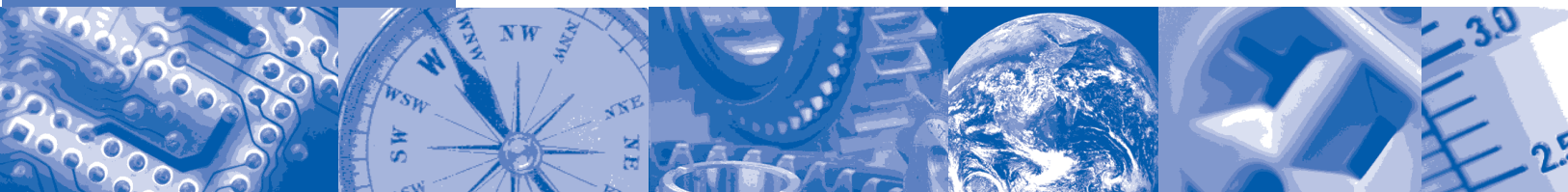


ANSI/ISA-TR12.24.01-1998 (IEC 60079-10 Mod)



Recommended Practice for Classification of Locations for Electrical Installations Classified as Class I, Zone 0, Zone 1, or Zone 2



**ISA—The Instrumentation,
Systems, and
Automation Society**

Approved 31 May 2000



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ANSI/ISA-TR12.24.01-1998 (IEC 79-10 Mod), Recommended Practice for Classification of Locations for Electrical Installations Classified as Class I, Zone 0, Zone 1, or Zone 2

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Preface

This ISA recommended practice is based on IEC Publication 79-10. It is the intention of the ISA SP12 Committee to develop an ISA Recommended Practice that is harmonized with IEC 79-10 to the fullest extent possible.

This preface, as well as all footnotes and annexes, is included for informational purposes and is not part of ANSI/ISA-TR12.24.01-1998 (IEC 79-10 Mod).

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Foreword

This recommended practice is a modification of IEC 79-10, *Electrical Apparatus for Explosive Gas Atmospheres*, Part 10: Classification of Hazardous Areas, normalized as an American National Standard, with additional material added as appendices specifically for the classification of locations for electrical installations classified as Class I, Zone 0, Zone 1, or Zone 2 Classification of hazardous areas. U.S. National Deviations are shown by ~~strikeout~~ through text deleted and underline under text added. There are five annexes in this recommended practice. All annexes are Informative and are not considered part of this recommended practice.

1 General

1.1 Scope

~~This part of IEC 79~~ ISA-TR12.24.01 is concerned with the classification of hazardous areas where flammable gas or vapor risks may arise, in order to permit the proper selection and installation of apparatus for use in such hazardous areas (see Notes 1 and 4).

It is intended to be applied where there may be a risk of ignition due to the presence of flammable gas or vapor, 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 fibers;
- d) catastrophic failures which are beyond the concept of abnormality dealt with in this ~~standard~~ recommended practice (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).

This ~~standard~~ recommended practice 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, standards, or recommended practices relating to those industries or applications.

NOTE 1 — For the purpose of this ~~standard~~ recommended practice, 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 such other events that are not predictable.

NOTE 4 — In any ~~process plant facility~~, 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~~ recommended practice may be used with judgment for other ignition sources.

NOTE 5 — Mists may form or be present at the same time as flammable vapors. This may affect the way flammable material disperses and the extent of any hazardous areas. The strict application of area classification for gases and vapors 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 vapors 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 ~~normative~~ documents contain provisions which, through reference in this text, constitute provisions of this ~~part of IEC 79 recommended practice~~. At the time of publication, the editions indicated were valid. All ~~normative~~ documents are subject to revision, and parties to agreements based on this ~~part of IEC 79 recommended practice~~ are encouraged to investigate the possibility of applying the most recent editions of the ~~normative~~ documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards. ANSI maintains registers of currently valid American National Standards.

