EUROPEAN STANDARD **EN 60079-10**

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English version

Electrical apparatus for explosive gas atmospheres
Part 10: Classification of hazardous areas
(IEC 60079-10:2002)

Matériel électrique pour atmosphères explosives gazeuses
Partie 10: Classement des emplacements dangereux
(CEI 60079-10:2002)

Elektrische Betriebsmittel für gasexplosionsgefährdete Bereiche
Teil 10: Einteilung der explosionsgefährdeten Bereiche
(IEC 60079-10:2002)

This European Standard was approved by CENELEC on 2002-12-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

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Foreword

The text of the International Standard IEC 60079-10:2002, prepared by SC 31J, Classification of hazardous areas and installation requirements, of IEC TC 31, Electrical apparatus for explosive atmospheres, was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 60079-10 on 2002-12-01 without any modification.

This European Standard supersedes EN 60079-10:1996.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2003-12-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2005-12-01

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, Annex ZA is normative and Annexes A, B and C are informative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60079-10:2002 was approved by CENELEC as a European Standard without any modification.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60050-426	1990	International Electrotechnical Vocabulary (IEV) Chapter 426: Electrical apparatus for explosive atmospheres	-	-
IEC 60079-4	1975	Electrical apparatus for explosive gas atmospheres Part 4: Method of test for ignition temperature	-	-
IEC 60079-4A	1970	Part 4: Method of test for ignition temperature – First supplement	-	-
IEC 60079-20	1996	Part 20: Data for flammable gases and vapours, relating to the use of electrical apparatus	-	-

INTERNATIONAL STANDARD

IEC 60079-10

Fourth edition
2002-06

Electrical apparatus for explosive gas atmospheres –

Part 10: Classification of hazardous areas

*This **English-language** version is derived from the original **bilingual** publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.*

Reference number
IEC 60079-10:2002(E)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICAL APPARATUS FOR EXPLOSIVE GAS ATMOSPHERES –

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FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60079-10 has been prepared by subcommittee 31J: Classification of hazardous areas and installation requirements, of IEC technical committee 31: Electrical apparatus for explosive atmospheres.

This fourth edition cancels and replaces the third edition published in 1995, and constitutes a technical revision.

The text of this standard is based on the following documents:

FDIS	Report on voting
31J/82/FDIS	31J/84/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

Annexes A, B and C are for information only.

The committee has decided that the contents of this publication will remain unchanged until 2007. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

INTRODUCTION

In areas where dangerous quantities and concentrations of flammable gas or vapour may arise, protective measures are to be applied in order to reduce the risk of explosions. This part of IEC 60079 sets out the essential criteria against which the risk of ignition can be assessed, and gives guidance on the design and control parameters which can be used in order to reduce such a risk.

This standard can be used as a basis for the proper selection and installation of apparatus for use in a hazardous area.

ELECTRICAL APPARATUS FOR EXPLOSIVE GAS ATMOSPHERES –

Part 10: Classification of hazardous areas

1 General

1.1 Scope

This part of IEC 60079 is concerned with the classification of hazardous areas where flammable gas or vapour risks may arise, in order to permit the proper selection and installation of apparatus for use in such hazardous areas.

It is intended to be applied where there may be a risk of ignition due to the presence of flammable gas or vapour, mixed with air under normal atmospheric conditions (see note 2), but it does not apply to

a) mines susceptible to firedamp;

b) the processing and manufacture of explosives;

c) areas where a risk may arise due to the presence of ignitable dusts or fibres;

d) catastrophic failures which are beyond the concept of abnormality dealt with in this standard (see note 3);

e) rooms used for medical purposes;

f) areas where the presence of flammable mist may give rise to an unpredictable risk and which require special consideration (see note 5);

g) domestic premises.

This standard does not take into account the effects of consequential damage.

Definitions and explanations of terms are given together with the main principles and procedures relating to hazardous area classification.

For detailed recommendations regarding the extent of the hazardous areas in specific industries or applications, reference may be made to the codes relating to those industries or applications.

NOTE 1 For the purpose of this standard, an area is a three-dimensional region or space.

NOTE 2 Atmospheric conditions include variations above and below reference levels of 101,3 kPa (1 013 mbar) and 20 °C (293 K), provided that the variations have a negligible effect on the explosion properties of the flammable materials.

NOTE 3 Catastrophic failure in this context is applied, for example, to the rupture of a process vessel or pipeline and events that are not predictable.

NOTE 4 In any process plant, irrespective of size, there may be numerous sources of ignition apart from those associated with electrical apparatus. Appropriate precautions will be necessary to ensure safety in this context. This standard may be used with judgement for other ignition sources.

NOTE 5 Mists may form or be present at the same time as flammable vapours. This may affect the way flammable material disperses and the extent of any hazardous areas. The strict application of area classification for gases and vapours may not be appropriate because the flammability characteristics of mists are not always predictable. Whilst it can be difficult to decide upon the type and extent of zones, the criteria applicable to gases and vapours will, in most cases, give a safe result. However, special consideration should always be given to the danger of ignition of flammable mists.

1.2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050(426):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 426: Electrical apparatus for explosive atmospheres*

IEC 60079-4:1975, *Electrical apparatus for explosive gas atmospheres – Part 4: Method of test for ignition temperature*

IEC 60079-4A:1970, *First supplement to IEC 60079-4 (1966), Electrical apparatus for explosive gas atmospheres – Part 4: Method of test for ignition temperature*

IEC 60079-20:1996, *Electrical apparatus for explosive gas atmospheres – Part 20: Data for flammable gases and vapours, relating to the use of electrical apparatus*

2 Definitions and terms

For the purpose of this part of IEC 60079, the following definitions and terms apply.

NOTE Where a definition appears in this clause and in IEC 60050(426), the definition given in this clause is applicable.

2.1
explosive atmosphere
mixture with air, under atmospheric conditions, of flammable substances in the form of gas, vapour, mist or dust, in which after ignition, combustion spreads throughout the unconsumed mixture

[IEV 426-02-02, modified]

2.2
explosive gas atmosphere
mixture with air, under atmospheric conditions, of flammable substances in the form of gas or vapour in which, after ignition, combustion spreads throughout the unconsumed mixture

[IEV 426-02-03, modified]

NOTE Although a mixture which has a concentration above the upper explosive limit (UEL) is not an explosive gas atmosphere, it can readily become so and, in certain cases for area classification purposes, it is advisable to consider it as an explosive gas atmosphere.

2.3
hazardous area
area in which an explosive gas atmosphere is present, or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of apparatus

[IEV 426-03-01, modified]

2.4
non-hazardous area
area in which an explosive gas atmosphere is not expected to be present in quantities such as to require special precautions for the construction, installation and use of apparatus

[IEV 426-03-02, modified]

2.5
zones
hazardous areas are classified into zones based upon the frequency of the occurrence and duration of an explosive gas atmosphere, as follows:

2.5.1
zone 0
place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is present continuously or for long periods or frequently

[IEV 426-03-03, modified]

2.5.2
zone 1
place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally

[IEV 426-03-04, modified]

2.5.3
zone 2
place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only

[IEV 426-03-05, modified]

NOTE 1 In this definition, the word "persist" means the total time for which the flammable atmosphere will exist. This will normally comprise the total of the duration of the release, plus the time taken for the flammable atmosphere to disperse after the release has stopped. (The term "persistence time" as used in annex B refers specifically to only one part of the total time for which the flammable atmosphere will exist.)

NOTE 2 Indications of the frequency of the occurrence and duration may be taken from codes relating to specific industries or applications.

2.6
source of release
point or location from which a flammable gas, vapour, or liquid may be released into the atmosphere in such a way that an explosive gas atmosphere could be formed

[IEV 426-03-06, modified]

2.7
grades of release
there are three basic grades of release, as listed below in order of decreasing frequency and likelihood of the explosive gas atmosphere being present:

a) continuous grade;

b) primary grade;

c) secondary grade.

A source of release may give rise to any one of these grades of release, or to a combination of more than one

2.7.1
continuous grade of release
release which is continuous or is expected to occur frequently or for long periods

2.7.2
primary grade of release
release which can be expected to occur periodically or occasionally during normal operation

2.7.3
secondary grade of release
release which is not expected to occur in normal operation and, if it does occur, is likely to do so only infrequently and for short periods

2.8
release rate
quantity of flammable gas or vapour emitted per unit time from the source of release

2.9
normal operation
situation when the equipment is operating within its design parameters

NOTE 1 Minor releases of flammable material may be part of normal operation. For example, releases from seals which rely on wetting by the fluid which is being pumped are considered to be minor releases.

NOTE 2 Failures (such as the breakdown of pump seals, flange gaskets or spillages caused by accidents) which involve urgent repair or shut-down are not considered to be part of normal operation nor are they considered to be catastrophic.

NOTE 3 Normal operation includes start-up and shut-down conditions.

2.10
ventilation
movement of air and its replacement with fresh air due to the effects of wind, temperature gradients, or artificial means (for example, fans or extractors)

2.11
explosive limits

NOTE The terms "explosive limit" and "flammable limit" are equivalent. IEC 60079-20 and IEC 61779-1 use the term "flammable limit" whilst all the other standards use the more widely accepted term "explosive limit".

2.11.1
lower explosive limit (LEL)
concentration of flammable gas or vapour in air, below which the gas atmosphere is not explosive

[IEV 426-02-09, modified]

2.11.2
upper explosive limit (UEL)
concentration of flammable gas or vapour in air, above which the gas atmosphere is not explosive

[IEV 426-02-10, modified]

2.12
relative density of a gas or a vapour
density of a gas or a vapour relative to the density of air at the same pressure and at the same temperature (air is equal to 1,0)

2.13
flammable material (flammable substance)
material which is flammable of itself, or is capable of producing a flammable gas, vapour or mist

2.14
flammable liquid
liquid capable of producing a flammable vapour under any foreseeable operating conditions

2.15
flammable gas or vapour
gas or vapour which, when mixed with air in certain proportions, will form an explosive gas atmosphere

2.16
flammable mist
droplets of flammable liquid, dispersed in air so as to form an explosive atmosphere

2.17
flashpoint
lowest liquid temperature at which, under certain standardized conditions, a liquid gives off vapours in a quantity such as to be capable of forming an ignitable vapour/air mixture

[IEV 426-02-14]

2.18
boiling point
temperature of a liquid boiling at an ambient pressure of 101,3 kPa (1 013 mbar)

NOTE The initial boiling point that should be used for liquid mixtures is to indicate the lowest value of the boiling point for the range of liquids present, as determined in a standard laboratory distillation without fractionation.

2.19
vapour pressure
pressure exerted when a solid or liquid is in equilibrium with its own vapour. It is a function of the substance and of the temperature

2.20
ignition temperature of an explosive gas atmosphere
lowest temperature of a heated surface at which, under specified conditions, the ignition of a flammable substance in the form of a gas or vapour mixture with air will occur

[IEV 426-02-01, modified]

NOTE IEC 60079-4 and IEC 60079-4A standardize a method for the determination of this temperature.

2.21
extent of zone
distance in any direction from the source of release to the point where the gas/air mixture has been diluted by air to a value below the lower explosive limit

2.22
liquefied flammable gas
flammable material which is stored or handled as a liquid and which at ambient temperature and atmospheric pressure is a flammable gas

3 Safety and area classification

3.1 Safety principles

Installations in which flammable materials are handled or stored should be designed, operated and maintained so that any releases of flammable material, and consequently the extent of hazardous areas, are kept to a minimum, whether in normal operation or otherwise, with regard to frequency, duration and quantity.

It is important to examine those parts of process equipment and systems from which release of flammable material may arise and to consider modifying the design to minimize the likelihood and frequency of such releases and the quantity and rate of release of material.

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.

In the case of maintenance activities other than those of normal operation, the extent of the zone may be affected but it is expected that this would be dealt with by a permit-to-work system.

In a situation in which there may be an explosive gas atmosphere, the following steps should be taken:

a) eliminate the likelihood of an explosive gas atmosphere occurring around the source of ignition, or

b) eliminate the source of ignition.

Where this is not possible, protective measures, process equipment, systems and procedures should be selected and prepared so the likelihood of the coincidence of a) and b) is so small as to be acceptable. Such measures may be used singly, if they are recognized as being highly reliable, or in combination to achieve an equivalent level of safety.

3.2 Area classification objectives

Area classification is a method of analysing and classifying the environment where explosive gas atmospheres may occur so as to facilitate the proper selection and installation of apparatus to be used safely in that environment, taking into account gas groups and temperature classes.

In most practical situations where flammable materials are used, it is difficult to ensure that an explosive gas atmosphere will never occur. It may also be difficult to ensure that apparatus will never give rise to a source of ignition. Therefore, in situations where an explosive gas atmosphere has a high likelihood of occurring, reliance is placed on using apparatus which has a low likelihood of creating a source of ignition. Conversely, where the likelihood of an explosive gas atmosphere occurring is reduced, apparatus constructed to a less rigorous standard may be used.

It is rarely possible by a simple 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 detailed approach is therefore necessary and this involves the analysis of the basic possibility of an explosive gas atmosphere occurring.

The first step is to assess the likelihood of this, in accordance with the definitions of zone 0, zone 1 and zone 2. Once the likely frequency and duration of release (and hence the grade of release), the release rate, concentration, velocity, ventilation and other factors which affect the type and/or extent of the zone have been determined, there is then a firm basis on which to determine the likely presence of an explosive gas atmosphere in the surrounding areas.

This approach therefore requires detailed consideration to be given to each item of process equipment which contains a flammable material, and which could therefore be a source of release.

In particular, zone 0 or zone 1 areas should be minimized in number and extent by design or suitable operating procedures. In other words, plants and installations should be mainly zone 2 or non-hazardous. Where release of flammable material is unavoidable, process equipment items should be limited to those which give secondary grade releases or, failing this (that is where primary or continuous grade releases are unavoidable), the releases should be of very limited quantity and rate. In carrying out area classification, these principles should receive prime consideration. Where necessary, the design, operation and location of process equipment should ensure that, even when it is operating abnormally, the amount of flammable material released into the atmosphere is minimized, so as to reduce the extent of the hazardous area.

