

A Practitioner's Handbook for potentially explosive atmospheres

PUBLICATION 186

Edition 7

Released by SAI Global. NOT FOR RESALE

A Practitioner's Handbook for potentially explosive atmospheres

Publication 186

Edition 7

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ISBN 978 0 85931 212 7
Imprint reference 03-2016
First published 03-2016

Sold by: The Engineering Equipment and Materials Users Association
Registered and Trading Address:
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Preface

The majority of countries have now imposed requirements to employ only competent persons to undertake electrical installation and maintenance work. Historically, companies provided in-house training for employees who were expected to work in potentially explosive atmospheres.

In 1990, the EEMUA Electrical Engineering Committee prepared guidelines indicating six areas where special tuition was required. Together with JTL, the training company set up by the Electrical Contractors Association, training schedules were developed and the criteria laid down with which training and assessment centres would need to comply, forming the basis of the CompEx® scheme. JTLimited, as the CompEx® Certification Body, is accredited to IEC / ISO 17024 and those who successfully complete the underpinning knowledge and practical assessments are awarded a CompEx® 'Certificate of Core Competence'.

This Publication was originally proposed to be a set of course notes to underpin the CompEx® training. Its usefulness as a Practitioner's Handbook for those working in potentially explosive atmospheres was recognised. Consequently the content was enlarged to provide a sufficient depth of detail to resolve most issues connected with installation, inspection, test, maintenance and, to a lesser extent, with decommissioning.

The Publication is seen as a useful source of information for trainers, assessors and trainees. The CompEx® underpinning knowledge assessment includes multiple choice questions. These are cross referenced in the database to the relevant clause in the IEC standards where appropriate. EEMUA comment:

Where comments are inserted into the main text of this publication which represents EEMUA/JTL guidance which is not derived from or may even conflict with text in the IEC standard, it is prefixed with 'EEMUA comment:' and is enclosed in a rectangular box.

A further booklet called the Toolbox Guide (EEMUA Publication 214), based on this Practitioner's Handbook, serves as an 'aide memoire' to craftspersons when at work. Both of these Publications, EEMUA 186 and 214, have the wide support of industry in general and the oil, gas and petrochemical industries in particular. The content has been discussed widely to minimise the possibility of serious error and omission.

Care has been taken to ensure accurate cross-referencing with international and national regulations and standards in force at the time of publication. *However the reader should always follow current legislation and standards in force within the country in which they are working.*

Acknowledgements

Acknowledgements are given to all who have assisted in the drafting or in the verification of parts of the content in this and previous editions. These include members of the EEMUA Electrical Committee and UK Oil & Gas (formerly United Kingdom Offshore Operators Association) Electrical Engineering Committee, together with JTLimited, the Institution of Engineering and Technology (formerly Institution of Electrical Engineers), Energy Institute (formerly Institute of Petroleum), British Standards Institution, Health & Safety Executive, **Electrical** Contractors' Association, SummitSkills (formerly National Electrotechnical Training), manufacturers, training providers and assessors. CompEx® is a registered trademark of JTLimited, the CompEx® certification body.

Introduction and Scope

Potentially explosive atmospheres occur in many industries, not only in onshore and offshore petrochemical processing and refining plants, but also in places such as fuel filling stations, garage workshops, liquor distilleries, paint spraying plants, flour mills, woodworking plant, coal handling plant, the water and waste treatment industries etc. Failure to adopt correct and safe working practices could result in ignitions of explosive gases and dust clouds, not necessarily at the time the work is done but possibly at some future date.

This Publication is concerned with ignition caused by electrical and mechanical sources and is based on the requirements of international and European standards, directives and regulations. It is divided into 14 Chapters.

- The first six Chapters are relevant to places where flammable gases may exist.
- The seventh extends the scope into areas where combustible dusts may be present.
- The eighth chapter is specific to installations in garage forecourts and similar places where flammable materials are stored, used or dispensed.
- The ninth chapter gives details relevant to the water and wastewater industry.
- The tenth chapter concerns mechanical ignition sources.
- The eleventh chapter focuses on application design engineering and the duties of the Responsible Person as defined in IEC standards.
- The final chapters give references, definitions and information on the CompEx® competency certification scheme.

This Publication is not intended to be, and can never be, a full treatise on all facets of working in potentially explosive atmospheres, but fulfils an important need, as explained in the Preface.

Principal Changes in this Seventh Edition

Previously, the Fourth Edition of this Publication was a significant revision. The Fifth Edition had fewer revisions by comparison, though there were significant changes in Chapter 8, which was updated to deal with all types of fuel filling stations, including those dispensing Autogas, in addition to petrol and diesel fuels.

The Sixth Edition of EEMUA 186 introduced two new Chapters entitled 'Mechanical' and 'Applications design engineering'. Chapter 8 (regarding fuel filling stations) was further updated to take account of the 3rd Edition of the APEA/EI guide while the rest of the publication was updated to align with the latest versions of the relevant standards.

This seventh edition of EEMUA 186 has been further updated to align with the latest versions of the relevant standards, in particular, the 5th (2013) editions of IEC 60079-14 and 60079-17. Chapters 8 (Fuel Filling Stations), 9 (Hazardous Areas in the Water and Wastewater Industries) and 10 (Mechanical) have not been amended.

Note: In the 5th editions of IEC 60079-14 and IEC 60079-17 the subject of Heating Systems is extensively covered. This seventh edition of Publication 186 does not cover this topic.

The clauses which have been amended are listed in Table 0.

Table 0 Amendments with respect to the 6th edition of 186

Clause number		Title	Summary	Source
6th Ed.	7th Ed.			
Front page	Same	A Practitioner's Handbook for Electrical and Mechanical design, ...	Change 'design' to 'selection'.	
Preface	Same	Preface	Updated	
Preface	Same	Preface	Explanation of 'EEMUA/JTL comments' inside rectangular box.	
Acknowledgements	Same	Acknowledgements	CompEx® is a registered trademark of JTLimited	
Introduction and Scope	Same	Introduction and Scope	Summary of chapters updated.	
Principle changes	Same	Principle changes ...	Updated, Table 0 added.	
1.1.4.2	Same	The ATEX Equipment Directive	New ATEX Directive 2014/34/EU	ATEX
1.1.4.2	Same	The ATEX Equipment Directive	Revised definition of 'Protective systems'	ATEX 2014/34/EU Article 2
1.2	Same	Standards	Clause restructured: 1.2.1: BS, US, 1.2.2: European, International, 1.2.3: Other bodies, 1.2.4: Standards numbering, 1.2.5: Using standards	
	1.2.1.2 (New clause)	US codes	NEC 500 to 506	NEC 500
1.2.2.2	Same	International standards	Relationship: IEC-Regional-National standards, Foreword and National Annexes explained.	

