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British Standard 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 2. Classification of hazardous areas

Code de bonne pratique pour la sélection, l'installation et l'entretien des matériels électriques à utiliser dans les atmosphères explosibles (à l'exception des applications dans les mines ou de la préparation et la fabrication des explosifs
Partie 2. Classification des zones dangereuses

Richtlinie für die Auswahl, Aufstellung und Instandhaltung von elektrischen Betriebsmitteln für explosionsgefährdete Bereiche (außer für Verwendung im Bergbau oder bei der Verarbeitung und Herstellung von Sprengstoffen)
Teil 2. Klassifizierung von gefärlichen Bereichen

British Standards Institution

Contents

	Page
Foreword	Inside front cover
Committees responsible	Back cover
Code	
0. Introduction	1
1. Scope	2
2. Definitions and explanation of terms	2
3. Objective of area classification	2
4. Fundamental safety concept	2
5. Basis of area classification	3
6. Factors determining the type and extent of zones	3
7. General classification procedure	4
8. Outdoor areas	5
9. Indoor areas	9
Appendices	
A. The effect of ventilation in buildings containing hazardous areas	12
B. Examples of zones surrounding a source of release	13

	Page
Tables	
1. Example of a table used in an area classification study	6
2. Natural infiltration into buildings	13
Figures	
1. Determination of type and extent of zone	7
2. Example of an area classification drawing	8
3. Continuous grade of release in an outdoor area: natural ventilation	13
4. Primary grade of release in an outdoor area: natural ventilation	14
5. Secondary grade of release in an outdoor area: natural ventilation: single source and zone	14
6. Primary grade of release in a small indoor area: artificial ventilation: single source multiple zone	15
7. Primary grade of release in a large indoor area: artificial ventilation: single source multiple zone	15
8. Single zone indoor area with opening into a Zone 2	16

Foreword

This British Standard has been prepared under the direction of the General Electrotechnical Engineering Standards Committee.

BS 5345 is a revision of CP 1003 : Parts 1, 2 and 3 and should be used for all new installations of electrical apparatus in potentially explosive atmospheres. However, CP 1003 will be retained temporarily 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 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, protection against electrical ignition is achieved by implementing one of two procedures. Whenever practicable, the electrical apparatus should be located outside hazardous areas; alternatively 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 whilst others 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 for electrical apparatus to be used in hazardous areas. This code 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 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.

This code of practice represents a standard of good practice and takes the form of recommendations. Compliance with it does not confer immunity from relevant legal obligations.

British Standard 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 2. Classification of hazardous areas

0. Introduction

BS 5345 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 : Part 1 : 1964, Part 2 : 1966) and Part 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

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 protected by pressurization 'p' (including continuous dilution) and for pressurized rooms

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

Part 10*† The use of gas detectors

This Part of BS 5345 should be read in conjunction with other Parts, and in particular with Part 1 which describes 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, i.e. the division of a hazardous area into Zones 0, 1 and 2, are described in this Part of the code. It should be noted that formerly the various parts of a hazardous area were known as 'Divisions', rather than 'Zones'.

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 combustible dusts, which are outside the scope of this code.

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 those with expert knowledge of the area classification of similar installations. (See Part 1 of the code.)

Electrical apparatus in each of the classified zones should be suitably protected by design and manufacture, and should also be installed, operated and maintained in a manner 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 : Parts 1, 2 and 3 will eventually be withdrawn.

*In course of preparation.

†It has been decided by the responsible Technical Committee that BS 5345 will not apply to combustible dusts and, therefore, the proposed Part 'Installation and maintenance requirements for electrical apparatus for use with combustible dusts' referred to, as Part 10, in other Parts of this code published before this decision will not appear as a Part of BS 5345. The proposed Part 11 'Specific industry applications' will consist of a bibliography of relevant codes and requirements and will not be a Part of BS 5345.

1. Scope

This Part of BS 5345 provides guidance on the classification of areas where flammable gas or vapour risks may arise in order to permit the proper selection of electrical apparatus and/or Zone 1, and where this is not reasonably practicable recommendations produced for specific industries or particular applications but may be used as an alternative or where no such guidance is available.

It is intended for application in industries where there may be flammable gas or vapour risks but does not apply to the following.

(a) Areas where risks may arise due to the presence of ignitable dusts or fibres.

(b) Catastrophic failures that are beyond the concepts of abnormality dealt with in this code.

NOTE 1. Catastrophic in this context is applied, for example, to the rupture of a process vessel or a pipeline.

(c) Ignition sources other than those associated with electrical apparatus.

NOTE 2. In any plant, works or installation irrespective of size, there may be numerous sources of ignition apart from those associated with electrical apparatus. Precautions will be necessary for other sources of ignition to ensure safety but guidance on this aspect is outside the scope of this code.

NOTE 3. The titles of the publications referred to in this code are listed on the inside back cover.

2. Definitions and explanation of terms

The definitions and terms 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 given in the appropriate Parts of the code. For the purposes of this Part, the following definitions and terms apply.

NOTE. Traditionally, when dealing with area classification, a volume in space has been described as an area. That concept is perpetuated in this document.

2.1 hazardous area. An area in which explosive gas/air mixtures are or may be expected to be present in quantities such as to require special precautions for the construction and use of electrical apparatus.

2.2 non-hazardous area. An area in which explosive gas/air mixtures are not expected to be present in quantities such as to require special precautions for the construction and use of electrical apparatus.

2.3 Zone* 0, 1 and 2. In a hazardous area three types of zone are recognized, in sequence of decreasing probability of explosive gas/air mixtures being present.

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

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

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

2.4 source of release. A point from which a flammable gas, vapour or liquid may be released into the atmosphere.

2.5 grades of release*. An indication, by analysis of the source of release, of the expected frequency and duration of release from that source.

2.6 continuous grade of release. A grade of release in which the release is continuous or nearly so.

2.7 primary grade of release. A grade of release in which the release is likely either regularly or at random times during normal operation.

2.8 secondary grade of release. A grade of release in which the release is unlikely to happen in normal operation and in any event will be of limited duration.

2.9 ventilation. Movement and replacement of air by either natural or artificial means.

2.10 natural ventilation. Ventilation caused by wind or thermal effects.

2.11 artificial ventilation. Ventilation caused by mechanical means, e.g. fans.

2.12 extent of zone. The distance in any direction from the source of release to the point where the gas mixture has been diluted by air to a value below the lower explosive limit.

3. Objective of area classification

The objective of area classification is the notional division of a works, plant or installation (hereinafter referred to as plant) into zones within which the likelihood of the existence of an explosive gas/air mixture is judged to be high, medium, low or so low as to be regarded as negligible. An area classification established in this way provides a basis for the selection of electrical apparatus that is protected to a degree appropriate to the risk involved. The type of protection of the apparatus selected will be such that the likelihood of it being a source of ignition, at the same time as the surrounding atmosphere is explosive, is accepted as being negligibly small.

It is essential that all the factors influencing the classification are fully considered in order to minimize the likely simultaneous existence of an explosive gas/air mixture and a source of ignition from electrical apparatus.

When the hazardous areas of a plant have been classified, the remainder will be defined as non-hazardous areas.

4. Fundamental safety concept

4.1 General. It is a fundamental requirement for safety that process equipment and systems should be designed, installed, operated and maintained so that releases of flammable materials into the atmosphere are minimized.

4.2 Design. It is important to examine those parts of process equipment and systems from which release of flammable material might arise in normal operation and to consider modifying the design to minimize both the likelihood of such releases and the rate of release of material. Similar consideration should be given to those parts of process equipment and systems from which release of flammable material might arise during abnormal operation to minimize the rate of release.

*Specific industry codes may contain guidance on the interpretation of the zone and grade of release definitions in terms of frequency and duration.

These fundamental considerations should be examined at an early stage of the design development of any process plant and should also receive prime attention in carrying out the area classification study.

NOTE. Clause 7 describes how these considerations affect the area classification procedures.

Proper attention to these considerations will ensure that the areas where an explosive gas/air mixture is likely to occur in normal operation (Zones 0 and 1) are a minimum in both number and extent. This will also ensure that areas where an explosive gas/air mixture is likely to occur in abnormal operation (Zone 2) are also limited in extent.

4.3 Operation and maintenance. Operation and maintenance should be taken into account when designing process equipment and systems in order to meet the overall fundamental safety concept. The effect of operating and maintenance procedures should also be carefully considered during the area classification study, e.g. the effect of the routine opening of parts of closed process systems, such as for filter changing.

Once plant has been classified it is important that no modification to process materials, process equipment or operating procedures is made without discussion with those responsible for the area classification. Such modification may change the area classification. Where changes are necessary, it is essential that they are recorded and that any re-classification is carried out.

It is necessary to ensure that process equipment maintained on or off the plant is subject to careful examination during and after reassembly to maintain the integrity of the original design before bringing it back into service.

4.4 Special considerations. Where the possibility of release of flammable material to atmosphere is exceedingly remote, e.g. from all-welded pipelines or other systems of high integrity manufactured, installed and maintained to appropriate standards and codes, the surrounding area may be considered non-hazardous.

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If the total quantity of flammable material available for release is small, e.g. laboratory use, whilst a potential hazard may still exist, it may not be appropriate to use area classification. In such cases. account should be taken of the particular risks involved when selecting electrical apparatus.