Once a plant has been classified and all necessary records made, it is important that no modification to equipment or operating procedures is made without discussion with those responsible for the area classification. Unauthorized action may invalidate the area classification. It is necessary to ensure that all equipment affecting the area classification which has been subjected to maintenance is carefully checked during and after re-assembly to ensure that the integrity of the original design, as it affects safety, has been maintained before it is returned to service.

4 Area classification procedure

4.1 General

The area classification should be carried out by those who have knowledge of the properties of flammable materials, the process and the equipment, in consultation, as appropriate, with safety, electrical, mechanical and other engineering personnel.

The following subclauses give guidance on the procedure for classifying areas in which there may be an explosive gas atmosphere and on the extent of zones 0, 1 and 2. An example of a schematic approach to the classification of hazardous areas is given in figure C.1.

The area classification should be carried out when the initial process and instrumentation line diagrams and initial layout plans are available and confirmed before plant start-up. Reviews should be carried out during the life of the plant.

4.2 Sources of release

The basic elements for establishing the hazardous zone types are the identification of the source of release and the determination of the grade of release.

Since an explosive gas atmosphere can exist only if a flammable gas or vapour is present with air, it is necessary to decide if any of these flammable materials can exist in the area concerned. Generally speaking, such gases and vapours (and flammable liquids and solids which may give rise to them) are contained within process equipment which may or may not be totally enclosed. It is necessary to identify where a flammable atmosphere can exist inside a process plant, or where a release of flammable materials can create a flammable atmosphere outside a process plant.

Each item of process equipment (for example, tank, pump, pipeline, vessel, etc.) should be considered as a potential source of release of flammable material. If the item cannot contain

flammable material, it will clearly not give rise to a hazardous area around it. The same will apply if the item contains a flammable material but cannot release it into the atmosphere (for example, an all-welded pipeline is not considered to be a source of release).

If it is established that the item may release flammable material into the atmosphere, it is necessary, first of all, to determine the grade of release in accordance with the definitions, by establishing the likely frequency and duration of the release. It should be recognized that the opening-up of parts of enclosed process systems (for example, during filter changing or batch filling) should also be considered as sources of release when developing the area classification. By means of this procedure, each release will be graded either "continuous", "primary" or "secondary".

Having established the grade of the release, it is necessary to determine the release rate and other factors which may influence the type and extent of the zone.

If the total quantity of flammable material available for release is "small", for example, laboratory use, whilst a potential hazard may exist, it may not be appropriate to use this area classification procedure. In such cases, account shall be taken of the particular risks involved.

The area classification of process equipment in which flammable material is burned, for example, fired heaters, furnaces, boilers, gas turbines etc., should take into account purge cycle, start-up and shut-down conditions.

4.3 Type of zone

The likelihood of the presence of an explosive gas atmosphere and hence the type of zone depends mainly on the grade of release and the ventilation.

NOTE 1 A continuous grade of release normally leads to a zone 0, a primary grade to zone 1 and a secondary grade to zone 2 (see annex B).

NOTE 2 Where zones created by adjacent sources of release overlap and are of different zonal classification, the higher risk classification will apply in the area of overlap. Where overlapping zones are of the same classification, this common classification will normally apply.

However, care needs to be taken where the overlapping zones relate to flammable materials which have different apparatus groups and/or temperature class. So, for example, if a zone 1 IIA T3 area overlapped a zone 2 IIC T1 area, then classifying the overlap as zone 1 IIC T3 may be over-restrictive but classifying it as zone 1 IIA T3 or zone 1 IIC T1 would not be acceptable. In this situation, the area classification should be recorded as zone 1 IIA T3 and zone 2 IIC T1.

4.4 Extent of zone

The extent of the zone depends on the estimated or calculated distance over which an explosive atmosphere exists before it disperses to a concentration in air below its lower explosive limit. When assessing the area of spread of gas or vapour before dilution to below its lower explosive limit, expert advice should be sought.

Consideration should always be given to the possibility that a gas which is heavier than air may flow into areas below ground level (for example, pits or depressions) and that a gas which is lighter than air may be retained at high level (for example, in a roof space).

Where the source of release is situated outside an area or in an adjoining area, the penetration of a significant quantity of flammable gas or vapour into the area can be prevented by suitable means such as:

a) physical barriers;
b) maintaining a sufficient overpressure in the area relative to the adjacent hazardous areas, so preventing the ingress of the explosive gas atmosphere;
c) purging the area with sufficient flow of fresh air, so ensuring that the air escapes from all openings where the flammable gas or vapour may enter.

The extent of the zone is mainly affected by the following chemical and physical parameters, some of which are intrinsic properties of the flammable material; others are specific to the process. For simplicity, the effect of each parameter listed below assumes that the other parameters remain unchanged.

4.4.1 Release rate of gas or vapour

The greater the release rate, the larger the extent of the zone. The release rate depends itself on other parameters, namely

a) Geometry of the source of release

   This is related to the physical characteristics of the source of release, for example, an open surface, leaking flange, etc. (see annex A).

b) Release velocity

   For a given source of release, the release rate increases with the release velocity. In the case of a product contained within process equipment, the release velocity is related to the process pressure and the geometry of the source of release. The size of a cloud of flammable gas or vapour is determined by the rate of flammable vapour release and the rate of dispersion. Gas and vapour flowing from a leak at high velocity will develop a cone-shaped jet which will entrain air and be self-diluting. The extent of the explosive gas atmosphere will be almost independent of wind velocity. If the material is released at low velocity or if its velocity is reduced by impingement on a solid object, it will be carried by the wind and its dilution and extent will depend on wind velocity.

c) Concentration

   The release rate increases with the concentration of flammable vapour or gas in the released mixture.

d) Volatility of a flammable liquid

   This is related principally to the vapour pressure, and the enthalpy ("heat") of vaporization. If the vapour pressure is not known, the boiling point and flashpoint can be used as a guide.

An explosive gas atmosphere cannot exist if the flashpoint is above the relevant maximum temperature of the flammable liquid. The lower the flashpoint, the greater may be the extent of the zone. If a flammable material is released in a way that forms a mist (for example, by spraying) an explosive atmosphere may be formed below the flashpoint of the material, for example.

NOTE 1 Flashpoints of flammable liquids are not precise physical quantities, particularly where mixtures are involved.

NOTE 2 Some liquids (for example, certain halogenated hydrocarbons) do not possess a flashpoint although they are capable of producing an explosive gas atmosphere. In these cases, the equilibrium liquid temperature which corresponds to the saturated concentration at the lower explosive limit should be compared with the relevant maximum liquid temperature.

e) Liquid temperature

The vapour pressure increases with temperature, thus increasing the release rate due to evaporation.

NOTE The temperature of the liquid after it has been released may be increased, for example, by a hot surface or by a high ambient temperature.

4.4.2 Lower explosive limit (*LEL*)

For a given release volume, the lower the *LEL* the greater will be the extent of the zone.

Experience has shown that a release of ammonia, with an *LEL* of 15 % by volume, will dissipate rapidly in the open air, so an explosive gas atmosphere will normally be of negligible extent.

4.4.3 Ventilation

With increased ventilation, the extent of the zone will normally be reduced. Obstacles which impede the ventilation may increase the extent of the zone. On the other hand, some obstacles, for example, dykes, walls or ceilings, may limit the extent. A compressor shelter with a large roof-ventilator and with the sides open sufficient, to allow free passage of air through all parts of the building is considered well ventilated and should be treated as an outdoor area (i.e. "medium" degree and "good" availability).

4.4.4 Relative density of the gas or vapour when it is released

If the gas or vapour is significantly lighter than air, it will tend to move upwards. If significantly heavier, it will tend to accumulate at ground level. The horizontal extent of the zone at ground level will increase with increasing relative density and the vertical extent above the source will increase with decreasing relative density.

NOTE 1 For practical applications, a gas or vapour which has a relative density below 0,8 is regarded as being lighter than air. If the relative density is above 1,2, it is regarded as being heavier than air. Between these values, both of these possibilities should be considered.

NOTE 2 With gases or vapours lighter than air, an escape at low velocity will disperse fairly rapidly upwards; the presence of a roof will, however, inevitably increase the area of spread under it. If the escape is at high velocity in a free jet the action of the jet, although entraining air which dilutes the gas or vapour, may increase the distance over which the gas/air mixture remains above its lower flammable limit.

NOTE 3 With gases or vapours heavier than air, an escape at low velocity will tend to flow downward and may travel long distances over the ground before it is safely dispersed by atmospheric diffusion. Special regard therefore needs to be paid to the topography of any site under consideration and also to surrounding areas in order to determine where gases or vapours might collect in hollows or run down inclines to lower levels. If the escape is at high velocity in a free jet the jet-mixing action by entraining air may well reduce the gas/air mixture to below its lower flammable limit in a much shorter distance than in the case of a low-velocity escape.

NOTE 4 Care needs to be taken when classifying areas containing cryogenic flammable gases such as liquefied natural gas. Vapours emitted can be heavier than air at low temperatures and become lighter than air on approaching ambient temperature.

4.4.5 Other parameters to be considered

a) Climatic conditions

The rate of gas or vapour dispersion in the atmosphere increases with wind speed but there is a minimum speed of 2 m/s – 3 m/s required to initiate turbulent diffusion; below this, layering of the gas or vapour occurs and the distance for safe dispersal is greatly increased. In plant areas sheltered by large vessels and structures, the speed of air movement may be substantially below that of the wind; however, obstruction of air movement by items of equipment tends to maintain turbulence even at low wind speeds.

NOTE 1 In annex B (clause B.4), 0,5 m/s wind speed is considered to be appropriate for determining the rates at which ventilation in an outdoor situation dilutes a flammable release. This lower value of wind speed is appropriate for that purpose, in order to maintain a conservative approach, even though it is recognized that the tendency of layering may compromise the calculation.

NOTE 2 In normal practice the tendency of layering is not taken into account in area classification because the conditions which give rise to this tendency are rare and occur for short periods only. However, if prolonged periods of low wind speed are expected for the specific circumstance then the extent of the zone should take account of the additional distance required to achieve dispersion.

b) Topography

Some liquids are less dense than water and do not readily mix with water: such liquids can spread on the surface of water (whether it be on the ground, in plant drains or in pipe trenches) and then be ignited at a point remote from the original spillage, therefore putting at risk a large area of plant.

The layout of the plant, where possible, should be designed to aid the rapid dispersal of explosive gas atmospheres. An area with restricted ventilation (for example, in pits or trenches) that would otherwise be Zone 2 may require Zone 1 classification; on the other hand, wide shallow depressions used for pumping complexes or pipe reservations may not require such rigorous treatment.

4.4.6 Illustrative examples

Some ways in which the above-mentioned parameters affect the vapour or gas release rate and hence the extent of the zone are demonstrated in the examples in annex C.

a) Source of release: open surface of liquid

In most cases, the liquid temperature will be below the boiling point and the vapour release rate will depend principally on the following parameters:

- liquid temperature;
- vapour pressure of the liquid at its surface temperature;
- dimensions of the evaporation surface;
- ventilation.

b) Source of release: virtually instantaneous evaporation of a liquid (for example, from a jet or spray)

Since the discharged liquid vaporizes virtually instantaneously, the vapour release rate is equal to the liquid flow rate and this depends on the following parameters:

- liquid pressure;
- geometry of the source of release.

Where the liquid is not instantaneously vaporized, the situation is complex because droplets, liquid jets and pools may create separate sources of release.

c) Source of release: leakage of a gas mixture

   The gas release rate is affected by the following parameters:

   – pressure within the equipment which contains the gas;
   – geometry of the source of release;
   – concentration of flammable gas in the released mixture.

For examples, of sources of release, see clause A.2.

5 Ventilation

5.1 General

Gas or vapour released into the atmosphere can be diluted by dispersion or diffusion into the air until its concentration is below the lower explosive limit. Ventilation, i.e. air movement leading to replacement of the atmosphere in a (hypothetical) volume around the source of release by fresh air, will promote dispersion. Suitable ventilation rates can also avoid persistence of an explosive gas atmosphere thus influencing the type of zone.

5.2 Main types of ventilation

Ventilation can be accomplished by the movement of air due to the wind and/or by temperature gradients or by artificial means such as fans. So two main types of ventilation are thus recognized:

a) natural ventilation;
b) artificial ventilation, general or local.

5.3 Degree of ventilation

The most important factor is that the degree or amount of ventilation is directly related to the types of sources of release and their corresponding release rates. This is irrespective of the type of ventilation, whether it be wind speed or the number of air changes per time unit. Thus optimal ventilation conditions in the hazardous area can be achieved, and the higher the amount of ventilation in respect of the possible release rates, the smaller will be the extent of the zones (hazardous areas), in some cases reducing them to a negligible extent (non-hazardous area).

Practical examples for guidance on the degree of ventilation which may used are given in annex B.

5.4 Availability of ventilation

The availability of ventilation has an influence on the presence or formation of an explosive gas atmosphere and thus also on the type of zone. Guidance on availability is given in annex B.

NOTE Combining the concepts of degree of ventilation and level of availability results in a quantitative method for the evaluation of zone type (see annex B).

6 Documentation

6.1 General

It is recommended that area classification is undertaken in such a way that the various steps which lead to the final area classification are properly documented.

All relevant information used should be referred to. Examples of such information, or of a method used, would be:

a) recommendations from relevant codes and standards;

b) gas and vapour dispersion characteristics and calculations;

c) a study of ventilation characteristics in relation to flammable material release parameters so that the effectiveness of the ventilation can be evaluated.

Those properties which are relevant to area classification of all process materials used on the plant should be listed and should include molecular weight, flashpoint, boiling point, ignition temperature, vapour pressure, vapour density, explosive limits, gas group and temperature class (IEC 60079-20). A suggested format for the materials listing is given in table C.1.

The results of the area classification study and any subsequent alterations to it shall be placed on record. A suggested format is given in table C.2.