Clause number		Title	Summary	Source
6th Ed.	7th Ed.			
1.2.4.3	1.2.3.	International electrical standards	Updated reference to EN 60079-17	
1.2.5.1 Table 1	Same	Principal standards for gases	Updated table	
1.2.5.2 Table 2	Same	Principal standards for combustible dusts	Updated table	
1.3.1	Same	Product certification by an IECEx certification body within the IECEx system	IEC 61241 withdrawn, add ISO/IEC 17025 and 17065	
1.3.2	Same	ATEX Certification by a Notified Body	Clarify that text refers to ATEX. Reference to ISO/IEC 17025 and 17065.	
2.1.1	Same	Characteristics of gases and vapours – General	IEC EPLs equated to ATEX Categories	
2.1.4	Same	Explosive limits	'Explosive' limits changed to 'Flammable' Limits	60079-10-1
2.3	Same	Area classification – Gases	UK concerns relating to IEC 60079-10-1:2015	BS EN 60079-10-1
3.1.1	Same	Equipment Explosive atmospheres – Equipment types – General – Overview	Clarification of Group III equipment.	60079-0
3.1.3 Table 9	Same	New title: Relationship between Zones, Equipment Groups, Equipment Protection Levels (EPLs) and ATEX Categories	Table replaced by similar table from 60079-0	60079-0
3.1.4 Table 10	Same	Types of protection which may be used based on EPL/Category requirements	Updated table	60079-14 Cl. 5.4.2 Table 2
3.1.4 Table 11	Same	Types of protection, zones of use, categories and EPLs for gas zones	Updated table	60079-14 Cl. 5.4.2 Table 2
3.1.4.9	Same	Special protection 's'	Ex's' is now a concept recognised by IEC	IEC 60079-33 Introduction

Clause number		Title	Summary	Source
6th Ed.	7th Ed.			
	3.1.4.10 New clause	Type of protection 'op' – Optical radiation	Ex'op' is now a concept recognised by IEC	60079-14-
3.1.4.12	3.1.4.13	Use in association with gas subdivisions	Removal of Group II marking	
3.1.5	Same	Ex components	Equipment and Component certification requirements	60079-14
	3.1.10 New clause	Selection of radiating equipment	Guidance	60079-14 Cl. 5.7
	3.1.11 New clause	Selection of ultrasonic equipment	Guidance	60079-14 Cl. 5.8
3.2.3.2.7	Same	Use of thread adapters and blanking plugs	Clarification	60079-14 Cl. 10.6.1 & 10.5
3.3.2.3	Same	EPL/Category and zones of use	Ex'p' alternative markings.	60079 14-13
3.3.2.3	Same	Table 14 Pressurisation – determination of type of protection	Update Table, delete 186 6th edition Table 15	60079-14 Cl. 17.2.1 Table 16
3.3.2.4	Removed	Use with gas subdivisions	Ex'p' equipment to be marked with Gas sub- division.	
3.3.3.5	Same	Pressurised rooms and analyser houses	Update text	60079-14 Cl. 17.4
3.5.2.4	Same	Use with gas subdivisions	Ex'n' equipment to be marked with Gas sub- division.	60079-0
3.5.3.8	Same	Special markings	Ex'nL' replaced by Ex'ic'	60079-0
3.6.1	Same	Definitions	'Gas' removed from definition of Associated Apparatus	60079-14 3.5.2
3.6.3.1	Same	Simple apparatus	Minor updating of definition. Documentation requirements added.	60079-14 Cl. 16.4
3.10.2.1	Same	Type of Protection 's' – Special protection	Standards references updated	60079-33
	3.11 New clause	Type of protection 'op' – Optical radiation	Ex'op' text added.	60079-14 Cl. 22
3.11.1	3.12.1	Cable glands and their selection – Objective	Barrier gland clarification	EEMUA
3.11.3.1	3.12.3.1	Requirements	Certification of cable glands and blanking elements.	60079-0 Cl. 16.3

Clause number		Title	Summary	Source
6th Ed.	7th Ed.			
3.11.3.4	3.12.3.4	Barrier Glands	WARNING: Selection criteria.	BS EN 60079-14 National Annex
3.11.6.1	3.12.6.1	Cable gland – Selection Table 17: Selection of glands, adapters and blanking elements	Incorporated Table 10 from IEC 60079-14	60079-14 Cl. 10.2 Table 10
3.11.6.2	3.12.6.2	Selection of cable gland and cable entry device – Non-barrier glands	Addition of Ex'tb'.	
3.11.6.3	3.12.6.3	Selection of cable gland and cable entry device – Barrier glands	Reference to BS EN 60079-14 National Annex	
	3.13.1.6 New clause	Jointing	Text omitted from current edition of IEC 60079-14	60079-14:2007 Cl. 9.6.6
3.12.3.2	3.13.3.2	Cables for fixed wiring	Cables to be compact as well as circular	60079-14 Cl. 9.3.2
3.13.4.1	3.14.4.1	Markings required by IEC 60079-0 – General	Sub groups required, IP rating is optional	60079-0
3.13.4.2.2	3.14.4.2.2	Type of protection symbol	Cross reference to section 3.1.4 Table 11	60079-14 Table 2
4.1.1	Same	Contractor's responsibility	Clarify	
4.2.2.1	Same	Equipment containing batteries	Title changed to 'Personal equipment'. Updated guidance including Solar operated equipment	60079-14 Cl. 5.10.3
	4.4.1.6 New clause	Light metals as construction materials	Light metal content restrictions	60079-14 Cl. 6.1
	4.4.1.7 New clause	Non Ex electrical equipment above hazardous areas	New guidance	60079-14 Cl. 6.3.7
4.4.4.1 Table 19	Same	New title: Minimum distance of obstruction from the flameproof flange joints related to the gas group of the hazardous area.	Use title and headings from standard	60079-14 Cl. 10.2 Table 13

Clause number		Title	Summary	Source
6th Ed.	7th Ed.			
4.4.5.3	Same	Ex 'e' glands for normal cable types and for MICC	Clarification regarding lock nuts	EEMUA
4.4.6.2.4	Same	Insulation – Voltage withstand	Clarification of I.S. cable insulation requirements	60079-14 Cl. 12.2.2.1
	4.4.6.3 New clause	Terminal boxes	New requirements for terminal boxes in I.S. circuits	60079-14 Cl. 16.1
4.4.7.3	Same	Cable entry and barrier gland selection	Explanation of BS EN guidance and recent research	60079-14 Cl. 10.6.2, BS EN 60079-14 NA, EEMUA research (1976 and 2015)
4.5.6.3	Same	Non-metallic materials used for construction or protecting purposes	Guidance for non-metallic materials	60079-14 Cl. 6.5
4.6	Same	Completion of the installation	Initial inspection is 'Detailed'	60079-14 Cl. 4.3
5.1	Same	Introduction	Reference to BS 5345 removed. Accreditation of Inspection Bodies	UKAS RG101
5.3.3.1	Same	Location of various zones	Symbol key and EPL requirements on drawings	60079-14 Cl. 5.3 Table 1
	5.3.4 New clause	Documentation	Inspection documentation, Verification Dossier	60079-14 Cl. 4.2, 60079-17 Cl. 4.1
5.4.1.1	Same	Initial inspection	Clarification of location of requirements	60079-14 Cl. 4.3, 60079-17
5.4.1.3	Same	Sample inspection	Sample should be a 'representative' proportion	60079-17 Cl. 3.11
5.5.1	Same	Specific inspection requirements – General	Ex't', 'tD' and 'pD' incorporated into the inspection tables. Tables aligned with IEC 60079-17 and explanatory notes amended/added as appropriate.	60079-17 Cl. 6

