment

2.6.1 Detailed installation advice is provided within BS EN 60079-14; however, Table 2 has been provided for quick reference to help determine which equipment can be installed within the different zones of a Cat A hazardous area. A degree of ingress protection giving additional weatherproofing may be required for an outdoor situation; see Table 2 Types of Protection for Cat A Installations.

2.6.2 The following additional notes are also applicable to the procurement of equipment for use within a Cat A area:

- (1) Equipment categories require specific certification from equipment manufacturers/suppliers. Equipment categories 1G and 2G shall have "Third Party Certification" (from an independent test house), while Cat 3G equipment may be self-certificated by the manufacturer.
- (2) Many of the types of protection are applicable to more than one zone.
- (3) Additional information regarding electrical equipment in gas/vapour hazardous areas is contained within BS EN 60079 series of standards.

Symbol	Type of Protection	Description	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 60079-11	0, 1 & 2	1G
Ex ib	INTRINSIC SAFETY	Limit energy of sparks and limit the temperature	BS EN 60079-11	1 & 2,	2G
Ex e	INCREASED SAFETY	No arcs, sparks or hot surfaces	BS EN 60079-7	1 & 2	2G
Ex o	OIL IMMERSION	Keep the flammable gas away from any hot surfaces and ignition capable equipment:	BS EN 60079-6	1 & 2	2G
Ex m	ENCAPSULATION	Keep the flammable gas away from any hot surfaces and ignition capable equipment:	BS EN 60079-18	1 & 2	2G
Ex q	POWDER (QUARTZ/SAND) FILLED	Contain the explosion and quench flames	BS EN 60079-5	1 & 2	2G
Ex p	PRESSURISED APPARATUS	Keep the flammable gas away from any hot surfaces and ignition capable equipment	BS EN 60079-2	1 & 2	2G
Ex d	FLAMEPROOF	Contain the explosion and quench flames	BS EN 60079-1	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	2	3G

Table 2 Types of Protection for Cat A Installations

2.7 Category B – Zone Determination

2.7.1 Cat B areas are sub divided into three zones, as shown in Table 3, that recognise the differing degrees with which concentrations of explosives dust may arise in terms of both the frequency of occurrence and the probable duration of existence on each occasion.

2.7.2 It is recognised that the definition of a ‘dust cloud’ is poorly defined within the literature but for the purpose of this document it is a volume which contains 10 g/m³ or greater of particles with a diameter of 200µm or less.

2.7.3 Equipment procured for use in explosives dust atmospheres shall always be certified and marked in accordance with DSEAR standards.⁹

MoD Category	DSEAR Zone	DSEAR Description	Equipment Category	Dust Tightness to BS 60529
Cat B Zone 20	Zone 20	“A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is present continuously, or for long periods or frequently”	1D	IP6X
Cat B Zone 21	Zone 21	“A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is likely to occur in normal operation occasionally”	2D	IP6X
Cat B Zone 22	Zone 22	“A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is not likely to occur in normal operation but, if it does occur, will persist for a short period only”	3D	IP5X

Table 3 Classification for Explosives Dust Risks

2.8 Category B - Standard of Installation/Equipment

2.8.1 Detailed installation advice is provided within BS EN 60079-14 (Electrical apparatus for use in the presence of combustible dust). A degree of protection giving additional weatherproofing may be required for an outdoor situation - see Table 5: Degree of Ingress Protection for further details.

2.8.2 The following additional notes are also applicable to the procurement of equipment for use within a Cat B area:

- (1) Equipment categories require specific certification from equipment manufacturers/suppliers. Equipment categories 1D and 2D shall have “Third Party Certification” (from an independent test house), while Cat 3D equipment may be self-certificated by the manufacturer.
- (2) Many of the types of protection are applicable to more than one zone.
- (3) Additional information regarding electrical equipment in dust hazardous areas is contained within BS EN 60079 series of standards.

⁹ The special cases of subliming explosives and sub-micron particles will be dealt with separately.

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 6007911	20, 21 & 22	1D
Ex ibD	INTRINSIC SAFETY	Limit energy of sparks and limit the temperature	BS EN 6007911	21 & 22,	2D
Ex mD	ENCAPSULATION.	Keep the flammable dust away from any hot surfaces and ignition capable equipment.	BS EN 6007918	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 60079-4	21 & 22	2D
Ex ta, tb or tc	ENCLOSURE IP6X or IP5X	Keep the flammable dust away from any hot surfaces and ignition capable equipment.	BS EN 6007931	20, 21 & 22	1D or 3D ¹⁰

Table 4 Types of Protection for Cat B Installations

2.8.3 The Design Authority and/or the PT shall provide the assessment of an explosives article or substance, with respect to dust producing characteristics within the service environment. In making judgements about the dust producing characteristics of an explosive device, Design Authorities should note that all explosives, even rubbery propellant, might give rise to dust. Explosives such as nitroglycerine may give rise to vapour that can condense to liquid or crystalline explosive. Sublimation may occur during manufacturing processes.

2.8.4 During decision making about the dust producing nature of an explosive device, it is important to address the packaging/enclosure of the device and its capacity for preventing the egress of dust during the full spectrum of its service environment. Accidental spillage of dust shall be immediately and safely removed.

2.9 Special Dust Cases

2.9.1 It may be necessary to employ special enclosures to exclude sub-micron dust particles produced by machining explosives and to counter the risk from explosives which sublime. Neither of these situations will be encountered during the maintenance of service stores but may occur during research/manufacturing processes. PTs are required to confirm that sub-micron dust and subliming explosives do not feature in their product designs.

2.10 Category C Electrical Installations

2.10.1 Category C electrical installations are required for explosives buildings where the explosives and the activity within do not give rise to flammable vapour or explosive dust atmosphere or give rise to an explosive hazard due to accumulated dust. Electrical equipment and installations are to comply with the specifications at Annex C.

¹⁰ See BS EN 60079-31 for further information.

2.10.2 Area classification shall take account of all processes involved in the licensed area which could generate an explosive atmosphere e.g. use of solvents or paint spraying which may attract a DSEAR zone & signage.

2.10.3 Plant rooms and ancillary rooms within Category C buildings which have no direct access to the Category C explosives area should not be classified as explosives areas but shall meet all relevant industrial standards.

2.10.4 Plant rooms and ancillary rooms within Cat C buildings which have direct access to the Cat C area shall be classified to Cat D standard (see Para 2.11).

2.10.5 Additional levels of protection may be required where equipment is installed externally or in harsh environmental conditions (e.g. underground/coastal explosive facilities; see BS7671 for guidance).

2.11 Category D Electrical Installations

2.11.1 Category D comprises buildings, rooms, etc. where authorised small quantities of explosives, except HD 1.1, are stored or processed (see Chapter 10 Sect 8 for further details) as determined by the departmental IE, and in which explosives are not exposed, and activities do not give rise to flammable vapour or explosives dust. Electrical equipment and installations are to comply with Annex E.

2.12 Aircraft Maintenance Facilities for Weapon Support Purposes

2.12.1 Aircraft Maintenance Facilities, e.g. Hangars and Hardened Aircraft Shelters (HAS), are classified into fuel risk areas by the Crown Fire Service. In addition, JSP482 also categorises these areas for explosives storage. It is therefore possible for this type of facility to have more than one category applied to them. Aircraft Maintenance Facilities may not be DSEAR classified entities in their own right but some activities within the HAS/Hangar (e.g. fuelling) may produce a temporary classified zone for the duration of that activity. Such activities and the extent of the resultant classified area are determined by the relevant platform PT based on input from commodity PTs where appropriate.

2.12.2 The electrical installation within a HAS/Hangar is therefore only required to be of a normal industrial standard unless the Aircraft Maintenance Facility is licensed to store explosives in which case CAT C standards shall be observed.

2.12.3 Fire Officers require that hangar construction be such that power supplies are installed a minimum of 500mm above the floor and that pits and depressions are avoided. This approach allows for the flexible use of hangars including the assignment of hazardous areas up to 500mm above the floor if the processes used require this. If there is a pit or depression it shall comply with Crown Fire Standard E10.

2.12.4 Portable equipment shall attract a category appropriate to the situation in which it may be used and the hazardous area zone(s) arising from activities which may be present when it is being used.

2.12.5 Any electrical equipment for use in Aircraft Maintenance Facilities is also to be assessed for its EMC and shall demonstrate that it complies with the EMC directive. Due regard shall be taken of any effect the electrical equipment may have on aircraft and weapon systems. See Paragraph 6.2 to determine the extent of the EMC testing to be carried out.

2.13 Electrical Systems on Vehicles and Mechanical Handling Equipment

2.13.1 Safety requirements for electrical systems on vehicles and mobile mechanical handling equipment operated in explosives areas are specified in Chapter 16.

3. ELECTRICITY DISTRIBUTION EXTERNAL TO ESA

3.1 Protection from Power Supply Authority Overhead Power Lines

3.1.1 This Sections deals with the protection of explosives buildings from power supply authority overhead lines and associated network and installations.

3.1.2 Such installations are not permitted in, nor permitted to pass over, an explosives area or building.

3.1.3 The breaking of an overhead conductor is a rare occurrence and the operation of circuit protection devices cannot be accepted as a total safeguard. Therefore, safe distances shall be applied as determined below.

3.1.4 The physical safe distance (D) may be calculated by reference to the height (H) of the supporting structure (or the height of the highest conductor if greater) and the length of the span (S). The greater distance derived from either of the following expressions should be observed:

$$D = \frac{S}{2} - H \text{ or } D = 2H$$

Note. This expression assumes that, if a break were to occur in the overhead line, natural recoiling of the broken line will restrict swing in a direction normal to the line axis to less than half the span distance

4. ELECTRICITY DISTRIBUTION WITHIN THE ESA

4.1 Electrical Distribution Within Explosives Areas

4.1.1 The electrical distribution in an explosives area may be by means of underground cables or overhead lines. Underground cables are preferred and should be provided wherever practicable. Cables shall not be laid below buildings.

4.1.2 Overhead lines shall be sited at greater than $D = S/2 - H$ or $D = 2H$ (as 2 defined above), measured horizontally from any explosives building. Overhead lines to buildings shall terminate at not less than this distance, with the remaining distance being completed by underground cable.

4.1.3 Surge protective devices shall be fitted between live conductors and earth and between live and neutral conductors at the junctions of overhead lines and underground cables.

4.2 Lighting Columns

4.2.1 Lighting columns shall be sited so as to ensure that in the event of failure no live conductor is able to fall onto an explosive building. Supports shall be installed a minimum distance of 1.5 times their height away from the building.

4.3 Crossing of Roads and Railways

4.3.1 Where possible the explosives area electrical distribution overhead power lines, should not cross roads and railways. Where such crossings are unavoidable, precautions shall be taken to reduce to a minimum the length of time vehicles loaded with explosives stand below the power lines. Power line crossings of roads and railways should be clearly marked (e.g. by painting yellow box markings on roads).

4.3.2 Spans of overhead power lines at road and rail crossings and immediately adjacent spans should be inspected regularly and the results recorded. Power lines spanning roads and rail crossing in explosive storage areas shall be visually inspected annually for signs of mechanical damage, corrosion, overheating, loose fastening and general deterioration. The inspection of the power line spanning the road/rail crossing is limited to the distance between the poles or pylons immediately adjacent to the crossing. The full extent of inspection criteria is detailed within ESTC Standard 6 – Part 2.

4.4 Plans of Underground Cable Runs

4.4.1 Explosives establishments shall hold and maintain plans showing the position and size of all underground cables, including the location of all joints in cables, cable pits, etc. within the explosives areas.

4.5 Siting of Distribution & Supply Equipment

4.5.1 The probability of a catastrophic failure of electrical transformers, leading to an explosion or fire is generally considered low. However, these events occur primarily due to poor installation or maintenance. Consideration shall therefore be given to the location of such equipment so as not to create a hazard to explosives buildings.

4.5.2 Table 5 below provides required distances that shall be kept between explosives buildings and electrical distribution and supply equipment.

Operating Voltage	Distance	Notes
415V 3 phase and below	0m	Applies to equipment not containing HV to LV transformers
HV-HV or HV-LV switchgear with non-flammable insulation	20m	HV (High Voltage) = above 1000V LV (Low Voltage) = below 1000V
HV-HV or HV-LV switchgear with flammable insulation	45m	

Table 5 Safe Distances for Low Voltage and High Voltage Switchgear

4.5.3 Portable electrical generation equipment shall not be used within an explosives area or building, without approval from the relevant IE.

5. ELECTRICAL SUPPLIES AND WIRING SYSTEMS IN EXPLOSIVES BUILDINGS

5.1 Supply to Buildings Containing Explosives

5.1.1 The voltage to earth shall not exceed 400V RMS 3 phase, (+10%) 50/60Hz. The source shall be directly connected to earth at one point of the system.

5.2 Earthing Arrangements

5.2.1 Earthing arrangements for explosives buildings (except Cat D) shall be restricted to TN-S complying with BS7671.

5.3 Main Switches

5.3.1 Supply of electricity to an explosives building shall be controlled by one or more 'main' switches positioned outside the building (main switches shall not be placed within the plant room). Where there is more than one main switch, e.g. for essential and non-essential circuits they shall be in close proximity to each other, and their purpose clearly marked.

5.3.2 Main switch(s) shall be capable of immediately isolating every live conductor (i.e. all phase/line and neutral conductor) entering the building and disabling the output of any uninterruptible power supplies (UPS)¹¹ other than circuits dedicated to supplying emergency lighting providing that the UPS complies with the relevant requirements of BSI BS EN 62040.

5.3.3 Rules for final circuit switches are listed at Paragraph 5.4.

5.3.4 Distribution boards controlling the supply to an explosives building shall be located outside the building, or in a plant room, which has a minimum half-hour fire resistance, and which does not open directly into the building or rooms containing explosives.

5.3.5 Provision of remotely controlled switchgear, with fail-safe configuration, may be considered. The remote-control station should be sited outside the building concerned and in a clearly visible position. It should be suitably protected from the environment.

5.4 Final Circuits

5.4.1 Final circuits shall be controlled by switches that ensure complete isolation of all conductors from the supply (i.e. all phases/line and neutral). Switches may be within the building provided that they conform to the category appropriate to the building.

5.4.2 This does not apply to switches controlling heating systems which are always to be located outside the explosives building or in the plant room.

5.4.3 When an explosives building is vacated all non-essential services shall be switched off.

5.5 Protection from External Transients

5.5.1 Transient over-voltage protection and over-current protection compliant with BS7671 shall be provided on all primary circuits feeding the final circuits in explosives buildings. Surge protective devices shall also be provided where deemed beneficial to explosives safety, see Para 20 for requirements with respect to surge protection from lightning.

5.6 Wiring Systems

5.6.1 Compatibility with chemicals and/or explosives in the area shall be considered when deciding the type of cable to be used.

¹¹ IDS Control panels contain backup batteries and in the event of a main power failure an alarm is sent to the monitoring guard room.

5.6.2 Cables with a single solid core conductor or single layer of insulation are prohibited other than where used for alarm circuits or emergency lighting. Such cables shall be either MIMC or a thermosetting insulated fire-resistant type.

5.6.3 Cables within Cat A & B facilities and DSEAR zones shall comply with the requirements of BS EN 60079-14.

5.6.4 The following wiring systems are permitted in explosives buildings and consideration should be given to the use of fire retardant low smoke/fume emission plastic materials.

- (1) Synthetic rubber or PVC insulated cables in screwed steel conduit may be used in Category A, B, C and D.
- (2) Synthetic rubber or PVC insulated cables in trunking or non-metallic conduit may be used in Category C and D buildings only.
- (3) Mineral Insulated Metal Covered (MIMC) cables heavy-duty 750 volt working (see Para 5.10).
- (4) XLPE or PVC insulated multi-core armoured cables (see Para 5.11).
- (5) Thermo-plastic insulated lead sheathed cables with protective covering of thermo-plastic material (see Para 5.12).
- (6) Thermosetting insulated cables in screwed steel conduit may be used in Cat A, B, C and D buildings.
- (7) Communications cables (including IT systems) in screwed steel conduit may be used in Cat A, B, C and D buildings.

5.7 Cables Used in Conduit and Trunking Systems

5.7.1 Power cables shall be synthetic rubber, PVC, LSF or XLPE insulated of 450/750-volt grade complying with BS 6007, BS 6004, BS 7211 or BS 7889. The cross-Sectional area of a conductor shall be appropriate for the current loading and not less than 1.5mm². Cables for communication and alarm systems may be insulated flexible cords complying with BS 6500. The cross-Sectional area of a conductor shall not be less than 0.35mm².

5.8 Conduit

5.8.1 In Category A & B areas and DSEAR zones all conduit fittings shall be selected to meet the requirements of the Equipment Category. Equipment Categories are set by the zoning decisions arising from Area Classification. Glands shall be certified to the standard appropriate to the Zone.

5.8.2 Conduits in Category C and D areas shall comply with BS 4568, BS 4607 or BS EN 61386-1. The following requirements also apply:

- (1) Conduits may be heavy gauge solid drawn, continuously seam welded and galvanised, Black enamel or Non-metallic.
- (2) Metal conduit shall be screwed tightly into all fittings and equipment with the minimum of exposed thread.

- (3) Running couplers are permitted.
- (4) Conduit shall be fixed with a minimum of 12mm clearance from walls and be supported by appropriately robust saddles.
- (5) The use of flexible conduit shall be kept to a minimum.
- (6) Rigid PVC conduit system shall comply with BS 4607 Part 1 and BS 4607 Part 2.
- (7) Additional protection against mechanical damage shall be provided as necessary.
- (8) Where slip joints or sliding couplers are used, joints should be made using a suitable adhesive.
- (9) A separate and adequately rated protective earth (PE) continuity conductor shall be installed throughout the systems.

5.9 Trunking and Cable Tray Systems

5.9.1 Metallic or non-metallic trunking may only be used in Category C and D installations.

5.9.2 Cable tray or hanger support systems may be employed for Category C and D installations where armoured and metal-sheathed cables are used. Additional protection against mechanical damage shall be provided as necessary.

5.10 Mineral Insulated Metal Covered Cables

5.10.1 Mineral Insulated Metal Covered cables shall comply with BS EN 60702-1 and shall be of a grade suitable for voltages up to 750V. The outer covering shall be of Low Smoke and Low Acid Gas Emission material. Cables shall be fitted with terminations, which comply with BS EN 60702-2.

5.10.2 For Category A and B facilities the installation of MIMC cables shall meet BS EN 60079-14 and shall only be installed by appropriately qualified personnel.

5.10.3 NOTE: CABLE, GLANDS AND TERMINATIONS SHALL BE FROM THE SAME MANUFACTURER.

5.11 Armoured and Metal Sheathed Cables

5.11.1 PVC and XLPE insulated wire armoured and sheathed cables shall comply with BS 6346 and BS 7655/BSI BS EN 50363. The outer metal sheaths shall be compatible with any explosives or chemicals used in the vicinity of the installation. Additional protection against mechanical damage shall be provided where necessary.

5.11.2 Thermoplastic insulated lead sheathed cables with a protective covering of thermoplastic material are provided for use in Germany. The Verband Deutscher Elektrotechniker (VDE) Code Designation is NYBUY-J.

5.12 Thermosetting Insulating Cables Low Fume Hazard (LFH)

5.12.1 Thermosetting insulated cables (non-armoured) shall comply with BS 7211 for lighting and power.

5.12.2 Thermosetting insulated cables (armoured) shall comply with BS 6724 for lighting and power.

5.13 Communications and Instrumentation Cables

5.13.1 Communications and instrumentation cables that are armoured, sheathed or screened, shall comply with BS EN 50290 and BS EN 50288.

5.14 Socket Outlets

5.14.1 Where the installation of socket outlets is essential then the classification and standard of sockets used shall meet the requirements of this document and any relevant British and European standards for use in hazardous areas. Sockets shall comply with IEC 60309, have switched interlocks and appropriate ATEX certification if in Cat A and B or DSEAR Zoned processing areas.

5.14.2 Domestic Style sockets (BS 1363 style) shall only be permitted within non-explosives areas or within used for research & development activities, or Authorised Quantity Licenced facilities. Such sockets are only to be used for essential tasks, only task specific electrical equipment may be plugged in and they are to be labelled appropriately.

5.14.3 In some circumstances it is recognised that replacing a standard 3 pin domestic socket may have a detrimental effect on the electrical protection and performance of the specific equipment in question. In such cases an assessment should be made in conjunction with the explosive licence holder to establish if it is appropriate to retain the BS1363 style plug & socket arrangement. However due to the risk of unauthorised electrical equipment being introduced the installation of a fused spur/socket to establish as good a level of protection shall always be considered and preferred.

5.14.4 Where it is agreed to use such an arrangement then a robust safety management procedure should be instigated to prevent unapproved electrical equipment being used. This does not apply to non-explosives areas within an explosive building or other areas within the ESA e.g. admin areas and plant rooms or small quantity research facilities as described in Section 1.10.

5.14.5 Multi-point adapters shall not be used unless there is a specific operational need and a risk assessment has been undertaken.

5.15 Residual Current Devices (RCD)

5.15.1 RCD shall be installed to provide personnel shock protection for all multiuse power sockets within explosives buildings. RCD shall comply with BS EN 610081 and be rated to no greater than 30mA.

5.15.2 Portable/ 'Plug-in' devices and devices integral with socket outlets shall be tested by the user prior to each day's use. The test involves operating the integral test device fitted to the RCD¹².

5.15.3 Fixed devices giving dedicated or multi-circuit RCD protection (i.e. at distribution board) shall be tested by a competent person using the integral test device at not greater than three monthly intervals.

¹² The integral test device only enables the mechanical parts of the RCD to be checked.

5.15.4 All RCD, including devices integral with socket outlets, shall be tested by a competent person using an approved test instrument in accordance with the periodicity as required by ESTC Standard 6.