6.2 Drawings, data sheets and tables

Area classification documents should include plans and elevations, as appropriate, which show both the type and extent of zones, ignition temperature and hence temperature class and gas group.

Where the topography of an area influences the extent of the zones, this should be documented.

The documents should also include other relevant information such as

a) the location and identification of sources of release. For large and complex plants or process areas, it may be helpful to itemize or number the sources of release so as to facilitate cross-referencing between the area classification data sheets and the drawings;

b) the position of openings in buildings (for example, doors, windows and inlets and outlets of air for ventilation).

The area classification symbols which are shown in figure C.1 are the preferred ones. A symbol key shall always be provided on each drawing. Different symbols may be necessary where multiple apparatus groups and/or temperature classes are required within the same type of zone (for example, zone 2 IIC T1 and zone 2 IIA T3).

Annex A
(informative)

Examples of sources of release

A.1 Process plant

The following examples are not intended to be rigidly applied and may need to be varied to suit particular process equipment and situations.

A.1.1 Sources giving a continuous grade of release

a) the surface of a flammable liquid in a fixed roof tank, with a permanent vent to the atmosphere;
b) the surface of a flammable liquid which is open to the atmosphere continuously or for long periods (for example, an oil/water separator).

A.1.2 Sources giving a primary grade of release

a) seals of pumps, compressors or valves if release of flammable material during normal operation is expected;
b) water drainage points on vessels which contain flammable liquids, which may release flammable material into the atmosphere while draining off water during normal operation;
c) sample points which are expected to release flammable material into the atmosphere during normal operation;
d) relief valves, vents and other openings which are expected to release flammable material into the atmosphere during normal operation.

A.1.3 Sources giving a secondary grade of release

a) seals of pumps, compressors and valves where release of flammable material during normal operation of the equipment is not expected;
b) flanges, connections and pipe fittings, where release of flammable material is not expected during normal operation;
c) sample points which are not expected to release flammable material during normal operation;
d) relief valves, vents and other openings which are not expected to release flammable material into the atmosphere during normal operation.

A.2 Openings

The following examples are not intended to be rigidly applied, but may need to be varied to suit particular situations.

A.2.1 Openings as possible sources of release

Openings between areas should be considered as possible sources of release. The grade of release will depend upon

– the zone type of the adjoining area;
– the frequency and duration of opening periods;
– the effectiveness of seals or joints;
– the difference in pressure between the areas involved.

A.2.2 Openings classification

Openings are classified as A, B, C, D with the following characteristics:

A.2.2.1 Type A – Openings not conforming to the characteristics specified for types B, C or D

Examples:

– open passages for access or utilities, for example, ducts, pipes through walls, ceilings and floors;
– fixed ventilation outlets in rooms, buildings and similar openings of types B, C and D which are opened frequently or for long periods.

A.2.2.2 Type B – Openings which are normally closed (for example, automatic closing) and infrequently opened, and which are close-fitting.

A.2.2.3 Type C – Openings normally closed and infrequently opened, conforming to type B, which are also fitted with sealing devices (for example, a gasket) along the whole perimeter; or two type B openings in series, having independent automatic closing devices.

A.2.2.4 Type D – Openings normally closed conforming to type C which can only be opened by special means or in an emergency.

Type D openings are effectively sealed, such as in utility passages (for example, ducts, pipes) or can be a combination of one opening type C adjacent to a hazardous area and one opening type B in series.

Table A.1 – Effect of openings on grade of release

Zone upstream of opening	Opening type	Grade of release of openings considered as sources of release
Zone 0	A	Continuous
	B	(Continuous)/primary
	C	Secondary
	D	No release
Zone 1	A	Primary
	B	(Primary)/secondary
	C	(Secondary)/no release
	D	No release
Zone 2	A	Secondary
	B	(Secondary)/no release
	C	No release
	D	No release
NOTE For grades of release shown in brackets, the frequency of operation of the openings should be considered in the design.		

Annex B
(informative)

Ventilation

Introduction

The purpose of this annex is to assess the degree of ventilation and to extend clause 5 by defining ventilation conditions and by means of explanations, examples and calculation, so giving guidance on the design of artificial ventilation systems, since these are of paramount importance in the control of the dispersion of releases of flammable gases and vapours.

The method developed allows the determination of the type of zone by

– estimating the minimum ventilation rate required to prevent significant build-up of an explosive gas atmosphere;
– calculating a hypothetical volume, V_z which allows determination of the degree of ventilation;
– estimating the persistence time of the release;
– determining the type of zone from the degree and availability of ventilation and the grade of release using table B.1;
– checking that the zone and persistence time are consistent.

It is not intended that these calculations are used to directly determine the extent of the hazardous areas.

Although primarily of direct use in indoor situations, the concepts explained may assist in outdoor locations, for example, by determination of the application of table B.1.

B.1 Natural ventilation

This is a type of ventilation which is accomplished by the movement of air caused by the wind and/or by temperature gradients. In open air situations, natural ventilation will often be sufficient to ensure dispersal of any explosive gas atmosphere which arises in the area. Natural ventilation may also be effective in certain indoor situations (for example, where a building has openings in its walls and/or roof).

NOTE For outdoor areas the evaluation of ventilation should normally be based on an assumed minimum wind speed of 0,5 m/s, which will be present virtually continuously. The wind speed will frequently be above 2 m/s however, in particular situations, it may be below 0,5 m/s (for example, at the immediate surface of the ground).

Examples of natural ventilation:

– open air situations typical of those in the chemical and petroleum industries, for example, open structures, pipe racks, pump bays and the like;
– an open building which, having regard to the relative density of the gases and/or vapours involved, has openings in the walls and/or roof so dimensioned and located that the ventilation inside the building, for the purpose of area classification, can be regarded as equivalent to that in an open-air situation;
– a building which is not an open building but which has natural ventilation (generally less than that of an open building) provided by permanent openings made for ventilation purposes.

B.2 Artificial ventilation

B.2.1 General

The air movement required for ventilation is provided by artificial means, for example, fans or extractors. Although artificial ventilation is mainly applied inside a room or enclosed space, it can also be applied to situations in the open air to compensate for restricted or impeded natural ventilation due to obstacles.

The artificial ventilation of an area may be either general or local and, for both of these, differing degrees of air movement and replacement can be appropriate.

With the use of artificial ventilation it is possible to achieve

– reduction in the type and/or extent of zones;
– shortening of the time of persistence of an explosive gas atmosphere;
– prevention of the generation of an explosive gas atmosphere.

B.2.2 Design considerations

Artificial ventilation makes it possible to provide an effective and reliable ventilation system in an indoor situation. An artificial ventilation system which is designed for explosion protection should meet the following requirements:

– its effectiveness should be controlled and monitored;
– consideration should be given to the classification inside the extract system and immediately outside the extract system discharge point and other openings of the extract system;
– for ventilation of a hazardous area the ventilation air should normally be drawn from a non-hazardous area taking into account the suction effects on the surrounding area;
– before determining the dimensions and design of the ventilation system, the location, grade of release and release rate should be defined.

In addition, the following factors will influence the quality of an artificial ventilation system:

– flammable gases and vapours usually have densities other than that of air, thus they will tend to accumulate near to either the floor or ceiling of an enclosed area, where air movement is likely to be reduced;
– changes in gas density with temperature;
– impediments and obstacles may cause reduced, or even no, air movement, i.e. no ventilation in certain parts of the area.

B.2.3 Examples of artificial ventilation

B.2.3.1 General artificial ventilation

– a building which is provided with fans in the walls and/or in the roof to improve the general ventilation in the building;
– an open-air situation provided with suitably located fans to improve the general ventilation of the area.

B.2.3.2 Examples of local artificial ventilation

– an air/vapour extraction system applied to an item of process equipment which continuously or periodically releases flammable vapour;

– a forced or extract ventilation system applied to a small, ventilated local area where it is expected that an explosive gas atmosphere may otherwise occur.

B.3 Degree of ventilation

The effectiveness of the ventilation in controlling dispersion and persistence of the explosive gas atmosphere will depend upon the degree and availability of ventilation and the design of the system. For example, ventilation may not be sufficient to prevent the formation of an explosive gas atmosphere but may be sufficient to avoid its persistence.

The following three degrees of ventilation are recognized.

B.3.1 High ventilation (VH)

Can reduce the concentration at the source of release virtually instantaneously, resulting in a concentration below the lower explosive limit. A zone of negligible extent results. However, where the availability of ventilation is not good, another type of zone may surround the zone of negligible extent (see table B.1).

B.3.2 Medium ventilation (VM)

Can control the concentration, resulting in a stable zone boundary, whilst the release is in progress, and where the explosive gas atmosphere does not persist unduly after the release has stopped.

The extent and type of zone are limited to the design parameters.

B.3.3 Low ventilation (VL)

Cannot control the concentration whilst release is in progress and/or cannot prevent undue persistence of a flammable atmosphere after release has stopped.

B.4 Assessment of degree of ventilation and its influence on the hazardous area

B.4.1 General

The size of a cloud of flammable gas or vapour and the time for which it persists after release stops can be controlled by means of ventilation. A method for evaluating the degree of ventilation required to control the extent and persistence of an explosive gas atmosphere is described below.

It should be appreciated that the method is subject to the limitations described and therefore gives only approximate results. The use of the safety factors should, however, ensure that the results obtained err on the side of safety. The application of the method is illustrated by a number of hypothetical examples (clause B.7).

The assessment of the degree of ventilation first requires the knowledge of the maximum release rate of gas or vapour at the source of release, either by verified experience, reasonable calculation or sound assumptions.

B.4.2 Estimation of hypothetical volume V_z

B.4.2.1 General

The hypothetical volume V_z represents the volume over which the mean concentration of flammable gas or vapour will be either 0,25 or 0,5 times the *LEL*, depending on the value of a safety factor, *k*. This means that, at the extremities of the hypothetical volume estimated, the concentration of gas or vapour would be significantly below the *LEL,* i.e. the volume where the concentration is above the *LEL* would be less than V_z.

B.4.2.2 Relationship between hypothetical volume V_z and hazardous area dimensions

The hypothetical volume V_z gives a guide as to the volume of flammable envelope from a source of release but that envelope will not normally equate to the volume of the hazardous area. Firstly, the shape of the hypothetical volume is not defined and will be influenced by ventilation conditions (see B.4.3 and clause B.5). The degree and availability of ventilation and possible variations in these parameters will influence the shape of the hypothetical volume. Secondly, the position of the hypothetical volume with respect to the source of release will need to be established. This will primarily depend on the direction of ventilation with the hypothetical volume biased in the down-wind direction. Thirdly, in many situations, (for example, outdoor conditions), account must be taken of the possibility of varying directions of ventilation.

Thus the volume of hazardous area from a given source of release will generally be several or even many times larger than the hypothetical volume V_z.

To ascertain the hypothetical volume (see equations B.4 and B.5), it is necessary to first establish the theoretical minimum ventilation flow rate of fresh air to dilute a given release of flammable material to the required concentration below the lower explosive limit. This can be calculated by means of the equation:

$$(\mathrm{d}V/\mathrm{d}t)_{\min} = \frac{(\mathrm{d}G/\mathrm{d}t)_{\max}}{k \times LEL_{\mathrm{m}}} \times \frac{T}{293} \qquad \text{(B.1)}$$

where

$(\mathrm{d}V/\mathrm{d}t)_{\min}$ is the minimum volumetric flow rate of fresh air (volume per time, m^3/s);

$(\mathrm{d}G/\mathrm{d}t)_{\max}$ is the maximum rate of release at source (mass per time, kg/s);

LEL_m is the lower explosive limit (mass per volume, kg/m^3);

k is a safety factor applied to the LEL_m; typically:

k = 0,25 (continuous and primary grades of release)

k = 0,5 (secondary grades of release);

T is the ambient temperature (in Kelvin, K).

NOTE For converting LEL_v (vol %) to LEL_m (kg/m^3), the following equation may be used for normal atmospheric conditions as given in 1.1;

$$LEL_m = 0{,}416 \times 10^{-3} \times M \times LEL_v$$

where M is the molecular mass (kg/kmol).

The relationship between the calculated value $(\mathrm{d}V/\mathrm{d}t)_{\min}$ and the actual ventilation rate within the volume under consideration (V_0) in the vicinity of the release can then be expressed as a volume (V_k).

NOTE Where there are multiple sources of release within the volume which is served by the ventilation under consideration (V_o), it is necessary to determine the value of $(dV/dt)_{min}$ for each source of release and grade of release. The flow rates thus determined should then be summated in accordance with table B.2:

$$V_k = \frac{(dV/dt)_{min}}{C} \tag{B.2}$$

where

C is the number of fresh air changes per unit time (s^{-1}) and is derived from

$$C = \frac{dV_o/dt}{V_o} \tag{B.3}$$

where

dV_o/dt is the total flow rate of fresh air through the volume under consideration, and

V_o the entire volume (within the control of the plant) served by the actual ventilation in the vicinity of the release being considered.

NOTE For indoor situations, V_o will generally be the volume of the room or building being considered unless there is ventilation specific and local to the release being considered.

Equation (B.2) would hold for an instantaneous and homogeneous mixing at the source of release given ideal flow conditions of the fresh air. In practice, such ideal situations will generally not be found, for example, because of possible impediments to the air flow, resulting in badly ventilated parts of the area. Thus, the effective air exchange at the source of release will be lower than that given by C in equation (B.3), leading to an increased volume (V_z). By introducing an additional correction (quality) factor f to equation (B.2), one obtains

$$V_z = f \times V_k = \frac{f \times (dV/dt)_{min}}{C} \tag{B.4}$$

where f is the efficiency of the ventilation in terms of its effectiveness in diluting the explosive gas atmosphere, with f ranging from f = 1 (ideal situation) to, typically f = 5 (impeded air flow).

B.4.2.3 Open air

In an open-air situation even very low wind speeds will create a high number of air changes. For example, consider a hypothetical cube with side dimensions of 15 m in an open area. In this case a wind speed of approximately 0,5 m/s will provide an air exchange rate of more than 100/h (0,03/s) with volume V_o of 3 400 m^3.

