BRITISH STANDARD

BS 5345-8: 1980

Code of practice for

Selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining applications or explosive processing and manufacture) —

Part 8: Installation and maintenance requirements for electrical apparatus with type of protection "s" — Special protection

UDC 696.6:621.3 – 7:614.83

Cooperating organizations

The General Electrotechnical Engineering Standards Committee, under whose direction this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

British Approvals Service for Electric Cables Ltd.
Associated Offices Technical Committee*
British Electrical and Allied Manufacturers' Association (BEAMA)*
British Radio Equipment Manufacturers' Association
British Steel Corporation
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This British Standard, having been prepared under the direction of the General Electrotechnical Engineering Standards Committee, was published under the authority of the Executive Board and comes into effect on 29 February 1980

The following BSI references relate to the work on this standard:
Committee reference GEL/114
Draft for comment 75/20875 DC

ISBN 0 580 11144 X

Amendments issued since publication

Amd. No.	Date of issue	Comments

Contents

Foreword

BS 5345 is a revision of code of practice CP 1003-1, CP 1003-2 and CP 1003-3 and should be used for all new installations of electrical apparatus in potentially explosive atmospheres. However, CP 1003 will be retained for some time as a reference guide for the many existing plants installed according to the earlier code.

Many gases, vapours, mists and dusts encountered in industry are flammable. When ignited, they may burn readily and with considerable explosive force if mixed with air in the appropriate proportions. It is often necessary to use electrical apparatus in locations where such flammable materials may be present, and appropriate precautions should therefore be taken to ensure that all such apparatus is adequately protected in order to reduce the likelihood of ignition of any external explosive atmosphere. When using electrical apparatus, potential ignition sources include electrical arcs and sparks, hot surfaces and, in certain circumstances, frictional sparks.

In general, electrical safety is ensured by implementing one of two procedures. Either the electrical apparatus should be located, whenever practicable, outside hazardous areas; or the electrical apparatus should be designed, installed and maintained in accordance with measures recommended for the area in which the apparatus is located.

Several techniques are available for the protection of electrical apparatus in hazardous areas. Some of these techniques (or "types of protection" as they are known) have been used for many years and have come to be regarded as traditional. Other types of protection have been introduced only recently.

This code of practice describes the basic safety features of these types of protection, full details of which are given in the relevant standards, and recommends the selection, installation and maintenance procedures that should be adopted to ensure the safe use of electrical apparatus in hazardous areas. This code therefore takes account of the significant developments that have taken place in area classification and in the design, manufacture and use of electrical apparatus for hazardous areas since the preparation of the earlier code of practice CP 1003.

It is important to note that this code of practice deals with *explosion* hazards due to the presence of flammable gas/air mixtures; it does not provide guidance on the extra precautions to be taken where such gases involve a *toxic* hazard.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 8, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

0 Introduction

This document is Part 8 of code of practice BS 5345. The code gives guidance in the selection, installation and maintenance of electrical apparatus for use in areas where flammable materials are generated, processed, handled or stored, and that are therefore potentially hazardous.

In common with the earlier code of practice for the use of electrical apparatus in hazardous areas (CP 1003-1:1964, CP 1003-2:1966 and CP 1003-3:1967), the present code is divided into a number of Parts. Each Part deals with the installation and maintenance requirements appropriate to one of the types of protection that may be used to achieve electrical safety, or with basic requirements and considerations that are fundamental to the use of electrical apparatus in hazardous areas, and that therefore provide the basis for the other Parts of the code.

The full list of Parts is as follows:

— *Part 1: Basic requirements for all Parts of the code;*

— *Part 2: Classification of hazardous areas*[1)];

— *Part 3: Installation and maintenance requirements for electrical apparatus with type of protection "d". Flameproof enclosure;*

— *Part 4: Installation and maintenance requirements for electrical apparatus with type of protection "i". Intrinsically safe apparatus and systems;*

— *Part 5: Installation and maintenance requirements for electrical apparatus with type of protection "p". Pressurization and continuous dilution*[1)];

— *Part 6: Installation and maintenance requirements for electrical apparatus with type of protection "e". Increased safety;*

— *Part 7: Installation and maintenance requirements for electrical apparatus with type of protection N;*

— *Part 8: Installation and maintenance requirements for electrical apparatus with type of protection "s". Special protection;*

— *Part 9: Installation and maintenance requirements for electrical apparatus with type of protection "o". Oil-immersed apparatus, and with type of protection "q". Sand-filled apparatus*[1)];

— *Part 10: Installation and maintenance requirements for electrical apparatus for use with combustible dusts*[1)];

— *Part 11: Specific industry applications*[1)];

— *Part 12: The use of gas detectors*[1)].