5.15.5 Portable/plug-in devices that fail the integral 'trip-test' shall be removed from service until repaired or replaced. Fixed RCDs, including devices integral with socket outlets, that fail 'trip-test' or approved instrument test shall have their associated circuits isolated until defective devices are replaced or repaired.

5.15.6 Where it is not practicable to fit an RCD for operational reasons, its omission must be fully risk assessed and justified by a competent person. This risk assessment shall be fully documented in order to provide an audit trail.

6. ELECTRICAL EQUIPMENT GENERAL REQUIREMENTS & EMC

6.1 Introduction

6.1.1 Electrical equipment shall not be installed, taken into or used in buildings containing explosives unless it is compliant with this Chapter, or permitted by written approval of the relevant IE. The protection accorded is to be appropriate to the electrical category of the area in the building in which it will be used.

6.1.2 The procurer is responsible for ensuring that products comply with statute (UK HSAWA 1974 etc and EU directives (CE Marked)) and this Chapter before they are supplied for use.

6.1.3 Additionally, explosives shall never be stored within 0.5m of any electrical equipment. Areas from which explosives are specifically excluded shall be clearly marked.

6.2 Design and Construction of Electrical Installations and Equipment

6.2.1 Provision and maintenance of electrical installations and equipment to the standards outlined in this document, is an integral safety requirement for explosives buildings. In addition to the safety features detailed in this document, compliance with the Electricity at Work Regulations (SI 1989 No.635) and the current edition of the Regulations for Electrical Installations (BS 7671) and PUWER are essential. Particular attention shall be paid to the following:

- (1) Suitable overload, short circuit and earth fault protection shall be provided to ensure the clearance of any fault condition in accordance with BS7671.
- (2) The containment of overheating or sparking within equipment enclosures during normal use. This is in addition to any special provisions required by Cat A, B, C, D or DSEAR associated electrical standards. Selection of equipment shall, where reasonably practicable, provide best and safest performance.

6.3 Material Restrictions

6.3.1 There are restrictions on the use of certain materials (e.g. light alloys) in the construction of equipment intended for use in CAT A and CAT B buildings. Advice is provided within British and European standards.

6.4 Temperature Considerations

6.4.1 The design temperature limitations for electrical equipment under normal conditions shall not exceed the following:

- (1) For Category A Facilities and those with DSEAR Zones 0, 1 & 2: The appropriate T Class (see Table 6) as determined through the assessment of all relevant processes and substances.
- (2) For Category B Facilities and those with DSEAR Zones 20, 21 & 22: The appropriate T Class (see Table 6) as determined through the assessment of all relevant processes and substances.
- (3) For Category C & D Facilities: Maximum enclosure surface temperatures, as defined in BS7671 clause 423.1 and table 42.1, are 90°C.

Class	Maximum Surface Temperature Degrees Centigrade
T1	450
T2	300
T3	200
T4	135
T5	100
T6	85

Table 6 Maximum Surface Temperature

6.4.2 The reference ambient temperature is normally 40°C. A different reference ambient temperature may be adopted if precautions are taken to ensure that the appropriate surface temperature limit will not be exceeded.

6.4.3 Non ATEX equipment will not normally exhibit a temperature ('T') rating. Therefore, for category C and D electrical installations with no DSEAR zoning the designer and/or installer shall make a competent assessment of the equipment and make an informed judgment whether the equipment is likely to exceed the temperatures quoted in BS7671 in normal operation, prior to its installation.

6.5 Degrees of Protection Provided by an Enclosure (BS EN 60529)

6.5.1 Markings indicating the degree of protection provided by an enclosure consist of the letters IP, followed by two characteristic digits signifying respectively conformity with the requirements of Table 7 Degrees of Protection Provided by an Enclosure (IP Code to BS EN 60529) below. The first numeral designates the degree of protection of persons against contact with live or moving parts inside the apparatus and against the ingress of solid foreign bodies. The second numeral designates the degree of protection against the ingress of liquid. The minimum level of protection of enclosures for each category of electrical installation is given in the relevant Sections within this Chapter.

First Digit	Degree of protection	Second Digit	Degree of protection
0	No protection of persons against contact with live or moving parts inside the enclosure. No protection of equipment against ingress of solid foreign bodies	0	No protection
1	Protection against accidental or inadvertent contact with live or moving parts inside the enclosure by a large surface of the human body e.g. hand, but no protection against deliberate access to such parts. Protection against solid objects greater than 50mm	1	Protection against drops of condensed water. Drops of condensed water falling on the enclosure shall have no harmful effect.
2	Protection against contact with live or moving parts inside the enclosure by fingers. Protection against solid objects greater than 12mm	2	Protection against drops of liquid. Drops of falling liquid shall have no harmful effect when the enclosure is tilted at any angle up to 15° from the vertical
3	Protection against contact with live or moving parts inside the enclosure by tools, wires or such objects of a thickness greater than 2.5mm. Protection against ingress of small solid bodies	3	Protection against rain. Water falling in rain at an angle up to 60° to the vertical shall have no harmful effect
4	Protection against contact with live or moving parts inside the enclosure by tools, wires or such objects of a thickness greater than 1mm. Protection against the ingress of small solid foreign bodies	4	Protection against splashing. Liquid splashed from any direction shall have no harmful effect
5	Complete protection against contact with live or moving parts inside the enclosure. Protection against harmful deposits of dust. The ingress of dust is not totally prevented, but dust cannot enter in an amount sufficient to interfere with satisfactory operation of the equipment enclosed	5	Protection against water jets. Water projected by a nozzle from the direction under stated conditions shall have no harmful effect
6	Complete protection against contact with live or moving parts inside the enclosure. Protection against ingress of dust.	6	Protection against conditions on ships decks (decks watertight equipment). Water from heavy seas shall not enter the enclosure under prescribed conditions
		7	Protection against immersion in water. It shall not be possible for water to enter the enclosure under stated conditions of pressure and time
		8	Protection against indefinite immersion in water under specified pressure. It shall not be possible for water to enter the enclosure.

Table 7 Degrees of Protection Provided by an Enclosure (IP Code to BS EN 60529)

6.6 Electromagnetic Compatibility (EMC) and OME RADHAZ

6.6.1 Every item of electrical equipment shall be selected and erected so that it will neither cause harmful effects to other equipment nor impair the supply during normal

service including switching operations. It is necessary to ensure that the electromagnetic emissions (deliberate and accidental) from electrical equipment fitted to and used within explosives buildings are controlled to protect:

- (1) The electro-explosive devices (EED) in weapons and stores¹³.
- (2) Electronic equipment and radio receivers associated with weapons and/or control systems in the buildings or nearby.

6.6.2 Under the requirements of Def Stan 07-85 EED circuits in weapons are to be assessed for their susceptibility to RF emissions. Such assessments are required (as part of the introduction into service process) for the weapon/store in all modes of packaging/operation/test. When packed in their ESTC approved container, stores are normally considered to be “hard” to the Minimum Service RF Environment specified in Def Stan 59-411 Part 2 but when unpacked, under test or during processing operations their susceptibility may be considerably increased. These issues are discussed in more detail in Chapter 24.

6.6.3 Equipment which transmits radio frequency energy, e.g. Wi-Fi, blue tooth, radar, transmitters, mobile telephones, microwave devices etc. are to be controlled in accordance with Chapter 24.

6.6.4 The Electromagnetic Compatibility (EMC)¹⁴ performance of electrical equipment in explosive buildings shall meet the following requirements:

(1) STORAGE BUILDINGS

(a) Installed and portable equipment shall meet the EMC requirements for Light Industrial and Residential equipment as defined in EN specifications 61000-6-1 and 61000-6-3 or relevant product specific standard (see also note below). Where equipment has been designed and manufactured specifically for defence purposes it may not have been tested to the BS standards. Such equipment may have been tested to Def Stan 59-411 or another Military Standard. Equipment meeting Def Stan 59-411 at the level equivalent to the ships below deck limits is acceptable.

(b) MHE shall meet the EMC requirements of EN12895 as discussed in Chapter 16.

(c) BS standards other than those mentioned above may be offered for some equipment depending on their application.

(2) PROCESS BUILDINGS

(a) Equipment not connected to weapons/stores

(i) Equipment permanently installed in process buildings but not electrically connected to a weapon at any time nor within 1m of an unpackaged weapon shall meet the EMC requirements for Light Industrial and Residential equipment as defined in EN 61000-6-1 and

¹³ Stores are defined as either an explosive filled store with EED as part of the assembly or an EED which is packaged or handled as a discrete item.

¹⁴ NOTE: Equipment may be CE marked in accordance with EMC Directive 2014/30/EU and the manufacturer state it meets the requirements of a relevant EN EMC standard without an EMC test having been conducted. Those purchasing/ installing equipment shall therefore obtain test results for the equipment from the supplier/manufacturer to demonstrate compliance.)

61000-6-3 or relevant product specific standard (see also note above).

(ii) MHE shall meet the EMC requirements of proscribed within Chapter 16.

(iii) Portable equipment (not directly connected to a weapon/store) shall meet the EMC requirements for Light Industrial and Residential equipment as defined in EN 61000-6-1 and 61000-6-3.

(iv) Fixed or portable equipment (and their cables) within 1m of an unpackaged weapon/store shall also meet the radiated emission criteria of Def Stan 59-411 Part 3 tests DRE 01.B (Sea Service use – below decks) and DRE 02.B (Land, Sea and Air use). If an equipment cables are run parallel to cables connected to a weapon under test for 2m or more then tests DCE01, DCE02 and DCE03 shall also be conducted using the Land Class D limits.

(b) Equipment connected to weapon/stores

(i) Fixed or portable electrical equipment which are directly connected to a weapon under test shall have conducted emission and susceptibility tests on the cables connected to the weapon, completed to the same EMC standard as used for the weapon. The relevant limits to be used shall be those applicable to the weapon being tested.

(ii) For power supply lines which interface only with the facility domestic supplies the conducted tests and limits applied may be taken from BS EN 61000-6-1 and 61000-6-3 but with the addition of the transient test DCS06 (to land service limits) from Def Stan 59-411.

(iii) In addition, the radiated susceptibility test, DRS 02, shall be conducted on all equipment directly connected to weapon systems in explosive buildings using (as a minimum) a field strength of 20 V/m from 1 MHz to 10 GHz with modulations as defined in Def Stan 59-411. A higher limit may be required if a test system is also to be used in an operational setting. Radiation emissions test shall be to the BS EN 61000-6-3 standard, except where the test equipment is within 1m of the weapon when the same standard as used for the weapon shall be used.

7. FIXED ELECTRICAL EQUIPMENT

7.1 Requirement

7.1.1 All electrical equipment which is to be installed into the fixed installation shall meet the requirements of this Chapter, corresponding to the electrical category of the building, as well as the relevant British and European standards.

7.2 Definition of Fixed Electrical Equipment

7.2.1 Fixed Electrical Equipment: Electrical equipment supplied via one or more permanently wired outlets i.e. without the use of plugs and sockets.

7.3 Luminaires (Light Fittings)

7.3.1 Luminaires shall be of the correct power rating as shown on the installation drawings.

7.3.2 Where a Central Battery Unit (CBU) is specified to power emergency lighting luminaires for Category A and B buildings, it shall be sited in an external plant room.

7.3.3 Emergency luminaires with internal batteries shall not have their enclosure compromised while explosives are present unless suitable safety management arrangements are in place to prevent risk of battery coming into contact with explosives.

7.4 Heating/Air Conditioning and Humidity Controlling Appliances

7.4.1 Heating appliances shall only be installed where absolutely essential, which shall be determined by the munitions and personnel environmental requirements. Where such appliances (e.g. radiators) are a requirement the additional requirements of Chapter 17 shall be complied with.

7.4.2 All heating and air conditioning equipment shall be permanently installed. All heating equipment shall comply with the electrical category of the area it is installed in.

7.4.3 All appliances are subject to the maximum surface temperature limits prescribed in Para 6.4 for the relevant electrical category.

7.4.4 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.

7.4.5 All heaters shall be fitted with a thermal cut-out, which is not self-resetting with falling temperature to ensure compliance with the maximum surface temperature limits. This requirement may be waived (but only within Category C and D areas), when a surface temperature of 85°C max is defined as a part of the certification, by a recognised authority for the appliance. Provision of such a cut-out shall not invalidate any certification of the appliance.

7.4.6 Electrically heated air re-circulating systems or heating appliances containing exposed explosives (e.g. conditioning chambers) are not permitted in Category A or B buildings.

7.4.7 Electrically heated floors and ceilings are not permitted in any explosives building.

7.5 Equipment used for heating Explosives

7.5.1 Equipment used for heating explosives e.g. conditioning chambers, 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 tamper-proof, and its operation shall be frequently tested. The equipment shall be fitted with an indicator light to show when the heater is energised. Additional requirements of Chapter 17 shall also be complied with.

7.6 Fixed Communication Equipment, Fire and Security Alarm Systems

7.6.1 Communications and alarm systems wiring shall be separated from power wiring. All equipment shall comply with the enclosure standard required by the facility in which it shall be installed and also meet both the general and EMC requirements of para 6.2.

7.7 Closed Circuit Television and Thermal Camera Systems

7.7.1 All equipment shall comply with the enclosure standard required by the facility in which it shall be installed and also meet both the general and EMC requirements of para 6.2.

7.8 Heat Sealing Machines

7.8.1 Heat Sealing Machines may only be installed in Category C and D buildings and shall be hard-wired in the facility. Inductive Heat Sealing Machines are not to be used in any Category of explosives facility.

7.8.2 Heat sealing equipment with external surface temperatures exceeding the maximum temperature limitations for the facility may not be installed or used unless approval has been granted. The sealing wire shall not be accessible to touch and shall be protected by a guard at all times.

8. PORTABLE ELECTRIC EQUIPMENT

8.1 Requirement

8.1.1 Portable electrical equipment which is to be brought into an explosives facility with explosives present shall meet the requirements of this Chapter, corresponding to the electrical category of the building, as well as the relevant British and European standards.

8.2 Definition of Portable Electrical Equipment

8.2.1 Mains operated equipment supplied from one or more socket outlets, and battery-operated equipment is regarded as portable.

8.3 Mains Powered Portable Equipment

8.3.1 Flexible cable, or cord, serving portable equipment shall comply with BS EN 50525-1. It shall be sheathed with rubber, PVC or PCP, tinned copper braided and sheathed overall with PVC or PCP. A separate core shall be provided for the protective earth conductor for class 1 equipment. Class II equipment will not normally have an earth connection. Any screening shall be electrically bonded to the earth conductor.

8.3.2 Where there is a requirement for portable mains equipment to be permanently switched on and left unattended then that equipment shall demonstrate fault performance.

8.3.3 If portable mains powered equipment is to be used on a conducting floor it shall comply with the requirements of Section 16.

8.4 Battery Operated Equipment and Equipment containing Batteries

8.4.1 Battery operated equipment is permitted in all explosives buildings provided it is compliant with the category and zone.

8.4.2 The following restrictions apply to batteries used in portable equipment:

- (1) Only dry batteries shall be used and shall be of the type recommended by the manufacturer of the equipment.

- (2) Batteries shall not be changed, or charged, in explosives buildings.
 - (3) Where there is a requirement for battery powered equipment to be permanently switched on and left unattended then that equipment shall be the subject of a documented risk assessment.
 - (4) Battery enclosures shall be sealed to the enclosure standards required.
 - (5) Battery covers should be retained with tamperproof fasteners.
 - (6) For rules on charging batteries used in MHE refer to Chapter 16.
 - (7) Self-contained safety torches and hand lamps shall comply with the category and zone in which they are to be used.
 - (8) Battery powered tools used by contractors on a temporary basis may be approved by the site ESR. Controls on use shall be included within the PTW(E).
 - (9) Battery powered wrist watches are permitted if firmly attached to the user.
- 8.4.3 Where an Uninterruptible Power Supply (UPS) is specified, it shall be sited in an external plant room.

8.5 Digital Cameras

8.5.1 Digital cameras for use in explosives areas shall comply with the requirements appropriate to the category in which they are to be used.

8.5.2 For Cat A, Cat B and DSEAR Zones an appropriate ATEX certified camera is necessary.

8.5.3 For Cat C & D areas cameras may be used providing that they meet the requirements of Annex C or E (whichever is appropriate), meet the EMC requirements of Para 6.6, and are subject to the following operational restrictions:

- (1) The camera shall only be operated whilst attached to a tripod or worn with an appropriate neck/wrist strap.
- (2) Camera batteries shall not be changed or charged whilst in the explosive area.
- (3) Cameras are only to be taken into explosives areas for the duration of the task required. They shall be immediately removed upon completion of the task.
- (4) Cameras with integrated flash units may only be operated at distances of 1m or greater from OME.

8.5.4 Fluorescent flash units shall not be used in explosives areas. LED studio lighting may be used as an alternative, but it shall meet the requirements of the Category/Zone of the building.

8.5.5 It is recognised that in some situations a suitably compliant camera will not be available. In these instances, temporary permission may be granted to use noncompliant cameras within Cat C and Cat D areas, but this shall be done on a case-by-case basis by the IE.

8.6 Electric Soldering Irons

8.6.1 Electric soldering irons may be used only in Category C and Category D explosive buildings and shall be temperature-controlled. When a soldering iron is used the following conditions shall be observed:

- (1) Soldering shall be carried out only at a designated working station away from the bulk of the ammunition in the building and where no other work on explosives is being done.
- (2) The bench top shall be of incombustible material and a suitable fireproof storage space shall be provided to accommodate the hot iron.
- (3) The size and rating of the iron shall be as small as practicably consistent with the task to be carried out.
- (4) The flexible cable fitted to the iron shall be maintained in accordance with the requirements set out in Section 18.4.
- (5) Each electric soldering iron shall be connected to either a permanently wired outlet, or a separate wall mounted double pole switched socket outlet, that will ensure complete isolation, and which is provided with pilot lamp indication.
- (6) When a non-temperature-controlled soldering iron has been switched on and left unused for a period of 10 minutes, the iron shall be switched off and the tip shall be allowed to cool for a period of 5 minutes; only after this cooling period may the iron be switched back on.

8.7 Medical Aids (Internal and Externally Worn Types)

8.7.1 Medical aids such as hearing aids and internal devices are permitted in explosives areas however the use of other external medical aids in explosives buildings is subject to the approval of the appropriate IE. They shall be firmly attached to the wearer and shall be properly maintained.

8.8 Defibrillators

8.8.1 Defibrillators are often carried on emergency vehicles on MOD property. The use of such equipment in explosives areas or buildings is subject to the following:

- (1) Defibrillators are not to be used in the presence of flammable agents or atmospheres, or on conducting floors.
- (2) Defibrillators are not to be used inside a PES except in a medical emergency, in which case a minimum separation distance of 10m is to be maintained between the defibrillator and all explosives when it is being used.
- (3) If the circumstances require the use of the defibrillator inside the exclusion zone or a PES, the senior person present is to consider the risk to the persons present from the explosives, and if considered possible, move the patient or the explosives to provide as large a separation distance as possible, preferably outside the PES.

8.8.2 While it will be necessary to charge the defibrillator capacitor bank at the location it is to be used, the normal rules for battery charging and changing are to be followed (see Section 8.4).

8.9 X-Ray Equipment

8.9.1 Where X-ray equipment is required for the inspection of explosive stores:

- (1) Radiography is to be confined to Category C and Category D areas. Where it is essential that such equipment be used in a higher risk area, advice and written approval shall be obtained from a competent authority.
- (2) Control equipment shall not be located in the explosives room.
- (3) The X-ray head shall be an industrial type with the appropriate enclosure for the Category concerned, or it shall be pressurised.

8.10 Electronic Environmental Monitoring/Data Logging Equipment

8.10.1 Electronic environmental monitoring equipment is acceptable within any Category of explosives area or building provided it is compliant with the general requirements and the detailed requirements of the enclosure standard required by the facility in which it shall be installed. It shall also meet the EMC requirements of Paragraph 6.2. If the equipment contains a deliberate transmitter then the requirements of Chapter 24 shall apply.

8.10.2 Environmental monitoring equipment is normally designed to log data across the "Manufacture to Target" sequence and will require occasional maintenance and "Download" of data. Download processes which involve direct electrical connection are not compatible with the benign storage environment and packaged items shall be taken to the explosives process facility. Note however that battery changing and charging shall take place outside the PES.

8.11 Equipment for Testing Electro-Explosive Devices (EEDs)

8.11.1 Electrical equipment designed for testing EEDs shall not be brought into use unless it is approved in writing by the relevant authority.

8.11.2 Any approval activity shall follow the design principles contained within Def Stan 07-85.

9. OTHER ELECTRICAL EQUIPMENT

9.1 Electrical Equipment Installed on Piers, Jetties and other licensed PES

9.1.1 Other PES include covered/uncovered Road/Rail Transfer points, open overnight temporary (<24 Hrs) and permanent (>24 Hrs) storage areas and Marshalling yards.

9.1.2 Electrical installations for these facilities may not need to be designed to comply with all the requirements of this Chapter. However, the HoE shall ensure that all such facilities shall have their electrical equipment and installations periodically maintained in accordance with ESTC Standard 6 Part 1 and/or the relevant BS or BS EN standards; whichever is the more applicable.

9.2 Computers and Computerised Equipment

9.2.1 The requirements of this Paragraph apply to both mains and battery powered computing equipment.

9.2.2 Computers, computerised equipment and peripherals may be used within explosives areas provided they meet the requirements of the explosives building category.

9.2.3 Full compliance shall include EMC testing to the standards defined in para 6.2.

9.2.4 Cathode Ray Tube displays are not permitted in explosives buildings due to the hazards associated with high voltages and static electricity.