ANSI/ISA-S12.13, Part I, Performance Requirements, Combustible Gas Detectors

ANSI/ISA- RP12.13, Part II, Installation Operation and Maintenance of Combustible Gas Detection Instruments

IEC 50(426): ~~1990~~, *International Electrotechnical Vocabulary (IEV) - Chapter 426.- Electrical apparatus for explosive atmospheres*

IEC 79-1A: Construction and Verification Tests of Flameproof Enclosures of Electrical Apparatus

IEC 79-3: Spark-Test Apparatus For Intrinsically Safe Circuits

IEC 79-4: ~~1975~~, *Electrical apparatus for explosive gas atmospheres - Part 4: Method of test for ignition temperature*

IEC 79-4A: ~~1970~~, *First supplement to IEC 79-4 (1966)*

IEC 79-12: Classification of Mixtures of Gases or Vapours With Air According To Their Maximum Experimental Safe Gaps and Minimum Igniting Currents

ANSI/API RP 14F: Recommended Practice for Design and Installation of Electrical Systems for Offshore Production Platforms

API RP 505: Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, or Zone 2

ASTM E-659: Test for Autoignition Temperature of Liquid Chemicals

IP 15, Institute of Petroleum: Area Classification Code for Petroleum Installations – Part 15

NFPA 30: Flammable and Combustible Liquids Code

NFPA 70: National Electrical Code[®]

NFPA 325M: Guide to Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids

NFPA 497: Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations For Electrical Installations In Chemical Process Areas

1.3 Purpose

The purpose of this recommended practice is to provide guidelines for classifying hazardous (classified) locations for the selection and installation of electrical equipment. Basic definitions given in the 1995 edition of IEC 79-10, *Electrical apparatus for explosive gas atmospheres, Classification of hazardous areas*, have been followed in developing this recommended practice. This publication is only a guide and requires the application of sound engineering judgment.

Electrical installations in areas where flammable liquids or gases are produced, processed, stored or otherwise handled can be suitably designed if the locations of potential sources of release and accumulation are clearly defined. Once a location has been classified, requirements for electrical equipment and associated wiring should be determined from applicable publications. Applicable publications may include NFPA No. 70 (NEC) or API RP 14F. Reference Section 1.2 for other possible applicable publications.

2 Definitions and terms

For the purpose of this recommended practice ~~part of IEC 79~~, the following definitions and terms apply.

2.1 explosive gas atmosphere:

a mixture with air, under atmospheric conditions, of a flammable material in the form of gas or vapor 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.

2.2 hazardous area:

an 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]

NOTE — The term “hazardous (classified) location” is defined in ANSI/ISA-S12.1.01. TR12.24.01 uses the term “hazardous area.” The two terms should be considered synonymous.

2.3 non-hazardous area:

an 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]

NOTE — The term “unclassified location” is defined in ANSI/ISA S12.1.01. S12.24.01 uses the term “non-hazardous area.” The two terms should be considered synonymous.

2.4 ~~zone 0, 1, and 2 locations~~ zone:

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

2.4.1 ~~class I, zone 0:~~

~~an area in which an explosive gas atmosphere is present continuously or for long periods. [IEV 426-03-03, modified]~~

2.4.2 ~~class I, zone 1:~~

~~an area in which an explosive gas atmosphere is likely to occur in normal operation. [IEV 426-03-04]~~

2.4.3 ~~class I, zone 2:~~

~~an area in which an explosive gas atmosphere is not likely to occur in normal operation and, if it does occur, is likely to do so only infrequently and will exist for a short period only. [IEV 426-03-05, modified]~~

2.4.1 class I, zone 0:

a Class I, Zone 0, location is a location (1) in which ignitable concentrations of flammable gases or vapors are present continuously; or (2) in which ignitable concentrations of flammable gases or vapors are present for long periods of time.

NOTE 1 — As a guide in determining when flammable gases or vapors are present continuously or for long periods of time, refer to Recommended Practice for Classification of Locations for Electrical Installations of Petroleum Facilities Classified as Class I Zone 0, Zone 1, or Zone 2, API RP 505-1996; Electrical Apparatus for Explosive Gas Atmospheres, Classifications of Hazardous Areas, IEC 79-10; and Area Classification Code for Petroleum Installations, Model Code, Part 15, Institute of Petroleum; and Electrical Apparatus for Explosive Gas Atmospheres, Classifications of Hazardous (Classified) Locations, ISA S12.24.01-1997.

NOTE 2 — This classification includes locations inside vented tanks or vessels containing volatile flammable liquids; inside inadequately vented spraying or coating enclosures, where volatile flammable solvents are used; between the inner and outer roof sections of a floating roof tank containing volatile flammable liquids; inside open vessels, tanks and pits containing volatile flammable liquids; the interior of an exhaust duct that is used to vent ignitable concentrations of gases or vapors; and inside inadequately ventilated enclosures containing normally venting instruments utilizing or analyzing flammable fluids and venting to the inside of the enclosures.

NOTE 3 — It is not good practice to install electrical equipment in Zone 0 locations except when the equipment is essential to the process or when other locations are not feasible. (See NEC Section 505-2 FPN No. 2.) If it is necessary to install electrical systems in a Zone 0 location, it is good practice to install intrinsically safe systems as described by NEC Article 504.