Where the liquid temperature cannot be raised above its flash point and where release of the liquid under pressure as a flammable mist can be neglected, the surrounding area may be considered non-hazardous (but see the Highly Flammable Liquids and Liquefied Petroleum Gases Regulations 1972 (SI 1972 No. 917) which defines highly flammable liquids in terms of flash point). In assessing the liquid temperature, account should be taken of all likely causes of liquid heating, e.g. process, solar or accidental access to hot surfaces.

Where a flammable material is burned, e.g. in a boiler or gas turbine, it may not be appropriate to classify the immediate area in accordance with this Part of the code. In such cases any electrical apparatus in this area should be selected taking account of the risks involved during normal operation, during start-up and when the unit is shut down.

5. Basic of area classification

It is rarely possible by cursory examination of a plant or plant design to decide which parts of the plant can be equated to the three zonal definitions (Zones 0, 1 and 2). A more objective approach is therefore necessary and involves the assessment of the basic possibility of an explosive gas/air mixture occurring. Since an explosive gas/air mixture can exist only if a flammable gas, vapour or mist is present with air, it is necessary to decide if any of these flammable materials can exist in the area concerned. Generally speaking such materials (and also flammable liquids and solids that may give rise to them) are contained within process equipment which may or may not provide total enclosure. To assess the possibility of an explosive gas/air mixture existing in an area it is therefore necessary to determine how the items of process equipment containing flammable materials can release them to atmosphere. Once this has been done there is then a firm basis on which to determine the likely presence of an explosive gas/air mixture in the surrounding areas. This approach therefore requires detailed consideration to be given to each item of process equipment that contains a flammable material, and which could therefore be a source of release.

In order to simplify the classification procedure and to introduce some standardization, the concept of grades of release is used. (See clauses 2, 6 and 7.)

There is in most cases a direct relation between the grade of release and the type of zone to which it gives rise. For example, a primary grade of release may release flammable material to atmosphere in normal operation, hence there may be an explosive gas/air mixture in normal operation around the source. The area around this source will therefore be Zone 1. Similar relationships apply for continuous and secondary grades of release.

NOTE. For further information on the relationship between grades of release and zones, see clauses 6 and 7.

The types of zone having thus been decided, it remains to establish the extent of each zone in terms of horizontal and vertical distances to complete the area classification procedure.

6. Factors determining the type and extent of zones

6.1 Types of zone. Sources of release should first be identified and graded continuous, primary or secondary as defined in clause 2.

The grade of release is dependent only on frequency and duration of release; it is not dependent on the total rate of release or the characteristics of the released material. When the grade of release has been decided, the type of zone in the immediate vicinity of the release can be determined, i.e.:

(a) continuous grade leads to Zone 0;

(b) primary grade leads to Zone 1*;

(c) secondary grade leads to Zone 2*.

*While this relation will apply in most cases, consideration should be given to the likely persistence time of the explosive gas/air mixture which may, in special cases, be sufficiently long to necessitate a zone number lower than that given by this relation. The persistence time will depend on the topography and ventilation of the area and the characteristics of the flammable material (see 6.2). Sufficiently long persistence times may apply, for example, in cases of badly ventilated deep pits in which heavy vapours may collect and persist or in cases where there are large numbers of sources of release in very close proximity.

A continuous grade of release will lead to a Zone 0, the extent of which is determined in accordance with **6.2**; similarly, a primary grade of release will lead to a Zone 1, the extent of which is determined in accordance with **6.2**.

The continuous and primary grade sources of release should also be examined for abnormal operation when an increased release rate will lead to a Zone 2 outside the already determined Zone 0 or Zone 1.

The shape of the envelope of the Zone 2 so generated need not necessarily be the same as that for the Zone 0 or 1.

It does not, however, follow that there will always be a Zone 2 outside the Zone 1 or 0 already assigned to the normal release.

The following examples are given to illustrate the principle of multiple zones.

(a) A source may release material at a small rate in normal operation thus giving rise to a localized Zone 1. Due to partial failure of the containment or to other abnormal conditions it may release material at a greater rate thus giving rise to a larger hazardous area. This will be a Zone 2 measured from the source, and extending beyond the Zone 1 already determined.

(b) A source may release material continuously, at a small rate, thus giving rise to a small Zone 0 around it, but as in (a) an abnormal occurrence may give rise to an increased release rate thus giving rise to a Zone 2 of greater extent.

NOTE. For further details on determination of the type of zone, see clauses 7, 8 and 9 and appendix B.

6.2 Extent of zone

6.2.1 *General.* The extent of the zone is determined from a study of:

(a) the characteristics of the flammable materials;

(b) the rate of release;

(c) the type of release (jet or slow release);

(d) the ventilation in the area of release and in the general area of likely vapour spread;

(e) the topography of the plant (e.g. location of walls and slope of ground).

6.2.2 *Characteristics of the flammable material.* Broadly, materials fall into four categories:

(a) gases and vapours;

(b) liquids at temperatures below their atmospheric boiling points;

(c) liquids at temperatures above their atmospheric boiling points;

(d) mists.

The characteristics of the material that most affect the extent of the zone after the release are the vapour pressure, vapour density and lower explosive limit (LEL).

The vapour pressure of a liquid determines the rate of release of vapour after the escape. The vapour pressure will increase with increasing liquid temperature. The liquid temperature will be modified by the ambient temperature, the rate of evaporation and in certain cases by the temperature of the ground or surface beneath any established pool.

The vapour density of a gas or vapour is a factor in determining the distance that the vapour/air mixture will travel before reaching the lower explosive limit (i.e. the minimum theoretical safe distance, after dilution by the surrounding air). In practice the main distinction that needs to be drawn in respect of vapour density is between vapours which are lighter than or heavier than air.

6.2.3 *Rate of release.* The rate of release of a material from a normally closed system will depend on the size and shape of the orifice through which it escapes and the pressure, temperature and density of the material within the process at the source of release. The temperature is of significance, as far as rate of release is concerned, only with gases and liquids that are at or above their initial boiling points.

6.2.4 *Type of release.* Gases and vapours that are released in jet form will be diluted with air by jet mixing and those which are not released in jet form will be diluted with air either by diffusion or by turbulent dilution, depending on the relative air velocity in the area of release. However, if a jet strikes an obstruction so that its kinetic energy is dissipated, dilution thereafter will be by diffusion or turbulent dilution as in the case of a low velocity release.

6.2.5 *Ventilation.* For a given release rate of a particular material, the higher the relative air velocity in the area of the release the smaller the distance within which the vapour is diluted to the lower explosive limit. Account should be taken of the effect on ventilation of process plant disposition, the location of walls, pits, trenches, etc. and the heat from process plant.

NOTE. Ventilation is considered in more detail in clauses 8 and 9.

7. General classification procedure

7.1 Personnel involved. The area classification should be carried out by those who have knowledge of the process systems and equipment in consultation, where necessary, with safety and electrical engineering personnel. The agreement reached on the area classification should be formally recorded.

7.2 Properties of process materials. Those properties (relevant to area classification) of all process materials used on the plant should be listed and should include flash point, boiling point, melting point, ignition temperature, vapour pressure, vapour density and explosive limits.

NOTE. See BS 5345 : Part 1 for a list of some of these properties.

7.3 Determination of type and extent of zone

7.3.1 *General.* Established industry codes that give recommended types and extents of zones around various process items, equipment and facilities may be used for carrying out area classification, provided that the recommendations are appropriate to the cases under consideration. Where industry codes are not available or applicable, the procedure shown in figure 1 may be used. This procedure may also be used in developing industry codes.

NOTE. An explanation of the steps in figure 1 is given in **7.3.2** to **7.3.5** which should be read in conjunction with figure 1. The numbers in square brackets which appear in the text are the box numbers in figure 1.

The following procedure assumes that the likely persistence times of explosive gas/air mixtures are not sufficiently long to require a lower zone number (see the footnote to **6.1**).

7.3.2 *Grade of release.*
It is first necessary to determine whether the total quantity of flammable material available for release from the process equipment item is small (see 4.4) [1] and [2]. If it is considered small, area classification [38] may not be appropriate but certain special precautions may still be necessary [39]. Should the quantity not be considered small, it is necessary to determine [3] if release of flammable material is possible, neglecting catastrophic events (see clause 1). If release is not possible, the area around the equipment will be non-hazardous [37]. If release is possible, the grade of release (as defined in clause 2) should be determined [4].

NOTE. The grade of release is dependent only on the frequency and duration of release.

7.3.3 *Continuous grade.* Where the process item is graded continuous [5], consideration should be given to improving the process item containment to reduce the frequency and/or duration of release of the flammable material [6]. Where significant improvement can be made, it may be possible to regrade the item as a primary [18] or a secondary [31] source of release. Where such improvement is not possible, the release rate from the process item in normal operation [7] and [8] should be determined (see clause 6) and where possible reduced [9]. The distance from the process item to the point at which the vapour/air mixture is below the lower explosive limit should then be determined, taking into account the finally determined release rate and other characteristics [10] (see **6.2**). The distance so determined is the extent of the Zone 0 from the source [11].