9.2.5 The precautions applicable to battery changing and charging in Para 8.4 are to be complied with.

9.3 Electronic Asset Tracking Systems

9.3.1 Asset tracking systems are used to monitor the movement of hi-value assets throughout the logistics chain. The system can consist of one or more of the following items:

- (1) A battery powered Tag, which operates on a fixed RF at relatively low power and is attached to the asset being monitored.
- (2) A hand-held mobile Tag Reader, used to read the Tags by direct manual interrogation of the RF signal.
- (3) A fixed Tag reader, which reads the RF signal generated by the Tag.
- (4) A fixed converter and modem, which transmits the Tag information to a central control point.

9.3.2 Minimum separation distances shall be determined for devices that use a generic transmission standard, such as GSM and Bluetooth, as defined in JSP482 Chapter 24.

9.3.3 The precautions applicable to battery changing and charging in Section 8.4 shall to be complied with.

10. ALL UP ROUND (AUR) AUTOMATIC TEST SYSTEMS (ATS)

10.1.1 Annex B details the basic requirements for AUR ATS.

11. ELECTROSTATIC DISCHARGE (ESD) PROTECTION

11.1 Introduction

11.1.1 Explosive substances and articles may be sensitive to initiation via electrostatic discharge (ESD). It is necessary to prevent sources of ESD becoming a threat to such OME. The susceptibility of the most sensitive component dictates whether electrostatic precautions are required and if they are, to what level.

11.1.2 The phrase “sensitive component” is intended to encompass any safety critical explosive component of a weapon system or platform that could be compromised by defined ESD threats. The main discharge mechanisms of concern are:

- (1) Direct initiation of bulk energetic material via an electrostatic discharge spark.
- (2) Initiation of EEDs via a spark discharge through the bridge wire (known as Pin to Pin ESD).
- (3) Initiation of EEDs via a spark discharge from the outer casing of the device to an internal pin through the energetic material (known as Pin to Case ESD).

11.1.3 In addition to the above, indirect mechanisms of initiation of OME shall be considered when any safety critical sensitive electronics, fuels or degradation products are present.

11.1.4 MOD establishments and units processing explosive substances and articles sensitive to Electrostatic Discharge have a duty of care to ensure that every reasonable precaution is taken to minimise the risk of initiation of OME via ESD.

11.1.5 Safe operation shall be achieved by design rather than procedure. Where this is not possible the operation shall be demonstrated as ALARP as defined in JSP482 Chapter 1.

11.2 Determination of EED ignition energy

11.2.1 In order to determine the level of protection required when handling OME, the ignition energy of such items shall first be determined. It is the responsibility of the PT or design authority to provide this information to assist the processing establishment with selection of the appropriate Electrostatic Protected Area.

11.2.2 Def-Stan 59-114 Part 2 describes assessment and characterisation of EED and has tables of values for many common EED. This document shall be used to determine the ESD susceptibility level for all EEDs.

11.2.3 It should be noted that selection of the appropriate electrostatic regime for bulk explosives (bare charges, powders etc.) is not solely based on the results of electrical spark tests described in the EMTAP Manual of Tests; Test No 6 (Electric Spark test) and No 7 (Electric Spark Test Method for Sensitive Explosives). These tests can be found in the EMTAP Manual and further advice can be provided by DOSG ST1 and DOSG ST3.

11.3 Electrostatic (Conductive and Anti-Static) Protected Area (EPA) Control Measures

11.3.1 Mitigation of ESD hazards shall be assured by providing an appropriate Electrostatic Protected Area (EPA) for processing OME. Such areas need not be a complete building or room however the boundaries of the EPA, what it is to protect and how this will be achieved shall be clearly defined.

11.3.2 These requirements are determined by the need to keep any electrostatic energy sources below the ignition energy of the most sensitive exposed component as follows:

- (1) Where OME handled has an initiation energy of greater than 156mJ, first degree electrostatic precautions shall be taken. First degree precautions consist of the avoidance of exposed, isolated conductors and the earthing of all large conductive objects.
- (2) An Antistatic regime is required in the presence of OME that in their process configuration¹⁵ have ignition energies of above 1mJ and below 156mJ¹⁶. Detailed requirements for Antistatic regimes are contained in Paragraph 12.
- (3) A Conductive regime is required in the presence of OME that in their process configuration have ignition energies of 1mJ and below. This regime shall be enforced when processing any OME which has an unknown sensitivity. Detailed requirements for Conductive regimes are contained in Paragraph 13.
- (4) Mixed regimes are permitted providing that they comply with the requirements of Paragraph 14.

11.3.3 The following control measures may be used to protect against ESD, as appropriate to the unit/establishment:

11.4 Grounding/Equipotential Bonding Systems

11.4.1 Site authorities shall ensure all structural metalwork, metallic objects/stands and all other conductive articles shall possess a low resistance (<1MΩ) path to the equipotential bonding conductor (EPB).

11.4.2 Explosives assemblies shall not be connected to the facility earth system in such a way that lightning strike current can flow through the assembly, e.g. by connecting directly to a lightning down conductor.

11.5 Electrostatic Flooring

11.5.1 Specialist dissipative flooring may be installed within an explosives process building as part of the ESD protection system. The type of flooring required is dependent upon the OME being processed, see Paras 12.1.2(1) and 13.1.1(1) for resistance limits permitted.

¹⁵ Apparent vs True Susceptibility - in most cases components of all-up weapon systems are protected from harmful ESD by other components, eg casing. In some cases, this includes deliberate measures such as covers, packaging and circuit breaks provided by safety and arming units etc. Consequently, it will normally be reasonable to assess the weapon in its present state rather than its most vulnerable configuration. A Conductive Regime shall be enforced when there is any doubt over the susceptibility of the OME.

¹⁶ NATO STANAG 4370 (AECTP-250) defines the worst case human electrostatic source as being equivalent to 156mJ. Therefore, explosive substances and/or articles with ignition energies of above 156mJ only requires electrostatic control measures in the presence of unusual charge generation mechanisms, eg rotors of a hovering helicopter are capable of generating energies greater than 156mJ.

11.5.2 If operations performed within a building require the installation of an antistatic or conducting floor, it is preferable to install a conducting grade floor to accommodate future flexibility. However, in some environments this might be outweighed by the increased risk of electrocution in the event of an equipment fault. The sub-floor shall be protected by an effective damp proof membrane. Bonding strips shall be laid under each separate piece of floor covering to ensure effective electrical continuity throughout the floor.

11.5.3 Bonding strips with a spacing of approx. 600 mm, shall be laid on the subfloor under and in intimate electrical contact with the antistatic or conductive floor covering. In addition, at least two conductive paths to earth must be provided for each piece of floor covering and the bonding strips shall be connected to the equipotential bonding strip in positions, preferably at diagonally opposite points of the floor. Bonding strips must not cross flexible expansion joints; if necessary, flexible bonding cables may be used to couple adjacent bonding strips.

11.5.4 Where the floor covering is in tile form the bonding tape shall be laid under each row of tiles and all the tapes shall be connected together by a tape laid at right angles.

11.5.5 Stainless steel bonding tapes are preferable brass and copper are permitted. Aluminium shall not be used. They shall be at least 50mm wide if using sheet material (this will provide reliable connection across sheet joints) and not less than 0.2mm thick. For some other flooring systems (homogenous polymeric, trowelled finishes) the width of the conductive tapes is not important. The tapes shall be mechanically robust enough to last the design life of the floor and provide a low enough resistance to not contribute significantly to floor's electrical resistance¹⁷. Electrical continuity of under floor joints shall be achieved by riveting, soldering or conducting adhesive; connections to the earthing system of the building shall be made with screw clamps.

11.5.6 Where non-conducting adhesives are used care shall be taken to prevent the adhesive impairing the electrical continuity between the bonding tapes and the under surface of the floor covering. Cured or hardened adhesives shall be chemically compatible with any explosives that may be present in the building following the installation of the floor.

11.5.7 Waxes and polishes shall not be used on antistatic and conducting floors. The floor shall be cleaned by the method and at the frequency recommended by the manufacturer of the flooring material. If any area of the floor exhibits evidence of contamination by dirt, grease etc. that could affect its electrical resistivity then the area shall be cleaned by the recommended method to ensure continued safety.

11.6 Workbenches

11.6.1 For static control purposes explosives processing benches shall be bonded to the facility equipotential bonding system either directly or via feet made from a suitable conductor. It should be noted however that bonding directly to the conducting floor via conductive feet alone may be in conflict with the requirements of Para 19.3 if relevant.

11.7 Personnel Grounding

11.7.1 All personnel involved in handling ESD sensitive OME shall be effectively and continuously grounded. Effective continuous grounding of personnel can readily be achieved by providing a discharge path to ground via conductive/antistatic shoes and floors or via the use of wrist straps.

¹⁷ For new floors, initial measurements shall be a maximum of 50% of the upper limit to allow for degradation through life.

11.7.2 It is not always practical to use antistatic or conductive floors to control the electrostatic charge on personnel. Wrist straps, securely connected to an appropriate bonding point, are the recommended alternative. A test system shall be used to ensure the wearer presents a total resistance to earth appropriate to the static control regime before handling any electrostatic sensitive material or device.

11.7.3 Visitors equipped with temporary earthing devices (heel grounders, etc.) are permitted into conductive and antistatic areas but shall maintain a distance of at least 0.5m from explosives or explosives assemblies at all times.

11.7.4 Personnel shall ensure electrical insulators are kept separate from electrostatic sensitive materials and devices.

11.8 HAPTMs

11.8.1 A Hazardous Area Personnel Test Meter (HAPTM) shall be securely installed at the entrance to the area where OME is being processed. The earth terminal shall be connected directly to the earthed grid of the conducting floor.

11.8.2 In order to fulfil the intent of 11.7.1 it may be necessary to install more than one HAPTM per EPA, for example if the EPA covers the entirety of a large multi-cell structure it would be prudent to install a HAPTM in each cell.

11.8.3 The HAPTM confirms the subject's total resistance to earth via their footwear and flooring is below the maximum acceptable resistance for the appropriate regime. Resistance (hand to earth) in a conductive regime shall be $<1\text{ M}\Omega$ and the resistance (hand to earth) in an antistatic regime is required to be between $750\text{ k}\Omega$ to $15\text{ M}\Omega$.

11.8.4 An Antistatic Regime HAPTM also confirms whether the user's total resistance is high enough to minimise the consequence of a shock in the event of contact with faulty electrical equipment. The Antistatic HAPTM shall be capable of testing the hand to earth resistance of the user. The resistance through each foot shall be separately measured to provide a greater level of confidence.

11.8.5 Personnel must obtain a pass on the HAPTM before approaching any static sensitive material or device. Personnel failing the test must immediately leave the area and repair/replace the faulty PPE causing the failure. Re-entry to the statically controlled area shall only be allowed on successful retest.

11.8.6 It is very important that the test is performed on dry footwear, as it is possible to obtain a pass with wet footwear, which when dry would insulate the wearer from earth.

11.8.7 When using the HAPTM, personnel must ensure they achieve a pass for each foot independently.

11.8.8 HAPTMs shall be tested and maintained in accordance with the manufacturer's instructions.

11.9 Conditioning of Materials and PPE

11.9.1 The surface resistivity of many common materials, e.g. cotton, wood, paper, is significantly reduced after conditioning at a higher relative humidity. Without this conditioning, surfaces are able to retain hazardous charge and are more likely to electrically isolate conductive objects. Therefore, all large surfaces within explosive process rooms shall be conditioned at a relative humidity at least as high as the minimum required by the appropriate electrostatic regime. This conditioning shall be for

a minimum of 1 hour before exposing any static sensitive explosive or device and shall be maintained until the items are safely packaged.

11.10 Relative Humidity Display

11.10.1 All explosives process rooms shall be fitted with sufficient displays to allow the user to readily confirm that the Relative Humidity (%RH) meets the requirements of the static regime. Additional sensors and displays may be required within regions of large and/or segregated electrostatic areas.

11.11 Packaging

11.11.1 Where necessary packaging shall use static dissipative materials as required by Def Stan 00-88.

11.12 Special to Type Equipment

11.12.1 Design authorities for special to type support equipment for weapon systems/explosives assemblies shall identify any requirement for the dissipation of static charges. Where a potential hazard is confirmed, the authority shall design support equipment with the necessary low resistance connection to electrical earth. In most cases this will be achieved using conductive contact surfaces bonded to conductive wheels/tyres, trailing leads, feet, etc.

11.12.2 Mobile conducting equipment, e.g. trolleys, shall be provided with an effective path to earth. Tyres shall be of an antistatic or conducting material, depending on the regime they are being employed in. Gaseous or fluidic systems (LP and HP air) shall be fitted with grounded antistatic or conducting components. Drive or conveyor belts shall be antistatic/conductive depending upon the regime in force within the room.

11.12.3 Following these procedures will ensure that weapons/explosives assemblies carried on stands/trolleys are earthed. Sensitive items in explosive assemblies will be adequately protected from accumulation of hazardous electrostatic charge by a connection to earth of $\leq 1M\Omega$, e.g. via a connection to a conductive floor.

11.13 ESD Training & Awareness

11.13.1 All establishments which process OME sensitive to ESD shall ensure that all members of staff responsible for the safety of such OME are appropriately trained and competent to do so with respect to ESD.

11.13.2 Staff handling EEDs require training in the requirement for and use of suitable personal protective equipment, Hazardous Area Personnel Test Meters (HAPTM) and tools.

11.13.3 Personnel shall also be made aware where tasks undertaken will expose sensitive items and what they must do to ensure the safety of themselves and their co-workers.

11.14 Verification of EPA Control Measures

11.14.1 Units/Establishments shall ensure that all EPAs and associated equipment are inspected and tested at regular intervals as mandated in this Chapter, JSP 482 Chapter 20 and ESTC Std 6 Pt 1.

11.14.2 A pre-use inspection of the conducting/antistatic floor shall be carried out to ensure that it is clean, free from wear and tear and general defects, and that its periodic ESTC Standard 6 test is in date.

11.14.3 Electrostatic floors shall be tested in accordance with the requirements of ESTC Standard 6 and BSI BS EN 61340-4-3. Trend analysis of floor test results shall be carried out and where an increase in resistance between periodic testing gives cause for concern or where the test results are found to be close to the maximum allowed the period between tests shall be shortened.

11.14.4 Visual checks of the electrical bonding of benches, floors, chairs, trolleys, mats, workstations, separately grounded equipment or any other equipment that grounds an operator permanently or temporarily shall be carried out on a weekly basis. For infrequently used facilities that are used less than on a weekly basis, a prior to use visual check is satisfactory. Equipment subject to change of configuration shall be checked immediately after that change. Checks are to be recorded in the building Work Diary (or equivalent).

12. ANTISTATIC REGIME

12.1 Requirements

12.1.1 An antistatic EPA regime is required where the explosive item being processed has an ignition energy of above 1mJ and below 156mJ. In order to achieve this, it is vital that personnel are not able to accumulate a charge of 1mJ or greater.

12.1.2 Within an Antistatic Regime, the following precautions shall be taken:

- (1) Antistatic flooring shall be provided in accordance with BS EN 61340-4-1 and shall have a resistance to earth of between 50k Ω and 2M Ω . In addition, floors shall be tested in accordance with ESTC Std 6 Pt 1 & BS EN 61340-4-1.
- (2) Personnel shall wear electrostatic dissipative footwear (as defined in BS EN 61340-4-3) with a through sole resistance between 750 k Ω and 10 M Ω ¹⁸. Additionally, compliance with BS EN ISO 20345 should be provided to assure personnel protection from accidental foot injury.
- (3) An Antistatic HAPTM as per Para 11.8.3 shall be installed. This HAPTM shall meet the electrical requirements of the area where it is to be installed (ie Cat A, B, C or D).
- (4) A relative humidity of not less than 40% shall be maintained and confirmed by RH monitoring equipment with an accuracy of at least +/- 5% RH.
- (5) Personnel shall wear outer clothing of materials whose outer exterior surfaces having a surface resistivity of less than $1 \times 10^{12} \Omega$ (1T Ω) or less at the relative humidity of 40%. Therefore, the clothing shall be stored in an environment of the same RH as its working environment or no less than 40% for at least 30 minutes prior to use. The clothing shall be of an electrically homogenous textile, rather than one that relies upon a conductive grid or coating. Clothing (coveralls are recommended although a 2-piece outfit is permissible) shall fit properly and be correctly fastened. Gloves shall not be worn unless as a result of a risk assessment they are identified as Personal Protective Equipment

¹⁸ It should be noted that the resistance limits of BS EN 61340-4-3 for electrostatic dissipative footwear are 100 k Ω to 100 M Ω , and additional work will be required by the purchasing authority to confirm that shoes procured fall within the permitted range of between 750 k Ω and 10 M Ω .

(PPE) that will protect operators from an additional hazard. In this situation it will be necessary to balance the relative risks between the explosives and other identified hazard.

(6) Personnel shall not don or remove clothing whilst in the presence of explosives substances or articles.

(7) Loose resistive (surface resistivity of $1 \times 10^{11} \Omega/\text{m}^2$ (100 G Ω per metre squared) or more) materials, e.g. plastics, rubber, glass, etc., in the working area shall be restricted to a size not exceeding 75cm². In this context the word "loose" is meant to permit the presence of larger area, i.e. exceeding 75cm², of resistive materials which will be safe because they are fixed and remote from the sensitive materials or devices. In many cases loose items may be treated to improve their electrostatic characteristics.

12.1.3 These control measures are not intended, and do not, address the hazard present by flammable or explosive atmospheres. The credibility of any such hazard shall be determined and appropriate controls implemented, i.e. appropriate electrical equipment and a Conductive Regime.

12.2 Use of Wrist and Leg Straps within Antistatic Regimes

12.2.1 If wrist straps are specified for use within an Antistatic regime, they shall meet the following criteria:

- (1) The wristband shall be of the quick release type.
- (2) The end-to-end resistance (including the wrist strap, cabling and termination contact) shall not be less than 1 M Ω and not greater than 10 M Ω .
- (3) A dedicated connection point for wrist straps shall be established adjacent to the working area and shall be easily accessible. The connection point shall be clearly identified.
- (4) Consideration shall be given to installing continuous earth monitors in areas where wrist straps are used for prolonged periods.

12.2.2 Electrostatic dissipative leg straps are not to be used within antistatic process areas.

12.3 Checking of Antistatic Equipment Prior to Use

12.3.1 Checking of wrist cords and grounding cords shall be made each time the wearer enters the static controlled area. Each check shall be made with the wrist strap worn on the wearer's wrist and in contact with the wearer's skin. Checking shall include the measurement of an "end-to-end" resistance. Ideally, this check would be from wearer's skin to their local earth. Skin creams are available that have been designed to help people with dry skin to obtain good electrical contact with the wrist band. This check could readily be accomplished by connecting the wrist strap to local earth and testing the wearer with an appropriate ESD tester.

12.4 Test Methods for Antistatic Equipment

12.4.1 Measurement procedures for benches, floors, seating and outer garments including wrist cords and footwear (including leg straps and grounders) shall be in accordance with BS EN 61340, however where resistance limits differ, those from this document shall be used.

13. CONDUCTIVE REGIME

13.1 Requirements

13.1.1 Within a Conductive Regime, the following precautions shall be taken:

- (1) The resistance from the upper surface of the floor to earth shall be less than 50 k Ω . Floors shall be tested in accordance with ESTC Standard No 6 Pt 1.
- (2) Conductive footwear shall be provided in accordance with BS EN ISO 20344/ BS EN ISO 20345 (electrical resistance not greater than 100 k Ω). Footwear shall be tested (in combination with a person and flooring) using a HAPTM, every time an EPA is entered.
- (3) Personnel shall wear static dissipative outer clothing of materials whose outer exterior surfaces have a surface resistivity of $1 \times 10^{12} \Omega/\text{sq}$ or less at the relative humidity of 40%¹⁹. Therefore the clothing shall be stored in an environment of the same or higher RH than its working environment. Clothing shall be of an electrically homogenous textile, rather than one that relies upon a conductive grid or coating. Clothing (coveralls are recommended although a 2-piece outfit is permissible) shall fit properly and be correctly fastened. Gloves shall not be worn unless as a result of a risk assessment, they are identified as Personal Protective Equipment (PPE) to protect operators from an additional hazard. In this situation it will be necessary to balance the relative risks between the explosives and other identified hazards.
- (4) Personnel shall not don or remove clothing whilst in the presence of explosives substances or articles.
- (5) All conductors shall be effectively grounded, i.e. $\leq 1 \text{ M}\Omega$ resistance to earth at 100 volts^{20, 21}.
- (6) Conveyor belts shall be conducting types complying with the tests specified in BS EN 61340.
- (7) Bench tops, chairs and containers shall be of conducting material and effectively bonded to the conductive floor or equipotential bonding system. Seat covering material shall be of a static dissipative material and connected to the earthed frame of the chair (see BS EN 61340).
- (8) No materials capable of retaining significant electrostatic charge or of permitting the electrical isolation of significant conductors shall be permitted within the working area. Provided a high relative humidity is maintained, wood and other cellulose materials are acceptable.

¹⁹ However, it is recommended that anyone encountering improvised explosive devices of unknown sensitivity or highly flammable atmosphere, e.g. hydrogen-air, shall obtain advice from a competent authority.

²⁰ To avoid a potentially hazardous accumulation of charge the path for charge dissipation i.e. to ground, must permit a current that at least balances the charging current. Potentials below

²¹ V equate to less than 2.5 μJ on a 500pF person. Therefore, assuming the path for charge dissipation from the human body obeys Ohm's Law, safety can be assured if the resistance of path to ground is:

$$R < 100/I \text{ ohms}$$

In the worst case it is assumed that a charge generating process associated with a person can yield a charging current of 10^{-4}A . Consequently, a balancing, minimum dissipation current (I) will be obtained when the resistance to the ground (R) is 1M Ω . This person would be incapable of attaining a hazardous potential. In practice this conductive path can be achieved by the use of flooring and footwear or wrist straps with appropriate electrical properties.