In a conservative approximation using C = 0,03/s for an open-air situation, a hypothetical volume V_z of explosive gas atmosphere can be obtained by using the equation (B.5):

$$V_z = \frac{f \times (dV/dt)_{min}}{0,03} \tag{B.5}$$

where

f is a factor to allow for impeded air flow (see equation B.4);

$(dV/dt)_{min}$ is as previously defined (m^3/s);

0,03 is the number of air changes per second.

However, because dispersion is normally more rapid in an open-air situation as a result of the different dispersion mechanism, this equation will generally result in an overlarge volume.

To avoid compounding this position, care should be exercised in the realistic selection of a value for f.

B.4.2.4 Restricted open-air situation

If the ventilated volume is small (for example, a process oil-water separator) such as 5 m × 3 m × 1 m (V_o = 15 m^3) and wind speed of say 0,05 m/s than C will be 35/h (0,01/s).

B.4.2.5 Estimation of persistence time *t*

The time t required for the average concentration to fall from an initial value X_o to the LEL times k after the release has stopped can be estimated from:

$$t = \frac{-f}{C} \ln \frac{LEL \times k}{X_o} \tag{B.6}$$

where

- X_o is the initial concentration of the flammable substance measured in the same units as the LEL, i.e. %vol or kg/m^3. Somewhere in the explosive gas atmosphere, the concentration of the flammable matter may be 100 % vol (in general only in the very close vicinity of the release source). However, when calculating *t*, the proper value for X_o to be taken depends on the particular case, considering among other aspects the affected volume as well as the frequency and the duration of the release;
- C is the number of air changes per unit time;
- t is in the same time units as C, i.e. if C is the number of air changes per second, then the time *t* will be in seconds;
- f is a factor to allow for impeded air flow and is the same numerical value as applied in the determination of V_z (see equation B.4).
- ln is the natural logarithm, and
- k is a safety factor related to the LEL and is the same numerical value as applied in the determination of $(dV/dt)_{min}$ (see equation B.1).

The numerical value of *t* obtained by equation B.6 by itself does not constitute a quantitative means of deciding on the zone type. It provides additional information that has to be compared with the time scale of the particular process and situation.

B.4.3 Estimation of degree of ventilation

B.4.3.1 General

Initial estimations would suggest that a continuous grade of release leads to a zone 0, a primary grade to zone 1 and a secondary grade to zone 2; however, this is not always the case because of the effect of ventilation.

In some cases, the degree and level of availability of ventilation may be so high that in practice there is no hazardous area. Alternatively, the degree of ventilation may be so low that the resulting zone has a lower zone number (i.e. a zone 1 hazardous area from a secondary grade source). This occurs, for example, when the level of ventilation is such that the explosive gas atmosphere persists and is dispersed only slowly after the gas of vapour release has stopped. Thus, the explosive gas atmosphere persists for longer than would be expected for the grade of release.

The volume V_z can be used to provide a means of rating the ventilation as high, medium or low for each grade of release.

B.4.3.2 High ventilation (VH)

The ventilation may be regarded as high (VH) only when an evaluation of the risk shows that the extent of potential damage due to the sudden increase in temperature and/or pressure, as a result of the ignition of an explosive gas atmosphere of volume equal to V_z, is negligible. The risk evaluation should also take account of secondary effects (for example, further releases of flammables).

The above conditions will normally apply when V_z is less than 0,1 m^3. In this situation the hazardous area volume can be regarded as equal to V_z.

In practice, high ventilation can generally be applied only to a local artificial ventilation system around a source, to small enclosed areas or to very low release rates. Firstly, most enclosed areas contain multiple sources of release. It is not good practice to have multiple small hazardous areas within an area generally classified as non-hazardous. Secondly, with the typical release rates considered for area classification, natural ventilation is often insufficient even in the open. Furthermore, it is normally impracticable to ventilate artificially larger enclosed areas at the rates required.

NOTE Where the calculation for V_z is based on artificial ventilation, some consideration can be made of the manner in which the artificial ventilation is arranged, as it is often the case that the predominant ventilation air flow is to be extracted from the source of release and the dilution occurs in a direction which is away from the potential sources of ignition for example, as in the case of local extract systems or where the dilution ventilation is supplied to a relatively small enclosure such as an analyser house or pilot plant enclosure.

B.4.3.3 Low ventilation (VL)

Ventilation should be regarded as low (VL) if V_z exceeds V_0. Low ventilation will not generally occur in open air situations except where there are restrictions to air flow, for example, in pits.

B.4.3.4 Medium ventilation (VM)

If the ventilation is neither high (VH) nor low (VL) then it should be regarded as medium (VM). Normally, V_z will be less than or equal to V_0. Ventilation regarded as medium should control the dispersion of the release of flammable vapour or gas. The time taken to disperse an explosive gas atmosphere after release has stopped should be such that the condition for either a zone 1 or zone 2 is met, depending on whether the grade of release is primary or secondary. The acceptable dispersion time depends on the expected frequency of release and the duration of each release. When the volume V_z is significantly less than the volume of the enclosed space, it may be acceptable to classify only part of the enclosed space as hazardous. In some cases, depending on the size of the enclosed space, the volume V_z can be similar to the enclosed volume. In this case, all of the enclosed space should be classified as hazardous.

In outdoor locations except where V_z is very small or where there are significant restrictions to air flow, the ventilation should be regarded as medium (VM).

B.5 Availability of ventilation

The availability of ventilation has an influence on the presence or formation of an explosive gas atmosphere. Thus the availability (as well as the degree) of ventilation needs to be taken into consideration when determining the type of zone.

Three levels of availability of the ventilation should be considered (see examples in annex C):

– good: ventilation is present virtually continuously;
– fair: ventilation is expected to be present during normal operation. Discontinuities are permitted provided they occur infrequently and for short periods;
– poor: ventilation which does not meet the standard of fair or good, but discontinuities are not expected to occur for long periods.

Ventilation that does not even meet the requirement for poor availability must not be considered to contribute to the ventilation of the area.

Natural ventilation

For outdoor areas, the evaluation of ventilation should normally be based on an assumed minimum wind speed of 0,5 m/s, which will be present virtually continuously. In this case, the availability of the ventilation can be considered as good.

Artificial ventilation

In assessing the availability of artificial ventilation, the reliability of the equipment and the availability of, for example, standby blowers should be considered. Good availability will normally require, on failure, automatic start-up of standby blower(s). However, if provision is made for preventing the release of flammable material when the ventilation has failed (for example, by automatically closing down the process), the classification determined with the ventilation operating need not be modified, i.e. the availability may be assumed to be good.

B.6 Practical guide

The effect of ventilation on the type of the zones can be summarized in table B.1. Some calculations are included in B.7.

Table B.1 – Influence of ventilation on type of zone

	Ventilation						
Grade of release	**Degree**						
	High			**Medium**			**Low**
	Availability						
	Good	**Fair**	**Poor**	**Good**	**Fair**	**Poor**	**Good, fair or poor**
Continuous	(Zone 0 NE) Non-hazardous[a]	(Zone 0 NE) Zone 2[a]	(Zone 0 NE) Zone 1[a]	Zone 0	Zone 0 + Zone 2	Zone 0 + Zone 1	Zone 0
Primary	(Zone 1 NE) Non-hazardous[a]	(Zone 1 NE) Zone 2[a]	(Zone 1 NE) Zone 2[a]	Zone 1	Zone 1 + Zone 2	Zone 1 + Zone 2	Zone 1 or Zone 0[c]
Secondary[b]	(Zone 2 NE) Non-hazardous[a]	(Zone 2 NE) Non-hazardous[a]	Zone 2	Zone 2	Zone 2	Zone 2	Zone 1 and even Zone 0[c]

NOTE "+" signifies "surrounded by".

[a] Zone 0 NE, 1 NE or 2 NE indicates a theoretical zone which would be of negligible extent under normal conditions.

[b] The zone 2 area created by a secondary grade of release may exceed that attributable to a primary or continuous grade of release; in this case, the greater distance should be taken.

[c] Will be zone 0 if the ventilation is so weak and the release is such that in practice an explosive gas atmosphere exists virtually continuously (i.e. approaching a "no ventilation" condition).

Table B.2 – Procedure for summation of multiple releases within location V_o

Grade of release	Action to be taken with $(dV/dt)_{min}$
Continuous	Summate all values for $(dV/dt)_{min}$ and apply the resulting total in equations B.2 to B.6
Primary	In accordance with table B.3, summate the requisite number of the largest values of $(dV/dt)_{min}$ and apply the resulting total in equations B.2 to B.6
Secondary	Use only the largest single value of $(dV/dt)_{min}$ and apply this value in equations B.2 to B.6
NOTE The resulting value of $(dV/dt)_{min}$ for each row of the table should be applied to table B.1. Differing grades of release are not required to be summated.	

Table B.3 – Procedure for summation of multiple primary grade releases

Number of primary grade releases	Number of primary grade releases to be used in accordance with table B.2
1	1
2	2
3 to 5	3
6 to 9	4
10 to 13	5
14 to 18	6
19 to 23	7
24 to 27	8
28 to 33	9
34 to 39	10
40 to 45	11
46 to 51	12

Reference: Institute of Gas Engineers (UK).

B.7 Calculations to ascertain the degree of ventilation

NOTE 1 The *LEL* values used in these examples are for illustrative purposes only; they are not taken from IEC 60079-20.

NOTE 2 In the examples, it has been assumed that X_o = 100 %. This may give a pessimistic result.

Calculation No. 1

Characteristics of release

Flammable material	toluene vapour
Molecular mass of toluene	92,14 (kg/kmol)
Source of release	flange
Lower explosion limit (*LEL*)	0,046 kg/m^3 (1,2 % vol.)
Grade of release	continuous
Safety factor, k	0,25
Release rate, $(\mathrm{d}G/\mathrm{d}t)_{max}$	$2{,}8 \times 10^{-10}$ kg/s

Ventilation characteristics

Indoor situation	
Number of air changes, C	1/h, $(2{,}8 \times 10^{-4}$/s)
Quality factor, f	5
Ambient temperature, T	20 °C (293 K)
Temperature coefficient, (T/293 K)	1
Building size, V_o	10 m × 15 m × 6 m

Minimum volumetric flow rate of fresh air:

$$(\mathrm{d}V/\mathrm{d}t)_{min} = \frac{(\mathrm{d}G/\mathrm{d}t)_{max}}{k \times LEL} \times \frac{T}{293} = \frac{2{,}8 \times 10^{-10}}{0{,}25 \times 0{,}046} \times \frac{293}{293} = 2{,}4 \times 10^{-8} \ \mathrm{m^3/s}$$

Evaluation of hypothetical volume V_z:

$$V_z = \frac{f \times (\mathrm{d}V/\mathrm{d}t)_{min}}{C} = \frac{5 \times 2{,}4 \times 10^{-8}}{2{,}8 \times 10^{-4}} = 4{,}3 \times 10^{-4} \ \mathrm{m^3}$$

Time of persistence:

This is not applicable to a continuous release.

Conclusion

The hypothetical volume V_z is reduced to a negligible value.

Since V_z < 0,1 m^3 (see B.4.3.2) the degree of ventilation may be considered as high with regard to the source of release and area under consideration.

If the availability of the ventilation is "good" then there will be a zone 0 of negligible extent (see table B.1).

Calculation No. 2

Characteristics of release

Flammable material	toluene vapour
Molecular mass of toluene	92,14 (kg/kmol)
Source of release	failure of flange
Lower explosion limit (*LEL*)	0,046 kg/m^3 (1,2 % vol.)
Grade of release	secondary
Safety factor, k	0,5
Release rate, $(\mathrm{d}G/\mathrm{d}t)_{max}$	$2{,}8 \times 10^{-6}$ kg/s

Ventilation characteristics

Indoor situation

Number of air changes, C	1/h ($2{,}8 \times 10^{-4}$/s)
Quality factor, f	5
Ambient temperature, T	20 °C (293 K)
Temperature coefficient, (T/293 K)	1
Building size, V_o	10 m × 15 m × 6 m

Minimum volumetric flow rate of fresh air:

$$(\mathrm{d}V/\mathrm{d}t)_{min} = \frac{(\mathrm{d}G/\mathrm{d}t)_{max}}{k \times LEL} \times \frac{T}{293} = \frac{2{,}8 \times 10^{-6}}{0{,}25 \times 0{,}046} \times \frac{293}{293} = 1{,}2 \times 10^{-4}\ \mathrm{m^3/s}$$

Evaluation of hypothetical volume V_z:

$$V_z = \frac{f \times (\mathrm{d}V/\mathrm{d}t)_{min}}{C} = \frac{5 \times 1{,}2 \times 10^{-4}}{2{,}8 \times 10^{-4}} = 2{,}2\ \mathrm{m^3}$$

Time of persistence:

$$t = \frac{-f}{C} \ln \frac{LEL \times k}{X_o} = \frac{-5}{1} \ln \frac{1{,}2 \times 0{,}5}{100} = 25{,}6\ \mathrm{h}$$

Conclusion

The hypothetical volume V_z, although significantly less than V_o, is greater than 0,1 m^3.

The degree of ventilation may be considered as medium with regard to the source of release and area under consideration on this basis. However the flammable atmosphere would persist and the concept of zone 2 may not be met.