Clause number		Title	Summary	Source
6th Ed.	7th Ed.			
5.5.2	Same	Specific inspection criteria appropriate to equipment – Types 'd', 'e' and 'n' (except 'nL')	Ex't/tD' added to table	60079-17 Cl. 6 Table 1
5.5.2.1-Table 22-Part A	Same	Inspection criteria appropriate to equipment – Table 22 Types of protection 'd', 'e' and 'n' (except 'nL') – Part A: Equipment	Table aligned with IEC 60079-17, Ex 't/tD' added and explanatory notes amended / added as appropriate	60079-17 Cl. 6 Table 1
5.5.2.2-Table 22-Part B	Same	Inspection criteria appropriate to equipment – Table 22 Types of protection 'd', 'e' and 'n' (except 'nL') – Part B: Installation	Table aligned with IEC 60079-17, Ex 't/tD' added and explanatory notes amended / added as appropriate	60079-17 Cl. 6 Table 1
5.5.2.3-Table 22-Part C	Same	Inspection criteria appropriate to equipment – Table 22 Types of protection 'd', 'e' and 'n' (except 'nL') – Part C: Environment	Table aligned with IEC 60079-17, Ex 't/tD' added and explanatory notes amended / added as appropriate	60079-17 Cl. 6 Table 1
5.5.3.1-Table 23-Part A	Same	Inspection criteria appropriate to equipment – Table 23 Types of protection 'i' – Part A: Equipment	Table aligned with IEC 60079-17, additional explanatory text provided.	60079-17 Cl. 6 Table 2
5.5.3.2-Table 23-Part B	Same	Inspection criteria appropriate to equipment – Table 23 Types of protection 'i' – Part B: Installation	Table aligned with IEC 60079-17, additional explanatory text provided.	60079-17 Cl. 6 Table 2
5.5.3.3-Table 23-Part C	Same	Inspection criteria appropriate to equipment – Table 23 Types of protection 'i' – Part C: Environment	Table aligned with IEC 60079-17, additional explanatory text provided.	60079-17 Cl. 6 Table 2
5.5.4.1-Table 24-Part A	Same	Inspection criteria appropriate to equipment – Table 24 Types of protection 'p' – Part A: Equipment	Table aligned with IEC 60079-17, Ex 'pD' added and explanatory notes amended / added as appropriate	60079-17 Cl. 6 Table 3

Clause number		Title	Summary	Source
6th Ed.	7th Ed.			
5.5.4.2-Table 24-Part B	Same	Inspection criteria appropriate to equipment – Table 24 Types of protection 'p' – Part B: Installation	Table aligned with IEC 60079-17, Ex 'pD' added and explanatory notes amended / added as appropriate	60079-17 Cl. 6 Table 3
5.5.4.3-Table 24-Part C	Same	Inspection criteria appropriate to equipment – Table 24 Types of protection 'p' – Part C: Environment	Table aligned with IEC 60079-17, Ex 'pD' added and explanatory notes amended / added as appropriate	60079-17 Cl. 6 Table 3
5.6.1	Same	Inspection and maintenance records	Documentation requirements clarified	60079-17 Cl. 4.1, CompEx Ex14
6.5.1.5	Same	Paintwork	Clarification relating to Ex'd'.	60079-14 Cl. 14.3
6.5.5.5.6	Same	Sheath insulation test voltage	I.S. cable insulation capability clarified.	60079-14 Cl. 16.2.2.1
7.2.3.1	Same	Current standards	Dust standards updated	
7.2.3.2	Same	Superseded standards	IEC 60529 reference removed	
7.6	Same	Zones of use	Paragraph restructured	60079-14 Cl. 5
7.7	Same	Installation in combustible dust locations	Clause restructured, text added for Ex'm' and 't'	
7.8	Same	Inspection of installations	Dust requirements are now part of Tables 22, 23 and 24	60079-17
7.8.1	Clause and Table deleted	Specific inspection criteria appropriate to type of protection 'tD'	Inspection table for Ex'tD' deleted (see Tables 22, 23 and 24)	60079-17
11	Same	Application design engineering	Duties of Responsible person added	
12.1	References and Bibliography	Current standards	Standards list updated	
12.3	References and Bibliography	Directives, UK legislation and regulations	New ATEX Directive	
12.4	References and Bibliography	Other publications referenced	List extended and updated	

Clause number		Title	Summary	Source
6th Ed.	7th Ed.			
13.1	12.1	Defined terms – Certification etc	New definitions: Certificate, Equipment certificate, Ex Component Certificate, Ex Equipment Cable Gland, Ex blanking element and thread adapter.	60079-0
13.1	12.1	Defined terms – Electrical equipment	Revised definition	60079-14 Cl. 3.1.3
13.1	12.1	Defined terms – Hybrid mixture	New definition	60079-14 Cl. 3.2.4
13.1	12.1	Defined terms – Radio frequency identification (RFID)	New definition	60079-14 Cl. 3.15
14	13	The CompEx® competency scheme	Whole clause updated	
14.2	13	CompEx® Centre adverts	Centre adverts updated	

1. Directives, standards and legislation

1.1 European directives

1.1.1 Background

The creation of a single common market within Europe dates to the Treaty of Rome in 1957. Since 1957 a number of amendments to the basic treaty have been made in order to resolve difficulties and meet common objectives, including adoption of the name European Union in 1993.

Although the treaties are the ultimate source of EU Law, there are a number of legislative instruments available to the EU institutions, one of which is the directive. Directives are legislative instruments for which the precise details of implementation are left to national governments. In the UK, these legislative instruments/directives, when implemented as Statutory Instruments, are legally binding.

Directives are approved by the Council of the European Union after going through a rigorous drafting and consultation procedure during which all member states have a right, through their national body, to comment. National bodies hold regular briefing meetings during the consultation period, at which experts from national institutions and trade associations take part. By these measures, the contents of the proposed directive receive input and comment from experts in all member states. The final directive may not fully meet every requirement but a common agreement would be reached, acceptable to all parties. At the time a directive is finally approved by the Council of the European Union, implementation dates are set.

1.1.2 Trade directives

Trade directives are concerned with removal of technical barriers to trade within the European Union. They outline essential technical and safety requirements with which products have to comply. Newly designed products must comply with the Directive by a given date, with a transitional or extended period granted to allow manufacturers to bring their existing designs into line with the requirements.

In order to prove that a product does comply with a directive, routes are provided through which a manufacturer (or agent) may have their products verified for compliance. Equipment that complies with all relevant directives (at the time of manufacture) may have the CE marking applied (see Section 1.1.5).

1.1.3 Health and safety directives

Health and safety are important areas for European Union consideration and a number of European directives have been finalised, including ones concerning the use of workplace equipment, handling of chemical agents and safety signs. Of particular note is the ATEX Workplace Directive (also known as ATEX 137) on improving the safety and health protection of workers potentially at risk from explosive atmospheres (see Section 1.1.4.1).

1.1.4 Directives relevant to explosive atmospheres

For potentially explosive atmospheres, the directives concerned are the ATEX Directives. ATEX is an abbreviation from the French 'ATmosphères EXplosibles'.

1.1.4.1 The ATEX Workplace Directive

The ATEX Workplace Directive 1999/92/EC, also known as ATEX 137, on minimum requirements for improving the health and safety protection of workers potentially at risk from explosive atmospheres, was adopted in January 2000 and had a transitional period until mid-2006.

United Kingdom regulations, which put into effect the Directive are 'The Dangerous Substances and Explosive Atmospheres Regulations (Statutory Instrument 2002/2776)', also known as DSEAR.

The Directive defines requirements for worker safety and details both employer and employee requirements in this respect.

The worker safety requirements prescribed in UK law at the present time are no less onerous than those incorporated within the Directive. However, workers in some countries may benefit from the adoption of this Directive.

Unlike the ATEX Equipment Directive (below), this workplace directive has chosen to adopt zones of use according to the international definitions, i.e. Zones 0, 1 and 2 for the three gas classifications, and Zones 20, 21 and 22 for the three dust classifications.

1.1.4.2 The ATEX Equipment Directive

The ATEX Equipment Directive 94/9/EC, also known as ATEX 95, concerns equipment and protective systems for use in potentially explosive atmospheres. The Directive was adopted in March 1994 and came into force in 2003. In April 2016, this was replaced by ATEX Equipment Directive 2014/34/EU to conform to the 'New Legislative Framework' of the EU. From the users' point of view there was no change.