(9) A relative humidity of not less than 65% shall be maintained. RH monitoring equipment with an accuracy of at least +/- 5% RH is permitted.

13.1.2 RH limits may be reduced to an absolute minimum of 40% so long as site operators comply with all of the following:

- (a) No processing of bare primary explosives.
- (b) Operators shall continue to pass a HAPTM test.
- (c) Exclude all materials whose static dissipative properties are dependent upon a high RH.
- (d) All other requirements for a conducting regime in accordance with this Chapter have been met.

13.1.3 Note: Judgments can only be made locally when electrostatic expertise exists on site.

14. MIXED STATIC PROTECTED AREAS

14.1 Requirements

14.1.1 It is acceptable to combine areas of differing regime (uncontrolled, antistatic or conductive), within the same building or room provided the following additional precautions are taken:

- (1) The areas shall be clearly defined in terms of electrostatic regime on a drawing lodged with the licensing authority.
- (2) These areas shall be bounded by permanent (or semi-permanent) barriers. Any attempt to deviate from this shall be fully justified by a comprehensive risk assessment and submitted to the appropriate IE for a Technical Assessment in accordance with Chapter 9.
- (3) Suitable personnel test instrumentation (HAPTM) shall be available at the point of entry/exit to the controlled area.
- (4) Within the controlled areas the appropriate controls shall be followed (see checklist below).

14.1.2 When the fabric of a building/room provides a Conductive Regime, but the building is required to process explosive natures that require an Antistatic Regime or an uncontrolled electrostatic environment, it is not necessary to fully maintain all features of the Conductive Regime but rules for testing and maintaining conductive floors still apply.

14.1.3 Mixed electrostatic regimes within the same room or building raises concerns over the use of mains powered portable electrical equipment. Therefore, any such equipment used within the zoned area, or within arm's reach of the zoned area, shall be protected, as per the requirements of Section 16. This will reduce the risk of electrocution resulting from the use of defective non-Class II equipment within a Conductive Regime.

14.1.4 Such a mixed arrangement will be complex and will require the site to carefully control the transition from and back to the Conductive Regime. A checklist is provided below to assist:

- (1) Flooring
- (2) Conveyor belts
- (3) Bench tops
- (4) Chairs
- (5) Containers
- (6) Seat covering material
- (7) Footwear
- (8) Outer clothing
- (9) PPE
- (10) Donning and removal of outer clothing
- (11) Exclusion of insulators
- (12) Grounding of conductors
- (13) Relative humidity
- (14) Processing of primary explosives
- (15) HAPTM testing

15. TEST METHODS FOR FOOTWEAR AND CONVEYOR BELTS

15.1 For Conducting/Antistatic Footwear

15.1.1 The electrical properties of footwear will be tested by the manufacturer prior to distribution. Thereafter, the user shall use an appropriate HAPTM to confirm the acceptability of the combined resistance of person, footwear and floor. This check also confirms that the footwear's electrical performance has not degraded significantly. As a consequence, there is no need for an annual footwear resistance test.

15.2 For Conveyor Belts

15.2.1 Each surface of conveyor belting used for the movement of static sensitive explosives substances or articles shall be tested in accordance with BS EN ISO 284. Notwithstanding, the maximum acceptable resistance is 100 k Ω rather than the 300M Ω specified within the standard.

16. PERSONNEL SAFETY

16.1 Residual Current Devices


16.1.1 Residual Current Devices to BS EN 61008-1, rated at 30mA or below, shall be fitted to all multi-use socket outlets up to 20A within explosives storage and process buildings.

16.1.2 Sockets for the use of mobile outdoor equipment up to 32A shall be protected by an RCD.

16.1.3 Within facilities where either Antistatic or Conductive Regimes are employed it is essential that personnel are protected from lethal electric shock by appropriate measures.

16.1.4 RCD protection cannot be omitted unless a fully documented risk assessment is carried out and the omission justified by a competent person and subsequently agreed with those responsible for site safety.

16.2 Mains Powered Electrical Equipment Safety

16.2.1 Mains powered portable equipment²² used by a person standing on the conducting floor shall be double insulated to comply with BS2754 Class II (marked ) or fed from a fixed Separated Extra Low Voltage (SELV) supply complying with BS7671. This applies equally to all users of the facility; (cleaning staff, maintenance staff or explosives process workers) and includes all electrical equipment.

16.2.2 The 'Conducting Locations with Restricted Movement' section of the IET Wiring Regulations shall also be complied with.

16.2.3 The electrical systems of all explosives buildings shall have an effective equipotential bonding system.

16.2.4 When conducting or antistatic flooring is installed a notice prohibiting unauthorised electrical equipment shall be displayed.

16.2.5 Earth Monitoring devices in accordance with BS4444 shall be fitted to fixed electrical equipment with a supply voltage of 400V and within arm's reach of a person stood on a conducting or antistatic floor.

17. EXPLOSIVES PROCESSING DURING FIELD DEPLOYMENTS, OUT OF AREA AND EOD OPERATIONS

17.1.1 In order to assure the safe use of explosives in the field, it is necessary to impose the same standards of Conductive and Antistatic Regimes detailed in this Chapter as far as is reasonably practicable.

18. COMMISSIONING, INSPECTION AND TESTING OF ELECTRICAL INSTALLATIONS AND EQUIPMENT

18.1 Commissioning, Inspection and Testing

18.1.1 Electrical installations shall be commissioned, inspected and tested in accordance with this Chapter and ESTC Standard 6.

18.1.2 Stores licensed for the sole purpose of Small Arms Ammunition (SAA) storage may alternatively be commissioned and subject to periodic testing in accordance with BS7671 and as such industry standard forms may be used instead of ESTC Standard 6, such as NICEIC forms. However, the frequency shall be as prescribed in ESTC Standard 6 for Category D buildings.

18.2 Safety Precautions during Commissioning, Inspection and Testing

18.2.1 No electrical testing to be carried out whilst explosives or hazardous materials are present in Cat A, B or C or DSEAR zoned processing facilities.

²² For definition of portable equipment see para 8.1

18.2.2 Storage facilities may be subjected to electrical testing with explosives present so long as suitable safety management arrangements are in place and risk assessments have been carried out and documented to show that explosives are not at risk from the activity. Site authorities shall endeavour however to remove explosives prior to electrical testing wherever practicable.

18.2.3 Safety in works services on the Defence Estate, use of safe systems of work and appointment procedures is to be in accordance with JSP 375 and JSP 482.

18.2.4 The protection and control of personnel (including contractors) working in MOD explosives areas are to be in accordance with JSP 482 Chapter 18 and agreed in conjunction with the Head of Establishment (HOE) Explosives Safety Representative (ESR). In particular the number of operatives on site and the period of their exposure should be limited.

18.2.5 No testing or inspections shall be made on an installation in an explosive building without prior approval and written permission from the Head of the Establishment, or his delegated Explosives Safety Representative and an appropriate Permit To Work (Explosives) (PTW(E)) issued in accordance with JSP 482 Chapter 18. A nominated person shall first check that it is safe for testing to proceed. The nominated person shall have sufficient specialist electrical safety knowledge to make the necessary judgments.

18.2.6 Electrical test equipment containing transmitters (eg for Bluetooth communication) shall be subject to the restrictions detailed within JSP 482 Chapter 24.

18.2.7 Inspection and testing in explosives facilities shall only be carried out by competent personnel who:

- (1) Have adequate knowledge of the relevant parts of MOD Safety Rules and Procedures (JSP375) and MOD Explosives Regulations (JSP482). Particular focus should be given to this Chapter and Chapter 24.
- (2) Are trained and competent in the principles of the various types of electrical safety protection as covered in JSP 482 and JSP375. Regular toolbox talks on electrical safety aspects of these documents are recommended.
- (3) Cat A or Cat B explosives facilities and DSEAR Zones shall only be tested and inspected by suitably competent technicians²³.
 - (a) Visual inspections may be conducted by personnel who have received suitable ATEX/DSEAR awareness training. (The AP19 Hazardous Area training course is deemed acceptable to meet this requirement although may be excessive for those who are not APs. Other ATEX/DSEAR awareness courses are available from accredited suppliers.)
 - (b) Close and detailed inspections may only be conducted by technical staff who are COMPEX qualified in the appropriate discipline. This applies to all sites (except those with only Cat D facilities) and applies to all staff employed to maintain the electrical systems within the explosives licensed area.

²³ Flammable atmosphere "Hazardous Areas" can only be maintained by competent staff as defined by BS EN 60079-17.

- (4) Hold the following electrical test and inspection qualifications:
- (a) City & Guilds 2382
- (b) City & Guilds 2391 OR City & Guilds 2394/2395

	Cat C & Cat D All maintenance activities	Cat A, Cat B & DSEAR Visual	Cat A, Cat B & DSEAR Close & Detailed
C&G 2382	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
C&G 2391 OR C&G 2394 AND 2395	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
COMPEX (or equivalent)			<input checked="" type="checkbox"/>
ATEX/DSEAR awareness training		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Table 8 – Qualifications required for electrical maintenance in explosives areas

18.2.8 All relevant local Health and Safety and Fire precautions shall be observed when entering explosives facilities including where appropriate requirements for:

- (1) Ventilation of inspection spaces.
- (2) Gas free certificates.
- (3) Personal protective equipment.
- (4) Safety harnesses and fall arrest devices.
- (5) Minimum occupation (normally 2 people).
- (6) Obstruction free and safe access and egress.
- (7) Familiarisation with escape routes.

18.2.9 Stacks of explosives or ammunition shall not be used in any circumstances as a work platform or to gain access.

18.2.10 The earth protective conductor shall be visually inspected before any electrical tests are carried out. All joints and conductive paths connected to the protective conductor shall be verified for their continuity in accordance with BS 7671. Confirmation of the protective earth conductor shall then be tested using heavy current earth loop tests in accordance with BS 7671 and as detailed in ESTC Standard No 6.

18.2.11 Opportunity should be taken to carry out inspections and testing when a building is free from explosives. However, if it is essential to test when explosive stores are present in the building (Category C or D only) the Head of the Establishment, or his

delegated Explosives Safety Representative shall ensure that the following safety precautions are taken:

- (1) A comprehensive Safety Management Arrangement has been documented in accordance with JSP375 Vol 3 Chapter 3.
- (2) No explosives are connected to the earth system of the building or group of buildings sharing the same incomer.
- (3) All explosives are in ESTC approved packs. No unsealed, exposed explosives or unboxed weapons are permitted in the area under test.
- (4) The distance between explosives (stacked or otherwise) and electrical conductors and equipment shall be kept to a maximum during the testing and on no account less than 1m. This is particularly relevant where wiring is run overhead.
- (5) Testing points for connecting instruments shall be well removed from ammunition or explosives and should preferably be outside the area.

18.2.12 On completion of testing, shorting resistors shall be connected to the network under test to dissipate any residual charge that may have built up. The shorting resistors shall be connected for a period of 30 seconds. This time shall be allowed to elapse before disconnecting the test equipment.

18.2.13 The installation shall be comprehensively checked during testing for visible arcing and sparking and immediately after testing to ensure no excessive heat, smoke or fire has occurred.

18.2.14 Immediately following testing all test equipment shall be removed from the explosives building.

18.3 Electrical Installations - Frequency of Inspection and Testing

18.3.1 To comply with Regulation 4(2) of the Electricity at Work Regulations, all electrical installation shall be appropriately maintained, inspected and tested. All electrical installations in explosives buildings shall be inspected for any visible signs of damage or deterioration at specified intervals. The periods between inspections may be shortened in areas where there is an increased risk of explosion or where the atmosphere is corrosive or where plant and installations may be subject to mechanical damage.

18.3.2 All electrical installations within the enclosed explosives area shall be inspected and electrically tested not less frequently than recommended in ESTC Standard 6.

18.3.3 All testing and recording of results shall be undertaken in accordance with the requirements of ESTC Standard No 6 and a Log Book²⁴ shall be maintained.

18.3.4 A record of tests, with the findings and any recommendations, shall be kept for comparison with future results for a minimum period of 11 years to aid the detection of deterioration; where deterioration is detected a written report detailing the defects shall be made to the HOE.

18.3.5 Details of the due dates of all electrical tests shall be posted on the facility notice board to enable the building users to quickly verify that the facility is safe to use. An example form can be found in ESTC Standard 6.

²⁴ ESTC Standard 6 details the requirements for PES logbooks

18.4 Flexible Cable Inspection and Test

18.4.1 Flexible cables can deteriorate quickly in an industrial environment; within an explosives process environment equipped with conductive and antistatic floors they can become an electrocution risk with potentially fatal consequences. Building managers/supervisors shall ensure that all flexible cables are inspected and tested as described below:

- (1) Flexible cables on portable, plug-in, electrical appliances shall be inspected monthly or prior to use. A Portable Appliance Test (PAT) shall be carried out every 6 months. (For the detailed requirements of PAT, refer to JSP 375).
- (2) Flexible cables on fixed electrical appliances fitted with an electrical interface plug in explosives building shall be inspected prior to use and inspected monthly, with a PAT test every 6 month.

18.4.2 Equipment shall be labelled to show when the next tests are due.

19. LIGHTNING PROTECTION

19.1 Introduction

19.1.1 Effective lightning protection measures shall be taken for buildings and structures used for the manufacture, processing, handling, and storing of explosives, ammunition, or explosive components.

19.1.2 Lightning protection shall also be provided for open areas of licensed sites where the continued presence of explosives exceeds 24 hours, unless the explosives fall into the NEQ and HD categories of Section 19.2 'Exclusions'. See Annex D section 6.1 for further details.

19.1.3 Adverse lightning effects can be caused not only by direct strike/attachment to the building, but also by indirect means such as a direct strike to anywhere on a conductive penetration entering or exiting the structure/facility.

19.1.4 Lightning presents a hazard to explosives in a number of ways, principally:

- (1) The energy of the voltage drop created by a lightning attachment could initiate some explosives or explosive devices directly.
- (2) The surface flashover or arcing of the generated current between conductive surfaces that are not at equipotential could initiate the explosives or explosive devices directly by heat, spark, and/or by any molten metal created by the arc.
- (3) The same arcing could cause fires in electrical circuits and equipment.
- (4) The lightning could initiate fires involving combustible materials in facilities.
- (5) Spalling generated by the heat of the current flowing through the structural components of the facility could initiate, by impact, unprotected exposed explosives and explosive devices.
- (6) The lightning electromagnetic pulse (LEMP) energy radiated from a lightning strike

19.1.5 The probability of a structure being struck by lightning is relatively low in the UK with a cloud-to-ground strike density of between 1 and 2 ground strikes per square kilometre per year. However, over a long period of time it is the product of these lightning strikes and the effective collection area of the MoD's explosives estate which dictates that over time the risk of an explosives building being struck by lightning ceases to be tolerable.

19.1.6 BS EN 62305 'Protection Against Lightning', Part 2 details the methodologies for assessing exposure risk from lightning, nevertheless, structures with inherent explosive risks require the highest possible class of lightning protection, which is defined as 'Class 1' within the BS. As such lightning protection systems for all explosives licensed buildings, not covered by the exemption list in Paragraph 19.2, shall be designed in accordance with the requirements set out in BS EN 62305 for a Class 1 LPS.

19.1.7 Additional requirements are also contained within the remainder of this Section and Annex D of this Chapter.

19.1.8 It is important to recognise that lightning protection can be inherent in the structure or building design. E.g. Structural steel or reinforced concrete structures where the electrical connectivity of all conducting elements has been assured. Externally applied LPS to such structures or buildings provide only little additional protection to the contents albeit that to minimise the risk to some critical assets, or to provide additional lines of defence, their installation may still be necessary.

19.1.9 Protection from lightning induced hazards can best be achieved by installing an isolated LPS (e.g. catenary system) or by enclosing the explosives in an interconnected network of electrical conductors similar to a 'Faraday Cage', such that the exterior fields, currents, and voltages are shielded out. This would typically be provided by reinforcing bars of a cast in-situ RC structure where the bars are fully bonded (roof to walls to floor) and have deliberate earth connections.

19.1.10 The use of relatively widely spaced steel stanchions to provide a shield is effective at protecting the building structure from direct lightning strikes but does not prevent magnetic fields penetrating the building, as such additional measures may be required to protect contents from these fields. Annex D provides additional information for steel framed buildings.

19.1.11 All methods of LPS will require a system of equipotential bonding and minimum separation distance from the boundaries of the structure to the explosives assets as detailed in Paragraph 19.3 below.

19.1.12 If a lightning storm has been in the area and it is believed that a building has been struck then a detailed visual inspection of the LPS shall be carried out as a matter of priority.

19.1.13 Unconventional LPS such as early streamer emission (ESE) and charge dissipation systems are strictly prohibited.

19.2 Exclusions

19.2.1 The installation of dedicated lightning protection systems may be omitted for the types of building listed below. Note - facilities listed below may require Surge Protective Devices (SPD) to be installed on incoming and outgoing services in accordance with Para 20 below.

- (1) Explosives stores sited underground to a significant depth; exclusion from provision of a LPS shall be with agreement from the licensing authority.

- (2) Explosives stores licensed under an Authorised Quantity (AQ) 25kg or AQ SAA only Licence (see Chapter 10) for explosives secured in approved containers (FSSP).
- (3) An AQ EOD garage that is purely a garage and has no explosives storage within another area of the building.
- (4) Facilities and buildings containing only HD1.4 small arms ammunition (see Chapter 10 Sect 8) in approved containers, or other explosives assets that cannot be ignited by lightning or its indirect effects e.g. Unprepared Iron Bombs with liners stored in open bays.
- (5) ISO containers of all welded construction and where all metal work complies with the requirements of BS EN 62305 Table 3, or those where the frame and all panels are electrically bonded using heavy duty bonding straps 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 (electrodes). The DC resistance to earth at any point of the ISO container shall be less than 10 ohms. ISO containers not designed to this standard require further lightning protection preferably via an overhead catenary system. Chapter 11 Annex C Appendix 4 gives more information on lightning protection principles for field deployment. ISO containers used as long-term storage facilities particularly in theatre shall be tested at 11-month intervals and the results recorded on the appropriate ESTC Standard 6 record sheets. Note that the separation distance for packaged explosives within ISO containers may be reduced from 500mm to 150mm where the construction meets these requirements.
- (6) NATO Hardened Aircraft Shelters (HAS). While HAS do not include metallic air termination networks the structures have been designed to withstand lightning strikes and do not require an additional air termination network to be fitted. HAS earthing electrodes shall however still require to be tested in accordance with ESTC Standard 6²⁵.
- (7) RUBB Shelters will generally not require additional LPS so long as the following requirements are met:
 - (a) DC resistance from the top of the structure to the base of each supporting leg is below 0.5 Ohms
 - (b) Spacing between legs are no greater than 10m apart, and legs are earthed at a maximum of 10m spacing on each side of the structure.
- (8) Minor processing facilities (as defined by JSP 482 Chapter 10 Section 8) unless the loss of the contents of the PES is operationally unacceptable and there is not an undue risk to personnel in the PES.

19.2.2 Facilities excluded from requiring lightning protection, but which still have a legacy system installed (e.g. due to a change of use) shall maintain the legacy system in accordance with ESTC Standard 6 or remove it.

19.2.3 There are no exclusions for structures or facilities used for the manufacture, processing (except minor processing), or out of container handling of explosives.

²⁵ HAS earthing networks vary in design, some utilising only buried earth rings with no earth rods. For HAS with these earthing designs, the installation of earth rods is not required while the building passes its full LPS fall of potential earth resistance test.

19.3 Internal Lightning Protection Installation & Separation Distances

19.3.1 All structures and buildings used for storage or processing of explosives shall have an internal lightning protection installation, which provides a means of equipotential bonding to metallic structures and/or components. Such a system is required to avoid the occurrence of dangerous flashover/sparking within the structure to be protected due to the lightning current flowing in the external LPS or structural steel components. Sparking occurring between the external LPS or structural steel and the metal installations, the external conductive parts or lines entering the structure, shall be considered dangerous.

19.3.2 Dangerous sparking shall be avoided by the use of equipotential bonding or insulation between the parts.

19.3.3 The following rules for electrical bonding shall be met:

- (1) Internal equipment/structures (including weapon stands) which are capable of carrying lightning currents shall be bonded to earth or electrically isolated from any other current carrying items by a suitable safe distance. Such a separation distance may be calculated using the methodology within BS EN 62305.
- (2) Where multiple items require bonding, the most practical solution is an Equipotential Bonding (EPB) strip run inside the building. The EPB strip shall be as low as possible on the walls, as close as practicable to the floor, and shall be bonded to the conductive/antistatic floor where installed. The EPB strip shall be lower than the item being protected wherever practicable.
- (3) The EPB strip shall be connected at one point only to the facility main earth bus bar. It shall not be deliberately connected to the LPS down conductors at any other point.
- (4) At doors/openings to buildings the strip shall be taken under the floor. Where the door frame is metallic this may be used for continuity. Where a strip has to be run over an opening no bonding connections to it shall be made above the opening.
- (5) Cables used to make bonds to the EPB shall be routed down the wall from the EPB and along the floor to the munition or stand. They shall not be taken directly to the munition/stand suspended or held above floor level (See Fig 2).
- (6) Munitions on test/assembly stands (and not insulated from the stand) shall not be directly connected to the EPB strip. They shall be bonded to the stand/trolley on which they are placed. The stand shall then be bonded to the EPB by a single connection from the lowest part of the stand as detailed above. Where a munition/sub-assembly is insulated from the stand and its size/position requires an equipotential bond a single connection to the EPB shall be made with the connecting cable run along the floor. Alternatively, where a weapon is insulated from the stand and connected to test equipment its bonding arrangement may be via the test equipment back to the facility earth, in which case additional EPB bonding shall not be made. The guiding principle in any bonding arrangement shall be to achieve a single bonding connection which avoids earth loops.
- (7) Connections to antistatic/conductive floors shall continue to be made in the correct manner as described in Para 11.5.
- (8) In storage areas equipotential bonding of munitions/items is not required where they are in their approved containers/packaging.