It is then necessary to determine whether release from the same process item is possible at a greater rate in abnormal operation and if so, whether this rate can be reduced [15]. If release at a greater rate is not possible, there will be no Zone 2 outside the Zone 0 [13] and [14]. If release at a greater rate is possible, the distance from the process item to the point at which the vapour/air mixture is below the lower explosive limit should be determined, taking into account the finally determined release rate in abnormal operation and other characteristics [16] (see **6.2**). The distance so determined is the extent of the Zone 2 from the source [17].

An example of a process item graded as continuous is a vent that releases a small amount of vapour continuously giving rise to a small Zone 0 [11] but where, due to abnormal process conditions, a larger release can occur giving rise to a larger Zone 2 [17] outside the Zone 0.

7.3.4 *Primary grade.* Where the process item is initially graded as primary [18], a procedure similar to that described in **7.3.3** and shown in [18] to [30] should be followed.

An example of an item graded as primary is a storage tank vent where flammable vapour is expelled during filling (primary grade) giving rise to a small Zone 1 [24] but where liquid spillage may occur under abnormal conditions giving rise to a larger Zone 2 [30] outside the Zone 1.

NOTE. The vapour space inside the tank may warrant a Zone 0 classification.

7.3.5 *Secondary grade.* Where the process item is initially graded secondary [31], a procedure similar to that described in **7.3.3** and shown in [31] to [36] should be followed.

An example of a process item graded as secondary is a pump seal where release in normal operation is negligible but where, abnormally, failure of the seal may occur, giving rise to a Zone 2 based on the release rate for the failure condition.

7.4 Area classification documentation. The area classification study may be carried out in the form of a table (see table 1) in which all process items are listed together with the process materials and conditions, a brief description of the process material containment and notes regarding the likelihood of release. From this information the grade of release can be determined, and hence the type of zone. To determine the extents of the zones, knowledge of likely release rates is required, together with the other information referred to in **6.2**.

NOTE. For further information, see clauses 8 and 9.

Alternatively, established industry codes that give recommended types and extents of zones around various process items may be used as a basis for area classification documentation, provided that the recommendations are appropriate to the cases under consideration.

When the types and extents of zones have been determined, an area classification drawing or other record should be produced. An example of an area classification drawing for a plant in an area of natural ventilation is shown in figure 2.

8. Outdoor areas

8.1 General. The area classification of outdoor areas should be based on the guidance given in clauses 3 to 7 modified where necessary by the considerations given in this clause.

8.2 Ventilation. The degree of natural ventilation in outdoor areas typical of those in the chemical and petroleum industries, which comprise open structures, pipebridges, pump bays, vessels, etc., will usually be sufficient to ensure that any explosive gas atmosphere arising in the area will not persist. Within these outdoor areas there may, however, be parts where the degree of ventilation is reduced, e.g. trenches, roof spaces or areas enclosed by walls that are high in relation to the area enclosed. In either case the general guidance given in clauses **3** to **7** will apply, the main difference being that the extent of the zones will be greater in the latter case due to the reduced ventilation. Since a major objective of plant design is to limit the number and extent of Zones 0 and 1, it is important to avoid, as far as possible, continuous and primary grade sources of release in areas with reduced ventilation. For the same reason, areas of reduced ventilation whether containing a source of release or not should, wherever possible, be located outside areas that are classified Zone 0 or 1.

8.3 Type and extents of zones. The type of zone can be determined directly from the grade of source of release (see clause **6**).

The extent of the zone will depend on the factors explained in **6.2**, all of which except ventilation can be determined from a knowledge of the process parameters, materials and equipment. As discussed in clause **7**, where established industry codes exist, they may be used for determining the type and extent of zones, providing that they truly represent the cases under consideration and take proper account of ventilation (but see the footnote to 6.1).

Table 1. Example of a table used in an area classification study (see 7.4)

Process equipment item			Flammable material	Process temperature and pressure	Description of flammable material containment	Ventilation	Source of release		Horizontal distance (note 1) from source to boundary of			Code reference	Remarks
No	Description	Location					Description	Grade	Zone 0	Zone 1	Zone 2		
1	2	3	4	5	6	7	8	9	10	11	12	13	14
C 52	Hydrogen vessel	Area 2 in open air	Hydrogen	30 °C, 2500 kPa	Closed system with valves; relief valve to flare	Natural (open air)	Flanges and valve seals (see column 14)	Secondary	—	—	– – – m	XYZ Code Page AB	Releases due to flange gasket or valve seal failures (abnormal)
J 29	Xylene pump	Area 5 in open air	Xylene	80 °C, 300 kPa	Closed system with valves and drains. Mechanical seals and throttle bush	Natural (open air)	Flanges and valve seals (see column 14)	Secondary	—	—	– – – m	XYZ Code Page CD	Releases due to flange gasket or valve seal failures (abnormal)
							Mechanical seal (see column 14)	Secondary	—	—	– – – m	XYZ Code Page EF	Negligible release in normal operation. Release on seal failure (abnormal)
J 94	Ethylene compressor (recipro-cating)	Area 4 in open building	Ethylene	70 °C, 2000 kPa	Closed system with glands, vents and cooler drain points	Natural (equivalent to open air)	Flanges, glands and valve seals (see column 14)	Secondary	—	—	– – – m	XYZ Code Page GH	Releases due to flange gasket, gland or valve seal failures (abnormal)
							Vents and drain points (see column 14)	Primary	—	– – – m	– – – m	XYZ Code Type KL	Small releases in normal operation. Larger release may occur due to incorrect operation (abnormal)
J 32 Tank	Fixed roof tank	Area 3 in open air	Gasoline	Ambient	Closed system except for pressure/ vacuum valve	Natural (open air)	Tank vent (see column 14)	Primary	Zone 0 in vapour space	– – – m	– – – m	XYZ Code Type MN	Vapour vented during normal filling Possibility of over-filling (abnormal)

NOTE 1. Vertical distances should also be recorded.

NOTE 2. The table may be extended to include apparatus groups and gas ignition temperatures of the flammable materials.