This Part of the code should be read in conjunction with the other Parts, and in conjunction particularly with Parts 1 and 2 which, taken together, describe the fundamental considerations that affect the selection, installation and maintenance of all electrical apparatus used in hazardous areas.

BS 5345 is based on the concept of area classification which recognizes the differing degrees of probability with which explosive (flammable) concentrations of flammable gas or vapour may arise in installations in terms of both the frequency of occurrence and the probable duration of existence on each occasion.

The detailed considerations that should be taken into account in deciding on an area classification are described in Part 2 of the code. For completeness, and for the convenience of readers, the definitions appropriate to area classification are repeated here. It should be noted that whereas, formerly, classified areas were known as Divisions, they are now called Zones. Three Zones are recognized, i.e.:

Zone 0 In which an explosive gas/air mixture is continuously present or present for long periods.

Zone 1 In which an explosive gas/air mixture is likely to occur in normal operation.

Zone 2 In which an explosive gas/air mixture is not likely to occur in normal operation, and if it occurs it will exist for only a short time.

It should be noted that this concept of area classification deals only with risks due to flammable gases and vapours and, by implication, mists. It does not deal with flammable dusts, which may lie quiescent for long periods of time until disturbed into suspension by a suitable mechanism. An area classification concept is being developed for dusts.

By implication, an area that is not classified as Zone 0, 1 or 2 is deemed to be a non-hazardous or safe area. If doubt exists as to the classification of an area that is judged to be hazardous or potentially hazardous, guidance should be sought at an early stage from the authority having jurisdiction in the industry or area concerned. (See Parts 1 and 2 of the code.)

[1)] In course of preparation.

Electrical apparatus used in each of the classified Zones should be suitably protected by design and manufacture, and should also be installed and maintained so as to ensure its safe use. BS 5345, in offering guidance in the selection, installation and maintenance of suitably protected apparatus, replaces CP 1003 and should be used for all new installations. It should also be used for changes to existing installations, though it is recognized that minor changes only to certain existing installations may need to be made in accordance with the recommendations of the earlier code. It is intended, however, that CP 1003-1, CP 1003-2 and CP 1003-3 will eventually be withdrawn from use.

Notwithstanding application of the installation recommendations of this code to existing installations, the recommendations for maintenance should be applied to all electrical apparatus and installations, irrespective of age and date of installation. It should also be noted that the installation and maintenance recommendations described in the code are supplementary to, and not alternative to, any requirements that would apply to general industrial installations (see also Part 1 of the code).

Section 1. General principles

1 Scope

This Part of BS 5345 describes the concept of ensuring electrical safety in hazardous areas by means of type of protection "s": special protection, and offers guidance in the selection, installation and maintenance of this type of electrical apparatus.

The recommendations of the code do not apply to the underground mining industry, where other precautions are necessary, though it is recognized that the recommendations of the code may be applied to the surface installations of mines.

Apparatus with type of protection "s" is designed for use in areas with flammable gas and vapour risks. For the use of this apparatus in areas with flammable dust risks, see Part 10 of this code.

2 References

The titles of the publications referred to in this code are listed on the inside back cover.

3 Definitions and explanation of terms

The definitions and terms that are generally applicable to hazardous areas and electrical apparatus used therein are included in Part 1 of this code, to which reference should be made.
The definitions and terms that are particularly relevant to individual types of protection are indicated in the appropriate Parts of the code.
For the purposes of this Part, the following definition applies.

type of protection "s": special protection

a concept that has been adopted to permit the certification of those types of electrical apparatus that, by their nature, do not comply with the constructional or other requirements specified for apparatus with established types of protection, but which, nevertheless, can be shown, where necessary by test, to be suitable for use in hazardous areas in prescribed Zones

NOTE This concept permits flexibility on the part of certifying and assessment authorities in their approach to applications for certification or assessment of apparatus, the use of which would otherwise not be permitted in hazardous areas on account of non-compliance with the requirements of standards for recognized or established types of protection. This applies not only to current types of apparatus, but also allows flexibility of approach to innovatory ideas and new designs, the development of which might otherwise be hindered.