- (9) Racking in storage areas which are exempt from the installation of a lightning protection system do not need to be bonded.
- (10) All conductive penetrations²⁶ of an explosives facility shall be made as close to the ground as possible.
- (11) Within new facilities, conductive penetrations shall be buried for 15m prior to entering building, they shall enter the building as close to the ground as possible and be bonded to the external LPS (or to rebar if the structure is reinforced concrete) at the point of penetration.
- (12) For existing facilities (undergoing a midlife upgrade or substantial remedial work) with conductive penetrations, an insulating Section shall be installed at the point of penetration (if practicable) with an external bond to external LPS and an internal bond to the EPB.
- (13) For existing facilities with conductive penetrations where an insulating Section is not feasible, bond to external LPS (or RC structure) only, unless the penetration is connected directly to an explosives assembly (e.g. a test waveguide or HP gas tube) in which case it shall also be connected to the internal EPB.
- (14) If there are penetrations which connect directly to an explosives assembly, they shall be subjected to close scrutiny regards their essentiality and the way in which they are connected/bonded.
- (15) Equipotential bonding of internal metal work may be needed even when the external LPS is not required as defined by the exclusions in Para 19.2.

19.3.4 The following rules for electrical insulation shall be met:

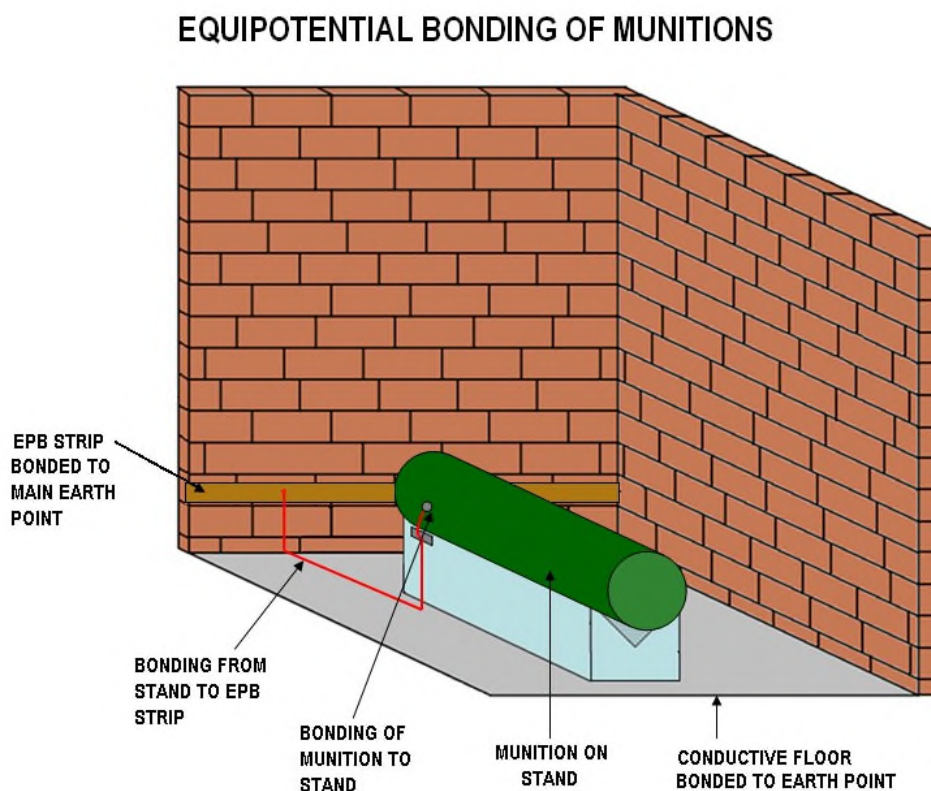
- (1) **Process Buildings:** Process buildings should maintain a separation distance of a least 500mm between OME and current carrying components²⁷ of the facility (including the LPS, all bonded items and metallic service pipes/conduits). Permitted exceptions are:
- (a) Explosives placed on benches or stands that are bonded in accordance with this chapter
 - (b) Excluding bonded benches and stands discussed above where 500mm cannot be achieved a bespoke separation distance should be calculated for each nature authorised to be processed within the building. The calculation is to be in accordance with BS EN 62305 and is to form part of the risk assessment for the specific activity. Further guidance on this is given in ST/0094 which can be obtained from the Defence Ordnance Safety Group ST3.
- (2) In processing areas particular care shall be taken to ensure the separation distance between OME and current carrying items is measured from metallic objects connected to the walls (such as test equipment, metallic stands and vent outlets/inlets which do not have insulating Sections).

²⁶ Conductive penetrations are pipes, sheathed cables, conduits, waveguides, rods that pass through the wall of the structure. They have the potential for conducting lightning current into the building.

²⁷ Current carrying components may be present internally, externally or embedded within the walls or roof. Typical examples are reinforced concrete walls/pillars, air termination mesh conductors fitted to the roof, down conductors or electrical conduit fitted to walls.

(3) **Storage Buildings:** A minimum separation distance of 500mm should be maintained between the outer surface of explosives packages and external/structural walls, support pillars and roof. The only permitted exceptions are:

(a) Provided a minimum separation distance of 500mm is maintained between explosives packaging and any current carrying components (including LPS, metallic pipes, wiring conduit, re-bar etc) a distance down to 150 mm may be applied to other areas. In buildings where mixed separation distances are applied a diagram indicating the position of all current carrying components, approved by the licensee, is to be posted in the building, and the separation distance required clearly marked on the floor. Where 150 mm is applicable to the whole building authorisation for its use shall be given in standing orders or other work instructions.



(b) When the only explosives in the building is correctly packed SAA of HD 1.4.

(c) A minimum separation distance of 150 mm is required

(d) Lockers licensed under Chapter 10 Section 8. The separation distance should be as great as reasonably practicable.

(e) When explosives are packed in containers larger than the standard NATO pallet and it is impractical to apply the 500mm separation distance. A bespoke separation distance should be calculated for each nature authorised to be processed within the building, in accordance with BS EN 62305. The calculation is to form part of the risk assessment for the specific activity.

(f) Where an ISO container is used for the storage of OME and is earthed in accordance with 18.2.1(5); in this instance a separation distance of 150 mm is suitable assuming a maximum internal stack height of 2m.

(4) When assessing if to apply separation distances below 500mm it should be recognised that as well as providing protection against flashover the 500mm distance allows reasonable natural air flow around stacks and good access for inspections.

(5) Notwithstanding (3) above, where stack heights are required to be greater than 4m the separation distance shall be increased to 0.75m or, if higher than 5m, the distance shall be determined by calculation using the method within ST/0094.

19.4 Control of Hazard to Personnel

19.4.1 The risk of lightning striking a building and causing a hazard to its contents can never be reduced to zero even with the installation of a fully compliant LPS and therefore cannot ensure that an explosive event will not take place. It is therefore essential to provide for the evacuation of personnel from an explosive site should a thunderstorm be imminent. All sites should have a clearly defined response to lightning hazards that includes an evacuation plan that provides for making safe the munitions and securing and electrically isolating the evacuated facilities. The entire procedure shall be exercised at least annually.

19.4.2 All sites with explosives processing and storage facilities are to have a mechanism in place which provides a 30-minute warning of approaching thunderstorms. This may be external to the site such as a nearby MET office or another MOD site. Sites with mass storage are however encouraged to install an onsite early warning system.

19.5 Making Safe Explosive Facilities In Event of lightning Activity Warning

19.5.1 Process Facilities:

- (1) Stop work.
- (2) Disconnect (if time permits) electrical test equipment from explosives assemblies.
- (3) DO NOT deliberately earth explosives assemblies but ensure that they are at least the required separation distance from the walls and all current carrying components of the facility.
- (4) Close windows, doors, and vents and re-package explosives, if possible.
- (5) Switch off electricity from outside.
- (6) Evacuate to a safe location.

19.5.2 Storage Facilities:

- (1) Stop work.
- (2) DO NOT deliberately earth explosives assemblies but ensure that they are least the required separation distance from walls and all current carrying components of the facility.
- (3) Close windows, doors, and vents.
- (4) Switch off electricity.
- (5) Evacuate to a safe location.

19.5.3 Open Storage Areas:

- (1) Stop work.
- (2) Cover and re-pack unprotected explosives if time permits.
- (3) Evacuate.

19.5.4 Stabling/Marshalling Areas:

- (1) Stop work.
- (2) Road and rail vehicles to be placed under cover if possible.
- (3) Evacuate.

20. SURGE PROTECTION OF ELECTRICAL AND ELECTRONIC SYSTEMS IN EXPLOSIVES FACILITIES

20.1 Details

20.1.1 Surge Protective Devices (SPD) shall be fitted to all new buildings licensed for the storage or processing of OME unless a risk assessment has identified that, considering the susceptibility of the items to be stored or processed to induced currents generated by natural (lightning etc) or man-made disturbances, it is not reasonably practicable to do so.

20.1.2 In deciding if SPD are to be omitted, in addition to the cost of the installation, the following should be considered:

- (1) The on-going cost of maintaining the validity of the risk assessment over time and if building requirements/purpose change.
- (2) The reduced flexibility of the facility. Prior to the storage or processing of a new item the risk assessment will need to be reviewed.
- (3) The general principle of risk management and the hierarchy of control. An engineered control measure (fitting SPD), provided it is reasonably practicable, is preferable to procedural control.

20.1.3 This decision should be made by a group of competent individuals and agreed by all parties including the IE and risk duty holder. If the decision is taken to omit SPDs

from an installation, the justification must be fully documented and held locally for future reference.

20.1.4 SPD selection and installation shall comply with BS EN 62305-4.

20.1.5 Surge protection is a specialist technique that is beyond the scope of laypersons to specify or install. Only persons competent in the field shall design/install an SPD installation in explosives buildings.

20.1.6 Category D facilities, excluding AQ stores (see para 20.2) whilst not requiring LPS, are not automatically exempt from the requirement to fit SPD. Such facilities will often have metallic conductors entering the building (communications lines, lighting circuits etc.) and all such penetrations must be considered.

20.1.7 All electrical, electronic, control, and signal lines that enter or exit an explosive facility can conduct dangerous over-voltage and over-current transients into the volume that requires protection. The magnitude of the transient will in general be governed by the gauge or size and length of the cable, but all cables should be treated as potentially dangerous and therefore protected by appropriate devices that operate rapidly and safely conduct the transients to earth.

20.1.8 Where SPDs are fitted to an explosive building, they shall be installed on each electrical, electronic, control and signal line entering and leaving the LPS protected volume of explosives buildings, between the respective conductor and the building earth and/or Faraday cage at the conductor's penetration point (Type 1 and Type 2 devices). It may be necessary to provide additional surge protection and/or transient protection for sensitive equipment located in the protected volume of the building and electrical equipment located more than 10m from the main distribution board (Type 2 and Type 3 devices).

20.1.9 Earthing conductors leading from the SPD shall be kept separated from the circuit protective conductors. All earth leads shall be as short as reasonably achievable to minimise the inductance and consequential let-through transients. As a guide the earth leads should be no longer than 300mm of 16mm² diameter cable. Where significantly longer cables are unavoidable consideration should be given to providing additional down-stream surge protection. SPD earthing leads should also not pass near or behind RCDs as the associated magnetic fields produced by the surge may cause the RCD to trip.

20.1.10 In most situations for explosives processing facilities two or three tiers (coordinated SPDs) of protection will be necessary for the power systems.

20.1.11 Other electrical/electronic systems such as CCTV, telephone or control circuits will need separate consideration and specialist advice sought for appropriate surge protection devices.

20.2 Exclusions

20.2.1 New storage facilities licensed under Chapter 10 Section 8, Authorised Quantities (AQ), are exempt from the requirement to fit SPD. This is based on the fact that there is no permanent presence of people in such stores and the basic AQ principle that if the contents of the store are involved in a fire or are initiated there are no external effects when the store is closed buildings to be licensed under Chapter 10 Section 8, Authorised Quantities (AQ), are exempt from the requirement to fit SPD. This is based on the fact that there is no permanent presence of people in such stores and the basic AQ principle that if the contents of the store are involved in a fire or are initiated there are no external effects when the store is closed.

CHAPTER 8**ANNEX A****LIST OF RELATED REGULATIONS, STANDARDS AND CODES OF PRACTICE**

Health and Safety at Work etc, Act 1974 and regulations made there under

The Dangerous Substances and Explosive Atmospheres Regulations 2002 (SI 2002 No 2776)

The Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 2016 (SI 2016 No 1107)

The Low Voltage Directive (2014/35/EC)

The Electricity at Work Regulations 1989 (SI 1989 No 635)

The Management of Health and Safety at Work Regulations 1999 (SI 1999 No 3242)

The Electricity Safety, Quality and Continuity Regulations (ESQCR) 2002.

The Electricity Safety, Quality and Continuity Regulations (ESQCR) 2002 (SI 2006 No 2665)

The Explosives Regulations 2014 (SI 2014 No 1638)

The Provision and Use of Work Equipment Regulations (PUWER) 1998 (SI 1998 No 2306)

JSP 375	Management of Health and Safety in Defence
DEF STAN 07-085	Design Requirements for Weapon and Associated Systems
DEF STAN 59-411	Electromagnetic Compatibility
DEF STAN 59-114	Safety Principles for Electrical Circuits in Systems Incorporating Explosive Components
BS EN 60079 series	Electrical Equipment for Explosive Atmospheres
BS EN 61340 series	Electrostatics
BS 7430	Code of practice for Earthing
BS 7671	Requirements for electrical installations :2018, IETV IEE Wiring Regulations: 18 th Edition
BS EN 62305	Series Protection against lightning

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CHAPTER 8**ANNEX B****REQUIREMENTS FOR AUTOMATIC TEST SYSTEMS (ATS)
FOR ALL-UP-ROUND TESTING AND SECTION TESTING****CONTENTS**

Paragraph

1 REQUIREMENTS FOR AUTOMATIC TEST SYSTEMS (ATS) FOR ALL-UP-ROUND TESTING AND SECTION TESTING

- 1.1 Introduction
- 1.2 Definition
- 1.3 Acceptance
- 1.4 Safety and Monitoring (S&M)
- 1.5 General Requirements
- 1.6 Electromagnetic Compatibility (EMC)
- 1.7 Safety Features
- 1.8 Performance Characteristics
- 1.9 System Requirements
- 1.10 Software

1.1 Introduction

1.1.1 The PT or equipment provider is responsible for compliance with these regulations but may employ a competent third party to provide safety assurance. Notwithstanding this, the Original Equipment Manufacturer is responsible for demonstrating that the test equipment is safe according to all relevant legislation; this is a legal requirement.

1.1.2 ATS shall comply in full with the requirements of this Annex and the relevant parts of the main Chapter for the electrical category of the explosives building.

1.1.3 It is imperative that the requirements are understood and agreed early in the project lifecycle to ensure that the Duty Holder is not forced to accept noncompliant equipment resulting in costly mitigations.

1.2 Definition

1.2.1 The term Automatic Test System (ATS) applies to the whole integrated test system i.e. from the energy supply (electrical, pneumatic, or hydraulic) within the facility to the weapon interface.

1.2.2 The equipment design shall meet all European and UK Statutory Legislation and Ministry of Defence Policy.

1.2.3 ATS are designed to determine the serviceability of an All Up Round (AUR) and a Section Under Test (SUT). It is a piece of test equipment that supplies stimuli to and monitors responses from the AUR and SUT. It is normally computer controlled and often uses instrumentation designed around industry standard such as VXI Plug & Play. ATS includes the test fixtures and/or stands that may also include active components.

1.2.4 Automatic Test Equipment (ATE) System Software shall provide the basic controlling function of the ATE. This software shall also provide the operator Graphical User Interface (GUI).

1.2.5 ATE Application Software is that software specifically designed to control the test sequence for a particular AUR and SUT.

1.2.6 If designed to test an AUR or a SUT, the ATS shall ensure that:

- (1) Operator safety and ordnance explosive Safety shall not be compromised.
- (2) The facility is not subjected to an intolerable risk.
- (3) The weapon system is in a known safe state after test.

1.3 Acceptance

1.3.1 The equipment Duty Holder has the responsibility for accepting the equipment into service and any residual risks associated with the ATE. Such acceptance should be based upon evidence from the OEM and advice and guidance from subject matter experts as required.

1.3.2 The site(s) Head of Establishment(s) where the equipment will be operated will also have to accept the equipment and any residual risks as the equipment is installed, used and maintained within his/her domain. Due to specific environments residual risks may evolve and new risks emerge.

1.3.3 A competent third party can provide assistance to the Duty Holder but cannot accept the equipment or any risks associated with it, this is the responsibility of the Duty Holder.

1.4 Safety and Monitoring (S&M)

1.4.1 If an ATS is used within an Integrated Weapons Complex (IWC), the ATS shall interface with the IWC Safety and Monitoring System (S&M) and Common Isolation Device (CID).

1.4.2 If an ATS is used within a Non-Explosive Workshop (NEWS) a full Hazard and Operability Analysis (HAZOP) shall be conducted to determine if an S&M is required.

1.4.3 Safety shall be by design and not by procedure.

1.4.4 The probability of a hazardous event occurring shall be As Low As is Reasonably Practicable (ALARP) but shall not be greater than 1 in 10^6 per test throughout the service life of both the weapon and test equipment. This safety standard shall be maintained for all forms of AUR testing of weapons irrespective of whether the testing is conducted when the AUR is adjacent, loaded to a launch platform, or in base or depot facilities.

1.5 General Requirements

1.5.1 The recommended test configuration shall be for remote personnel operation.

1.5.2 In the event of alongside testing (people alongside the weapon under test), in any form, the requirements of Def Stan 07-85 shall be invoked.

1.5.3 All ATS and SUT power supplies shall have automatic control facilities to protect against 'Over Current' and 'Under Current' conditions.

1.5.4 All ATS and SUT power supplies shall have automatic control facilities to protect against 'Over Voltage' and 'Under Voltage' conditions.

1.5.5 It shall not be possible for the ATS to restart after power down or an interruption without manual intervention.

1.5.6 When safety functions are controlled by software, then such software shall be deemed safety critical and treated in accordance with Def Stan 00-55 and JSP 454.

1.5.7 When pre-set overload levels have been exceeded, a safe power-down of the AUR or SUT shall take place.

1.5.8 Adapter or "breakout" boxes shall not to be included in the ATS design.

1.5.9 Personnel RADHAZ risk and mitigation shall be in accordance to JSP 375 Volume 2 Leaflet 37 and JSP 392 Radiation Safety Handbook.

1.5.10 Earthing and Grounding of the ATS shall be in accordance to JSP 482 Chapter 8.

1.6 Electromagnetic Compatibility (EMC)

1.6.1 The ATS shall meet the European Directive and UK Legislation and include the requirements of JSP 482 Chapter 8 titled EMC and Ordnance Munition Explosive (OME) RADHAZ.

1.6.2 The EMC test shall include all cables and any Common Isolation Device (CID) used in the test system.

1.6.3 The EMC demonstrations shall test the ATS in self-test configuration in wrap back mode.

1.7 Safety Features

1.7.1 A Safety Case shall be provided to the authority before the installation and commissioning of the equipment.

1.7.2 The design of the equipment shall be such that when installed, used and maintained in accordance with the manufacturers' instructions it will not present an intolerable hazard to the operator, maintainer, AUR, SUT, or the facility.

1.7.3 No safety feature shall be based on the assumption that knowledge of the equipment is held beyond that contained in the relevant equipment handbooks or screen prompts.

1.7.4 The ATS shall be designed to be more than one fault safe (i.e. at least 2 independent faults shall occur to cause a personnel, fire or explosion hazard).

1.7.5 Multiple faults, which are produced by a common event, shall be treated as a single fault condition.

1.7.6 The overall probability of a hazardous event occurring shall be shown to be less than 1 in 10⁶ per test (whether individual block or full test).

- 1.7.7 It shall not be possible to apply energy to any un-terminated cable or hose.
- 1.7.8 During the test sequence, the protection devices are to be programmed to follow the current and voltage profile of the AUR or SUT continuously.
- 1.7.9 Performance of safety features of the ATS shall be adequately verified by test/maintenance procedures applied to the complete system.
- 1.7.10 Electro Explosive Device (EED) shall not to be automatically tested by the ATS.
- 1.7.11 EED test system shall comply with Def Stan 07-85.
- 1.7.12 Safety systems, which protect EEDs, shall not to be compromised by the ATS.
- 1.7.13 If any protection or safety devices are overridden during AUR or SUT testing, the associated risks are to be identified, assessed and quantified.
- 1.7.14 A technical construction file, including all safety documentation, EMC test reports etc shall be provided to the Authority.
- 1.7.15 No energy hazards, (e.g. exposure to live parts, high pressure or hazardous substances) are to be presented to the operators or maintainers. Movement of test beds via remote operation or maintenance shall be indicated in the appropriate documentation.
- 1.7.16 It shall not be possible for ATS interconnections to be incorrectly configured.
- 1.7.17 The ATS design shall ensure that:
- (1) No radioactive hazards with an accessible level of > 5 micro Sieverts/hr.
 - (2) No electrostatic discharge hazards exist to itself or the AUR or SUT.
 - (3) No toxic risks.
 - (4) No light and near light radiation hazards (e.g. from lasers etc.).
 - (5) No radio frequency hazards.
 - (6) No acoustic hazards to AUR or SUT or personnel.