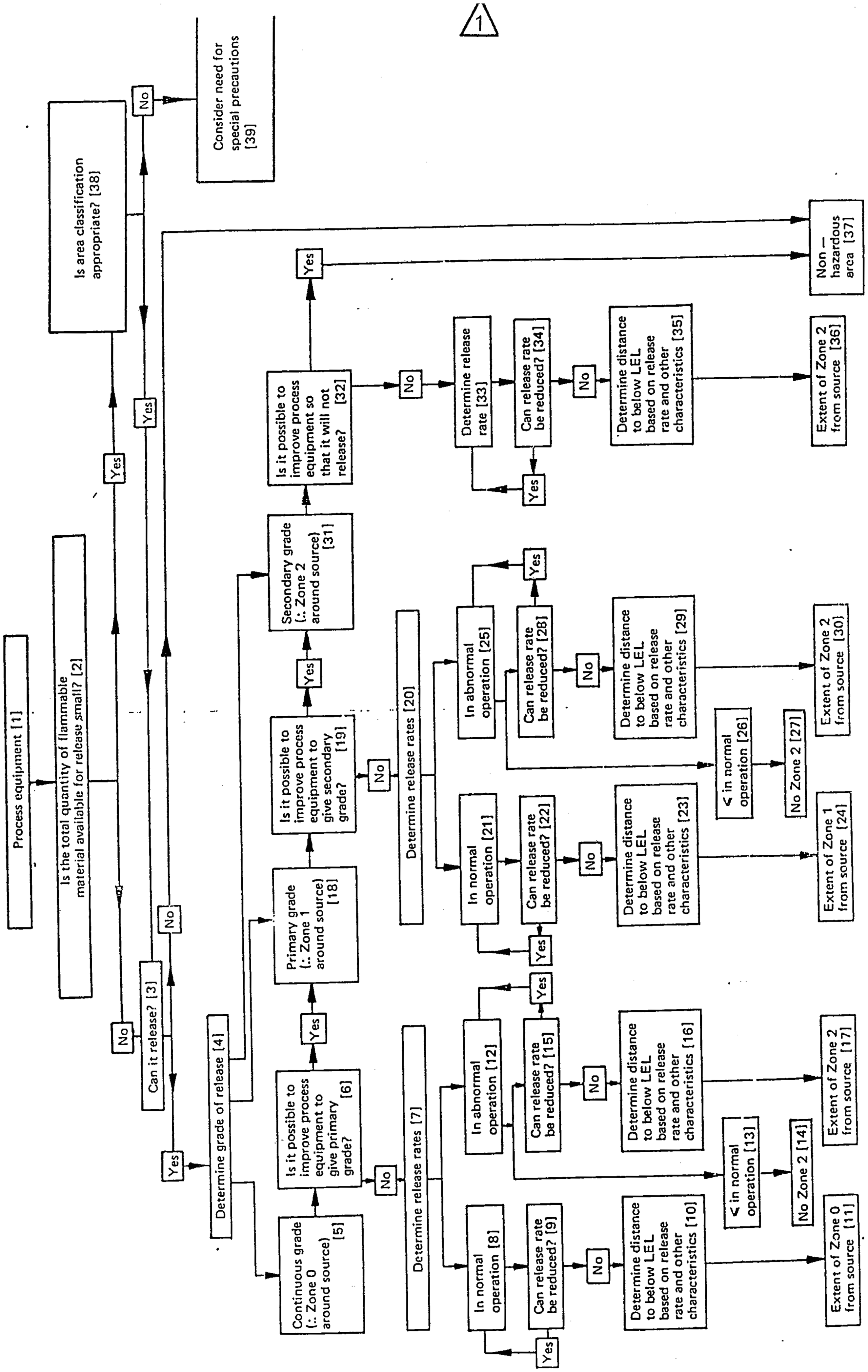

Figure 1. Determination of type and extent of zone

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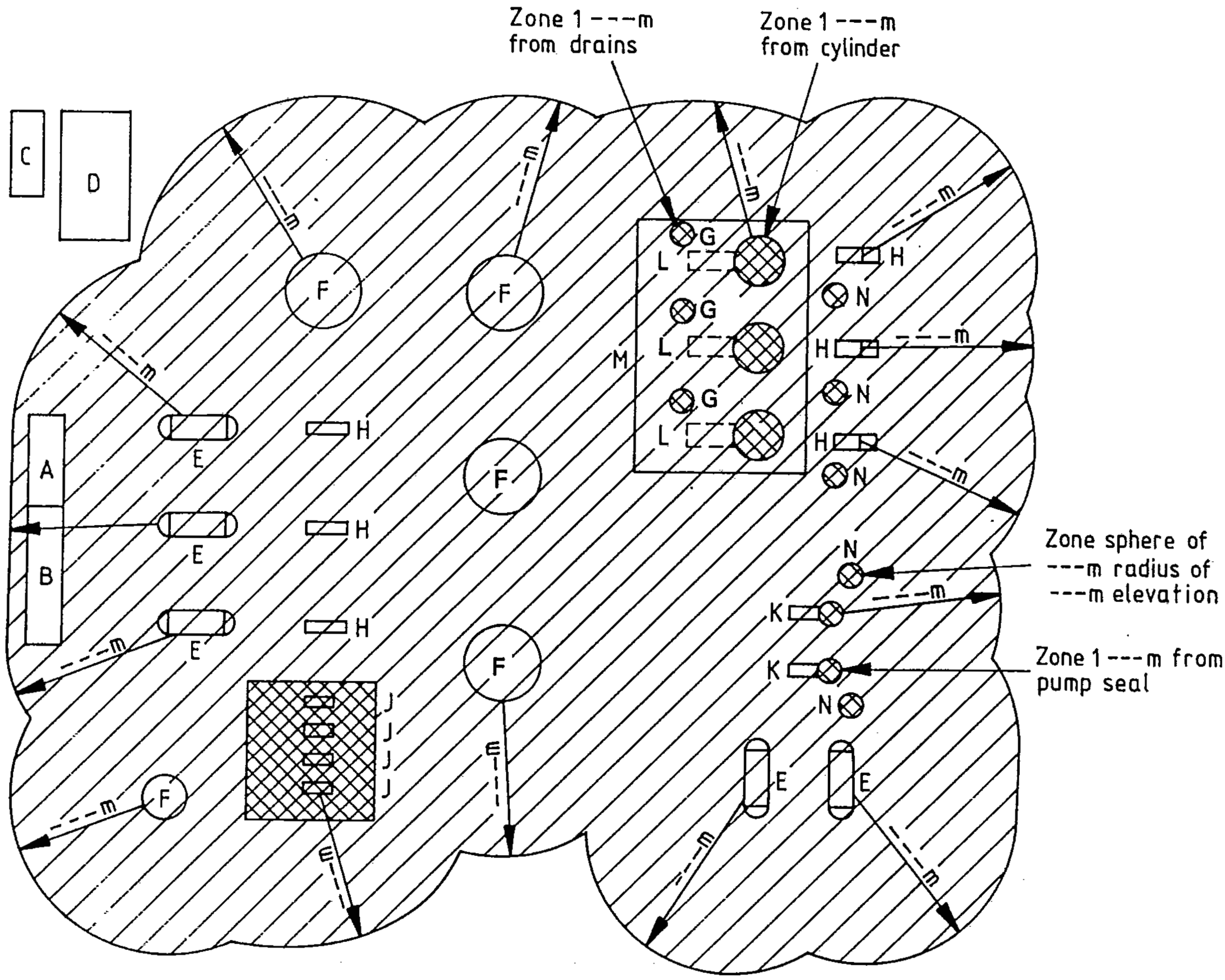
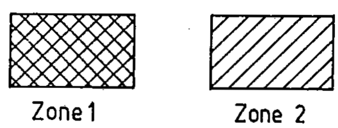
[AMD 5754]





NOTE 1. All dimensions are measured from sources of release.

NOTE 2. In some cases it may be more practical to establish the actual boundary of a classified area at more convenient geographical limits.

Symbol	Description
A	Control room, pressurized
B	Switch house, pressurized
C	Workshop
D	Heater area
E	Vessel
F	Distillation column
G	Drain
H	Pump (seals unlikely to release in normal operation)
J	Pump (seals likely to release in normal operation)
K	Pump (seals likely to release in normal operation)
L	Reciprocating compressor
M	Compressor house (open building)
N	Vents (high or low level)

NOTE. The above table is given for explanation of this drawing only. It will not appear on the completed area classification drawing.

Details to be added where necessary regarding:

(a) Localized Zones 0 or 1

(b) Vertical distances of Zones 0, 1 and 2. In some cases it will be necessary to draw sections to clarify vertical distances

(c) The title of the code that has been used as a basis for extents of areas

(d) Apparatus group and temperature class for selection of electrical apparatus

Figure 2. Example of an area classification drawing

A principal feature of the guidance given in clauses **3** to **7** has been the emphasis placed on making the total plant design fit the desired end result, namely the elimination of Zone 0 and/or Zone 1, and where this is not reasonably practicable limiting their extent.

When this guidance is adopted, the following area classification pattern emerges.

(a) *Zones 0.* These will generally be limited to such places as the vapour spaces of tanks and vessels or immediately around small vents operating continuously or for long periods.

(b) *Zones 1.* These will surround sources of release, such as tank vents or the seals of certain rotating machines, where flammable material release in normal operation is to be expected. If proper attention has been paid to process equipment design and operating procedures to limit rates of release, the extents of Zones 1 should be very small.

(c) *Zones 2.* The majority of the hazardous area will be Zone 2, the extent being determined by the distance it is judged the explosive gas/air mixture will travel in the conditions prevailing before it is diluted to below the lower explosive limit.

NOTE 1. For the classification of buildings and enclosures located totally or partly within outdoor areas, reference should be made to **9.6**.

NOTE 2. See figures 3, 4 and 5 for examples of zones in outdoor areas.

9. Indoor areas

9.1 General. The term 'indoor area' includes the interiors of buildings and other enclosures.

The area classification of indoor areas should be based on the guidance given in clauses **3** to **7**, modified where necessary by the considerations given in this clause.

9.2 General ventilation. The general ventilation of indoor areas may be either natural or artificial (see appendix A). Three main cases may be considered.

(a) A building with a ventilated roof space and sufficient openings in the sides to allow free passage of air through the building. Such a building may have a degree of ventilation sufficient for it to be regarded as the equivalent of an outdoor area.

(b) An enclosed building in which natural ventilation is provided by appropriately sized and located openings in the enclosure.

(c) An enclosed building in which artificial ventilation is provided by appropriately sized and located fans and openings in the enclosure.

In items (b) and (c) the degree of ventilation will vary widely depending on the sizes and locations of openings and fans but will probably be less than in an outdoor area, and as a consequence will give rise to zones of greater extent for a given release rate.

It is not possible to give fixed rules for the degree of general ventilation required but as a guide the ventilation should as a minimum be sufficient:

(1) to avoid, in Zone 2 areas, undue persistence of an explosive gas/air mixture following the release from any secondary grade of release, taking account of the likely release rates;

(2) to ensure that, taking account of the likely release rates, the extents of Zones 0 and 1 are not greater than those indicated in **9.4**.

Thus, for indoor areas the degree of general ventilation should be carefully assessed. Industry codes may contain guidance relating to such assessment.

9.3 Special considerations for sources of release

NOTE. Attention is drawn to the Highly Flammable Liquids and Liquefied Petroleum Gases Regulations, 1972 (SI 1972 No. 917).

9.3.1 *Identification of sources of release.* In indoor areas each room should be considered separately and the sources of release therein identified and graded as continuous, primary or secondary, paying particular attention to the following.

(a) *Transportable containers.* In addition to fixed plant items that need to be identified and graded as sources of release, many processes carried out indoors involve the movement of vessels containing flammable liquids or solids wet with flammable liquids. It is necessary to identify the route and final location of such sources of vapour release and hence the area over which releases can occur.

(b) *Doorways and other openings.* In indoor areas, flammable gases, vapours and liquids can be transmitted from one part of a building to another through openings, e.g. internal doorways, stairwells, lift shafts, pipe and cable galleries, drains and gulleys. Any transmission routes of this kind leading from hazardous areas should themselves be considered as possible sources of release affecting the classification of the areas to which they may lead.

9.3.2 *Continuous and primary grades of release.* All continuous and primary grades of release should be subject to special scrutiny and, to ensure that no large area is capable of becoming hazardous in normal operation, the following procedures are recommended.

(a) Where a continuous grade of release is unavoidable, either it should be piped directly to a safe discharge point outside the buiding or point-source (extract) ventilation should be provided to achieve the same objective. In either case the means provided to contain the release (the pipework in the first and the ducting and associated fan(s) in the second) should be of such integrity that failure of purpose can be considered as not likely to occur in normal operation and, furthermore, the maintenance of the vent or extract system should be of such a standard that any fault which does develop will be rapidly rectified. Any increase in the extent of the hazardous area for this reason may thus be regarded as arising from a secondary grade of release.