4 Description of technique

Because of the basic concept of type of protection "s" there can be no detailed specification for apparatus forming the subject of this code. There is no single technique, but the basic concept of type of protection "s", which does not allow of writing detailed specifications for apparatus, embraces an unspecified number of individual techniques. None of these techniques can be adequately specified by the established types of protection. The following are a few examples to illustrate the types of apparatus that may be certified within the concept of special protection.

a) **Encapsulation.** Electrical apparatus may be partly or wholly encapsulated in a suitable medium, e.g. a thermosetting resin, so that the external atmosphere is prevented from reaching the protected apparatus.

b) **Gas detection and analysis apparatus.** Instruments that use changes in refractive index as the principle of their operation are certain types of gas analysers which may be certified in their entirety. More frequently, however, the concept of special protection will apply not to an instrument as a whole, but to a particular element or component part, the remainder of the apparatus being certified in accordance with an established type of protection, e.g. "d" flameproof enclosure; "e" increased safety; "i" intrinsic safety; or "p" pressurization and continuous dilution, according to the characteristics of the apparatus and its enclosure. Examples of the latter type of instrument are those that use thermal and/or catalytic elements as the gas detection device. Often such elements may be ignition sources in both normal as well as abnormal operation, and the instrument has to be suitably protected to prevent transmission of an internal ignition to the external atmosphere. Suitable protection may be achieved by the use of flame arrestors which, in the absence of a specification for their use, means recourse to the application of the special protection concept.

c) **Factory-sealed handlamps.** Factory-sealed handlamps are usually provided with a tubular fluorescent lamp, and incorporate an integral flexible supply cable so that the complete fitting is assembled and sealed by the manufacturer. (See also **16.5**.)

5 Relevant specifications

There are no national or International Standards for electrical apparatus with type of protection "s". The existence of a specification might be considered to inhibit the flexibility that the concept of special protection is intended to provide. However, the British Approvals Service for Electrical Equipment for use in Flammable Atmospheres (BASEEFA)[2)] has published a certification Standard SFA 3009:1972 for apparatus with special protection, which indicates requirements for some methods of protection that are considered as "special" for certification purposes.

Section 2. Selection of apparatus

6 General

The factors that affect the selection generally of electrical apparatus used in hazardous areas are described in detail in section 2 of Part 1:1976 of this code. The specific factors that need to be taken into account when selecting apparatus and systems with type of protection "s" are described in clauses **7** to **11** of this section. It is very important, for this type of apparatus, that the certification documents be examined for details of the conditions of use.

7 Permissible Zones of use

7.1 Electrical apparatus having a particular type of protection or combination of types of protection may be used only in certain hazardous areas or Zones according to the level of safety inherent in its design. Agreed Zones of use for each of the permissible types of protection are indicated in section 2 of Part 1 of this code. For apparatus with type of protection "s", the following subclauses are applicable.

7.2 Electrical apparatus with type of protection "s" may normally be used in Zone 1 (see SFA 3009) and, by implication, in the less hazardous Zone 2.

7.3 Notwithstanding the recommendation of **7.2**, certain types of apparatus may be developed specifically for use in Zone 0 applications. It is also feasible that apparatus having special protection may be designated for use in Zone 2 only. Care should be exercised to ensure that the apparatus is suitable for the intended Zone of use.

8 Temperature classification

8.1 The maximum temperature appropriate to the temperature class should not exceed the ignition temperature of the flammable gas or vapour expected to be present in the hazardous area, or the lowest value of ignition temperature if more than one flammable gas or vapour is present.

8.2 Electrical apparatus with special protection should be selected according to its temperature classification. (See Part 1 of this code.)

[2)] Health and Safety Executive, BASEEFA, Harpur Hill, Buxton, Derbyshire SK17 9JN.