1.8 Performance Characteristics

- 1.8.1 All energy supplies to an AUR or SUT are to be subjected to a monitor on their permitted current profiles at each test stimulus or measurement parameter change.
- 1.8.2 All power supplies to an AUR or SUT are to be subjected to a monitor on their permitted voltage profiles at each test stimulus or measurement parameter change.
- 1.8.3 A masking period to allow for settling and switching transients is to be permitted provided the required Safety Analysis criteria are met.
- 1.8.4 Emergency stop or cancelling devices are to be of a manual reset type and visible external to the cabinets.
- 1.8.5 Emergency stop or cancelling devices are to be adjacent to the specified operators control position and on any portable element of ATS.

1.8.6 The operator is to have the ability to monitor any necessary displays from the normal operating position.

1.8.7 When used in the 'Automatic' mode all accessible manual controls of the ATS(s) with the exception of the emergency power off button and the Abort Keyboard Key shall be 'locked out' or otherwise made inoperative.

1.8.8 ATS cabinets shall be protected by thermally operated cut-outs such that when the safe operating temperature is exceeded a controlled power down occurs.

1.8.9 Automatic operation shall allow the full range of tests to be carried out without exceeding the AUR or SUT thermal limits as specified in the Production Acceptance Specification (PAS) or Maintenance Acceptance Specification (MAS).

1.8.10 The ATS shall be capable of conducting ATS self-tests and checks up to and including the AUR or SUT interface connectors.

1.9 System Requirements

1.9.1 All ATS energy supplies shall be supplied from a single source through a single connector (or hard-wired).

1.9.2 The ATS shall not interfere with the operation of site fitted RCDs.

1.9.3 The following Fire protection policy is to be adopted:

(1) All ATS cabinets located in the explosives test room alongside the AUR or SUT shall be integrated into the facility fire detection and fire protection system (S&M).

(2) Where practicable, fire detection and fire protection shall be fitted to all ATS cabinets.

1.9.4 All sources of energy available to the AUR or SUT shall pass through a Common Isolation Device (CID). This demonstrably high integrity device shall be capable of isolating all energy supplies from the AUR or SUT in the event of an automatic or manual instruction to disconnect the AUR or SUT from the ATS.

1.9.5 Transient over voltage and surge suppression devices shall be installed in the mains input system of all ATS.

1.9.6 The zero-volt lines within the ATS are to be regarded as signal lines and are not to be used as the protective earth conductor.

1.9.7 Connectors are to be so designed or arranged that damage by incorrect mating or interconnection is not possible, and that a positive lock can be achieved.

1.9.8 All connectors shall be provided with metal or static dissipative captive protective end caps to ensure against mechanical or Electrostatic Discharge (ESD) damage whilst not connected to the SUT.

1.9.9 ATS cables and/or equipment entering, passing through or residing in explosives test facilities shall comply with the requirements of this Chapter.

1.9.10 The ATS is to be designed so that in the event of any type of power-down:

- (1) Damage is not caused to the AUR.
- (2) Damage is not caused to the SUT.
- (3) Damage is not caused to the ATS.

1.9.11 All power up and power down sequencing is to be controlled automatically by the ATS.

1.9.12 Before making any electrical connections to the AUR or SUT, the ATS shall ensure that all power supplies used by the ATS, AUR or SUT are within the parameters specified in the Test Specifications.

1.9.13 The ATS must not apply power to the AUR or SUT until the ATS initialisation is complete.

1.9.14 Powering Down of the Test Equipment must first ensure that the AUR or SUT is powered down in a controlled manner and then power itself down, again in a controlled manner.

1.9.15 Any special sequencing is to be automatically controlled by the ATS and must not require operator intervention during either power up or power down.

1.9.16 In no circumstances are the AUR, SUT or the ATS to be left in an unsafe or undefined state following power down.

1.9.17 Power down as a result of self-monitoring must not damage the AUR, SUT or ATS.

1.9.18 It must not be possible for an automatic restart to occur following a power down.

1.9.19 When the ATS detects a potentially hazardous condition in itself it must, in the order stated:

- (1) Remove all power supplied to the AUR or SUT within 1 second.
- (2) Perform a power down of itself and not re-start.

1.9.20 If the ATS detects a potentially hazardous condition in the AUR or SUT, all power is to be disconnected from the AUR or SUT immediately. NOTE: Power is to not be reapplied until the state of the AUR or SUT is established and be by manual intervention only, i.e. not automatic

1.9.21 If the power supplied to the ATS falls outside the specified limits the ATS must perform a controlled Power Down.

1.9.22 ATS power-down must also take place in response to operation of the manual emergency stop buttons.

1.10 Software

1.10.1 The executive and test software is to be produced to the following standards:

- (1) Software Structure - JSP 188 (To be incorporated into JSP(D) 543 – Defence Technical Documentation - Policy and Requirements.)
- (2) Software Content - DEF Stan 00-52.
- (3) Guide to the Achievement of Quality Assurance of ATE Test Software BS7165.
- (4) Safety related ATS control software, DEF Stan 00-56.

1.10.2 An integrity check shall be automatically carried out on all software immediately prior to that software being used.

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CHAPTER 8**ANNEX C****REQUIREMENTS FOR ENCLOSURES FOR CATEGORY C ELECTRICAL
INSTALLATIONS AND EQUIPMENT****CONTENTS**

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- 1.1 Introduction
- 1.2 Construction
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2 SCHEDULE OF TESTS

- 2.1 Test No 1
- 2.2 Test No 2
- 2.3 Test No 3

Table

C-1 Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)

1. GENERAL REQUIREMENTS**1.11 Introduction**

1.11.1 The following requirements have been prepared for the selection of electrical equipment for use in Category C explosives buildings.

1.11.2 The requirements are based on enclosures without ventilation openings which need not necessarily be airtight, but which shall be built to comply with the construction requirements and type tests in the following Paragraphs.

1.11.3 The protection against ingress of solids provided by the enclosures is to comply with the requirements of BS EN 60529, IP 4X or equivalent.

1.11.4 The surface temperature of electrical enclosures is not to exceed those temperatures defined in Para 6.4 of this document appropriate to the electrical category of the building.

1.11.5 Equipment shall meet the EMC requirements of Section 6.6 of the main text in this Chapter.

1.12 Construction

1.12.1 Construction requirements are:

(1) Enclosures may be metal or plastic (if used in static controlled areas see Section 11 to 14 of this Chapter).

(2) All materials used in the construction (including inspection windows and light transmitting parts) shall resist the propagation of flame.

(3) Transparent covers (including inspection window and light transmitting parts) may be glass or plastic, providing they comply with this annex. They are to be positively secured to the main enclosure.

(4) Enclosures are to be provided with compliant (IP4X or equivalent) conduit and/or cable entries.

1.13 Tests

1.13.1 The tests are to be type tests and are to be made on a representative enclosure in new condition. It shall pass all specified tests and is to satisfy those requirements that can be checked only by inspection. The tests are to be carried out at an ambient temperature of 25°C +/- 5°C.

1.13.2 Manufacturers shall have the appropriate ISO 9000 accreditation and shall certify that production equipment complies with the specification against which the type tests were conducted.

2. SCHEDULE OF TESTS

2.1 Test No 1

2.1.1 Protection against the ingress of foreign bodies as detailed in BS EN 60529, IP 4X. This is a test made with a steel wire of 1mm diameter. The test is satisfactory if the wire cannot enter the enclosure.

2.1.2 Note, for equipment which require gaps in their enclosure greater than 1mm to enable them to function e.g. smoke detectors, an IPXXD rating is acceptable.

2.2 Test No 2

2.2.1 Enclosures, including light transmitting parts, are to withstand the impact energies required to meet the IK ratings specified in Table C-1, as defined in BS EN 62262.

2.2.2 Each impact is to be made using the apparatus described in BS EN 600682-75.

Component	IK Code to BS EN 62262
1. Guards, protective covers, fan hoods and cable entries	IK 08
2. Plastic enclosures	IK 08
3. Light metal or cast metal enclosures.	IK 08
4. Enclosures of materials other than above with wall thickness of less than 1mm.	IK 08
5. Light transmitting parts without guards.	IK 07
6. Light transmitting parts with guards.	IK 06

Table C-1: Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)

2.2.3 The enclosure is to be tested when it is fully assembled and mounted on a rigid base. When the plane of the impact is to be altered the base should be moved to achieve the desired new position.

2.3 Test No 3

2.3.1 Drop one sample of the portable equipment²⁸ (equipment that may be hand carried) electrical apparatus, in the most unfavourable attitude, four times from a height of 1m on to a concrete surface. The integrity of the apparatus enclosure is not to be impaired after this test. The equipment need not necessarily be functional after the test.

²⁸ This test should be conducted by the designer/supplier and if the item is high value/low population equipment could be proven by testing of a dummy device or simulation.

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CHAPTER 8**ANNEX D****LIGHTNING PROTECTION SYSTEMS****CONTENTS**

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 - 2.3 Surface Mounted Air Termination
 - 2.4 Reinforced Concrete Structures & Steel Framed Buildings with Metallic Cladding
 - 2.5 Suspended Air Termination Network (Catenary System)
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- 1 Illustrations of Typical Lightning Protection Systems

1. GENERAL REQUIREMENTS

1.1 Introduction

1.1.1 The purpose of a lightning protection system (LPS) 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 isolated LPS; integral meaning attached to the building or utilising parts of the building structure, and isolated meaning an electrically separate LPS which is not fixed to or part of the building structure.

1.1.2 In general these regulations draw on the requirements for a Class 1 LPS as defined in BS EN 62305, however where there are differences between the BS EN and this standard, JSP482 shall take precedence.

1.1.3 It is important to note that no design of LPS can be guaranteed to give total immunity from damage by lightning discharge, however an LPS utilising a Faraday cage type design, together with a suspended air termination is considered to provide the greatest degree of protection when all other measures such as surge protection and equipotential bonding have been taken.

1.1.4 To this end an isolated²⁹ lightning protection system shall be used for all facilities of highest risk, i.e. all processing facilities and storage facilities containing explosives sensitive to electrical induction, or thermal or mechanical shock, or where the consequences of an explosion may be very serious.

1.1.5 For storage facilities, the isolated lightning protection system will offer the best protection and shall be the preferred option for any new facility. However, if the facility offers inherent lightning protection (such as reinforced concrete or steel frame) or installing an isolated system is not cost effective then a non-isolated LPS may be used.

1.1.6 This annex shall be read in conjunction with Para 19 of this Chapter which provides additional information and guidance on the selection and installation of lightning protection systems (LPS).

2. DESIGN REQUIREMENTS

2.1 General

2.1.1 The main component parts of an LPS which are described in detail in this Annex are:

- (1) Air Termination Network (ATN).
- (2) Down Conductors.
- (3) Earth Termination Network.
- (4) Test Joints and Bonds.
- (5) Surge Protection Devices (SPD)

²⁹ An isolated LPS, as defined within BS EN 62305, is one whereby the air termination system and down conductor system are positioned in such a way that the path of the lightning current has no contact with the structure to be protected until the point it reaches a common earth point.

2.1.2 Modern facilities use metal extensively in their construction and there is considerable benefit in utilising such metal parts to maximise the number of parallel conducting paths providing a surface mounted air termination system and earthing termination network is included. For example, properly bonded reinforcing bars in a R/C facility can be used as down conductors, and steel roof cladding may be used as the LPS air termination provided a minimum gauge of metal is used³⁰.

2.1.3 The LPS and the means of fixing it should be effective, simple, rugged, and permanent, and as far as possible, accessible for testing and maintenance; this is particularly applicable to earth termination networks which are hidden from view.

2.1.4 The use of unnecessary clamp connectors, which are liable to be disconnected, shall be avoided. Such connectors shall only be used where it is necessary to disconnect for test purposes.

2.1.5 The main danger posed by unbonded structural metal or metal cladding is damage from side flashing where the unbonded metalwork relative to roof or down conductors may offer an alternative current path to earth. This can be avoided by isolation or by bonding.

2.1.6 Measurements of soil resistivity shall be undertaken prior to the construction of a building requiring an LPS to ensure that the LPS will have a satisfactorily low resistance to earth for safe lightning current dissipation.

2.1.7 When determining the LPS design consideration shall also be given to the through-life costs of maintaining the LPS.

2.2 Zone of Protection Afforded by LPS Air Termination

2.2.1 The purpose of the air termination is to safely intercept lightning in the event of a strike to the building. It can either be fixed to the roof itself, utilising a network of conductors or utilise the roof structure itself if the material meets the thickness requirements of BS EN 62305-3 table 3. The air termination can also be physically isolated from the building by utilising a pole close to and standing tall of the building being protected, or a suspended catenary system; these types of LPS are designed to take a strike in preference to the building and offer the most effective protection.

2.2.2 To ensure that the LPS air termination is designed to provide adequate protection to a building, designers shall have a thorough understanding of conductor spacing and zones of protection provided by LPS conductors as defined in BS EN 62305. The following Paragraphs summarise the theory however this provides only basic information and designers shall be expected to be fully conversant with the full requirements of the British & European Standard.

2.2.3 In accordance with BS EN 62305, where the metal thickness of the total area of the roof material does not meet the minimum required by the standard, the air termination network shall be designed using one of the following 3 methods.

(1) Rolling Sphere Method: This method may be applied to all building designs; however, for all complex shaped buildings and buildings of 20m in height and greater it shall be the mandatory design method. The method is described within BS EN 62305 as the process of rolling an imaginary sphere of 20m radius (40m diameter) around the external surfaces of the building requiring protection. Where the sphere comes into contact with the building, LPS conductors, either surface mounted, or separated mast /catenary system will be required. See Appendix 1 Figs D-1 to D-4 of this Annex for an illustration of the rolling sphere method.

³⁰ Minimum gauge of metal used as part of LPS is given in BS EN 62305-3 table 3

(2) Protection Angle Method: This method is suitable for simple buildings and structures below 20m in height. The zone of protection provided by air termination conductors is defined in BS EN 62305 as a solid angle which varies with the height of the mast and which has its apex at its highest point. For masts up to 2m in height a protective angle of 70 degrees has been given in the Standard however this angle reduces to around 20 degrees at an apex height of 20m above the area requiring protection. The change in angle size is not linear and BS EN 62305 shall be consulted to determine the actual angle of protection for any air termination conductor which has its apex at greater than 2m above the area to be protected. See Fig D6 of Appendix 1 for an illustration of the protective angle method.

(3) The Mesh Method: This method may be applied for all simple plane surfaces and requires conductors to be laid in a mesh/grid formation of 5m x 5m maximum. Additional requirements for surface mounted air termination networks are included in Para 2.3 and are of particular importance for structures with roofs at different levels.

2.3 Surface Mounted Air Termination

2.3.1 A surface mounted air termination network comprises of air rods (finials), a meshed conductor network or a combination of both.

2.3.2 The rolling sphere or angle of protection methods, as described above and in BS EN 62305 part 3 for a class 1 LPS shall be used to determine the positioning of surface mounted air termination system components.

2.3.3 The surface mounted air termination shall consist of Air Rods (finials) and tape conductors, which shall be installed at locations to meet the requirements of Paragraph 2.3.1 above.

2.3.4 Air Termination Network conductors shall be of bare copper or aluminium only (i.e. not covered with insulation).

2.3.5 Bare conductors may lie on the surface of the roof provided that the roofing materials are either not of dissimilar metals to the ATN conductors (which may cause corrosion) or if not metallic, are non-combustible and do not cover them.

2.3.6 If the roof surface is made from dissimilar metals or combustible material stand-off fittings or fire-resistant layers shall be fitted between the conductor and the roof material.

2.3.7 The edges and apexes are the most vulnerable parts of a roof. Conductors shall therefore be placed as close as practicable to the edges (within 100mm) and shall be above the highest level of the roof. Where this is not achieved finials shall be installed to protect the vulnerable points of the roof- see Paragraph 2.2 and BS EN 62305 for further details on zones of protection provided by LPS conductors.

2.3.8 When a facility has roofs at different levels, each level shall be protected. The fixed air termination network on a roof at one level, may afford protection to a roof at a lower level so that a separate network on the whole or part of the lower roof may not be necessary. See Fig D 6 and Fig D 7 for examples.

2.4 Reinforced Concrete Structures & Steel Framed Buildings with Metallic Cladding

2.4.1 The LPS air termination for reinforced concrete structures and steel framed buildings is dealt with separately in Paragraphs 4 and 5 respectively.

2.5 Suspended Air Termination Network (Catenary System)

2.5.1 A suspended air termination network comprises two or more poles (acting as down conductors) supporting an aerial conductor or system of conductors, as illustrated in Fig D 8.

2.5.2 Support poles shall be positioned at least 2m from the facility. When one pole consists of a non-conducting material, a conducting tape shall be provided to bond the aerial conductor to the earth termination network. All stay wires are also to be bonded to the earth termination network. The earth termination network shall have a ring electrode to optimise earth connectivity.

2.5.3 To prevent flash over, the minimum clearance between the lowest part (sag) of an aerial conductor system and the protected facility shall be greater than 2m except where the distance between support poles is greater than 50m. In these cases, the formulae specified by BS EN 62305 for calculating the separation distance for a Class 1 lightning protection system shall be used. If there are sharp/pointed metallic earth bonded components protruding from the protected building, such as a ventilation stack, a clearance of greater than 5m is required from the highest point on the structure.

2.6 Vertical Air Termination Network (Mast)

2.6.1 Where the LPS air termination comprises a single metallic pole (see Fig D 5) the separation distance from the building to be protected shall be a minimum of 2m or the distance calculated in accordance with BS EN 62305 Part 3 for Class 1 lightning protection systems, whichever is greater.

2.6.2 Stay wires shall be bonded at the upper end of the Lightning Protection System and, at the lower end, are to be bonded to the buried ring earth electrode.

2.7 Down Conductors

2.7.1 A surface mounted air termination network shall be provided with the required number of down conductors to meet the requirements of BS EN 62305 with a minimum of 4 around the perimeter of the facility. They should be equally spaced as far as possible but not more than 10m apart and shall be installed at exposed corners as a priority. Down conductor material may be bare copper or aluminium but shall be covered by insulating material or installed on spacers if it is required to prevent corrosion from contact with dissimilar metals. Each down conductor shall have an associated earth rod as specified in BS EN 62305 Part 3.

2.7.2 Down conductors shall not be taken inside buildings however metal structural elements used as down conductors may have internally exposed parts which shall be taken into account with respect to the internal layout of the facility.

2.7.3 All down conductors shall be installed as straight and vertical as possible. They shall form the most direct path from the air termination to earth without sharp bends. Any unavoidable loops shall have a radius which conforms to the requirements of BS EN 62305 Part 3.

2.7.4 If the reinforcing bars or steel frames of a facility are being used as the down conductors then the connection to the earth termination network shall take place approximately 100mm above ground level. The connection to the reinforcing bars or frame shall be such that it can be inspected readily but will also be protected from the elements.

2.8 Earth Termination networks

2.8.1 Earth termination networks are to be a minimum of 600mm from the wall footings. An earth termination shall consist of earth electrodes made up of rods, tapes or other means of providing a connection to the general mass of earth.

2.8.2 Where rod electrodes are used they shall be driven to the depths necessary to give the desired earth resistance; the minimum depth being that at which the rod penetrates into soil of permanent dampness. Where more than one rod is necessary to obtain the desired resistance, the spacing between the rods shall be at least equal to the driven depth. Earth rods have a finite life of approximately 30 years; increasing resistivity is caused by failure of the copper plating and consequent rusting of the steel rod beneath. Failing rods must be replaced. See Fig D 12 for an illustration on group electrode spacing.

2.8.3 All earth electrodes of a system shall be interconnected by a ring conductor buried at least 600mm below ground. The earth systems of adjacent structures should be interconnected where reasonably practicable and where the ground conditions make the achievement of the required earth resistance difficult.

2.8.4 In difficult ground conditions where rod electrodes prove ineffective, e.g. in areas of deep gravel or those having little soil cover, the advice within BS EN 62305 shall be followed.

2.8.5 When a facility is sited on bare rock a satisfactory earth electrode may be obtained by rock drilling and back filling the hole with sifted soil or a mixture of carbon powder and copper dust before driving the earth rods. The diameter of the hole should be 75mm or greater. Coke, breeze or fly ash is not to be used for back fill owing to their corrosive effect on copper. Bentonite and Marconite are commercially available products that may be used to improve the ground conductivity around electrodes.

2.8.6 Chemical earth rods which give a controlled release of a saline type solution into a backfilled area may be used if difficult ground conditions are encountered, this may remove the need to drive extra rods if space is limited. These types of earth rod are not recommended as they often need regular re-filling with an appropriate chemical solution, so a maintenance regime shall be adopted when using these rod types in order to maintain their effectiveness. Chemical rods can offer more consistent performance in desert conditions or climates with distinct wet and dry seasons.

2.8.7 In areas of high soil resistance or restricted space limiting the number of rods that can be driven, chemical rods may be used in conjunction with conductive or moisture retaining backfill. Note: These rods often require annual maintenance in order that they will continue to provide an acceptably low resistance.

2.8.8 When increasing earth rod resistance forces the driving of additional rods, the facility drawings shall be amended to reflect the change and future testing shall test the two (or more) rods as one electrode.

2.8.9 Water pipes or other services shall not to be used as part of the earth termination system, or as the earth electrode.

2.8.10 To allow for the isolation of and access to the electrodes during testing, the upper ends of the electrodes are to be terminated in a small covered service pit, which shall be made easily accessible for inspection and testing.

2.8.11 Where ground conditions exist which make the installation of a buried earth ring extremely difficult to install, a conductor is to be attached to and encircle the facility at a height of no greater than 500mm above ground level. It is to be permanently bonded to all down conductors. It is to be visible throughout its whole length, except where door openings, paths and roadways make it necessary for the conductor to go underground when it is to be drawn into a non-metallic pipe.