NOTE. In many cases it may be considered appropriate to provide an alarm to indicate failure of an extract ventilation system.

(b) The release rate from primary grades of release should be so controlled and the general ventilation (see **9.2**) should be such that the surrounding Zones 1 are very small. Where, exceptionally, the leakage rate cannot be sufficiently controlled to achieve this criterion, the release should be contained in a manner similar to that used for continuous grades of release.

9.3.3 *Secondary grades of release.* If in the fundamental plant design the number of continuous and primary grades of release are reduced to a minimum, and those primary grades of release that do exist are treated in accordance with **9.3.2**, the potential release points predominating will be secondary grades of release. These will give rise to surrounding Zones 2.

9.4 Type and extent of zones. A principal feature of the guidance given in clauses **3** to **7** has been the emphasis placed on making the total plant and building design fit the desired end result, namely, the elimination of Zone 0 or Zone 1, and where this is not reasonably practicable the limitation of the extent of these zones.

The following additional guidance is based on the conditions prevailing with any general artificial or point-source artificial ventilation in operation since this is the normal operating condition. In arriving at the final classification, consideration should be given to the possibility of failure of any artificial ventilation (e.g. due to fan failure) since this may necessitate an increase in the extent of the Zone 2. An increase in the extent of Zones 0 or 1 will not occur since any failure of artificial ventilation will be abnormal. This presupposes that action is taken to restore the ventilation as soon as possible.

When the recommendations of clauses **3** to **7** together with **9.1** to **9.3** are adopted, the following area classification pattern emerges.

(a) *Zones 0.* These will be limited to such places as the vapour spaces of tanks and vessels and to the confines of a local extract arrangement immediately around the continuous grades of release responsible for the condition.

(b) *Zones 1.* Primary grades of release generate Zones 1 around them. When the recommendations in **9.3.2** are followed, the extent of the zone will be very small. Checks are recommended to confirm the results in particular cases.

(c) *Zones 2.* Zone 2 classification (subject to the following exceptions) may well extend horizontally and vertically from the secondary grade of release until a physical barrier such as a wall or roof is met.

(1) *Limited volumes of flammable materials.* In some cases the quantity of flammable material handled may well be so limited and under such control that, in relation to the room volume, only small releases are possible and the risk of creating an explosive gas/air mixture throughout the whole room is negligible. In such cases the Zone 2 need not extend to the walls and roofs, but may terminate at a boundary representing the limit of spread of the gas/air mixture. Should the ventilation be provided by artificial means and should it be judged that there is a possibility of an explosive atmosphere occurring outside the previously determined boundary whilst the ventilation is not operating, then the extent of the Zone 2 should be based on these latter conditions. In making this judgement releases from continuous, primary and secondary grades of release should be considered, although release to the building atmosphere from continuous grade of release is likely only on failure of point source ventilation; furthermore the risk of coincidence of release from a secondary grade of release and ventilation failure may be negligible.

(2) *Adjacent areas.* Flammable gases, vapours or liquids may penetrate from rooms into adjacent areas through, for example, permanent openings in walls or floors.

The adjacent areas may be other rooms or an outdoor area outside the building and where these areas themselves contain sources of release, they will have been classified according to guidance given in this clause or in the case of outdoor areas in clause **8** (but see also **9.6**). An adjacent room or indoor area, not itself containing a source of release but having permanent openings into a room classified up to its natural physical boundaries as Zone 2, should normally also be classified Zone 2 throughout, the opening between the two being, for this purpose, regarded as a source of release. In the case of doors between the two areas, if those responsible for area classification have taken due account of the frequency of door opening, the standard of door sealing, the amount of air movement in the adjacent area, etc. and have thus assessed the likely penetration of explosive gas atmosphere in the adjacent areas, the extent to which this area is classified Zone 2 may be reduced. In the limit, if it is considered that there is a negligible risk of flammable material entering the adjacent room or indoor area in such a way that it could form an explosive gas/air mixture (as may be the case with air locks or self-closing doors) the area may be designated as non-hazardous.

If the adjacent area, not itself containing a source of release, is out-of-doors, the extent to which it should be classified as Zone 2 outside the opening depends on the distance that it is judged an explosive gas/air mixture could spread outwards from the building before its concentration is reduced to below its LEL; again, for this purpose, the opening is regarded as a source of release. In the case of door openings between the two areas, similar considerations to those in the previous paragraph apply.

Consideration should be given to the need to classify the areas immediately outside any discharge points from the general ventilation system. (See also figures 6 and 7.)

9.5 Point-source artificial ventilation. Where point-source artificial ventilation is required to remove flammable gas or vapour from a specific continuous or primary grade of release, the following recommendations apply.

(a) The air flow rate should be sufficient to reduce the concentration of flammable gas or vapour in the duct system to below* the LEL. If this cannot be achieved with certainty, additional precautions may be necessary, e.g. explosion vents coupled with continuous monitoring and alarm at a predetermined value of vapour concentration.

(b) The associated extract fan motor should be mounted outside the ducting. Consideration should be given to the material of construction of the fan and ducting to reduce the likelihood of sparking due to friction or static electricity. All ducts and associated items should be of fire resistant materials.

(c) Consideration should be given to the classification immediately outside the extract system discharge point.

9.6 Buildings and enclosures located totally or partly within outdoor hazardous areas

9.6.1 Where the buildings or enclosures contain a source of release, the classification will have been carried out in accordance with **9.1** to **9.5** but this should be modified where necessary to take account of the effect of the external classification as given in **9.6.2**.

*Typically 25 % of the lower explosive limit.

9.6.2 Where the buildings or enclosures do not contain a source of release, they will usually assume the same classification as the area in which any openings are situated (see figure 8).

In the case of large buildings, if, for example, the openings from the building or enclosure into a hazardous area are doors and those responsible for the area classification have taken due account of the frequency of door opening, the standard of door sealing, etc. and have thus assessed the likely penetration of explosive gas atmosphere into the building, the extent of the hazardous area within the building may be reduced.

In the case of large or small buildings or enclosures, if there are no openings into the hazardous area or if the openings are such that there is negligible risk of an explosive gas atmosphere entering the building or enclosure in such a way as to form an explosive gas/air mixture (as may be the case with air locks or self-closing doors) the internal area may be designated as non-hazardous.

It should be noted that since external areas with Zone 0 or 1 classification should be small in extent it is unlikely that a building or enclosure will have an opening into such an area and such an arrangement should in any case be avoided.

Appendix A

The effect of ventilation in buildings containing hazardous areas

A.1 General. The subject of ventilation within buildings, whether naturally or mechanically produced, is a complex one and it is emphasized that the design of ventilation systems, such as those required to reduce risk where flammable materials are handled, is a matter for ventilation experts. Their guidance should always be sought.

Preventing explosive gas/air mixtures from accumulating, and diluting and dispersing them when they do occur, depends principally on the presence of an adequate volume of air flowing through the affected area.

The information given in **A.2** to **A.4** considers those factors that relate to area classification and which may affect an otherwise normal design for natural and mechanical ventilation of buildings.

A.2 Natural and artificial ventilation. The movement of air into a building takes place most commonly by natural infiltration through cracks around doors, windows, structural side sheets, etc. and is due mainly to wind pressure acting on external walls; at wind speeds above 4.5 m/s a certain amount of infiltration even through brickwork is possible. Such natural air flow may be deliberately aided by the provision of purpose made wall openings to give cross-flow ventilation. Alternatively, where there is normally a temperature difference between the inside and outside of buildings, use may be made of the 'chimney' effect by providing openings in the walls at low level and in the roof.

In situations where natural or aided natural ventilation is inadequate for an intended purpose, artificial methods are used. These may be arranged to supply additional air to the building at any desired rate, extract air from it, or do both and constitute an active rather than passive means of obtaining the desired objective.

NOTE. It is common practice to refer to the number of times the air content of a building is changed in 1 h as 'the number of air changes per hour'. It is a convenient unit of measurement but relates to air quantity only; it gives no guidance as to air flow patterns. Table 2 gives typical values of the number of air changes per hour that take place due to unaided natural ventilation in buildings of different sizes and constructional features. For a building of known dimensions, the volume rate of air through it can be derived from the stated figures.

A.3 Natural ventilation. Where crack leakage is the sole source of infiltration into a building, measurable air velocities within it are very rarely attained. Purpose-made wall openings significantly alter this situation, particularly if they are located where maximum benefit is taken of the prevailing wind effects. Where such wall openings are installed they should be designed to provide the maximum air flow. Air distribution within the enclosure will depend upon the layout of plant, etc. and wind pressures imposed. The higher the pressure difference the higher the air change rate in the enclosure.

In the case of a partially enclosed building where the structural side sheets or in-fill brickwork is omitted up to some height, e.g. 3 m above ground level, around the whole periphery and there are no major obstructions within the building itself, then the passage of air at ground level is essentially unrestricted.