Calculation No. 3

Characteristics of release

Flammable material	propane gas
Molecular mass of propane	44,1 (kg/kmol)
Source of release	can-filling nozzle
Lower explosion limit (LEL)	0,039 kg/m^3 (2,1 % vol.)
Grade of release	primary
Safety factor, k	0,25
Release rate, $(dG/dt)_{max}$	0,005 kg/s

Ventilation characteristics

Indoor situation

Number of air changes, C	20/h ($5,6 \times 10^{-3}$/s)
Quality factor, f	1
Ambient temperature, T	35 °C (308 K)
Temperature coefficient, (T/293 K)	1,05
Building size, V_o	10 m × 15 m × 6 m

Minimum volumetric flow rate of fresh air:

$$(dV/dt)_{min} = \frac{(dG/dt)_{max}}{k \times LEL} \times \frac{T}{293} = \frac{0,005}{0,25 \times 0,039} \times \frac{308}{293} = 0,6 \text{ m}^3/\text{s}$$

Evaluation of hypothetical volume V_z:

$$V_z = \frac{f \times (dV/dt)_{min}}{C} = \frac{1 \times 0,6}{5,6 \times 10^{-3}} = 1,1 \times 10^2 \text{ m}^3$$

Time of persistence:

$$t = \frac{-f}{C} \ln \frac{LEL \times k}{X_o} = \frac{-1}{20} \ln \frac{2,1 \times 0,25}{100} = 0,26 \text{ h}$$

Conclusion

The hypothetical volume V_z, is not negligible but does not exceed V_o.

The degree of ventilation may be considered as medium with regard to the source of release and area under consideration based on these criterions. With a persistence time of 0,26 h, the concept of zone 1 may not be met if the operation is repeated frequently.

Calculation No. 4

Characteristics of release

Flammable material	ammonia gas
Molecular mass of ammonia	17,03 (kg/kmol)
Source of release	evaporator valve
Lower explosion limit (LEL)	0,105 kg/m^3 (14,8 % vol.)
Grade of release	secondary
Safety factor, k	0,5
Release rate, $(dG/dt)_{max}$	5×10^{-6} kg/s

Ventilation characteristics

Indoor situation

Number of air changes, C	15/h, ($4,2 \times 10^{-3}$/s)
Quality factor, f	1
Ambient temperature, T	20 °C (293 K)
Temperature coefficient, (T/293 K)	1
Building size, V_o	10 m × 15 m × 6 m

Minimum volumetric flow rate of fresh air:

$$(dV/dt)_{min} = \frac{(dG/dt)_{max}}{k \times LEL} \times \frac{T}{293} = \frac{5 \times 10^{-6}}{0,5 \times 0,105} \times \frac{293}{293} = 9,5 \times 10^{-5} \text{ m}^3/\text{s}$$

Estimation of hypothetical volume V_z:

$$V_z = \frac{f \times (dV/dt)_{min}}{C} = \frac{1 \times 9,5 \times 10^{-5}}{4,2 \times 10^{-3}} = 0,02 \text{ m}^3$$

Time of persistence:

$$t = \frac{-f}{C} \ln \frac{LEL \times k}{X_o} = \frac{-1}{15} \ln \frac{14,8 \times 0,5}{100} = 0,17 \text{ h (10 min)}$$

Conclusion

The hypothetical volume V_z is reduced to a negligible value.

The degree of ventilation may be considered as high (V_z < 0,1 m^3) with regard to the source of release and area under consideration based on these criterions (see table B.1).

If the availability of the ventilation is "good" then there will be a zone 2 of negligible extent (see table B.1).

Calculation No. 5

Characteristics of release

Flammable material	propane gas
Molecular mass of propane	44,1 (kg/kmol)
Source of release	compressor seal
Lower explosion limit (*LEL*)	0,039 kg/m^3 (2,1 % vol.)
Grade of release	secondary
Safety factor, *k*	0,5
Release rate, $(dG/dt)_{max}$	0,02 kg/s

Ventilation characteristics

Indoor situation

Number of air changes, *C*	2/h, ($5,6 \times 10^{-4}$/s)
Quality factor, *f*	5
Ambient temperature, *T*	20 °C (293 K)
Temperature coefficient, (*T*/293 K)	1

Minimum volumetric flow rate of fresh air:

$$(dV/dt)_{min} = \frac{(dG/dt)_{max}}{k \times LEL} \times \frac{T}{293} = \frac{0,02}{0,5 \times 0,039} \times \frac{293}{293} = 1,02 \text{ m}^3/\text{s}$$

Estimation of hypothetical volume V_z:

$$V_z = \frac{f \times (dV/dt)_{min}}{C} = \frac{5 \times 1,02}{5,6 \times 10^{-4}} = 9\ 200 \text{ m}^3$$

Time of persistence

$$t = \frac{-f}{C} \ln \frac{LEL \times k}{X_o} = \frac{-5}{2} \ln \frac{2,1 \times 0,5}{100} = 11,4 \text{ h}$$

Conclusion

In a room of 10 m × 15 m × 6 m for example, the hypothetical volume V_z will be greater than the volume of the room V_o. Furthermore, the persistence time is significant.

The degree of ventilation may be considered as low with regard to the source of release and area under consideration based on these criterions.

The area would be classified as at least zone 1 and maybe even zone 0 irrespective of the availability of the ventilation (see table B.1). This is unacceptable. Steps need to be taken to either reduce the leakage rate or vastly improve the ventilation maybe with local extract ventilation around the compressor seal.

Calculation No. 6

Characteristics of release

Flammable material	methane gas
Molecular mass of methane	16,05 (kg/kmol)
Source of release	pipe fitting
Lower explosion limit (*LEL*)	0,033 kg/m^3 (5 % vol.)
Grade of release	secondary
Safety factor, *k*	0,5
Release rate, $(dG/dt)_{max}$	1 kg/s

Ventilation characteristics

Outdoor situation	
Minimum wind speed	0,5 m/s
Resulting in an air exchange, *C*	$>3 \times 10^{-2}$/s
Quality factor, *f*	1
Ambient temperature, *T*	15 °C (288 K)
Temperature coefficient, (*T*/293 K)	0,98

Minimum volumetric flow rate of fresh air:

$$(dV/dt)_{min} = \frac{(dG/dt)_{max}}{k \times LEL} \times \frac{T}{293} = \frac{1}{0,5 \times 0,033} = 59,3 \text{ m}^3/\text{s}$$

Estimation of hypothetical volume V_z:

$$V_z = \frac{f \times (dV/dt)_{min}}{C} = \frac{1 \times 59,3}{3 \times 10^{-2}} = 2\,000 \text{ m}^3$$

Time of persistence:

$$t = \frac{-f}{C} \ln \frac{LEL \times k}{X_o} = \frac{-1}{0,03} \ln \frac{5 \times 0,5}{100} = 123 \text{ s (maximum)}$$

Conclusion

The hypothetical volume V_z is not negligible. Based on the assumption (see B.4.2) that for an outdoor situation a reasonable value for V_o would be 3 400 m^3, then V_z will be less than V_o.

The degree of ventilation may be considered as medium with regard to the source of release and area under consideration based on these criterions.

The availability of ventilation, being outdoors, is "good" and therefore the area will be classified as zone 2 (see table B.1)

Calculation No. 7

Characteristics of release

Flammable material	toluene vapour
Molecular mass of toluene	92,14 (kg/kmol)
Source of release	failure of flange
Lower explosion limit (*LEL*)	0,046 kg/m^3 (1,2 % vol.)
Grade of release	secondary
Safety factor, *k*	0,5
Release rate, $(dG/dt)_{max}$	6×10^{-4} kg/s

Ventilation characteristics

Indoor situation

Number of air changes, *C*	12/h ($3,33 \times 10^{-3}$)
Quality factor, *f*	2
Ambient temperature, *T*	20 °C (293 K)
Temperature coefficient, (*T*/293 K)	1
Building size, V_o	10 m × 15 m × 6 m

Minimum volumetric flow rate of fresh air:

$$(dV/dt)_{min} = \frac{(dG/dt)_{max}}{k \times LEL} \times \frac{T}{293} = \frac{6 \times 10^{-4}}{0,5 \times 0,046} \times \frac{293}{293} = 26 \times 10^{-3}\ \text{m}^3/\text{s}$$

Evaluation of hypothetical volume V_z:

$$V_z = \frac{f \times (dV/dt)_{min}}{C} = \frac{2 \times 26 \times 10^{-3}}{3,33 \times 10^{-3}} = 15,7\ \text{m}^3$$

Time of persistence:

$$t = \frac{-f}{C} \ln \frac{LEL \times k}{X_o} = \frac{-2}{12} \ln \frac{1,2 \times 0,5}{100} = 0,85\ \text{h (51 min)}$$

Conclusion

The hypothetical volume V_z is not negligible but does not exceed V_o.

The degree of ventilation may be considered as medium with regard to the source of release and area under consideration based on these criterions.

If the availability of the ventilation is "good" then the area should be regarded as zone 2 (see table B.1). Based on this persistence time, the concept of zone 2 would be met.

Annex C
(informative)

Examples of hazardous area classification

C.1 The practice of area classification involves a knowledge of the behaviour of flammable gases and liquids when they are released from containment, and sound engineering judgement based on experience of the performance of items of plant equipment under specified conditions. For this reason, it is not practicable to give every conceivable variation of plant and process characteristics. Therefore, the examples chosen are those which best describe the overall philosophy of area classification, so as to permit the safe use of apparatus in hazardous locations, where the dangerous material is a flammable liquid, liquefied gas or vapour, or material which is normally gaseous and flammable when mixed with air in appropriate concentrations.

C.2 In arriving at the distances shown in the diagrams, specific plant component conditions have been given. The leakage conditions have been considered in relation to the mechanical performance of the equipment and other representative design criteria. They are not generally applicable; factors such as inventory of process material, shut-off time, dispersion time, pressure, temperature and other criteria related both to plant components and process material all affect the area classification and will need to be applied to the particular problem being considered. Thus these examples represent guidance only and will need to be adapted so as to take into account particular circumstances.

C.3 According to the national or industrial code selected, the shape and extent of the zones may vary.

C.4 The intention of the examples which follow is not primarily that they should be used for area classification. Their principal objective is to demonstrate typical results which might be obtained in practice in a number of different situations by following the guidance and procedures in this standard including the use of table B.1. They may also be of use in developing detailed supplementary standards.

C.5 The figures shown are taken from, or correspond closely to, those in various national or industrial codes. They are intended only as a guide to the magnitude of the zones; in individual cases, the extent and shape of the zones may be taken from the relevant code.

C.6 If it is intended that the examples given in this standard be used for area classification in practice, account must be taken of the specific details of each individual case.

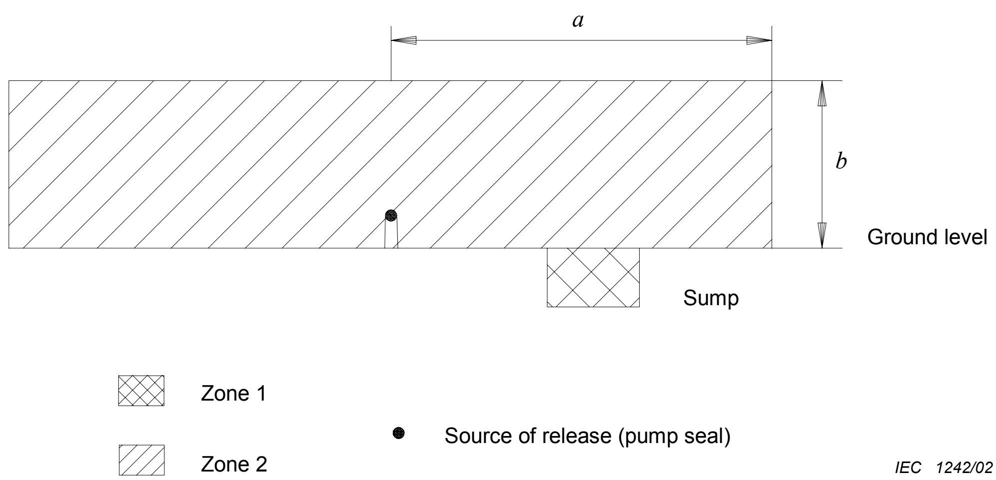
C.7 In each example, some but not all of the parameters which influence the type and extent of zones are given. The result of the classification normally gives a conservative result, taking into account those factors which have been specified and others which it has been possible to identify but not quantify. This means that, if it is possible to specify the operating parameters more closely, a more precise classification will be obtained.

Example No. 1

A normal industrial pump with mechanical (diaphragm) seal, mounted at ground level, situated outdoors, pumping flammable liquid:

Principal factors which influence the type and extent of zones		
Plant and process		
Ventilation	General	Sump
Type................................	Natural	Natural
Degree	Medium	Low
Availability.......................	Good	Good
Source of release		Grade of release
Pump mechanical seal		Secondary
Product		
Flash point.................................	Below process and ambient temperature	
Vapour density............................	Greater than air	

Not to scale



Taking into account relevant parameters, the following are typical values which will be obtained for a pump having a capacity of 50 m^3/h and operating at a low pressure:

a = 3 m horizontally from source of release;

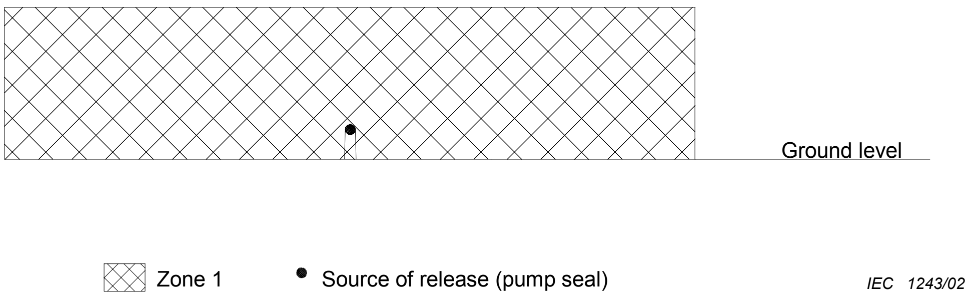
b = 1 m from ground level and up to 1 m above the source of release.