2.9 Test Joints

2.9.1 A multi-way, clamp type, test joint shall be constructed in each service pit. Only the earth termination networks shall be permitted below a test joint.

2.9.2 Poles supporting an air termination network shall be provided with test joints (at 500mm above ground level) connected to the earth termination network and to any stay wires at points as near as practicable to the pole.

2.9.3 Earth electrodes shall be capable of being isolated and a reference earth electrode shall be provided for testing purposes (particularly when the surrounding soil is covered with concrete or tarmac).

2.9.4 Where the steel structure of a facility is used as the down conductors, sufficient points of test shall be provided to enable the low resistance continuity of the steel structure to be checked. This is especially important for those parts of the structure that are not visible or accessible.

2.10 Bonds

2.10.1 All major items of metal external to, and forming part of a facility, are to be bonded to the LPS. Bonding material for explosives buildings shall be of annealed copper for both internal and external bonds. Resistance testing of bonds shall be performed during acceptance of the LPS installation and requires only periodic inspection through life.

2.10.2 The metal sheath or armour of incoming electrical supply cables shall be bonded to the LPS and to the enclosure of the main switch at the cable entry point only. The metal sheath or conduit of each circuit leaving the main switch shall be bonded to the switch enclosure. All other metal service pipes or conduits shall be bonded to the LPS at their point of entry to the facility only. All straight runs of metallic conduit, pipe work or metallic cable sheathing shall be bonded to the LPS at each entry and exit point outside the building. It shall be possible to isolate the LPS connection for test purposes.

2.10.3 Crane rails within a facility shall be bonded at one end to the EPB. Rails, which extend outside the facility, shall be bonded to the LPS at their point of entry. Rails which pass through a building shall be bonded to the LPS at their point of entry and exit.

2.10.4 The LPS shall be connected to the facility earth bus bar at one point only. The means of connection shall be such that it can easily be disconnected to enable tests to be made.

2.11 Surge Protection Devices (SPD)

2.11.1 See Para 20 of the main body of this document for the requirements for SPD in explosives buildings.

3. UNDERGROUND AND EARTH COVERED FACILITIES

3.1 Underground Facilities

3.1.1 Underground facilities shall not require a lightning protection system so long as the requirements of Chapter 8 Para 19.2 are met.

3.2 Earth Covered Facilities

3.2.1 Earth covered processing facilities shall have an isolated LPS such as a pole or catenary system over the structure as required by this annex.

3.2.2 Earth covered storage facilities with an exposed headwall shall have an air termination network connected to the reinforcing bars of the roof concrete and all exposed metalwork shall be bonded together and connected to the earthing system at the entrance to the structure.

3.2.3 An earth covered storage facility shall be protected against lightning in accordance with this annex, subject to the following requirements.

(1) The earth termination network conductor shall run underground at a distance of approximately 1m (where practical) from the base of the earth cover; it may be taken across the head wall, or other wall not covered with earth, at 500mm above ground level.

(2) Joints between down conductors and the earth termination network shall be readily accessible for inspection. These joints shall be within 150mm of the ground surface in a covered inspection pit.

4. REINFORCED CONCRETE (RC) FACILITIES

4.1 Introduction

4.1.1 These facilities if correctly constructed will have inherent lightning protection.

4.1.2 The structural steel components of the facility create a shield against the effects of lightning only when the conducting elements are electrically contiguous. For reinforced concrete structures this can only be assured by ensuring that the wall reinforcing bars are bonded to the reinforcements of the roof and floor during construction. Fig D 11 of Appendix 1 for this annex shows the structure of a reinforced concrete building with bonds that form a Faraday cage and provides for the inherent protection against the hazards related to direct lightning attachment. This Faraday cage shall be adequately bonded to the earth termination network for it to be an effective component of the LPS.

4.2 General

4.2.1 For such structures to be able to provide inherent protection all metallic penetrations, such as conduits and pipes, shall be bonded to the closest reinforcing bars at the point of entry.

4.2.2 All metallic doors and windows are to be bonded to their frames and the frames are to be bonded to the structure rebar.

4.2.3 Extensions of the reinforcing bars shall be provided to connect strike termination devices to reduce the risk of structural damage from lightning attachment. Steel portal frame with earth bonded profiled sheet cladding will provide a Faraday cage like structure but will afford less shielding effectiveness than reinforced concrete structures, under-floor reinforcing mesh shall also be bonded to the portal frames during construction.

4.2.4 The most important lightning protection feature of an RC explosives facility is the reinforcing bar mesh within the concrete shell: this will typically carry approximately 90% of the lightning current. Therefore, it is vital that the reinforcing bars completely encircle the volume of the facility; roof, walls and floor. To accomplish this, the reinforcing bars in adjacent structural elements (roof, walls and floor) shall be bonded as follows:

4.2.5 It cannot be assumed that all existing R/C and metal clad structures will provide inherent protection, this can only be assured by carrying out a low voltage shielding effectiveness test, (not described in this document). Where this cannot be done an approved external LPS shall be installed.

4.2.6 Remaining reinforcement crossovers shall be wire-tied at every intersection.

4.2.7 Fortuitously, the nature of the metallic connection and the very large number of bars and crossing points of such construction ensures a substantial subdivision of the total lightning current in a multiplicity of parallel discharge paths. To be fully effective as a shield against fields produced by lightning the RC mesh size should be no larger than 300 mm.

4.2.8 No separate down conductors are necessary on a facility of R/C construction which meets the above requirements.

4.2.9 At roof level, a Surface Mounted Air Termination Network (ATN) is required to reduce damage to the structure should the facility receive a lightning strike. Alternatively, an isolated LPS can be installed. Note: this does not apply to Hardened Aircraft Shelters (HAS) which have an internal metallic skin on the underside of the concrete which would prevent any spalling concrete from falling into the hanger. The fixed ATN shall be directly bonded to the reinforcing bars in the number of positions required for down conductors (in at least two diagonally opposite places). The details of bonding connections to the air termination network and other items and the reinforcing bars should be decided at the design stage.

4.2.10 If a pitched metal roof is fitted on a R/C facility then the roof may act as the ATN provided that the minimum material thickness requirements of BS EN 62305 Part 3 Table 3, is followed. If this type of roof is specified it is recommended that at least 2 finials are fitted, one at each end of the roof ridge.

5. STEEL FRAMED CONSTRUCTION

5.1 Introduction

5.1.1 A steel-framed structure with metal cladding may be regarded as self-protecting and forming a Faraday cage like shield provided that:

- (1) All the components of the facility are bonded together with a resistance of $<0.2\Omega$.
- (2) The resistance to earth of each vertical stanchion does not exceed 10Ω . (Can only be tested during construction).
- (3) The minimum thickness of metal used for the cladding and the roof, which forms part of the air termination network, shall be of a thickness specified in BS EN 62305 Part 3 Table 3.

5.2 Earthing and Bonding

5.2.1 The facility shall be adequately earthed; the foundations of the facility may have an adequately low earth resistance without additional earth electrodes, particularly if the facility foundation includes reinforced piles. A measurement of the earth resistance of the newly completed foundations will establish whether they are adequate alone, or whether further earth electrodes need to be added. The steel frames shall be fitted with connections at the top and bottom to provide a means of bonding the roof and earth mass to the frames. If the foundation alone is used, provision shall be made to bond each vertical stanchion of the steel structure to the earth matrix and in turn to the foundation concrete reinforcing bars/mesh.

5.2.2 All bonding and earth termination network resistance testing shall be performed during the construction phase, taking care to protect the bonds from the effects of corrosion. Testing of the resistance to earth of each stanchion shall be made before any electricity supply cables; rails or other metallic pipes are attached to the structure. Where these earth resistance requirements are not complied with, a ring conductor bonded to each stanchion and with earth electrodes at each end of the structure, shall be provided.

5.2.3 Further guidance for the use of steel structures in providing lightning protection is given in BS EN 62305.

6. OTHER CONSIDERATIONS

6.1 Presence of Explosives in the Open

6.1.1 Licensed open areas used for explosives storage for periods greater than 24 hours shall be provided with a properly installed and tested lightning protection system using a vertical or suspended air termination system, unless excluded under 19.2.1(4) of the main body of this chapter Storage facilities licensed under Chapter 10 Section 8, Authorised Quantities(AQ), are exempt from the requirement to fit SPD. This is based on the fact that there is no permanent presence of people in such stores and the basic AQ principle that if the contents of the store are involved in a fire or are initiated there are no external effects when the store is closed. This type of system shall still meet the angle of protection or rolling sphere requirements of BS EN 62305 for a class 1 LPS in relation to the OME it is intended to protect and comply with the earth rod impedance requirements of ESTC Standard 6 Pt 1. Where it is impractical to fit a Type B earthing

system, it is permissible for such a temporary LPS to have a Type A arrangement fitted, providing that it still passes the tests specified within ESTC Std 6 Pt 1.

6.1.2 For training exercises, where ammunition is considered in use, the installation of a lightning protection system may be omitted if their presence is less than one week, or if the explosives are exempt from the requirement of lightning protection as per paragraph 19.2 of the main body of the Chapter.

6.1.3 The angle of protection provided by such protection systems can be determined from BS EN 62305:2006 Part 3 Table 2.

6.1.4 ISO containers loaded with packaged ammunition may be stored in the open subject to the container meeting the requirements of Chapter 8 Para 19.2(5).

6.1.5 Unpackaged explosives are not to be stored in ISO containers, unless the LPS is provided by an isolated system. Packaging is required to provide standoff from the container walls.

6.2 Inspection & Testing of LPS

6.2.1 Inspection, testing and record keeping requirements of lightning protection systems shall be carried out in accordance with ESTC Standard No 6, however the following additional information will also be required to ensure full compliance with these regulations.

6.2.2 Where the LPS is provided by masts or suspended catenary wire, the visual inspection shall include inspection of the base of the supporting masts and stay wires for corrosion. In addition, the top of the masts shall be inspected for corrosion at periods not greater than 5 yearly. If corrosion is detected, testing shall be carried out to determine the extent of the deterioration. If deterioration has occurred to such an extent that the mast is deemed no longer structurally sound, the building being protected is to be emptied of explosives and the affected masts shall be replaced.

6.2.3 The maximum allowed resistance to earth for the LPS shall be as follows:

6.2.4 Full Lightning Protection System with all components fully connected shall be below 10 Ohms.

6.2.5 The maximum resistance to earth for each individual earth electrode (whether a single rod or multiple rods forming a single group) when disconnected from the LPS and earth termination network shall be below 10 Ohms multiplied by the number of rods/groups.

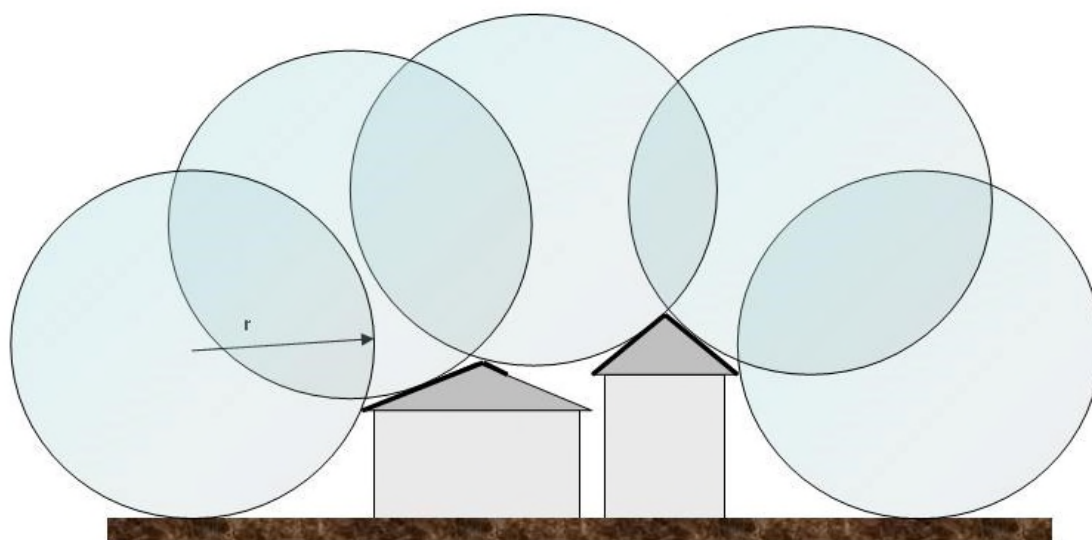
6.2.6 For buildings protected by catenary systems care shall be taken when determining the maximum allowable resistance for electrodes in isolation. For systems which employ multiple catenary LPS in parallel without the catenary wires connected between each parallel system, lightning current will have only two paths to flow; i.e. only the two supporting masts of the catenary system which was struck. The current will then flow down both masts and into the earth via the connected earth electrodes. For this reason, the LPS requires to be treated as having 2 'groups' or 2 electrodes. See Fig D 13 for an illustration of this example.

6.2.7 Testing of the LPS earthing shall be carried out using the fall of potential method (ie 3 or 4 terminal) as described in BS7430 and IET Guidance Note 3. Where this cannot be achieved, expert guidance shall be sought prior to conducting further measurements.

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CHAPTER 8**ANNEX D****APPENDIX 1****ILLUSTRATIONS OF LIGHTNING PROTECTION SYSTEMS****CONTENTS**

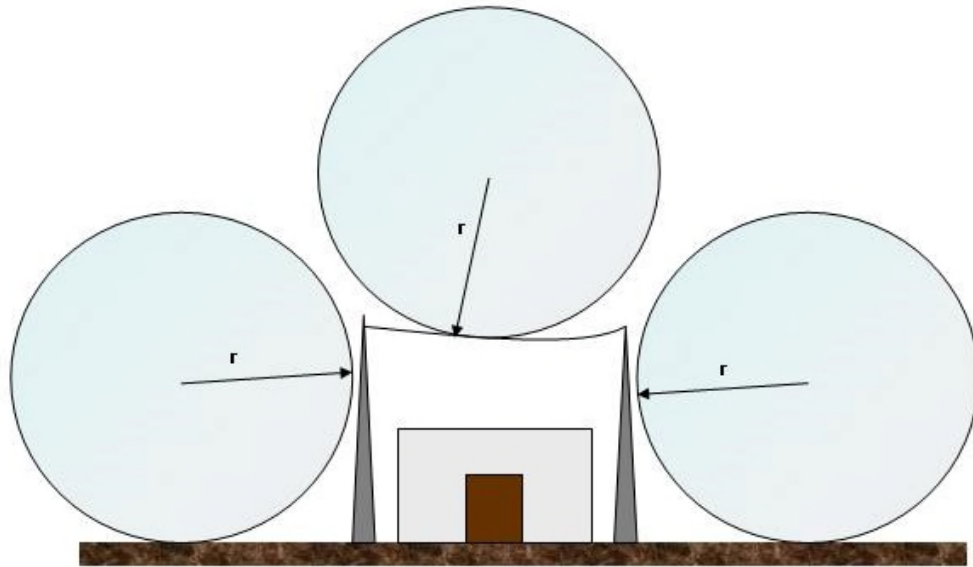
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$r = 20\text{m}$ in accordance with Table 2 of BS EN 62305 Part 3

— Indicates where air termination is required

Fig D1 Rolling Sphere principle protection of multiple buildings



$r = 20\text{m}$ in accordance with Table 2 of BS EN 62305 Part 3

Fig D2 Rolling Sphere Defined Protected Volume - Suspended Air Termination

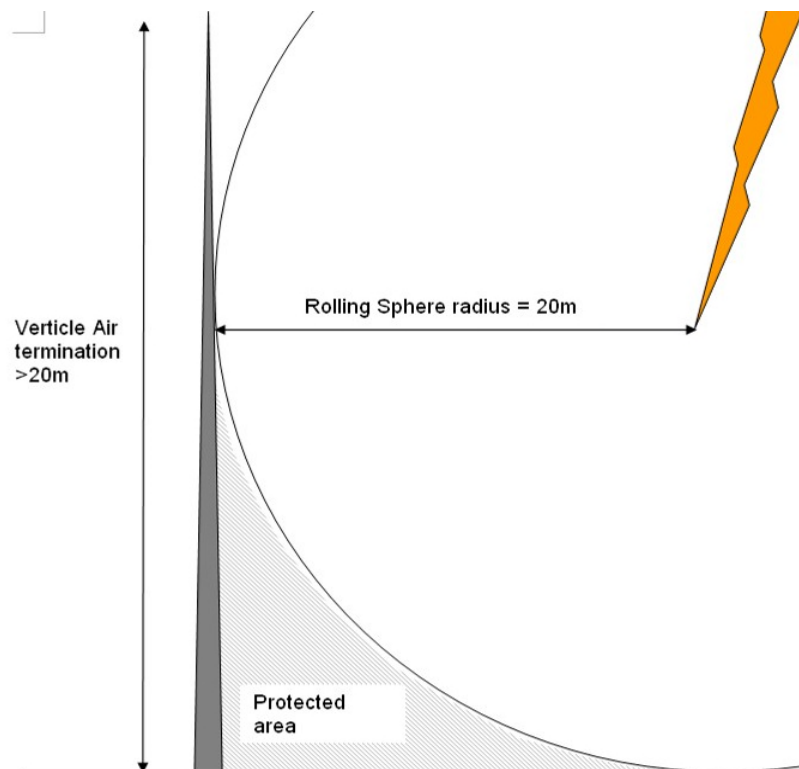


Fig D3 20m Rolling Sphere Principle - 20m or Higher structure

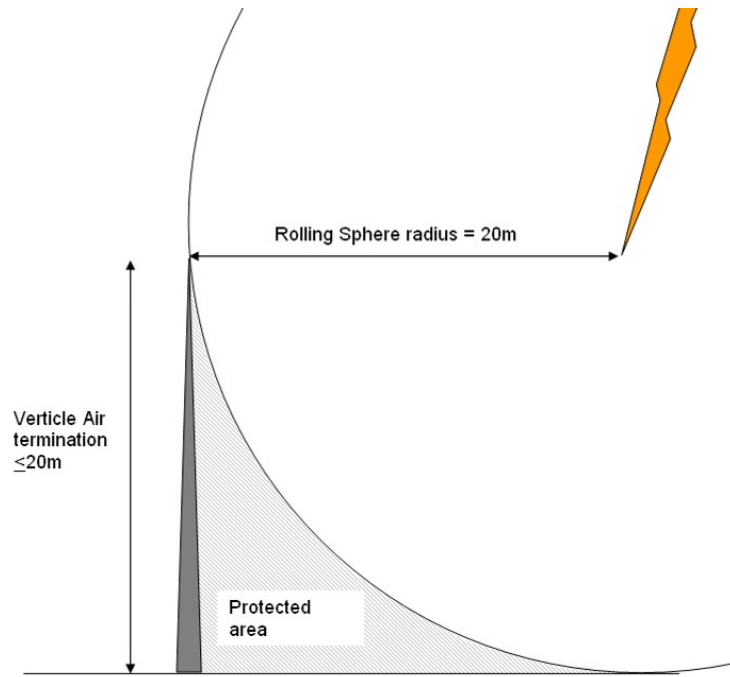
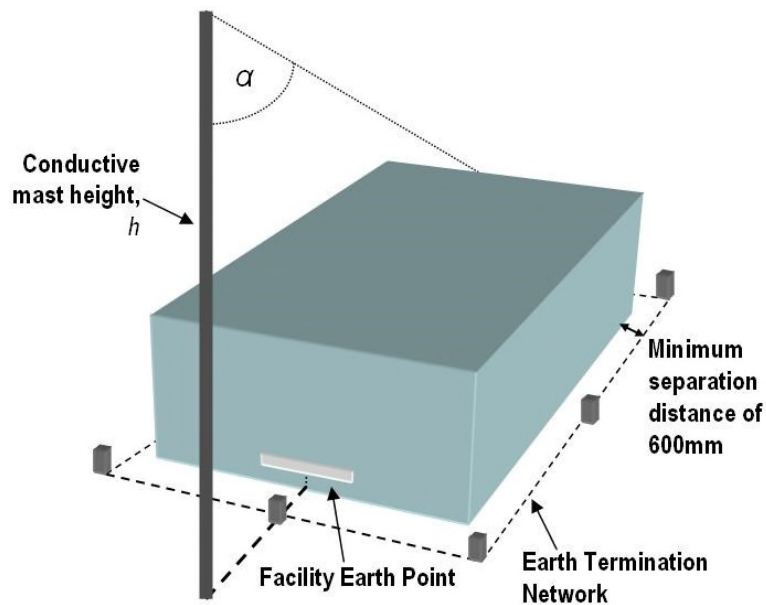


Fig D4 20m Rolling Sphere Principle – Structure less than 20m in height

NOTE:

20m rolling sphere will protect against all but the statistical 5th percentile (<5kA) lightning strokes. Median value 38kA, 99th percentile 200kA. These values will vary depending on the continent or hemisphere, representative of the UK prior to any update from climate change. Only a few kA change if any.