In single-storey buildings where heat is generated deliberately for purposes of operator comfort, or fortuitously from hot vessels, moving machinery and artificial lighting, use can be made of rising air convection currents (or the 'chimney' effect) to aid or increase the ventilation rate by the provision of louvred openings located as low as possible in external walls, and ridge or unit ventilators on the roof. To produce an effective improvement by this means requires a general temperature difference of at least 3 K between the inside and outside of the building. An exception to this occurs where a piece of plant equipment from which there is a high heat loss produces a strong localized upward air convection current capable of reaching roof level, where it can escape through a strategically placed ventilator. Where these buoyancy effects occur they will cause cold air to flow into the base of the hot column, and this will set up air circulations within the enclosure. Consideration should also be given to the fact that the 'chimney' effect may also induce flammable vapours into the building from adjacent low level sources.

NOTE 1 Even in unheated buildings, roof ridge ventilators may be used to prevent the accumulation of lighter-than-air gases. Care is necessary in their design to avoid down draughts from outside wind effects and adequate air inlets are required at low level.

NOTE 2. Where flammable gases and vapours that are heavier than air are involved, air inlets and air outlets at low level to provide dilution and cross-flow ventilation may be employed. Alternatively, dilution air may be drawn from high level and extracted at low level. Ventilation systems of this type tend to be more complex, and the building geometry and plant locations can have a major influence on the final design.

The 'chimney' effect may also occur and be utilized in multi-storey buildings, subject to the following cautionary observations.

(a) In such buildings the floors are frequently of concrete construction and serve as horizontal fire-breaks. Their integrity for that primary purpose takes precedence over breaching them for purposes of increasing ventilation.

(b) Open mesh floors offer marked resistance to the flow of air through them and even where ground level wall openings and roof ventilators are provided, it is essential for an adequate temperature difference to exist between floors to establish the 'chimney' effect.

Where open mesh floors are used, it cannot be assumed that good cross-ventilation at one working level, by virtue of open side walls in the building at that level, markedly affects the ventilation of the working levels immediately above and below. Therefore to take advantage of the 'chimney effect', it is essential that adequate positive temperature differences normally exist upwards from floor to floor.

(c) If no temperature difference exists from the inside to the outside of the building, the fitting of roof extraction fans rather than roof ventilators improves upward air flow and consequently ventilation. Associated air inlets are optimally placed when located at the lowest point appropriate to the particular installation.

A.4 **Artificial ventilation.** Where mechanical means are used to improve the general ventilation within a building for safety reasons, there is a constraint on the designer that the resultant air velocities do not cause discomfort to the operators working in the area. Acceptable air velocities in this context are taken to be 0.1 m/s at 16 °C to 0.3 m/s at 24 °C. If the design of a general artificial ventilation system leads to velocities in excess of these figures, there is an implication that a reappraisal of the basic plant design is necessary entailing either a reduction in the total potential release of flammable material or a more widespread use of point source (extraction) artificial ventilation to contain the individual releases.

In designing point source ventilation systems those aspects concerned with air extraction and, in particular, with the design of hoods, canopies, etc. require specialist treatment.

1 When using mechanical means for producing air flows it should be borne in mind that, whilst they have good air projection capabilities, i.e. throws of up to 30 fan diameters, depending on design, they have poor suction capabilities, i.e. up to one fan diameter. Therefore whilst roof mounted fans set up a positive air flow from the inside to the outside of the building, providing there are adequate air inlets, they have little influence on air flow patterns within the building.

Ducted systems can provide the means to stir up air in localized pockets where explosive gas/air mixtures would otherwise accumulate.

Table 2. Natural infiltration into buildings

Reproduced with permission from the CIBS Guide, Section A.4 Air Infiltration.*

Constructions	Air changes per hour
Multi-storey, brick or concrete constructions	
lower and intermediate floors	1
top floor with flat roof	1
top floor with sheeted roof, lined	1¼
top floor with sheeted roof, unlined	1½
Single-storey unpartitioned spaces: brick or concrete construction	
up to 300 m^3	1½
300 to 3000 m^3	¾
3000 to 10 000 m^3	½
over 10 000 m^3	¼
Curtain wall or sheet construction, lined:	
up to 300 m^3	1¾
300 to 3000 m^3	1
3000 to 10 000 m^3	¾
over 10 000 m^3	½
Sheet construction, unlined:	
up to 300 m^3	2¼
300 to 3000 m^3	1½
3000 to 10 000 m^3	1
over 10 000 m^3	¾

NOTE. These rates of infiltration are a guide and do not include the extra ventilation that may be caused by large open doorways, louvred ventilators and roof ventilators or by process air extraction systems installed for dust and fume removal.

Appendix B

Examples of zones surrounding a source of release

Figures 3 to 8 show (in plan view only) the zones surrounding a source of release in various situations. For clarity of presentation, vertical extents have been excluded and each example should be regarded as a guide to area classification that may be modified in accordance with this code.

NOTE 1. Some abnormal situations affecting zone number or extent are identified by specific notes.

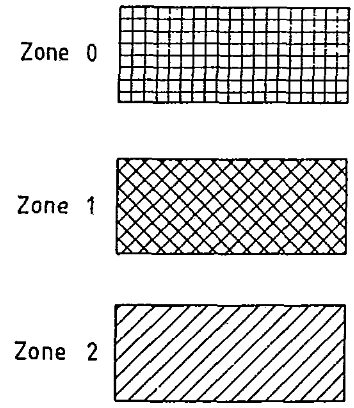
NOTE 2. Outdoor ventilation is in accordance with clause 8 and indoor ventilation is in accordance with clause 9.

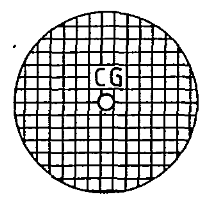
Key to figures 3 to 8

CG = continuous grade of release

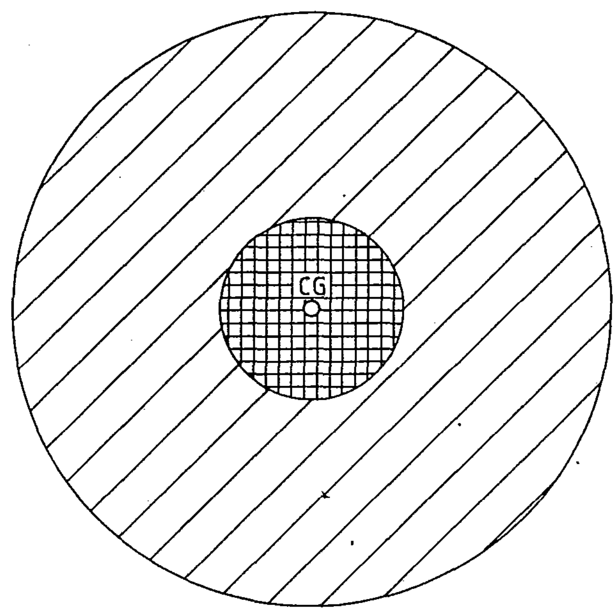
PG = primary grade of release

SG = secondary grade of release





(a) Single source and zone

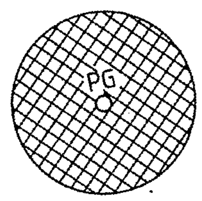


NOTE. The Zone 2 arises from a release in abnormal operation where the release rate is greater than that in normal operation.

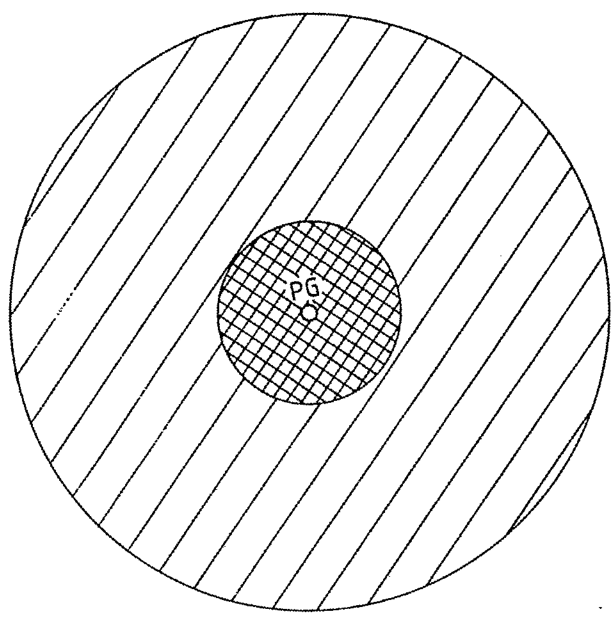
(b) Single source multiple zone

Figure 3. Continuous grade of release in an outdoor area : natural ventilation

*Obtainable from The Chartered Institution of Building Services, Delta House, 222 Balham High Road, London SW12 9BS.



