

Australian/New Zealand Standard™

Electrical apparatus for explosive gas atmospheres

Part 10: Classification of hazardous areas (IEC 60079-10:2002 MOD)



AS/NZS 60079.10:2004

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Electrical apparatus for explosive gas atmospheres

Part 10: Classification of hazardous areas (IEC 60079-10:2002 MOD)

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee MS-011, Classification of Hazardous Areas to supersede AS 2430.1—1987 and NZS 6101.1:1988, *Classification of hazardous areas, Part 1: Flammable gas and vapour atmospheres*.

This Standard incorporates Amendment No. 1 (March 2007). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

The objective of this Standard is to set out requirements for the classification of areas where flammable gas or vapour risks might arise, in order to permit the proper selection and installation of electrical apparatus for use in such hazardous areas. This Standard is for the use of manufacturers and installers of electrical equipment as well as by electrical inspecting authorities.

This Standard is an adoption with national modifications and has been reproduced from, IEC 60079-10:2002, *Electrical apparatus for explosive gas atmospheres—Part 10: Classification of hazardous areas*; it has been varied as indicated, for the protection of human health and safety, a legitimate reason under the WTO Agreement on Technical Barriers to Trade (TBT).

Variations to IEC 60079-10:2002 are indicated at the appropriate places throughout this standard. Strikethrough (~~example~~) identifies IEC text, tables and figures which, for the purposes of this Australian/New Zealand Standard, are deleted. Where text, tables or figures are added, each is set in its proper place and identified by shading (example).

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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.

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Australian/New Zealand Standard**Electrical apparatus for explosive gas atmospheres
Part 10: Classification of hazardous areas
(IEC 60079-10:2002 MOD)**

Any table, figure or text of the international standard that is struck through is not part of this standard. Any Australian/New Zealand table, figure or text that is added is part of this standard and is identified by shading.

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.
- h) areas which may be affected by oxygen enrichment.

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.

Some specific examples of area classifications are contained in the various Parts of AS/NZS 2430.3.

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.

References to International Standards that are struck through in this Clause are replaced by references to equivalent Australian or Australian/New Zealand Standards that are listed immediately thereafter and identified by shading. Any Australian or Australian/New Zealand Standard that is identical to the International Standard it replaces is appropriately identified.

AS 1940—1993, *The storage and handling of flammable and combustible liquids*

AS/NZS 2430.3:2004 (Parts 1 to 9), *Classification of hazardous areas—Examples of area classification*

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*~~

AS/NZS 60079.4:2000, *Electrical apparatus for explosive gas atmospheres Part 4: Method of test for ignition temperature (identical to IEC 60079-4:1975/Amdt 1:1995 and IEC 60079-4A:1970)*

~~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*~~

AS/NZS 60079.20:2000, *Electrical apparatus for explosive gas atmospheres Part 20: Data for flammable gases and vapours, relating to the use of electrical apparatus (identical to IEC 60079-20:1996)*

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~~

Refer to the definition in AS 1940.

NOTE 1 – In accordance with the above definition, kerosene and white spirit are flammable liquids whereas diesel fuel (distillate) is not.

NOTE 2 – Combustible liquids that are stored, handled or processed at a temperature $T \geq FP - 6^\circ \text{C}$ (where FP = flashpoint of the liquid) should be considered as flammable liquids and therefore zonal distances for such liquids should be determined accordingly.

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

NOTE – Droplets of combustible liquid in the air may also form flammable mists.

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]

NOTE – The standardized conditions are defined in the ADG Code in Australia and in the Hazardous Substances and New Organisms (HSNO) Act in New Zealand.

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.

A1

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.2G-4.

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 be 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.