United Kingdom regulations, which put into effect the Directive are 'The Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 1996 (Statutory Instrument 1996/192)' also known as EPS Regulations.

The Directive addresses requirements for certification, quality assurance and on-going surveillance of the manufacturing process.

The Directive was developed to define those features which were deemed to be necessary for consideration and incorporation into equipment being designed for use in potentially explosive atmospheres. Hazards are defined and protective measures are outlined in the Directive.

The ATEX Equipment Directive defines equipment, protective systems and components:

- **Equipment:** 'Equipment' means machines, apparatus, fixed or mobile devices, control components and instrumentation thereof and detection or prevention systems, which separately or jointly are intended for the generation, transfer, storage, measurement, control and conversion of energy for the processing of material and which are capable of causing an explosion through their own potential source of ignition. (Article 2, Paragraph 1).
- **Protective systems:** 'Protective systems' means devices (other than components of equipment) which are intended to halt incipient explosions immediately and/or to limit the effective range of an explosion and which are separately made available on the market for use as autonomous systems. (Article 2, Paragraph 2).
- **Components:** 'Components' means any item essential to the safe functioning of equipment and protective systems but with no autonomous function. (Article 2, Paragraph 3).

1.1.4.3 Equipment groups

Equipment is segregated into groups. The ATEX Equipment Directive states:

- Group I applies to equipment intended for use in underground mines, and to those parts of surface installations, liable to be endangered by firedamp (methane) and/or combustible dust.
- Group II applies to equipment intended for use in other places liable to be endangered by explosive atmospheres caused by gases, vapours and dusts or by explosive air/dust mixtures.

Note: IEC introduced (in 2006) a separate group for dusts known as Group III, which is subdivided into A: flyings, B: non-conductive dusts and C: conductive dusts (see IEC 60079-0).

For Group II equipment, three categories of equipment are considered. Although there are several clauses covering requirements for each category, they are primarily based on the probability of an ignition source being present.

Note: IEC (see IEC 60079-0) has introduced equipment protection levels (EPLs), which are similar to the ATEX Categories. It uses the suffixes 'a', 'b' and 'c' instead of the ATEX '1', '2' and '3'. For definitions of EPLs see Section 3.13.2.

1.1.4.3.1 Category 1 equipment

Category 1 equipment is designed to be capable of functioning in conformity with the operational parameters established by the manufacturer and ensuring a very high level of protection.

Equipment in this category is intended for use in areas in which explosive atmospheres caused by mixtures with air of flammable substances in the form of gases, vapours or mists, or where air/dust mixtures are present continuously, for long periods, or frequently (for example, Zone 0).

Equipment in this category has to ensure the requisite level of protection, even in the event of rare incidents relating to equipment, and is characterised by means of protection such that:

- either, in the event of failure of one means of protection, at least an independent second means provides the requisite level of protection; or

- the required level of protection is assured in the event of two faults occurring independently of each other.

1.1.4.3.2 Category 2 equipment

Category 2 comprises equipment designed to be capable of functioning in conformity with the operational parameters established by the manufacturer and of ensuring a high level of protection.

Equipment in this category is intended for use in areas in which explosive atmospheres caused by mixtures with air of flammable substances in the form of gases, vapours, mists or air/dust mixtures are likely to occur (for example, Zone 1).

The means of protection relating to equipment in this Category ensure the requisite level of protection, even in the event of frequently occurring disturbances or equipment faults, which normally have to be taken into account.

1.1.4.3.3 Category 3 equipment

Category 3 comprises equipment designed to be capable of functioning in conformity with the operational parameters established by the manufacturer and ensuring a normal level of protection.

Equipment in this category is intended for use in areas in which explosive atmospheres caused by mixtures with air of flammable substances in the form of gases, vapours, mists, or air/dust mixtures are unlikely to occur or, if they do occur, are likely to do so only infrequently and for a short period only (for example, Zone 2). Equipment in this category ensures the requisite level of protection in normal operation.

The three categories of equipment which are defined in the ATEX Equipment Directive normally (unless the risk assessment states otherwise) equate to types of equipment which may be used in Zones 0, 1 and 2 for gases and Zones 20, 21 and 22 for dusts. However, if a risk assessment is carried out to take into account the consequences of an ignition, it may be that it is concluded that in a particular Zone 1 area, equipment to Category 1 is required as the consequences are higher than normal. Conversely, it may be determined that in a different Zone 1 area, equipment to Category 3 may be permitted. It is intended that in future the area classification drawing specifies not only the zones but also the category/equipment protection level requirement.

1.1.5 CE mark

Equipment which meets the requirements of all relevant Directives at the time of manufacture can have the CE Mark affixed. The task of providing proof that the product conforms to the requirements of the Directives varies depending upon the product. In some cases a manufacturer's declaration of conformity is all that is required. In others, the submission of the product to a test and certification procedure is required. See Section 1.3 and Section 3.13 for further details.

This mark, together with appropriate details, gives an indication that the product complied with all relevant directives at the time of manufacture. The product documentation should explain which directives have been complied with. Products so marked may be freely used and traded throughout the European Union. Imported goods, of any type for which there is a directive in force, may not be sold in the European Union unless they have been granted CE Mark approval. There are a number of minor exceptions, mainly in relation to spare parts for existing equipment, some medical equipment and goods in the supply chain (i.e. taken into stock for resale prior to the compliance dates). From time to time, special arrangements can be made for the importation and use of unmarked equipment.

1.2 Standards

1.2.1 National Standards and Codes

1.2.1.1 British Standards Institution

The British Standards Institution (BSI) is the UK national standards body providing the organisation, facilities and structure for the preparation and publishing of UK national standards. As part of BSI, the British Electrotechnical Committee (BEC) is the national body responsible for the UK's electrical and electronic technical standards. The BEC is a participating member of European and international standards bodies and through this connection contributes to standards making worldwide.

As technology expands, different manufacturers produce their own solutions, versions and approach to meeting the challenge until many diverse products, all aimed at doing the same thing, appear on the market without any degree of interchangeability. There comes a time when it is realised that, if manufacturers were to standardise certain technical aspects of design, a product would result which is reliable, safe and interchangeable to a reasonable degree.

For example, by standardising the diameters of cables and of cable glands, it is always possible to obtain a suitable fit between cable and gland, no matter by whom they are made.

Whenever a need is seen for a new product design standard, standards bodies, such as BSI, set up a technical committee to which representatives of manufacturers, users, trades unions, government and other interested expert bodies are invited. They examine the technical content and arrive at a common solution to which a majority can subscribe. Standards are rarely concerned with product styling or general outward appearance, unless not to do so might compromise overall safety of the product. On completion of the first draft in committee the proposed standard is issued for general comment to a wider audience prior to completion of the final draft for publication.

Standards technical committees prepare different types of documents and those which could be encountered in working in potentially explosive atmospheres include:

- Product design standards or specifications, which specify preferred construction, testing and safety requirements;
- Concept standards outlining approved methods to achieve an end requirement, e.g. how equipment may be made flameproof;
- Codes of practice giving guidance on the selection and use of equipment;
- Specifications which give guidance on undertaking specific tasks.

1.2.1.2 US Codes

The NFPA 70 Chapter 5 is divided into Articles 500 to 506 which deal with electrical equipment in hazardous locations. The articles cover:

- 500: Hazardous locations Classes I, II and III, Divisions 1 and 2
- 501: Class I locations
- 502: Class II locations
- 503: Class III locations
- 504: Intrinsically Safe systems

- 505: Zones 0, 1 and 2 locations
- 506: Zones 20, 21 and 22 locations

Note: 501, 502 and 503 are sub-divided into General, Wiring and Equipment.