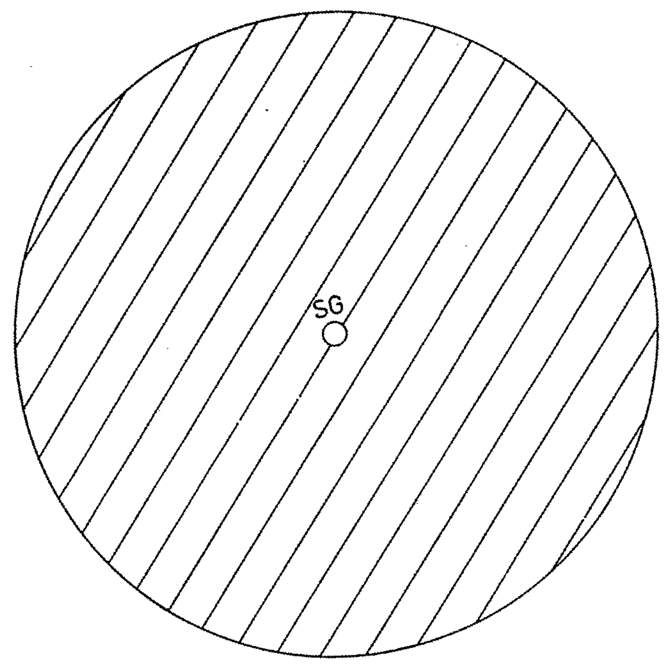
(a) Single source and zone



NOTE. The Zone 2 arises from a release in abnormal operation where the release rate is greater than that in normal operation.

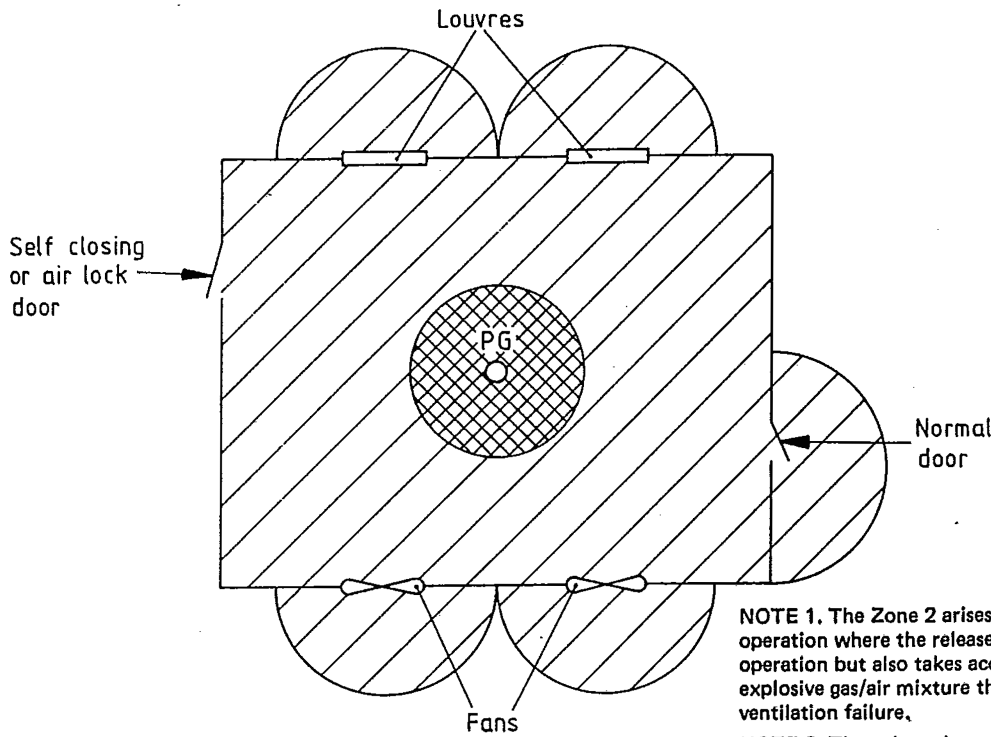
(b) Single source multiple zone

Figure 4. Primary grade of release in an outdoor area : natural ventilation



Single source and zone : natural ventilation

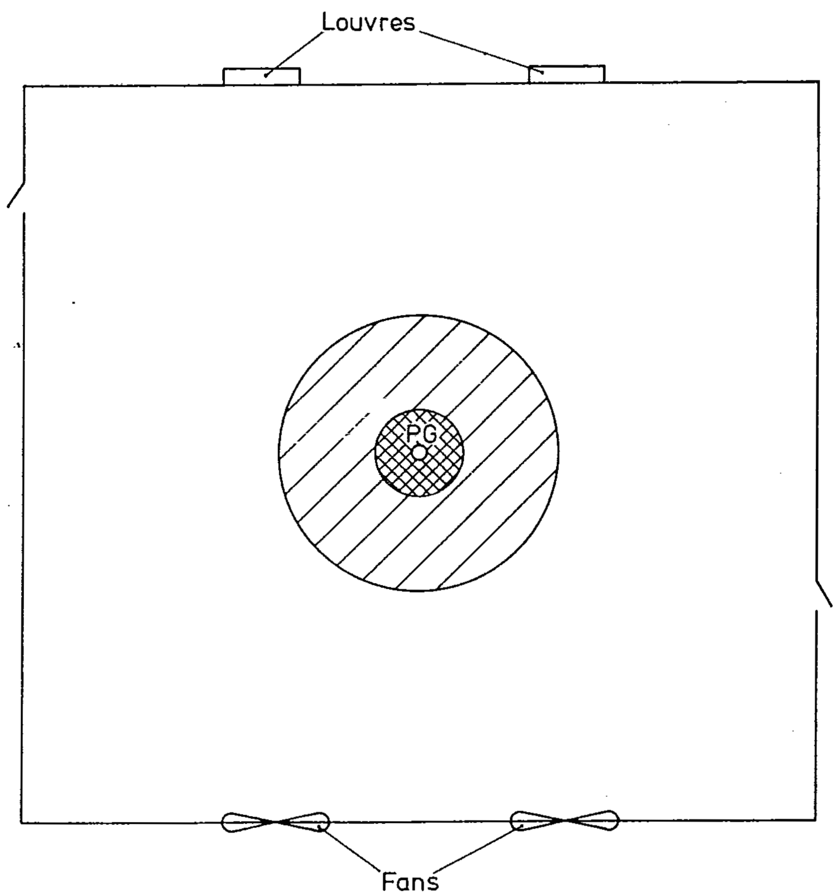
Figure 5. Secondary grade of release in an outdoor area : natural ventilation : single source and zone



NOTE 1. The Zone 2 arises primarily from a release in abnormal operation where the release rate is greater than that in normal operation but also takes account of the possibility of the spread of explosive gas/air mixture that may arise in some cases during ventilation failure.

NOTE 2. The enlarged zone may extend beyond the indoor area due to doorways or other openings.

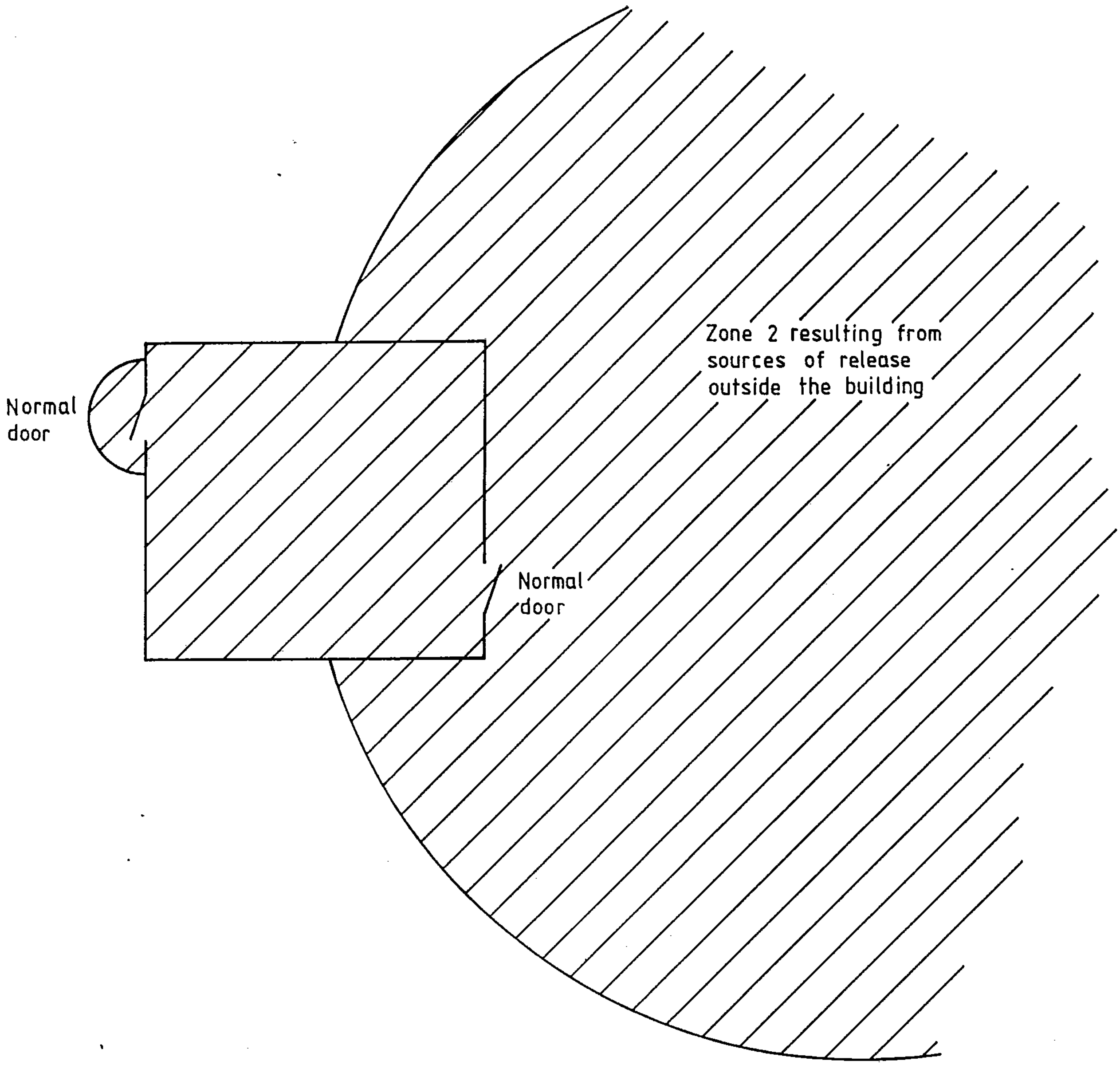
Figure 6. Primary grade of release in a small indoor area : artificial ventilation : single source multiple zone



NOTE 1. The Zone 2 arises primarily from a release in abnormal operation where the release rate is greater than that in normal operation but also takes account of the possibility of the spread of explosive gas/air mixture that may arise in some cases during ventilation failure.