Example No. 2

A normal industrial pump with mechanical (diaphragm) seal, mounted at ground level, situated indoors, pumping flammable liquid:

Principal factors which influence the type and extent of zones		
Plant and process		
Ventilation	General	Sump
Type	Artificial	None
Degree	Low	
Availability	Fair	
Source of release		Grade of release
Pump mechanical seal		Secondary
Product		
Flashpoint	Below process and ambient temperature	
Vapour density	Greater than air	

Not to scale



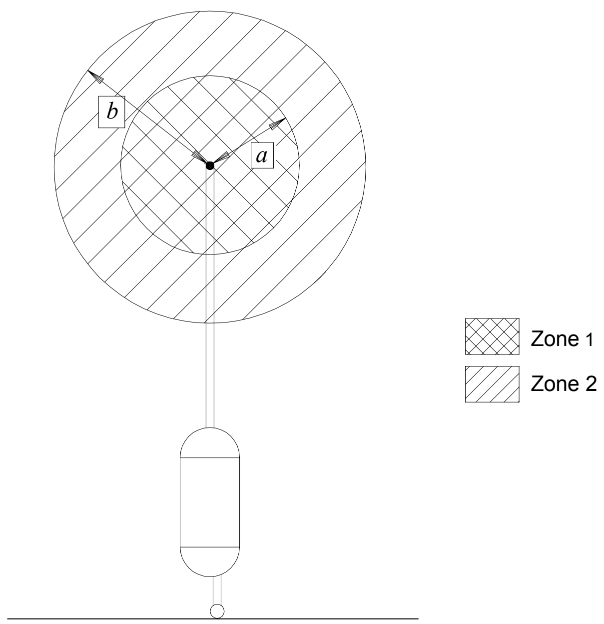
No dimensions are indicated since the resulting hazardous area will encompass the volume V_0. If the ventilation were to be improved to "medium" then the zone could be smaller and only zone 2 (see table B.1).

Example No. 3

Pressure breathing valve in the open air, from process vessel:

Principal factors which influence the type and extent of zones	
Plant and process	
Ventilation	
Type	Natural
Degree	Medium
Availability........................	Good
Source of release	Grade of release
Outlet from valve	Primary and secondary
Product	
Gasoline	
Gas density..........	Greater than air

Not to scale



• Source of release (vent outlet diameter 25 mm)

IEC 1244/02

Taking into account relevant parameters, the following are typical values which will be obtained for a valve where the opening pressure of the valve is approximately 0,15 MPa (1,5 bar):

a = 3 m in all directions from source of release;

b = 5 m in all directions from source of release.

Example No. 4

Control valve, installed in a closed process pipework system conveying flammable gas:

Principal factors which influence the type and extent of zones	
Plant and process	
Ventilation	
Type	Natural
Degree	Medium
Availability	Good
Source of release	Grade of release
Valve shaft seal	Secondary
Product	
Gas	Propane
Gas density	Greater than air

Not to scale

Taking into account relevant parameters, the following is the typical value which will be obtained for this example:

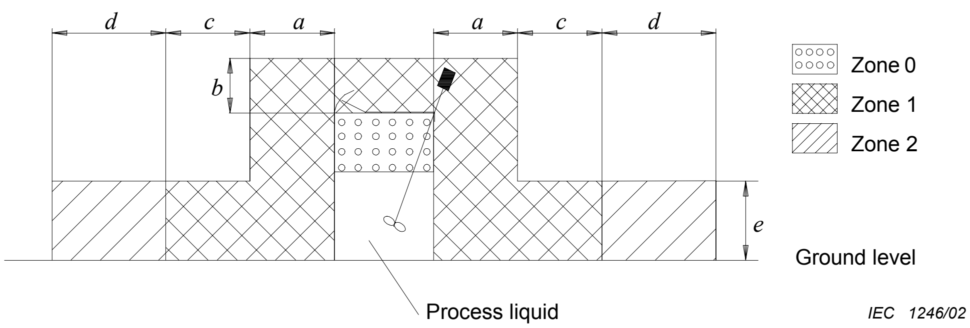
a = 1 m in all directions from source of release.

Example No. 5

A fixed process mixing vessel, situated indoors, being opened regularly for operational reasons. The liquids are piped into and out of the vessel through all welded pipework flanged at the vessel:

Principal factors which influence the type and extent of zones	
Plant and process	
Ventilation	
Type	Artificial
Degree.............................	Low inside the vessel; Medium outside the vessel
Availability.	Fair
Source of release	Grade of release
Liquid surface within the vessel.............................	Continuous
The opening in the vessel	Primary
Spillage or leakage of liquid close to the vessel	Secondary
Product	
Flashpoint.	Below process and ambient temperature
Vapour density	Greater than air

Not to scale



Taking into account relevant parameters, the following are typical values which will be obtained for this example:

a = 1 m horizontally from source of release;

b = 1 m above source of release;

c = 1 m horizontally;

d = 2 m horizontally;

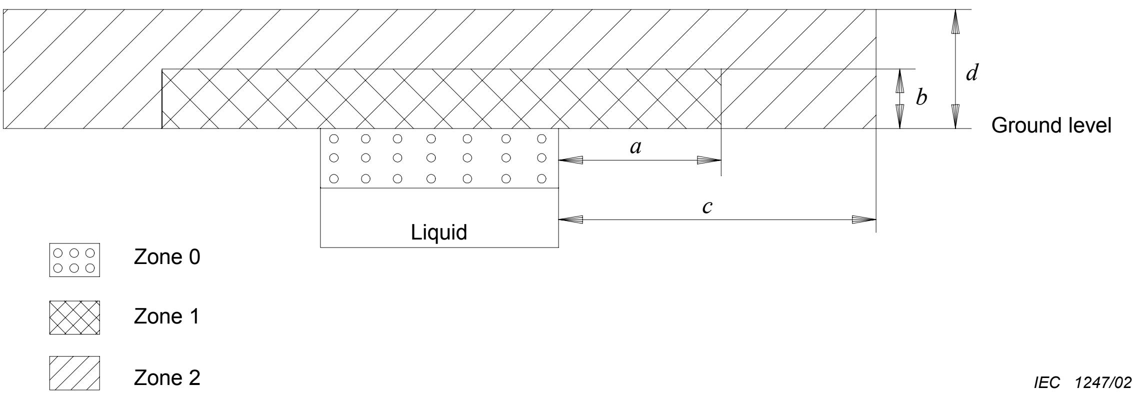
e = 1 m above ground.

Example No. 6

Oil/water gravity separator, situated outdoors, open to the atmosphere, in a petroleum refinery:

Principal factors which influence the type and extent of zones		
Plant and process		
Ventilation	Within the separator	Outside the separator
Type	Natural	Natural
Degree	Low	Medium
Availability	Good	Good
Source of release	Grade of release	
Liquid surface	Continuous	
Process disturbance	Primary	
Process abnormal operation	Secondary	
Product		
Flashpoint	Below process and ambient temperature	
Vapour density	Greater than air	

Not to scale



Taking into account relevant parameters, the following are typical values which will be obtained for this example.

a = 3 m horizontally from the separator;

b = 1 m above ground level;

c = 7,5 m horizontally;

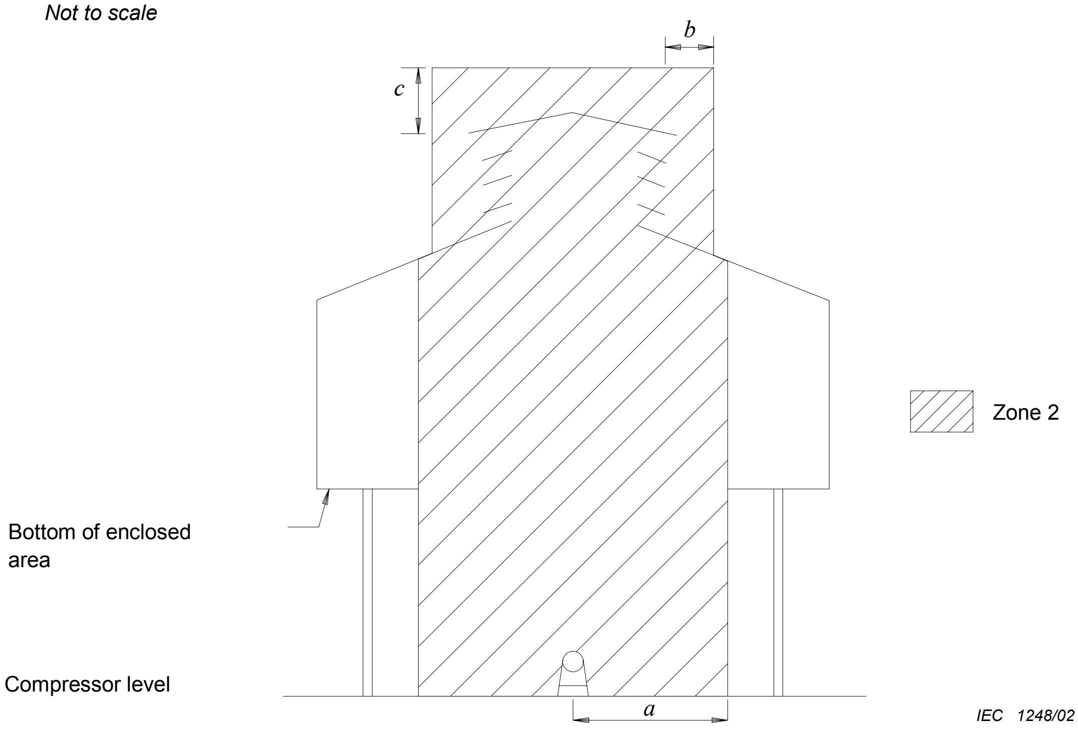
d = 3 m above ground level.

Example No. 7

Hydrogen compressor in a building which is open at ground level:

Principal factors which influence the type and extent of zones	
Plant and process	
Ventilation	
Type...	Natural
Degree	Medium
Availability	Good
Source of release	Grade of release
Compressor seals, valves and flanges close to the compressor	Secondary
Product	
Gas	Hydrogen
Gas density	Lighter than air

Not to scale



Taking into account relevant parameters, the following are typical values which will be obtained for this example:

a = 3 m horizontally from source of release;

b = 1 m horizontally from ventilation openings;

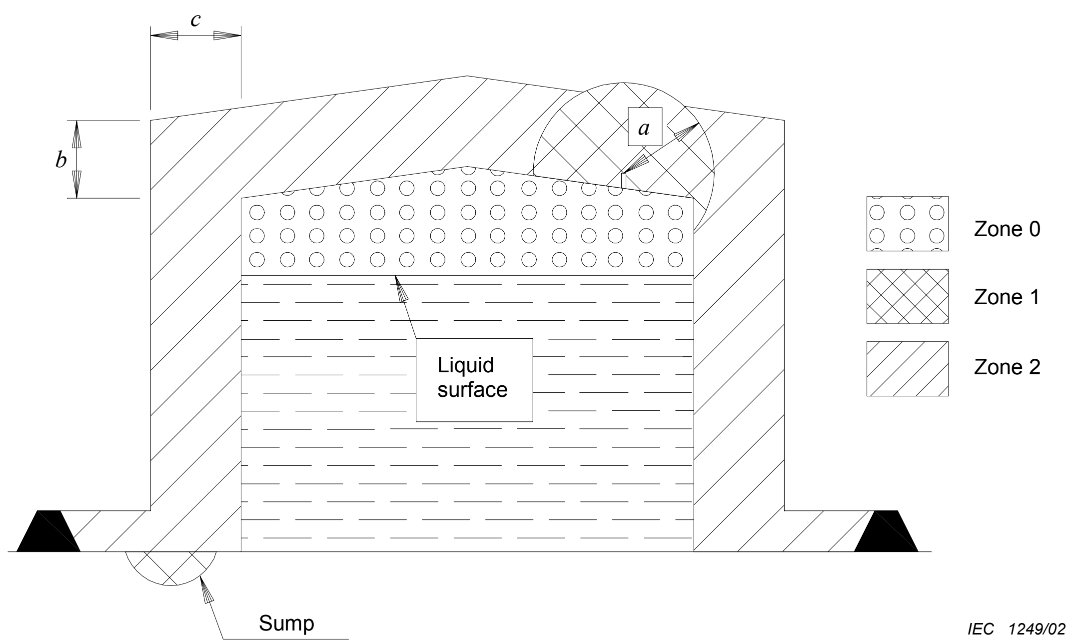
c = 1 m above ventilation openings.

Example No. 8

Flammable liquid storage tank, situated outdoors, with fixed roof and no internal floating roof:

Principal factors which influence the type and extent of zones	
Plant and process	
Ventilation	
Type	Natural
Degree............	Medium*
Availability..	Good
Source of release	Grade of release
Liquid surface..	Continuous
Vent opening and other openings in the roof	Primary
Flanges, etc. inside bund and overfilling of the tank....	Secondary
Product	
Flashpoint..	Below process and ambient temperature
Vapour density...	Greater than air
* Within the tank and the sump, low.	

Not to scale



Taking into account relevant parameters, the following are typical values which will be obtained for this example:

a = 3 m from vent openings;

b = 3 m above the roof;

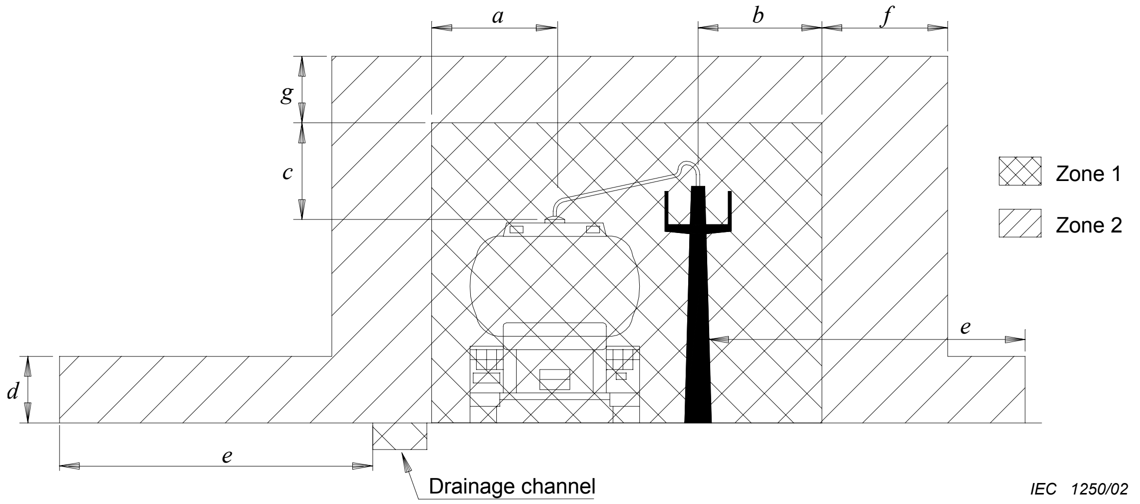
c = 3 m horizontally from the tank.