1.2.2 European and international standards

1.2.2.1 European standards

Prior to the development of the European Union, each country in Europe prepared its own national standards. In many instances there was a considerable degree of similarity between different national standards, but inevitably the range of content, test requirements and safety measures differed. This meant that equipment complying with one national standard did not meet the requirements of another national standard. As a consequence, equipment could not transfer freely across national boundaries. This was more difficult where nations were adamant that only equipment complying with their own national standards could be used.

With the development of the European Union, agreement was reached that wherever possible the national standards of each member country would be amended in order to harmonise standards across Europe. In the fullness of time new standards were to be developed which would be used throughout the European Union. New standards bodies were set up to develop these standards.

These are as follows:

- CEN European Committee for Standardization;
- CENELEC European Committee for Electrotechnical Standardization;
- ETSI European Telecommunications Standards Institute.

1.2.2.2 International standards

Long before the inauguration of the European standards bodies, international standards bodies had existed whose aim was to provide a degree of standardisation worldwide. International standardisation is of great importance to companies that operate globally.

The principal international organisations are:

- ISO International Standards Organization;
- IEC International Electrotechnical Commission;
- ITU International Telecommunications Union.

ISO prepares standards comparable with those produced by CEN, IEC comparable with CENELEC and ITU comparable with ETSI.

Just as there was logic behind harmonising European standards wherever possible, the opportunity for further harmonisation with international standards has been agreed in principle and is on-going. In the sphere of electrical equipment for use in potentially explosive atmospheres, a number of identical standards are now in use. In such situations the standards carry the same number, e.g. EN 60079-17 and BS EN 60079-17 are identical to IEC 60079-17.

However, sometimes national bodies (e.g. BSI in the UK) modify the Forward and/or add National Annexes to their version of the IEC or regional standard. The 5th edition of BS EN 60079-14 contains

such a modified Forward and a National Annex. The second edition of BS EN 60079-10-1 has a modified Forward and will have a National Annex by the end of 2016.

1.2.3 Other bodies involved in relevant standards and codes

1.2.3.1 Institution of Engineering and Technology, IET (formerly Institution of Electrical Engineers, IEE)

The IET has participated in electrical standardisation for several decades. In particular it produces the IET Wiring Regulations.

Whilst the IET Wiring Regulations were initially developed so that electricians had a standard for use in domestic, shop and office type premises, they extend now to cover all installations including factory and process plant.

Despite the word regulations in the title, there is no legal requirement or law demanding that they are followed, but if they are, a good standard results. Installations which comply with them should have no difficulty in meeting the relevant requirements of the Electricity at Work Regulations (1989).

Readers of this EEMUA Publication should be conversant with the contents of the IET Wiring Regulations and they should be referred to as any need arises. However, the special requirements for installations in potentially explosive atmospheres are not covered by the IET Wiring Regulations.

In 1995, a joint BSI and IET technical committee (JPEL/64) was formed to undertake future development of the Regulations which became BS 7671 Requirements for electrical installations. The 17th Edition of the IET Wiring Regulations is the most recent issue and came into effect July 2008 for new installations. The third Amendment to these Regulations was published in August 2015 and is the standard for all domestic and industrial installations designed after 1st July 2015.

Future work is related to integrating BS 7671 and the IET Wiring Regulations with the IEC similar standard. This has the ultimate aim of standardising wiring systems throughout Europe and the world.

1.2.3.2 Energy Institute, EI (formerly Institute of Petroleum, IP)

The Energy Institute drafts documents relevant to the many practical issues concerning petroleum. These include details relevant to drilling, extraction, refining, distribution and use.

The Energy Institute (EI) documents are, in many cases, complementary to the standards prepared by the national standards bodies. For instance, the 'Model Code of Safe Practice Part 15: Area Classification Code for Installations Handling Flammable Fluids' is termed by IEC 60079 as an 'industry code'. Many of the EI documents refer to design issues beyond the scope of this work. Trainees are not required to refer to them as part of the CompEx® course.

1.2.3.3 Oil & Gas UK (formerly United Kingdom Offshore Operators Association, UKOOA)

Oil & Gas UK is a trade association who represent the interests of those who are involved in the offshore side of petroleum production. Over the years Oil & Gas UK has prepared many codes of practice and guidance documents relating to exploration and production offshore.

1.2.3.4 Engineering Equipment and Materials Users Association, EEMUA

The Engineering Equipment and Materials Users' Association, EEMUA, is a European based, non-

profit distributing, industry Association run for the benefit of companies that own or operate industrial facilities. A full description is given at the beginning of this Publication (see page ii).

1.2.3.5 Institution of Gas Engineers and Managers

The Institution of Gas Engineers and Managers (IGEM) is a chartered professional body, licensed by the Engineering Council. IGEM produces a range of technical standards in the following areas: General; Gas Legislation; Gas Metering; Safety; Transmission and Distribution; and Utilization.

1.2.4 Standards numbering

The following standards numbering systems are in use.

1.2.4.1 UK national standards

UK national standards are developed solely for use in the UK where no other standard is available. They are numbered as BS xxxx together with the date. For example, BS 6121-1:1989 Mechanical cable glands. Specification for metallic glands.

There are also standard-like documents called Published Documents (PDs) which do not have the same status as British Standards. References to addendums are shown as +A1: 2013 where the number of the addendum is followed by the year it was published.

1.2.4.2 European standards

European standards are prepared for use throughout Europe and are published as national standards. For example, EN 1839:2012 Determination of explosion limits of gases and vapours. European standards are often given the national prefix for sales in each country, e.g. BS EN 1839:2012.

1.2.4.3 International electrical standards

International electrical standards have been developed by the IEC for use worldwide. Many have been adopted in Europe as replacements for similar national/European standards, in accord with existing agreements between IEC and CENELEC to work towards common standards wherever possible.

IEC standards have a five figure number starting with 6 as IEC 6xxxx + date, e.g. IEC 60079-17:2013 Explosive atmospheres. Part 17: Electrical installations inspection and maintenance.

Where the IEC standard has been adopted as the European standard it carries the 'EN' prefix. For example, EN 60079-17:2013 Explosive atmospheres. Electrical installations inspection and maintenance. It is then published in the UK with a 'BS EN' prefix.

Where the IEC standard has not been adopted as the European standard it retains the 'IEC' prefix. It is then published in the UK with a 'BS IEC' prefix.

The preparation of standards which are suitable for use throughout the world continues. Not all countries subscribe to international standards for various reasons but there are an increasing number of those that do. Universal adoption of international standards ensures that there is quality equipment, built to a common standard, available for purchase worldwide.

1.2.5 Using standards in electrical working in hazardous areas

New equipment should conform to the latest version of a standard. However, there are many items of equipment still in service which were built in accordance with standards which have now been superseded. Those engaged in inspection and maintenance require some guidance on the standards markings, which may be found on older equipment.

1.2.5.1 Standards relevant to gases

Table 1 lists the parts of IEC 60079, the current principal standard for gases. See the references for a complete listing of all standards including those superseded by IEC 60079.