NOTE 2. Consideration of all abnormal situations does not indicate extension of enlarged zones beyond the indoor area.

Figure 7. Primary grade of release in a large indoor area : artificial ventilation : single source multiple zone



NOTE 1. The Zone 2 need not necessarily extend over the whole indoor area.

NOTE 2. If the indoor area has no openings into the external Zone 2 or if the risk of an explosive gas/air mixture entering the indoor area is negligible, the indoor area may be classified non-hazardous.

Figure 8. Single zone indoor area with opening into a Zone 2

Publications referred to

BS 5345 Code of practice for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining applications or explosive processing and manufacture)
Part 1 Basic requirements for all Parts of the code

CP 1003 Electrical apparatus and associated equipment for use in explosive atmospheres of gas or vapour other than mining applications
Part 1 Choice, installation and maintenance of flameproof and intrinsically-safe electrical equipment
Part 2 Methods of meeting the explosion hazard other than by the use of flameproof or intrinsically-safe electrical equipment
Part 3 Division 2 areas

BS 5345 : Part 2 : 1983

This British Standard, having been prepared under the direction of the General Electrotechnical Engineering Standards Committee, was published under the authority of the Board of BSI and comes into effect on 29 April 1983.

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Committees responsible for this British Standard

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Council for Electrical Equipment for Flammable Atmospheres (BEAMA)
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Department of the Environment, Building Research Establishment (Fire Research Station)
Electric Cable Makers' Confederation
Electronic Components Industry Federation
Institution of Electrical Engineers
Institution of Gas Engineers

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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 2. Classification of hazardous areas

Revised text

AMD 5754
July 1989

Clause 4.4 Special considerations

Delete the first sentence of paragraph 2 and substitute the following.

'If the total quantity of flammable material available for release is small, e.g. laboratory use, whilst a potential hazard may still exist, it may not be appropriate to use *area classification*.'

AMD 5754
July 1989

Clause 7.3.2 Grade of release

Delete the first three sentences and substitute the following.

'It is first necessary to determine *whether the total quantity* of flammable material available for release from the process equipment item is small (see 4.4) [1] and [2]. If it is *considered small, area classification* [38] may not be appropriate but certain special precautions may still be necessary [39]. Should the quantity not be considered small, it is necessary to determine [3] if release of flammable material is possible, neglecting catastrophic events (see clause 1).'

AMD 5754
July 1989

Figure 1. Determination of type and extent of zone

Delete the existing figure and substitute the new figure 1 attached.

AMD 5754
July 1989

Clause A.3 Natural ventilation

Delete the third and fourth sentences of paragraph 1 and substitute the following.

'Where such wall openings are installed they should be designed to provide the maximum air flow. Air distribution within the enclosure will depend upon the layout of plant, etc. and wind pressures imposed. The higher the pressure difference the higher the air change rate in the enclosure.'

After the third sentence of paragraph 3 insert the following.

'Where these buoyancy effects occur they will cause cold air to flow into the base of the hot column, and this will set up air circulations within the enclosure.'

In line 1 of the note, after 'NOTE' insert '1'.

After this note insert the following.

'NOTE 2. Where flammable gases and vapours that are heavier than air are involved, air inlets and air outlets at low level to provide dilution and cross-flow ventilation may be employed. Alternatively, dilution air may be drawn from high level and extracted at low level. Ventilation systems of this type tend to be more complex, and the building geometry and plant locations can have a major influence on the final design.'

Delete the first sentence of item (c) and substitute the following.

'If no temperature difference exists from the inside to the outside of the building, the fitting of roof extraction fans rather than roof ventilators improves upward air flow and consequently ventilation.'

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July 1989

Clause A.4 Artificial ventilation

After the last sentence of paragraph 2 insert the following.

'When using mechanical means for producing air flows it should be borne in mind that, whilst they have good air projection capabilities, i.e. throws of up to 30 fan diameters, depending on design, they have poor suction capabilities, i.e. up to one fan diameter. Therefore whilst roof mounted fans set up a positive air flow from the inside to the outside of the building, providing there are adequate air inlets, they have little influence on air flow patterns within the building.

Ducted systems can provide the means to stir up air in localized pockets where explosive gas/air mixtures would otherwise accumulate.'

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Table 2. Natural infiltration into buildings

In column 1, delete 'm^2' (in twelve places) and substitute 'm^3'.

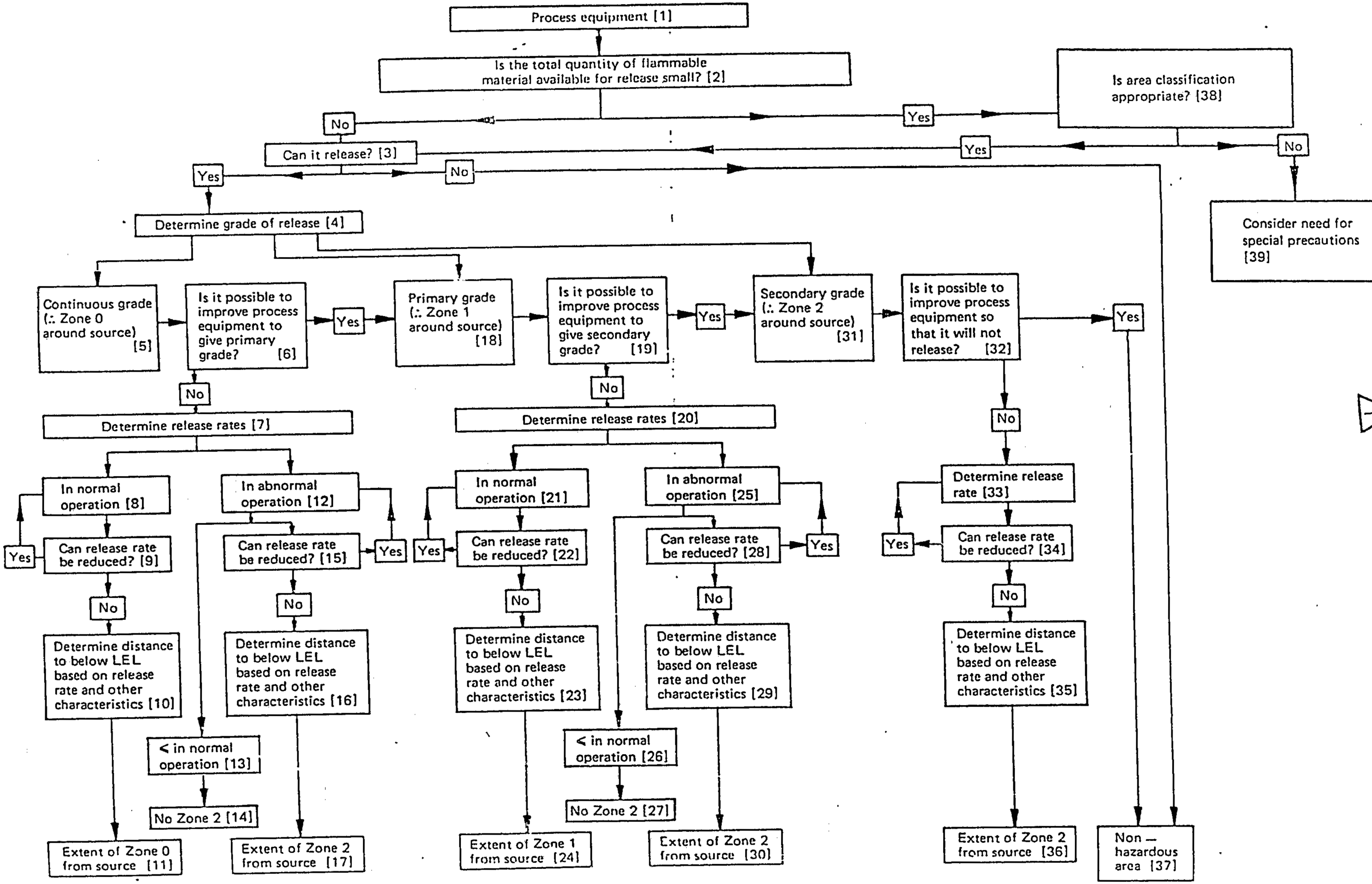

Figure 1. Determination of type and extent of zone

GEL/114