Example No. 9

Single tanker filling installation (during filling), situated outdoors, for gasoline, top filling with no vapour recovery:

Principal factors which influence the type and extent of zones	
Plant and process	
Ventilation	
Type	Natural
Degree..........	Medium
Availability	Good
Source of release	Grade of release
Openings in tank roof	Primary
Spillage at ground level	Secondary
Overfilling of tanker	Secondary
Product	
Flashpoint	Below process and ambient temperature
Vapour density..........	Greater than air

Not to scale



Taking into account relevant parameters, the following are typical values which will be obtained for this example.

a = 1,5 m horizontally from source of release;

b = 1,5 m horizontally from flexible joint;

c = 1,5 m above source of release;

d = 1 m above ground level;

e = 4,5 m horizontally from drainage channel/gantry;

f = 1,5 m horizontally from zone 1;

g = 1,0 m above zone 1.

NOTE 1 If the system is a closed system with vapour recovery, the distances can be reduced in such a way that zone 1 may be of negligible extent and zone 2 significantly reduced.

NOTE 2 Spillages due to overfilling are unlikely with vapour recovery systems.

Example No. 10

Hazardous area classification data sheet –
Part I: Flammable material list and characteristics

Sheet 1 of 2

Plant: paint factory (example 10)											Reference drawing: layout
1	2	3	4	5	6	7	8	9	10	11	12
	Flammable material			*LEL*		Volatility[a]					
No.	Name	Composition	Flash-point °C	kg/m³	vol. %	Vapour pressure 20 °C kPa	Boiling point °C	Relative density of gas or vapour to air	Ignition temperature °C	Group and temperature class[b]	Any other relevant information and remarks
1	Solvent with low flashpoint	C_6H_{12}	–18	0,042	1,2	5,8	81	2,9	260	IIAT3	

[a] Normally, the value of vapour pressure is given but, in the absence of that, boiling point can be used (4.4.1d)).

[b] For example, IIBT3.

Hazardous area classification data sheet –
Part II: List of sources of release

Sheet 2 of 2

Plant: paint factory (example 10) Area:															Ref. drawing: layout
1	2	3	4	5	6		7	8			9	10	11	12	13
	Source of release		Flammable material					Ventilation			Hazardous area				
No.	Description	Location	Grade of release[a]	Reference[b]	Operating temperature and pressure		State[c]	Type[d]	Degree[e]	Availability[e]	Zone type 0-1-2	Zone extent m		Reference	Any other relevant information and remarks
					°C	kPa						Vertical	Horizontal		
1	Seal of solvent pump	Pump area	S	1	Ambient	Ambient	L	A	Medium	Fair	2	1,0*	3,0**	Example No. 2	* Above the source of release ** From the source of release
2	Liquid surface on mixing vessel	Mixing area	C	1	Ambient	Ambient	L	A	Low	Poor	0	*	*	Example No. 5	* Inside vessel
3	Opening of mixing vessel	Mixing area	P	1	Ambient	Ambient	L	A	Medium	Fair	1	1,0*	2,0**	Example No. 5	* Above openings ** From openings
4	Spillage of mixing vessel	Mixing area	S	1	Ambient	Ambient	L	A	Medium	Fair	2	1,0*	2,0**	Example No. 5	* Above ground level ** From the vessel

[a] C – Continuous; S – Secondary; P – Primary.
[b] Quote the number of list in Part I.
[c] G – Gas; L – Liquid; LG – Liquefied gas; S – solid.
[d] N – Natural; A – Artificial.
[e] See annex B.

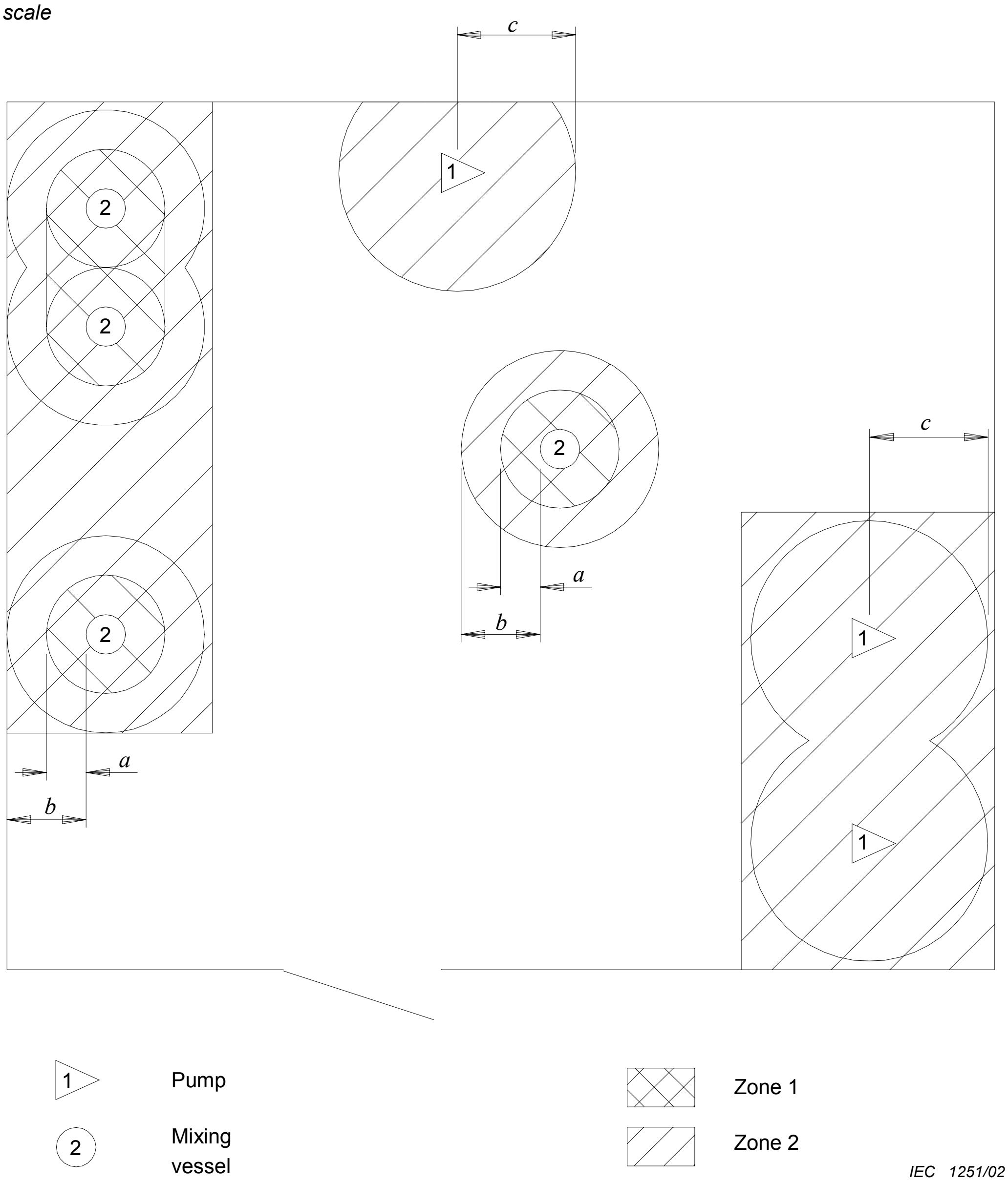
Example No. 10

Mixing room in a paint factory:

This example shows one way of using the individual examples No. 2 (with medium degree of ventilation) and No. 5. In this simplified example, four paint-mixing vessels (item 2) are situated in one room. There are also three pumps (item 1) for liquid in the same room.

The principal factors which influence the type of zones are given in the tables in examples No. 2 and No. 5.

Not to scale



Taking into account relevant parameters, (see hazardous area classification data sheets), the following are typical values which will be obtained for this example:

a = 2 m;

b = 4 m;

c = 3 m;

The drawing No. 10 is a plan view, for vertical extent of the zones see examples No. 2 and No. 5.

NOTE As in examples No. 2 and No. 5, the zones have a cylindrical shape around the sources of release. However, in practice, the zones are usually increased to a box shape if the vessels are situated close to each other. In this way there are no unclassified small pockets.

It is assumed that the pumps and vessels are connected by all-welded pipework and that flanges, valves, etc. are located close to these items of equipment.

In practice, there may be other sources of release in the room, for example, open vessels, but these have not been taken into account in this example.

If the room is small, it is recommended that zone 2 extends to the limits of the room.

Example No. 11

Hazardous area classification data sheet –
Part I : Flammable material list and characteristics **Sheet 1 of 3**

Plant: tank farm for gasoline (example 11)											Reference drawing: layout
1	2	3	4	5	6	7	8	9	10	11	12
	Flammable material			*LEL*		Volatility [a]					
N°	Name	Compo-sition	Flash-point °C	kg/m^3	vol. %	Vapour pressure 20 °C kPa	Boiling-point °C	Relative density of gas or vapour to air	Ignition temperature °C	Group and temperature class[b]	Any other relevant information and remarks
1	Gasoline		<0	0,022	0,7	50	<210	>2,5	280	IIAT3	
2	Fuel oil		55-65	0,043	1	6	200	3,5	330	IIAT2	
3	Water containing oil and gasoline		<0	–	>0,7	–	–	>1,2	>280	IIAT3	The values are estimated

[a] Normally, the value of vapour pressure is given, but in the absence of that, boiling-point can be used (4.4.1d)).

[b] For example, IIBT3.

Example No. 11

Hazardous area classification data sheet –
Part II : List of sources of release **Sheet 2 of 3**

Plant: tank farm for gasoline (example 11) Area:															Reference drawing: layout
1	2	3	4	5	6		7	8			9	10	11	12	13
	Source or release			Flammable material				Ventilation			Hazardous area				
N°	Description	Location	Grade of release[a]	Refer-ence [b]	Operating temperature and pressure °C	kPa	State[c]	Type[d]	Degree[e]	Avail-ability[e]	Zone type 0-1-2	Zone extent m Verti-cal	Hori zontal-	Refer-ence	Any other relevant information and remarks
1	Seal of gasoline pump	Pump areas	D	1	Ambient	Ambient	L	A	Medium	Fair	2	1,0*	3,0**	Example No. 1	* Above source of release ** From the source of release
2	Liquid surface on separator	Waste water treatment	C	3	Ambient	Ambient	L	N	Low	Good	0	*	*	Example No. 6	* Inside separator below ground level
								N	Medium	Good	1	1,0*	3,0**	Example No. 6	* Above ground level ** From separator
								N	Medium	Good	2	3,0*	7,5**	Example No. 6	* Above ground level ** From separator
3	Liquid surface on gasoline tanks	Tank areas	C	1	Ambient	Ambient	L	N	Medium	Poor	0	*	*	Example No. 8	* Inside the tank
4	Vent opening in gasoline tank	Tank areas	P	1	Ambient	Ambient	L	N	Medium	Good	1	3,0*	3,0**	Example No. 8	* 3 m around the vent
5	Flanges, etc. inside bund of gasoline tanks	Tank areas	D	1	Ambient	Ambient	L	N	Medium	Fair	2	*	*	Example No. 8	* Inside bund
6	Overfilling of gasoline tanks	Tank areas	D	1	Ambient	Ambient	L	N	Medium	Good	2	3,0*	3,0**	Example No. 8	* Above ground level

Example No. 11

Hazardous area classification data sheet –
Part II: List of sources of release *(continued)* **Sheet 3 of 3**

1	2	3	4	5	6		7	8			9	10	11	12	13
	Source of release			Flammable material				Ventilation			Hazardous area				
N°	Description	Location	Grade of release[a]	Reference [b]	Operating temperature and pressure		State[c]	Type[d]	Degree[e]	Availability[e]	Zone type 0-1-2	Zone extent m		Reference	Any other relevant information and remarks
					°C	kPa						Vertical	Horizontal		
7	Opening in tank roof of tanker filling installation	Loading area	P	1	Ambient	Ambient	L	N	Medium	Good	1	1,5*	1,5**	Example No. 9	* Above ground level ** From release
											2	1.0*	1,5**	Example No. 9	* Above release ** From release
8	Spillage at ground inside drainage channel of tanker filling installation	Loading area	D	1	Ambient	Ambient	L	N	Medium	Good	2	1.0*	4,5**	Example No. 9	* Above ground level ** From drain channel/gantry
9	Oil tank	Tank areas	–	2	–	–	L	–	–	–		…*	…**		* No hazardous area due to the high flashpoint of oil

[a] C – Continuous; S – Secondary; P – Primary.

[b] Quote the number of list in part I.

[c] G – Gas; L – Liquid; LG – Liquid gas; S – Solid.