Table 1 Principal standards for gases

IEC	Title	Notes
60079-10-1	Explosive atmospheres Part 10-1: Classification of areas – Explosive gas atmospheres	
60079-14	Explosive atmospheres Part 14: Electrical installations design, selection and erection	This standard also contains requirements for dusts
60079-17	Explosive atmospheres Part 17: Electrical installations inspection and maintenance	This standard also contains requirements for dusts
60079-19	Explosive atmospheres Part 19: Equipment repair, overhaul and reclamation	This standard also contains requirements for dusts
60079-20-1	Explosive atmospheres Part 20-1: Material characteristics - Gas and vapour classification, test methods and data	IEC60079-20-1 will be replaced by IEC 80079-20-1 in early 2017.
	Protection Type	Previous EN standard
60079-0	General	EN 50014
60079-1	'd'	EN 50018
60079-2	'p'	EN 50016
60079-5	'q'	EN 50017
60079-6	'o'	EN 50015
60079-7	'e'	EN 50019
60079-11	'i'	EN 50020
60079-15	'n'	EN 50021
60079-18	'm'	EN 50028
60079-25	'i' systems	EN 50039
60079-26	EPL Ga	–
60079-27	Fieldbus	–
60079-28	Optical radiation	–

1.2.5.2 Standards relevant to combustible dusts

Standards used for combustible dusts were redrafted to include requirements of the ATEX Equipment Directive (ATEX 95). At that time, their part numbers were also changed to align with those used for gases (effective by 2004). As from 2006, the requirements for dusts have been transferred to the corresponding IEC 60079 series. For further details see Chapter 7.

The principal standards for dust are indicated in Table 2 below.

Table 2 Principal standards for combustible dusts

IEC	Title	Notes
60079-10-2	Explosive atmospheres Part 10-2: Classification of areas – Combustible dust atmospheres	
60079-14	Explosive atmospheres Part 14: Electrical installations design, selection and erection	This standard also contains requirements for gases
60079-17	Explosive atmospheres Part 17: Electrical installations inspection and maintenance	This standard also contains requirements for gases
60079-19	Explosive atmospheres Part 19: Equipment repair, overhaul and reclamation	This standard also contains requirements for gases
80079-20-2	Explosive atmospheres – Part 20-2: Material Characteristics - Combustible dusts test methods.	
	Protection type	
61241-0	General	This standard has been withdrawn as all 61241 standards have been incorporated into 60079.
60079-0	General	
60079-2	'p'	IEC 61241-4 has been incorporated into 60079-2
60079-11	'i'	Dust requirements of IEC 61241-11 have been incorporated into 60079-11
60079-18	'm'	Dust requirements of IEC 61241-18 have been incorporated into 60079-18
60079-31	't'	Replaced IEC 61241-1

1.3 Product certification

1.3.1 Product certification by an IECEx certification body within the IECEx system

The stated objective of the IECEx System is to facilitate international trade in equipment and services for use in explosive atmospheres, while maintaining the required level of safety by:

- reduced testing and certification costs to manufacturer;
- reduced time to market;
- international confidence in the product assessment process;
- one international database listing; and
- maintaining international confidence in equipment and services covered by IECEx Certification.

Product certification is carried out by Approved IECEx Certification Bodies (ExCBs) to the requirements of IEC 60079 and ISO/IEC 17025 and 17065 standards. The current list of EXCBs is available on the IECEx website.

IECEx certification is gradually being accepted internationally. However, within Europe, ATEX certification is required for all new equipment being installed within the EU area. Many items of new equipment are being dual (IECEx and ATEX) certified.

1.3.2 ATEX Certification by a Notified Body

An ATEX Notified Body is a body which has been assessed to ISO/IEC 17025 and 17065 by a national body (United Kingdom Accreditation Service, UKAS, in the UK) and the body has been notified, to the European Commission by the notifying nation, as having appropriate skills, expertise and competence to undertake procedures relevant to product certification in accordance with the relevant European directive. For equipment for use in potentially explosive atmospheres the directive is the ATEX Equipment Directive (ATEX 95). The full list of European Notified Bodies to this Directive is listed on the EC's Europa website.

To obtain certification, an approved test house undertakes tests on a sample of the equipment in accordance with the requirements of the standard. The test figures are submitted to the Notified Body who then assesses the test results in association with the documentation and company details prior to granting an EU type examination certificate.

Based on the content of the certificate and on the requirements of the standard, the manufacturer includes identifying details on the nameplate and/or on an additional plate on the equipment. Where the tested item is small and insufficient space is available to add all the relevant details, special arrangements apply such as inclusion of relevant details in literature and in the certificate.

For full details on equipment marking see Section 3.13.

1.3.3 Impact of ATEX Equipment Directive on certification procedures

The ATEX Equipment Directive (ATEX 95) came into force in 1996. Suppliers were allowed to continue to manufacture products without complying with the Directive until the end of June 2003. As from July 2003, any newly produced equipment has had to conform to the ATEX Equipment Directive.

It was accepted that existing equipment can continue to be used until its useful life has expired, although a risk assessment was required to be carried out by July 2006 to justify its continued use.

Prior to ATEX, there was very little quality control and routine surveillance of test houses (the predecessors of Notified Bodies) with some notable exceptions. Manufacturing quality control and surveillance by the Notified Body now plays an increasingly important role in the procedure.

Equipment for Category 1 is required to be assessed by a Notified Body. Electrical equipment (and internal combustion engines) for Category 2 is required to be assessed by a Notified Body. Other equipment for Category 2 requires the manufacturer to provide a declaration of conformity. Category 3 equipment requires the manufacturer to provide a declaration of conformity.

1.3.4 Assessment

Equipment for use in potentially explosive atmospheres requires more rigorous safety standards than are required for equipment used in most industrial, office and domestic environments. The user seeks proof that equipment is suitable and is safe to use in the foreseeable site conditions.

The ATEX Equipment Directive prescribes two basic routes whereby a manufacturer might show compliance:

- **Standard:** Different types of protection as defined by European standards are recognised as being acceptable for a particular category. Each standard has very specific test requirements which have to be carried out before an equipment can be certified as complying with that standard.
- **Essential Health & Safety Requirements (EHSR):** Conformance with the EHSRs as defined in the ATEX Equipment Directive requires the Notified Body or manufacturer (depending on the category) to make an assessment and document those findings and any tests in the technical file.

Note: Many users are somewhat wary of using equipment which is certified to the EHSRs and not to a recognised type of protection because the installation, inspection and repair standards (IEC 60079-14, 17, 19) cannot be applied to such equipment.

1.4 Health and safety requirements in law

1.4.1 Basic requirements concerning the workplace

1.4.1.1 The principal acts and regulations

There are many UK Acts of Parliament and other legal regulations which concern safety in the workplace. Both employers and employees have duties in regard to the workplace. Other countries have similar regulatory frameworks.

The principal British Acts and Regulations are:

- **Factories Act 1961:** generally outlines an employer's duties with regard to the workplace.
- **Health and Safety at Work Act 1974:** imposes additional requirements regarding health and safety at work.
- **Electricity at Work Regulations 1989:** outlines requirements for the safe use of electricity and electrical work, including competency of workers.

- **Provision and Use of Workplace Equipment Regulations 1998 (PUWER):** outlines requirements for the provision and safe use of equipment provided in the workplace.
- **Management of Health and Safety at Work Regulations 1999 (MHSWR):** makes more explicit the employer's obligations to manage health and safety under the Health and Safety at Work Act.
- **Personal Protective Equipment Regulations 1992 (PPE):** provides guidance on situations where personal protective equipment, such as ear defenders and special clothing, are required.
- **Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR):** regulations implementing the ATEX Workplace (ATEX 137) Directive.

1.4.1.2 Basic duties of employer and employee

The employer's basic duty: Every employer has a 'duty of care' to provide a safe place in which to work and has to employ competent people.

The employee's basic duty: Every worker has a duty placed upon him to exercise diligence and care whilst undertaking allotted tasks.

Failure of the employer or employee to comply with the above basic requirements can result in appropriate legal action being taken.

1.4.2 The Health and Safety at Work Act 1974 (HASAW Act)

This Act imposes duties on employers, the self-employed and employees insofar as their work requires this.