8.3 Generally an ambient temperature of 40 °C is assumed in the rating of electrical apparatus for use in hazardous areas. Higher temperatures should be, and in exceptional cases lower temperatures may be, taken into account in determining the rating of the apparatus. In that event, the value of the rated maximum ambient temperature will be clearly marked on the apparatus. It should be noted that the certification will be invalidated if the apparatus is used at an ambient temperature higher than that for which the certification applies.

NOTE The choice of cables may be affected by rated maximum ambient temperature.

9 Apparatus subgrouping

9.1 Apparatus with type of protection "s" may be subject to subgrouping (see Part 1 of this code) and thus only applicable to a specific group of gases and vapours subject to the factors described in clauses **8** and **10**.

9.2 Notwithstanding **9.1**, apparatus may be protected by special protection and by one or more types of protection which may require apparatus subgrouping (e.g. see b) of clause **4**). Such apparatus will be marked following the recommendations of Appendix A. In these circumstances, the apparatus should be selected in accordance with the apparatus subgroup to which the flammable materials that may be present are allocated. (See Part 1 of this code.)

10 Environmental conditions

When selecting apparatus, care should be taken to ensure that the apparatus and its component parts are so constructed as to be sufficiently protected against electrical and mechanical failure in the intended conditions of use.

Particular attention should be given to the need for protection against the weather, the ingress of liquids and particulate matter, corrosion, the effect of solvents and the effect of heat from adjacent plant. (See Part 1 of this code.)

11 Requirements for certification

See Part 1 of this code.

Section 3. Installation requirements

12 General

As a consequence of the flexible approach that the concept of type of protection "s" allows in the development of electrical apparatus for use in hazardous areas, it would be impracticable to make specific recommendations for the installation of apparatus whose characteristics cannot be foreseen. The following clauses therefore offer general guidance for the installation of apparatus having special protection.

13 Wiring systems

13.1 The apparatus should be installed in accordance with the principles and general installation requirements described in section 3 of Part 1:1976 of this code. Particular consideration should be given to the recommendations for automatic electrical protection, earthing and bonding described in Part 1. Due account should also be taken of the additional factors indicated in **13.2** and **13.3**.

13.2 Apparatus with special protection but which is provided with external connections (or terminations) protected by an alternative type of protection should be installed in accordance with the recommendations given in the relevant Part or Parts of this code, according to the type of protection used.

13.3 The type of wiring system should be selected in accordance with the principles described in Part 1 of this code.

Section 4. Inspection, maintenance and testing

14 General

As a consequence of the nature of special protection, and in the absence of a national or international specification for the protective measures employed, it is possible to offer only general guidance for the inspection and maintenance of apparatus with type of protection "s". However, the safe and satisfactory operation of apparatus with type of protection "s" is dependent on high standards of inspection, maintenance and testing by trained and competent personnel.

15 Initial and periodic inspections

All electrical apparatus, systems and installations should be inspected prior to commissioning and after replacement in accordance with the "Initial" column of the inspection schedule (see Table 1).

Following any repair, adjustment or modification, those parts of the installation that have been disturbed should be checked in accordance with the relevant items in the "Initial" column of the inspection schedule.

All apparatus, systems and installations should be inspected regularly in accordance with the "Periodic" column of the inspection schedule.

If at any time there is a change in the area classification, or in the characteristics of the flammable material used in the area, or if the apparatus is moved from one location to another, a check should be made to ensure that the apparatus has the correct apparatus group (see **A.3**) and temperature class (see **A.4**), and continues to comply with the area classification.

A system should be established to record the results of all inspections and action taken to correct defects.

16 Maintenance

16.1 For applications of the concept of special protection to apparatus components or devices, the maintenance of which is not adequately provided for in **16.2** to **16.6**, guidance for satisfactory maintenance should be sought from the manufacturer and/or the regulatory authority having jurisdiction in the industry concerned.

16.2 No alteration that might invalidate the certificate or other document relating to the safety of the apparatus should be made to apparatus with type of protection "s" without appropriate approval.

16.3 Where encapsulating materials are used, these should be inspected for evidence of deterioration due to ageing, or due to the effects of thermal, chemical or corrosive agencies. Where deterioration is observed or is suspected, the encapsulated assembly should be replaced, with due consideration being given to the use of an alternative encapsulant more highly resistant to the thermal, chemical or corrosive agency.