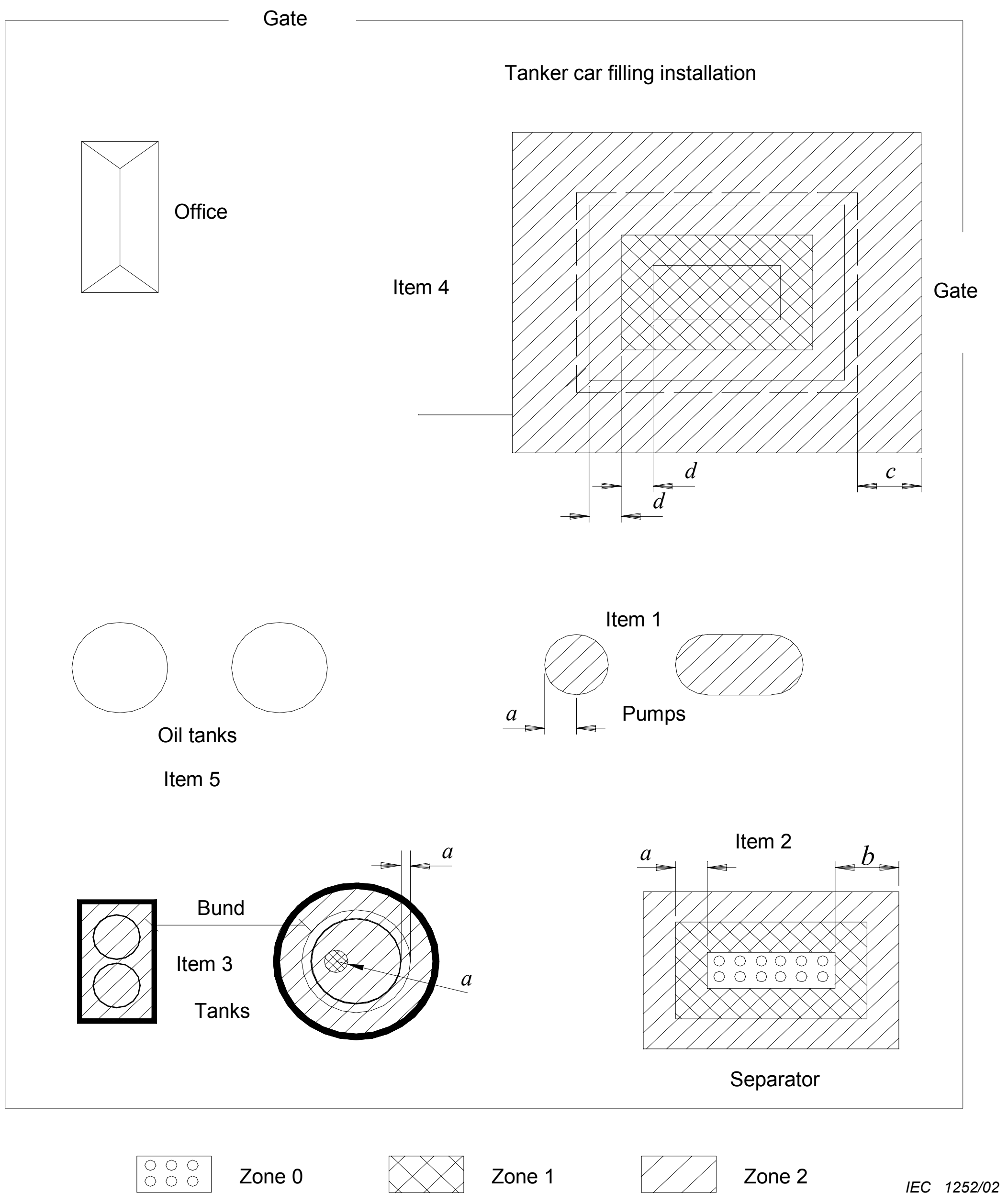
[d] N – Natural; A – Artificial.

[e] See annex B.

Example No. 11

Tank farm for gasoline and oil:

Not to scale



This example shows one way of using the individual example Nos. 1, 6, 8 and 9. In this simplified example, three storage tanks (bunded) for gasoline (item 3), five liquid pumps (item 1) placed close to each other, one single pump (item 1), one tanker filling installation (item 4), two oil tanks (item 5) and one oil/water gravity separator (item 2) are situated within the tank farm.

The principal factors which influence the types of zones are given in examples Nos. 1, 6, 8 and 9.

Taking into account relevant parameters, (see hazardous area classification data sheets), the following are typical values which will be obtained for this example.

a = 3 m

b = 7,5 m

c = 4,5 m

d = 1,5 m

The drawing No. 11 is a plan view; for vertical extent of the zones, see examples Nos. 1, 6, 8 and 9.

For details (zoning inside vessels, zoning extent, zoning around tank vents, etc.), see examples Nos. 1, 6, 8 and 9.

NOTE It is necessary to use examples Nos. 1, 6, 8 and 9 to obtain the correct zoning of the interior of tanks and separator (zone 0) together with zoning at tank vents (zone 1).

In practice there may be other sources of release; however, for simplicity, these have not been taken into account.

Table C.1 – Hazardous area classification data sheet – Part I: Flammable material list and characteristics **Sheet: 1/1**

Plant:											Reference drawing:
1	2	3	4	5	6	7	8	9	10	11	12
	Flammable material			*LEL*		Volatility[a]					
N°	Name	Composition	Flash-point °C	kg/m^3	vol. %	Vapour pressure 20 °C kPa	Boiling-point °C	Relative density of gas or vapour to air	Ignition temperature °C	Group and temperature class[b]	Any other relevant information and remarks

[a] Normally, the value of vapour pressure is given, but in the absence of that, boiling point can be used (4.4.1d)).

[b] For example IIBT3.

Table C.2 – Hazardous area classification data sheet – Part II: List of sources of release

Sheet: 1/1

Plant: Area:															Reference drawing:
1	2	3	4	5	6		7	8			9	10	11	12	13
	Source of release			Flammable material				Ventilation			Hazardous area				
No.	Description	Location	Grade of release[a]	Refer-ence[b]	Operating temperature and pressure °C	kPa	State[c]	Type[d]	Degree[e]	Avail-ability[e]	Zone type 0-1-2	Zone extent m Verti-cal	Hori-zontal	Reference	Any other relevant information and remarks

[a] C – Continuous; S – Secondary; P – Primary.

[b] Quote the number of list in Part I.

[c] G – Gas; L – Liquid; LG – Liquefied gas; S – Solid.

[d] N – Natural; A – Artificial.

[e] See annex B.

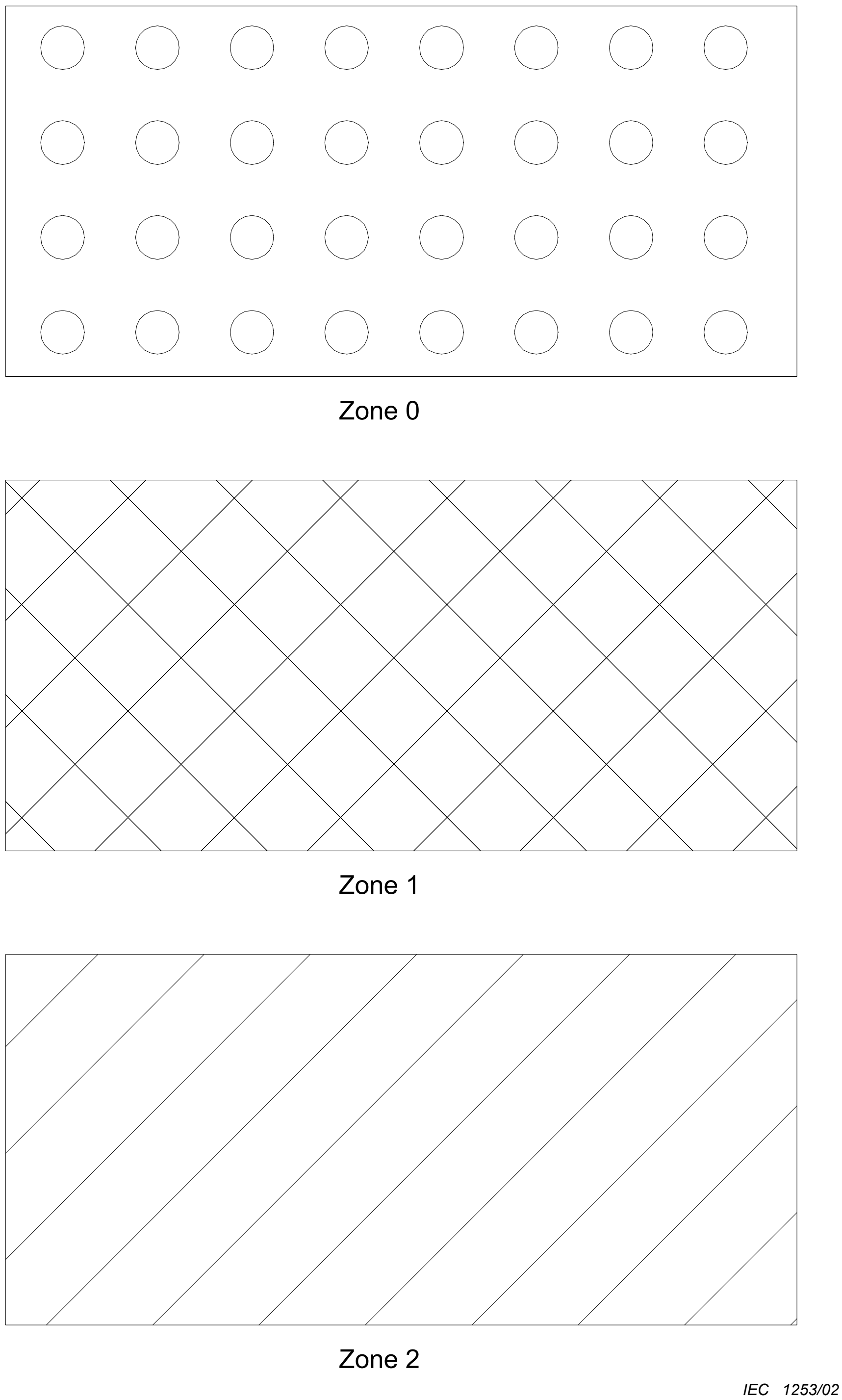


Figure C.1 – Preferred symbols for hazardous area zones

NOTES

1) Will be Zone 0 if the low ventilation (VL) is so weak and the release is such that in practice an explosive atmosphere exists virtually continuously i.e. approaching a "no ventilation" condition

2) The Zone 2 area created by secondary grade of release may exceed that attributable to a primary or continuous grade of release. In this case, the greater distance should be taken.

3) Zone 0 NE, 1 NE or 2 NE indicates a theoretical zone which would be of negligible extent under normal conditions.

4) "+" means "surrounded by"

5) A source of release may give rise to more than one grade of release or a combination

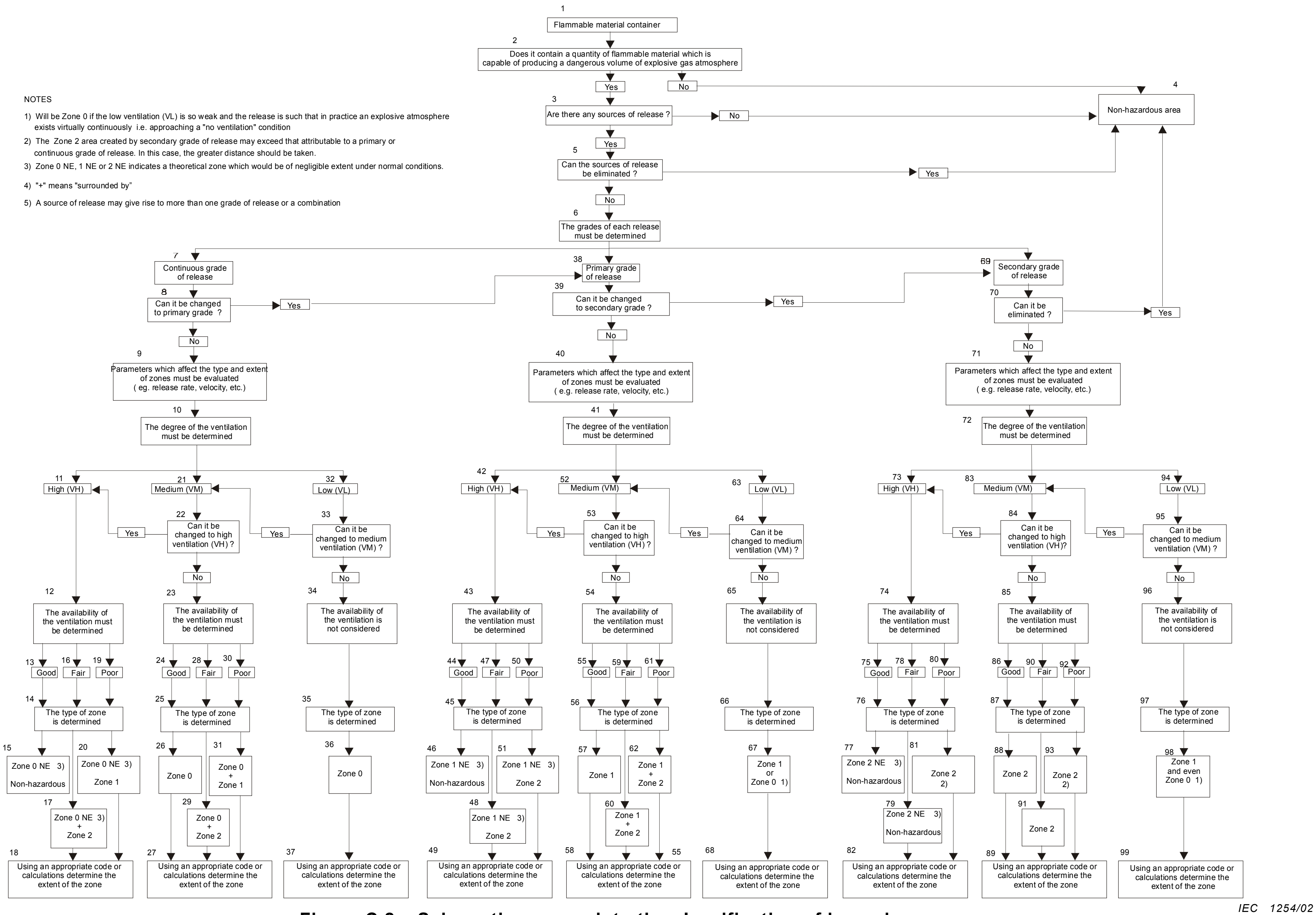


Figure C.2 – Schematic approach to the classification of hazardous areas