1.4.2.1 Duties of employers under HASAW Act

Under Section 2 of the HASAW Act – General duties of employers:

- **Section 2-1:** It shall be the duty of every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all his employees.
- **Section 2-2:** Without prejudice to the generality of an employer's duty under the preceding subsection, the matters to which that duty extends include in particular:
 - **Section 2-2a:** the provision and maintenance of plant and systems of work that are, so far as is reasonably practicable, safe and without risks to health.
 - **Section 2-2b:** arrangements for ensuring, so far as is reasonably practicable, safety, and absence of risks to health in connection with the use, handling, storage and transport of articles and substances.
 - **Section 2-2c:** the provision of such information, instruction, training and supervision as is necessary to ensure, so far as is reasonably practicable, the health and safety at work of his employees.
 - **Section 2-2d:** so far as is reasonably practicable as regards any place of work under the employer's control, the maintenance of it in a condition that is safe and without risks to health and the provision of means of access to and egress from it that are safe and without such risks.
 - **Section 2-2e:** the provision and maintenance of a working environment for his employees that is, so far as is reasonably practicable, safe, without risks to health, and adequate as regards facilities and arrangements for their welfare at work.

The Act expands on the above and also introduces requirements for employees as below.

1.4.2.2 General duties of employees at work under HASAW Act

These are exemplified by the following extracts. There are other employee duties but generally speaking employees are expected to carry out their tasks diligently, competently and with due regard for the safety of themselves and other employees.

Section 7 states it shall be the duty of every employee while at work:

- to take reasonable care for the health and safety of himself and of other persons who may be affected by his acts or omissions at work; and
- as regards any duty or requirement imposed on his employer or any other person by or under any of the relevant statutory provisions, to co-operate with him so far as is necessary to enable that duty or requirement to be performed or complied with.

Section 8 states that no person shall intentionally or recklessly interfere with or misuse anything provided in the interests of health, safety or welfare in pursuance of any of the relevant statutory provisions.

1.4.3 The Electricity at Work Regulations

The Electricity at Work Regulations were made to amplify and extend the duties placed on those employers and employees outlined in the HASAW Act. They impose precautions to be taken against the risk of death or personal injury from electricity at work activities.

The following list, though not exhaustive, provides an overview of the contents of the Electricity at Work Regulations, which are relevant to work in potentially explosive atmospheres.

Regulation 3: Person on whom duties are imposed by these Regulations.

- Except where otherwise expressly provided in these Regulations, it shall be the duty of every employer and self-employed person, to comply with the provisions of these Regulations in so far as they relate to matters within his control.
- It shall be the duty of every employee while at work:
 - to co-operate with his employer so far as is necessary to enable any duty placed on that employer by the provision of these Regulations to be complied with; and
 - to comply with the provisions of these Regulations in so far as they relate to matters which are within his control.

Regulation 4: Systems, work activities and protective equipment.

- All systems shall at all times be of such construction as to prevent, so far as is reasonably practicable, danger.
- As may be necessary to prevent danger, all systems shall be maintained so as to prevent, so far as is reasonably practicable, such danger.
- Every work activity, including operation, use and maintenance of a system and work near a system, shall be carried out in such a manner as not to give rise, so far as is reasonably practicable, to danger.
- Any equipment provided under these Regulations for the purpose of protecting persons at work on or near electrical equipment shall be suitable for the use for which it is provided, be maintained in a condition suitable for that use, and be properly used.

Regulation 5: Strength and capability of electrical equipment.

- No electrical equipment shall be put into use where its strength and capability may be exceeded in such a way as may give rise to danger.

Regulation 6: Adverse or hazardous environments.

- Electrical equipment which may reasonably foreseeably be exposed to:
 - mechanical damage;
 - the effects of weather, natural hazards, temperature or pressure;
 - the effects of wet, dirty, dusty or corrosive conditions; or
 - any flammable or explosive substance, including dusts, vapours or gasesshall be of such construction or as necessary protected as to prevent, so far as is reasonably practicable, danger arising from such exposure.

Examples of potentially illegal situations:

- persons working on electrical installations without proof that they are competent to do so;
- Equipment installed in a potentially explosive atmosphere must have appropriate explosion protection, otherwise it could be deemed to be illegally installed and used.
- a failure to maintain equipment which compromises safety;
- leaving a part which is 'live', at a dangerous voltage, accessible such that it could be touched by an unsuspecting person;
- leaving metalwork unearthed, which regulations require to be earthed; or
- replacing a fuse of higher rating or of an inappropriate type as fuses are provided to prevent danger.

1.4.4 Provision and Use of Work Equipment Regulations

These regulations are commonly referred to as the PUWER Regulations. The following sections are relevant to work in potentially explosive atmospheres.

Regulation 7: Specific risks

- Where the use of work equipment is likely to involve a specific risk to health or safety, every employer shall ensure that:
 - The use of that work equipment is restricted to those persons given the task of using it; and
 - Repairs, modifications, maintenance or servicing of that work equipment is restricted to those persons who have been specifically designated to perform operations of that description (whether or not they are also authorised to perform other operations).
- The employer shall ensure that the persons designated for the purposes of sub-paragraph (b) of paragraph (1) have received adequate training related to any operations in respect of which they have been so designated.

Regulation 9: Training

- Every employer shall ensure that all persons who use work equipment have received adequate training for purposes of health and safety, including training in the methods which may be adopted when using the work equipment, any risks which such use may entail and precautions to be taken.

1.4.5 The Management of Health and Safety at Work Regulations

These Regulations are commonly referred to as the MHSWR Regulations. The following sections are relevant to work in potentially explosive atmospheres. For guidance see HSE L21(1).

Regulation 3 requires an employer to carry out an assessment of risks to health and safety and assess where particular competence is required.

Regulation 10 requires an employer to provide information to employees, relating to risks identified in the assessment and preventive and protective measures.

Regulation 13 requires an employer to take into account the capabilities of employees regarding health and safety matters. Regulation 13 also requires an employer to ensure that employees are provided with adequate health and safety training at the time of recruitment and on being exposed to new and increased risks.

1.4.6 Personal Protective Equipment at Work Regulations

These Regulations are commonly referred to as the PPE Regulations.

Regulation 4 requires every employer to ensure that suitable personal protective equipment is provided for any employee who may be exposed to any risk to their health or safety while at work except where and to the extent that such risk has been adequately controlled by other means which are equally or more effective.

Protective equipment may include protection for the head, for feet and hands, and against noise. Special protective clothing may also be required.

1.4.7 Factories Act 1961 Section 31

Section 31 of the Factories Act 1961 requires precautions to be taken with respect to explosive or inflammable dust, gas, vapour or substance. Emphasis is placed on the need to prevent explosions by plant enclosure and the prevention of ignition sources as well as the prevention of dust accumulations.

The following is an extract from Section 31:

"Where in connection with any grinding, sieving, or other process giving rise to dust, there may escape dust of such a character and to such an extent as to be liable to explode on ignition, all practicable steps shall be taken to prevent such an explosion by enclosure of the plant used in the process, and by removal or prevention of accumulation of any dust that may escape in spite of the enclosure, and by exclusion or effective enclosure of possible sources of ignition."

Note: A significant part of the Factories Act 1961 has been repealed by later legislation, but not Section 31.

1.4.8 Control of Substances Harmful to Health Regulations

These Regulations are commonly referred to as the COSHH Regulations. They require an employer who utilises or handles substances which may be harmful to the health of workers, to undertake an assessment of the risks involved.

Employees are to be kept informed of the risks and the steps necessary to safeguard health.