16.4 Where flame arrestors are used, these should be inspected for mechanical integrity. If evidence of undue blockage due to accumulation of dirt or other deleterious substance is observed, or if there is evidence of thermal deterioration of the material used, the arrestor should be replaced by a new component of equivalent characteristics supplied by the manufacturer. Flame arrestors may be cleaned and re-used where necessary, but only where the maintenance of their flame-arresting properties and the integrity of the joint between the arrestor material and its housing can be assured.

16.5 Materials used to provide protective features inherent in the design of the apparatus should be inspected regularly and should be replaced if there is evidence of undue deterioration, e.g. due to chemical or corrosive effects.

On no account should any attempt be made to replace parts of factory-sealed units, which should be returned to the manufacturer for repair or replacement as appropriate.

16.6 Where primary or secondary cells are used in the protected apparatus, care should be taken to ensure that replacement cells are of the correct type and voltage.

17 Tests

Tests should be carried out after installation, but prior to commissioning, and subsequently periodically, to determine that the integrity of the installation is adequate and maintained. The tests are described in **32.1** of Part 1:1976 of this code of practice.

Table 1 — Inspection schedule for apparatus with type of protection "s"

Check that	Inspection category[a]		Notes
	Initial	Periodic	
Apparatus is appropriate to area classification.	A	B	
Surface temperature class is correct.	A	B	
Apparatus group (if any) is correct.	A	B	
Apparatus carries the correct circuit identification.	A	B	Apparatus has to be positively identified with its circuit to ensure that correct isolation can be carried out.
Enclosures, glasses and glass/metal seals are satisfactory.	A	A	
There are no unauthorized modifications.	A	A	
Bolts, glands and stoppers are complete and tight.	A	A	
There is no undue accumulation of dust or dirt.	B	B	Accumulation of dust or dirt can interfere with heat dissipation and result in surface temperatures higher than those permitted in the hazardous area.
Earthing is satisfactory.	A	A	
Condition of enclosure gaskets is satisfactory.	A	B	
Hermetically-sealed devices are undamaged.	A	B	
Electrical connections are tight.	A	B	
Motor fans and couplings are not rubbing on cowls/guards.	A	A	
Lamp rating and type are correct.	A	B	An "initial" inspection is necessary after relamping.
Electrical protection is satisfactory.	A	A	
Stopper-boxes and cable boxes are correctly filled.	A	B	
There is no leakage of compound from stopper or cable boxes.	B	B	
There is no obvious damage to cables.	A	A	
Apparatus is adequately protected against corrosion, the weather, vibration and other adverse factors.	A	A	
Encapsulating materials are satisfactory.	A	B	
Flame arrestors, where used, are present and satisfactory.	A	A	
Guards, where used, are present and correctly located.	A	B	

[a] Category "A" inspections should be carried out in all cases and, where periodic, they should be at intervals not exceeding two years. More frequent and/or more detailed inspection will be necessary where there is a corrosive or other adverse atmosphere, a high risk of mechanical damage or vibration, or where there are other onerous circumstances. The need for more frequent inspection may also be determined by operating experience.

The need for, the method, and the frequency of category "B" inspections is at the discretion of the engineer responsible. It is not intended that periodic inspections should incur undue disturbance of apparatus unless considered necessary by the engineer responsible.

Appendix A Marking of apparatus

A.1 General

All electrical apparatus certified for use in hazardous areas has to be marked with particulars that are prescribed in the specification for the type of protection used. The marking enables the apparatus to be easily identified for the purposes of both initial installation and subsequent inspection and maintenance.

The marking requirements normally include information relevant to the use of the apparatus in non-hazardous areas and such additional information as is necessary to ensure its safe use in hazardous areas. Typical marking requirements are given in section 6 of Part 1:1976 of this code. In the absence of a national or international specification for apparatus with special protection, it is assumed here that the requirements referred to in section 6 describe adequately the general marking that would be required for apparatus with type of protection "s". For completeness, the marking requirements are included here without comment, except where detailed explanation is required on account of considerations that are particularly relevant to special protection.