Angle α varies with height h – see BS EN 62305 Part 3 Table 2

Fig D5 Vertical Termination Network

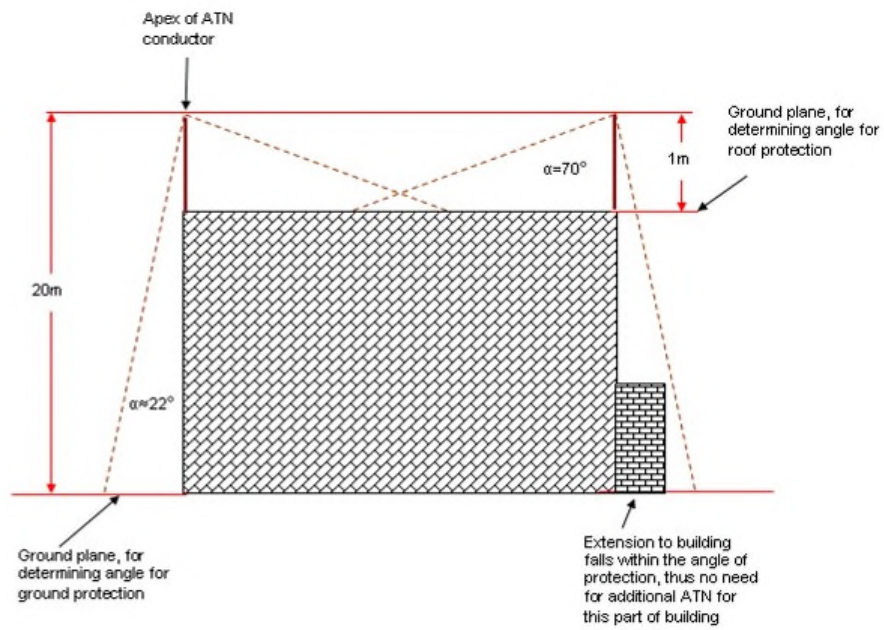


Fig D6 Protective Angle Method
Illustration of how angle changes with height above the protective plane

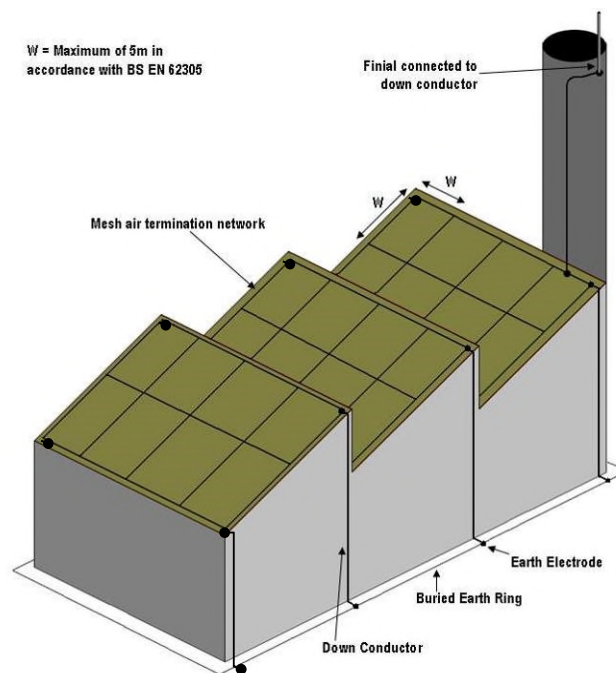


Fig D7 Surface Mounted ATN with 5m x 5m grid

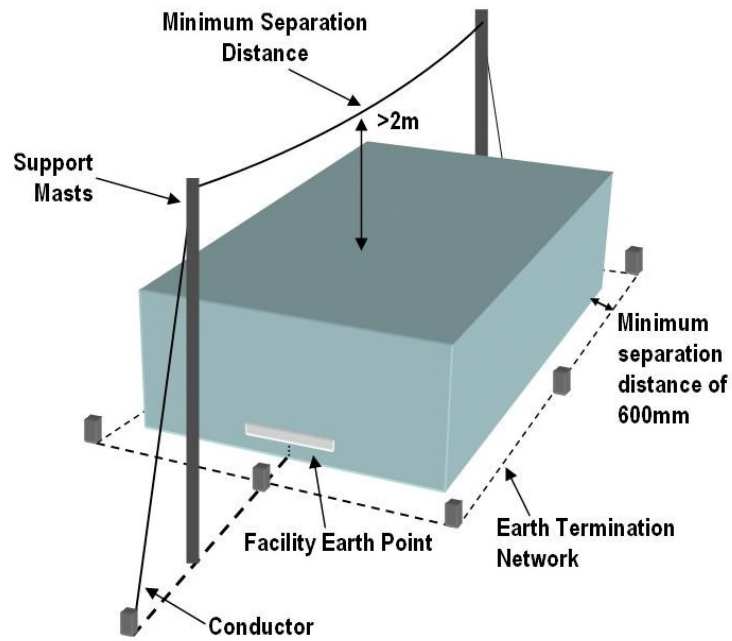


Fig D8 Suspended Air Termination Network

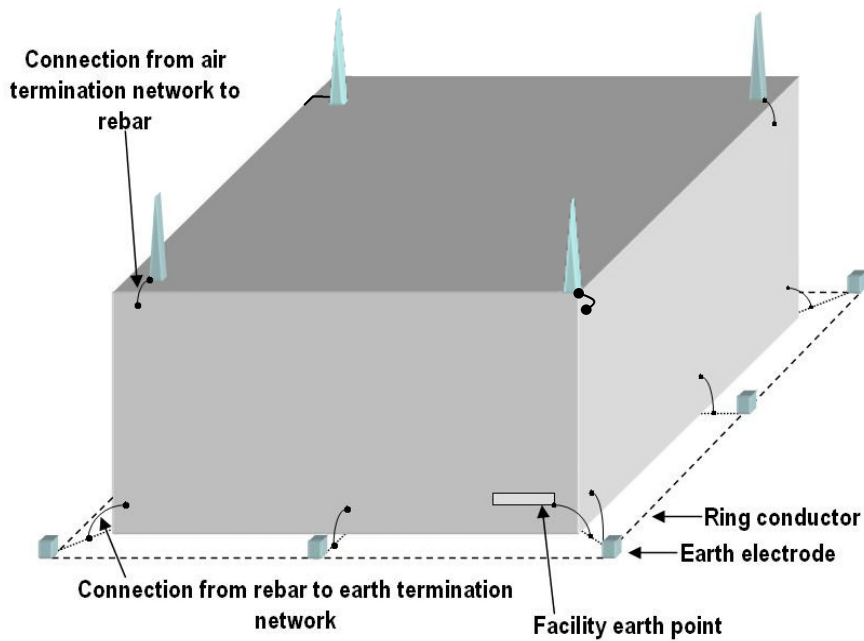


Fig D9 Reinforced Concrete Structure with fixed ATN

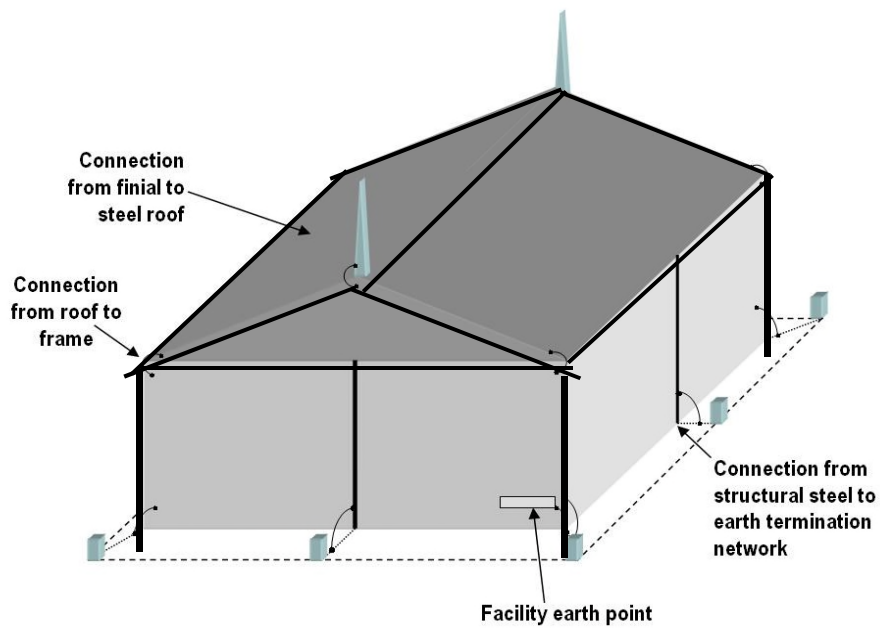


Fig D10 Steel Framed with Metal Cladding

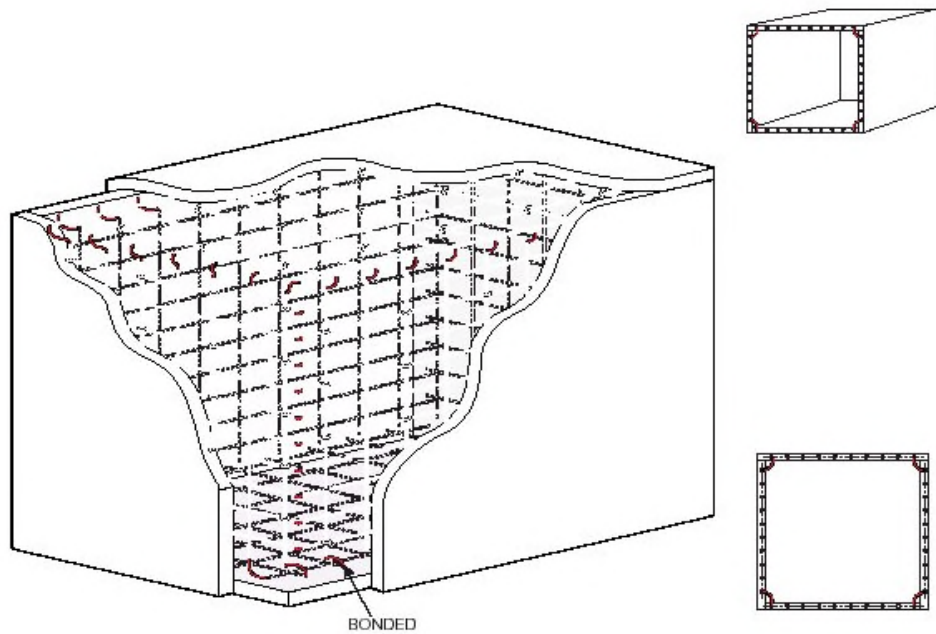


Fig D11 Reinforced Concrete 'Faraday Cage' Structure

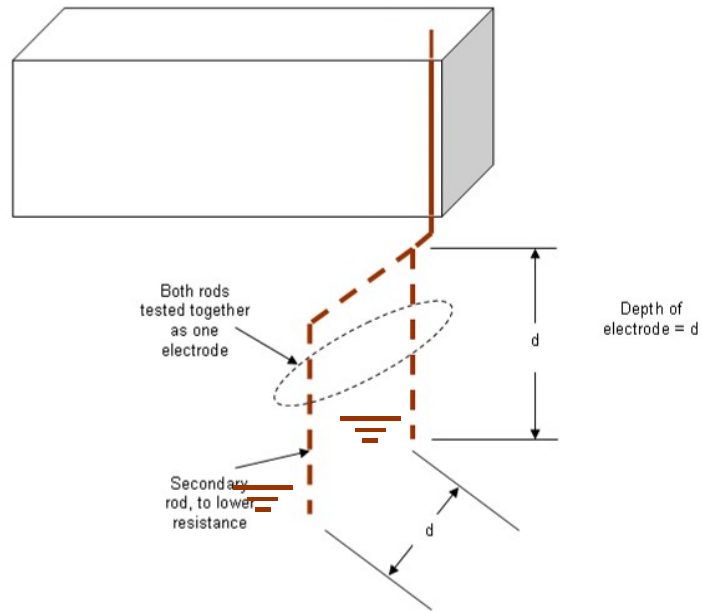


Fig D12 spacing of additional earth rods

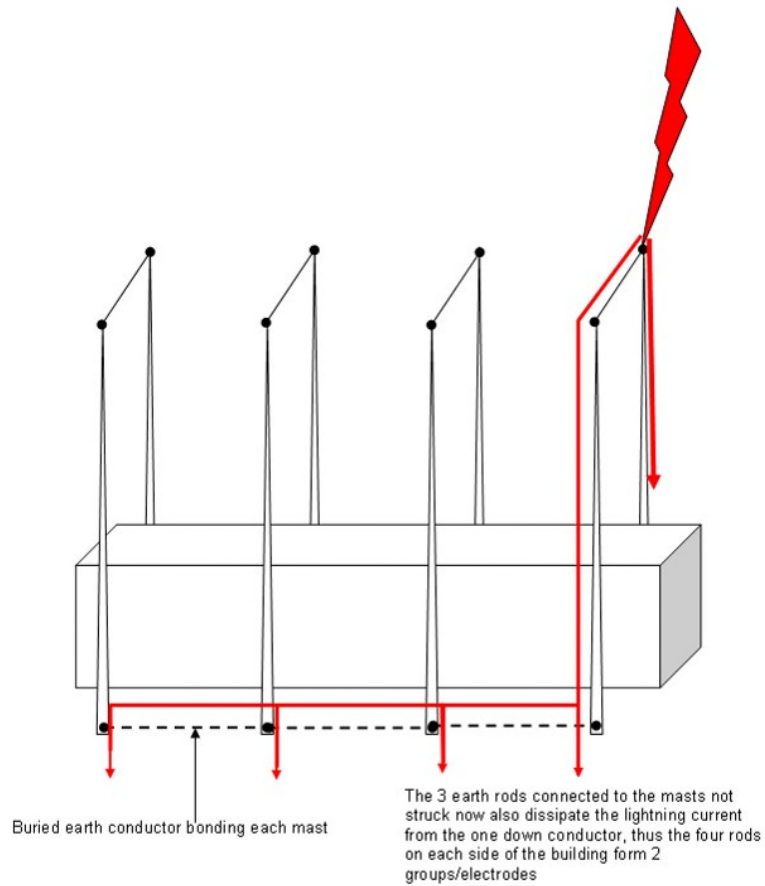


Fig D13 Building protected by multiple catenary LPS in parallel

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CHAPTER 8**ANNEX E****REQUIREMENTS FOR ENCLOSURES FOR CATEGORY D ELECTRICAL
INSTALLATIONS AND EQUIPMENT****CONTENTS**

Paragraph

1 GENERAL REQUIREMENTS

- 1.1 Introduction
- 1.2 Construction

1. GENERAL REQUIREMENTS**1.1 Introduction**

1.1.1 Category D comprises buildings and rooms where authorised quantities of explosives, except HD 1.1, are stored or processed (see Chapter 10 Sect 8) with the written agreement of the IE and in which explosives are not exposed, and do not give rise to flammable vapours or explosives dust.

1.1.2 The following recommendations have been prepared for guidance in the selection of electrical equipment for use in Category D explosives buildings. The recommendations are based on enclosures of a suitable standard for use in a general industrial environment:

- (1) The protection against the ingress of solids provided by enclosures shall comply with the requirements of BS EN 60 529, IP 4X or equivalent.
- (2) Enclosures including light transmitting parts shall be capable of withstanding the impact energy as required by BS EN 50102, IK 08.

1.2 Construction

1.2.1 Construction requirements are as follows:

- (1) All plastics used in the construction (including inspection windows and light transmitting parts) shall resist the propagation of flame.
- (2) Transparent covers (including inspection windows and light transmitting parts) may be glass or plastic, providing plastic material complies with sub-para (1) above. They shall be positively secured to the main enclosure.
- (3) Enclosures shall be provided with appropriate conduit and/or cable entries that do not degrade the enclosure's IP rating.

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CHAPTER 8**ANNEX F****CHEMICAL WEAPONS CONVENTION – INSPECTION OF MOD UK EXPLOSIVE AREAS****CONTENTS**

Paragraph

1 CHEMICAL WEAPONS CONVENTION

- 1.1 Background
- 1.2 Purpose of this Annex
- 1.3 Equipment Table

1. CHEMICAL WEAPONS CONVENTION**1.1 Background**

1.1.1 The International Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (CWC) 1993 came into force on 29 Apr 97. Broadly speaking, the Convention gives any signatory State the right to request a Challenge Inspection (CI) of any area or facility of any other signatory State that the challenging State may consider demonstrates non-compliance with the Convention. The UK Government has supported the CWC since its inception and its position is that any Challenge must be accepted by the UK in order to demonstrate the UK's full compliance with the Convention.

1.1.2 All MOD sites and buildings are therefore as a consequence of the Convention, rendered liable to physical inspection. A team of internationally accredited inspectors from the Organisation would carry out such inspections for the Prohibition of Chemical Weapons (OPCW) based in The Hague. There is a "pool" of such officials from which inspection teams will be assembled. Although no CIs have yet been requested by any of the Convention's signatory states, practice inspections have been carried out at a number of UK sites in order to test the various protocols and procedures that would be initiated by a formal CI. Thus, a formal CI of a UK ammunition facility would be a full-scale exercise which would involve non-UK personnel testing, analysing, measuring, etc, some or all of the equipment, ammunition, explosives or weapon systems within any MOD explosive area forming part of a challenged site.

1.1.3 JSP914 Supplement 4 (General Instructions for the Implementation of the UK's Obligations Under the Conventions on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons) provides more detail regarding the UK response in the case of a Challenge Inspection.

1.1.4 As part of the negotiation of the Convention the signatory states, including the UK, agreed an inventory of test and other equipment from which the CI teams may draw in order to carry out their inspections. MOD (UK)'s knowledge of some of the foreign manufactured equipment is not yet complete (even though specifications for the equipment may be available). The implications for explosive safety therefore are significant and judgements have been made regarding the potential use of these equipment within MOD explosives areas.

1.2 Purpose of this Annex

1.2.1 The purpose of this annex is to advise managements of MOD (UK) Explosive Areas of the above situation, and to alert them to the implications on explosives safety; to identify those equipment that may or may not be allowed within explosive areas, and those equipment for which a local substitute may need to be found, and to indicate any restrictions which are to be applied to those equipment allowed inside explosive areas. A comprehensive list of all these equipment is available on the JSP482 website under associated documents (DOSG report TA(E)2010-25). It has been compiled from the OPCW list of approved equipment referred to in Para 1.1.3. To ensure consistency and avoid confusion the identifying number for each item of equipment is that used in the OPCW list.

1.2.2 During a challenge inspection at a UK site, the inspection team will be accompanied by a team of UK personnel, including military escorts and scientific advisers. These escorts will have extensive knowledge of the Convention and the OPCW equipment and will provide advice to local representatives as well as conduct the ongoing negotiations inherent in such an inspection.

1.2.3 It should be noted that the list of equipment contained in DOSG report TA(E)-2010-25 is not exhaustive and is supplementary to the advice present in JSP914.

CHAPTER 8

ANNEX G

EXAMPLE ELECTRICAL CATEGORY SIGNAGE FOR EXPLOSIVES BUILDINGS

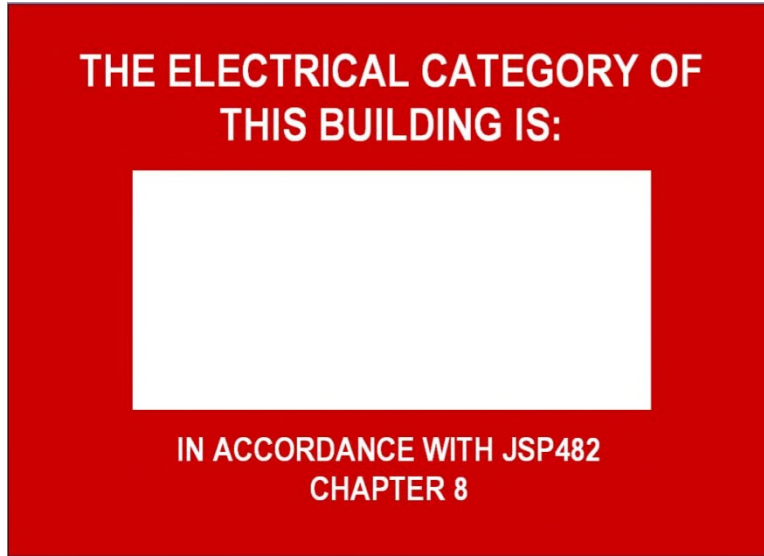


Fig G 1 Building Electrical Category Signage



Fig G 2 DSEAR Zoning Diagram

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CHAPTER 8**ANNEX H****MOD FORM 2256****ELECTRICAL EQUIPMENT APPROVAL REQUEST FORM**

1. This form shall be completed by the Head of Establishment or the nominated Explosives Safety Representative.
2. Once the form is completed the requester should forward it to a competent authority.
3. If approved a certificate will be issued for the equipment detailing any restrictions on use.

BASIC INFORMATION	
Ref:	
Date:	
Tasking organisation:	
Contact name:	
Contact e-mail:	
Contact telephone:	
LOCATION OVERVIEW	
Site:	
Building Number:	
Electrical Category of location equipment is to be used (A, B, C or D):	
Conducting Floor?	
EQUIPMENT TECHNICAL DETAILS	
Manufacturer:	
Model & Serial Number:	
Web link to technical details:	
Brief description of equipment, it's proposed use and duration:	
Is equipment CE marked?	
Equipment IP rating:	

Maximum surface temperature (°C) ³¹ :		
If portable, has the equipment been drop tested in accordance with JSP482 Chapter 8?		
Has equipment been impact tested in accordance with JSP482 Chapter 8?		
Other relevant technical information:		
Does the equipment meet the EMC requirements as described in JSP482 Chapter 8 section 6.6?		
Give details including test methods (e.g. Def Stan, Mil Stan etc) Attach evidence of EMC certification, including certificate and test data		
Does equipment contain transmitters?		
If yes, enter the output power in Watts, Gain (as a ratio) and frequency in Hertz:		Watts (no units) Hz
Equipment power supply type (mains/battery):		
Please explain any known noncompliance's:		
If equipment is mains powered and portable, and is to be used within an area that has a conducting floor, is it double insulated or will it be operated from a SELV supply?		

³¹ Equipment for use within Category A, B or DSEAR Zoned areas shall exhibit the appropriate 'T' classes as identified in the associated DSEAR assessment for the area. Equipment for use within Category C or D areas may not exhibit a T marking but the requester shall establish that the surface temperature of the enclosure does not exceed 90°C under normal conditions and 115°C under fault conditions.