1.4.9 Dangerous Substances & Explosive Atmospheres Regulations

These Regulations are commonly referred to as DSEAR. They combine parts of the Chemical Agents Directive with the requirements of the ATEX Workplace Directive.

The Regulations place extensive tasks on site operators to ensure that the workplace complies with these directives which affect the safety of personnel and the environment.

DSEAR includes the requirement that new equipment complies with the ATEX Equipment Directive (ATEX 95) and that existing equipment is maintained in a safe state until this is no longer possible or no longer required.

The Regulations also require operators of existing workplaces to undertake a full risk assessment.

2. Gases and vapours and area classification

2.1 Characteristics of gases and vapours

2.1.1 General

The gases with which we are concerned in this Publication are those which are flammable when mixed with air. Due to the presence of oxygen in air, the mixture burns fiercely if ignited. The resulting hot burning gas rapidly expands, potentially developing into an explosion. The volume of exploding material may result in substantial damage to surrounding buildings, equipment and persons in the vicinity. Incidents such as the Buncefield incident, Piper Alpha and the Flixborough disaster are on record. These emphasise the severity of an uncontrollable catastrophic situation.

To minimise the risk of an unwanted gas ignition, an immense amount of research and development has been undertaken in order to gain vital information relative to combinations of gas and air, such as might be present throughout manufacturing and process industries.

Owing to the wide range of conditions and circumstances it has been found necessary to create subdivisions of materials and adopt various procedures to insure that, even should a flammable gas be released, the means to ignite it should not be present.

This Section is concerned with the characteristics of flammable gases and vapours. Some consideration is also given to the types of flammable petroleum based liquids encountered in refineries and similar places.

Historically, a wide variety of terms have been used to describe equipment and the immediate surroundings where it is used. These have included gases, flammable, explosive, ignitable, combustible, locations, places, zones, areas, divisions, classes and groups.

In accordance with the ATEX Equipment Directive, equipment for use in potentially explosive atmospheres is divided into Equipment Groups and Equipment Categories. It is further subdivided based on the type of protection employed to achieve safety in the various zones of use. The IEC 60079 series of standards use Equipment Protection Levels (EPLs) rather than Categories. For more detailed information on category definitions and protection types, see Chapter 3.

Group I equipment is a designation given to equipment designed and tested for use underground where the risks are from methane (firedamp) and coal dust. Group I equipment is not discussed further in this Publication.

Group II equipment is a designation given to equipment designed for use above ground where risks from ignition of a wide range of flammable gases and ignitable dusts may be present.

Note: IEC introduced (in 2006) a separate equipment group for combustible dusts known as Group III which is subdivided into A: combustible flyings, B: non-conductive dusts and C: conductive dusts (see IEC 60079-0). Dust hazards are detailed within Chapter 7 of this Publication.

2.1.2 Gas subdivisions

Gases are divided into subdivisions and not into groups, although many people still refer to these as gas group A, B or C. These subdivisions are based on experimental work conducted with flameproof and intrinsically safe apparatus.

Thus gases may be categorised into subdivisions by one (or both) of two test methods:

- by their Maximum Experimental Safe Gap (MESG). MESG is based on work undertaken to develop flameproof equipment; or
- by their Minimum Ignition Current (MIC). MIC is of greatest value in determining standards for intrinsically safe apparatus.

Note: 'M' stands for Maximum in one case and Minimum in the other.

2.1.2.1 Subdivisions based on MESG

These gas subdivisions are based on the possibility of a burning gas mixture passing through a specified gap. Thus a gas with an MESG of 0.9 mm means that if the gap is less than 0.9 mm for the standard test gap length, the flame cannot pass through, but if it is greater it could. It is the maximum gap for that gas at the standard gap length.

2.1.2.1.1 Determination of MESG: test equipment

The experimental test rig consists of a strong interior spherical chamber, having an opening fitted with a flanged bolted-on cover. The cover overlaps the edge of the hole by 25 mm (1 inch approx.). Accurately dimensioned spacers can be placed between the cover and the chamber in order to provide for adjustment of the gap. A source of ignition (such as a spark plug) is fitted. The complete chamber is contained within an exterior cylindrical enclosure, which is fitted with an observation window.

The chamber and enclosure are now filled with a known gas and the igniter is set off to ignite the gas within the inner chamber. If the hot burning gas passes through the gap and ignites the gas in the enclosure, further tests are made using slightly smaller gaps, until a gap width is determined which prevents ignition of the external gas. Additional tests may be made with different proportions of oxygen in the gas/air mixture to ensure that under the worst conditions, the gap effectively prevents the transmission of the internal explosion to the outside atmosphere. This gap is the MESG. Over the years many tests have been carried and the data is published in several standards. Details of the test apparatus are included in IEC 60079-20-1.

It is a common misunderstanding that MESG is a constant for a particular gas. It is not, different values can be determined for the same gas in different test vessels, particularly for the more reactive gases, even the point of ignition can be significant. Nevertheless, standardising on the IEC vessel provides a useful reference source for categorisation.

The test is somewhat more involved than outlined above and various configurations of 'gap' have been tested. Applicable constructional gap dimensions may be found in IEC 60079-20-1. It has been found practical to subdivide flammable gases into one of three subdivisions, based on MESG. Gases used in industry are often mixtures of several gases. Procedures for calculating the MESG of mixtures are detailed in IEC 60079-20-1.

Table 3 Gas subdivisions based on MESG

Gas subdivision	Gap (gap length 25 mm)	Example	MESG
IIA	≥ 0.9 mm	Propane	0.92
IIB	0.5 to 0.9 mm	Ethylene	0.65
IIC	≤ 0.5 mm	Hydrogen	0.29

In practice however, considerable safety margins are applied. For example, the maximum gap to be used for Subdivision IIB with a 25 mm gap length is 0.2 mm and for hydrogen IIC is 0.1 mm, reducing to 0.04 mm for enclosures of volume greater than 500 cm³ (0.5 litre).

2.1.2.2 Subdivisions based on MIC

The intrinsic safety quality of an electric circuit is based on the fact that the energy available in that circuit is insufficient to ignite a gas. Some gases, such as hydrogen, ignite very easily whilst others, such as methane or butane, require about four times as much spark energy.

2.1.2.2.1 Determination of MIC for a flammable gas

The test rig used to determine the MIC is much simpler than that used for MESG determination. In brief, a motor driven rotating contact make/break unit, made to a specific design, is enclosed within a chamber (volume > 250 cm³). Practical application details may be found in IEC 60079-20-1 and IEC 60079-11.

The test gas is transferred to the chamber and the motor is started. The current is increased until the resultant spark ignites the gas. The test is repeated. There are very specific details in the standard regarding the circuitry used, the contact materials employed and the values of voltage, resistance, capacitance and inductance in the circuit.

Gases and vapours may be classified according to the ratio of their Minimum Igniting Currents (MIC) with the ignition current of laboratory methane. For most gases and vapours, it is sufficient to make only one determination of either MESG or MIC ratio to classify the gas or vapour. Group II equipment is subdivided and, for the purpose of classification of gases and vapours, the MIC ratios are:

Table 4 Gas subdivisions based on MIC

Gas subdivision	MIC ratio (compared to that of laboratory methane)	Example
IIA	> 0.80	Butane, MIC ratio of 0.94
IIB	from 0.45 to 0.80	Ethylene, MIC ratio of 0.53
IIC	< 0.45	Hydrogen, MIC ratio of 0.25

2.1.2.3 Correlation of the two types of test

Through selection of the appropriate gaps and ignition values noted above, gas subdivisions may be determined by either of the two methods. However, in some cases there is a need to check using both methods.

Note: Benzene and petroleum gases fall into Gas subdivision IIA.