A.2 Marking requirements

The marking requirements normally include general information relevant to the use of the apparatus, and such additional information as:

a) identification of the manufacturer;

b) the name, type or designation of the apparatus;

c) the number of the relevant British Standard or other certification standard (if any);

d) identification of the type of protection. Apparatus certified in accordance with the concept of type of protection "s" by a national certifying authority or other authority having jurisdiction in the industry concerned will be marked "Ex s" and with the symbol of the authority concerned [see IEC Publication 79-9: "Marking" published by the International Electrotechnical Commission (IEC)]. If the apparatus is assessed by an authority other than the national certifying authority or the authority having jurisdiction in the industry concerned, it should be marked "s" only;

e) the apparatus group (see **A.3**);

f) the number of the certificate or assessment and the name or registered mark of the certifying authority as applicable;

g) the temperature class or maximum surface temperature (see **A.4**);

h) the reference ambient temperature, if this is other than 40 °C;

i) any other relevant information; this will include rating data, etc.

A.3 Apparatus grouping

For many types of apparatus that are protected according to type of protection "s", the safety features used will be equally applicable to all flammable gases and vapours. Such apparatus will be marked with the symbol II, indicating its suitability for use with all flammable gases and vapours subject to considerations of temperature class and chemical compatibility. (See also **12.4** of Part 1:1976 of this code.)

For some types of apparatus, however, it may be necessary for the apparatus to be allocated a subgroup, namely IIA, IIb or IIC. This effectively limits the range of flammable gases and vapours with which the apparatus may be used. The extent of the limitation will depend on the group allocated since, generally, apparatus which is suitable for use with gases and vapours appropriate to an apparatus group having more severe design characteristics, e.g. Group IIC, may also be used with those gases and vapours appropriate to an apparatus, group having less severe design requirements, for example Group IIA or Group IIB. (See also Part 1 of this code.)

Examples of apparatus that are included in the latter category of grouping are those that incorporate means for the prevention of flame transmission, such as some types of gas detector, and apparatus incorporating two or more types of protection where one of these requires apparatus grouping. (See **A.5**.)

A.4 Temperature class

Electrical apparatus with special protection will normally be marked with a symbol selected from the range T1 to T6 inclusive, to indicate its temperature class. (See **12.2** of Part 1:1976 of this code of practice.)

This symbol is indicative of the maximum temperature reached by unprotected surfaces, measured, where necessary, under prescribed conditions, and has to be taken into account when the suitability of the apparatus for use with a particular flammable gas or vapour is being considered.

A.5 Apparatus with multiple types of protection

A.5.1 Where apparatus is protected by two or more types of protection, the marking will indicate the types of protection used. The mark "Ex" will be followed by the symbol for the main type of protection (or the type of protection used for the termination arrangements) with the additional protective features indicated subsequently in a subordinate manner.

For example: Ex e ia s

The marking indicates certified electrical apparatus protected overall by type of protection "e" increased safety, which will determine the installation requirements for the apparatus, and incorporating electrical circuits and a component part or parts that are protected in accordance with types of protection "i": intrinsic safety (category ia) and "s": special protection.

A.5.2 Those individual circuits and component parts that are protected other than by the main type of protection, should also be marked individually with the appropriate symbol to assist in their ready identification for inspection and maintenance purposes.

A.5.3 It may be anticipated that, increasingly in the future, apparatus will incorporate multiple types of protection, and that this will apply particularly to the concept of special protection, which is more likely to be applied to discrete components or devices used as part of an apparatus rather than to apparatus as a whole.

The use of multiprotective techniques increases the likelihood of apparatus that incorporates special protection being subject to apparatus grouping.

Publications referred to

CP 1003, *Electrical apparatus and associated equipment for use in explosive atmospheres of gas or vapour other than mining applications.*

CP 1003-1, *Choice, installation and maintenance of flameproof and intrinsically-safe electrical equipment.*

CP 1003-2, *Methods of meeting the explosion hazard other than by the use of flameproof or intrinsically-safe electrical equipment.*

CP 1003-3, *Division 2 areas.*

IEC 79, *Electrical apparatus for explosive gas atmospheres.*

IEC 79-9, *Marking.*

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