2.4.2 class I, zone 1:

a Class I, Zone 1 location is a location (1) in which ignitable concentrations of flammable gases or vapors are likely to exist under normal operating conditions; or (2) in which ignitable concentrations of flammable gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or (3) in which equipment is operated or processes are carried on, of such a nature that equipment breakdown or faulty operations could result in the release of ignitable concentrations of flammable gases or vapors and also cause simultaneous failure of electrical equipment in a mode to cause the electrical equipment to become a source of ignition; or (4) that is adjacent to a Class I, Zone 0 location from which ignitable concentrations of vapors could be communicated, unless communication is prevented by adequate positive pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.

NOTE 1 — Normal operations is considered the situation when facility equipment is operating within its design parameters. Minor releases of flammable material may be part of normal operations. Minor releases include the releases from mechanical packings on pumps. Failures that involve repair or shutdown (such as the breakdown of pump seats and flange gaskets, and spillage caused by accidents) are not considered normal operation.

NOTE 2 — This classification usually includes locations where volatile flammable liquids or liquefied flammable gases are transferred from one container to another. In areas in the vicinity of spraying and painting operations where flammable solvents are used; adequately ventilated drying rooms or compartments for evaporation of flammable solvents; adequately ventilated locations containing fat and oil extraction equipment using volatile flammable solvents; portions of cleaning and dyeing plants where volatile flammable liquids are used; adequately ventilated gas generator rooms and other portions of gas manufacturing facilities where flammable gas may escape; inadequately ventilated pump rooms for flammable gas or for volatile flammable liquids; the interiors of refrigerators and freezers in which volatile flammable materials are stored in the open, lightly stoppered, or easily ruptured containers; and other locations where ignitable concentrations of flammable vapors or gases are likely to occur in the course of normal operation, but not classified Zone 0.

2.4.3 class I, zone 2:

a Class I, Zone 2 location is a location (1) in which ignitable concentrations of flammable gases or vapors are not likely to occur in normal operation and if they do occur will exist only for a short period; or (2) in which volatile flammable liquids, flammable gases, or flammable vapors are handled, processed, or used, but in which the liquids, gases, or vapors normally are confined within closed containers or closed systems from which they can escape, only as a result of accidental rupture or breakdown of the containers or system, or as the result of the abnormal operation of the equipment with which the liquids or gases are handled, processed, or used; or (3) in which ignitable concentrations of flammable gases or vapors normally are prevented by positive mechanical ventilation, but which may become hazardous as a result of failure or abnormal operation of the ventilation equipment; or (4) that is adjacent to a Class I, Zone 1 location, from which ignitable concentrations of flammable gases or vapors could be communicated.

unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

NOTE 1 — The Zone 2 classification usually includes locations where volatile flammable liquids or flammable gases or vapors are used, but which would become hazardous only in case of an accident or of some unusual operating condition.

NOTE 2 — Indications of the frequency of the occurrence and duration may be taken from codes relating to specific industries or applications IP-15, The Institute of Petroleum Area Classification Code for Petroleum Installations, Part 15; API RP 505, Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, or Zone 2; and NFPA 497, Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations For Electrical Installations In Chemical Process Areas.

2.4.4 grouping and classification:

for purposes of testing, approval, and area classification, various air mixtures (not oxygen enriched) shall be grouped as follows (NFPA 70 Mod):

Group I is intended for use in describing atmospheres containing firedamp (a mixture of gases, composed mostly of methane, found underground, usually in mines). This standard does not apply to installations underground in mines.

Group II shall be subdivided into IIC, IIB, and IIA, as noted below, according to the nature of the gas or vapor, for protection techniques "d," "ia," "ib" [ia], and [ib], and, where applicable, "n" and "o."

Class I, Zone combustible materials are divided into three groups (NFPA 497):

Group IIC - Atmospheres containing acetylene, hydrogen, or flammable gas, flammable liquid produced vapor, or combustible liquid produced vapor mixed with air that may burn or explode, having either a maximum experimental safe gap (MESG) value less than or equal to 0.50 mm or a minimum igniting current ratio (MIC ratio) less than 0.45.

Group IIB - Atmospheres containing acetaldehyde, ethylene, or flammable gas, flammable liquid produced vapor, or combustible liquid produced vapor mixed with air that may burn or explode having either a maximum experimental safe gap (MESG) value greater than 0.50 mm and less than or equal to 0.90 mm or a minimum igniting current ratio (MIC ratio) greater than 0.45 and less than or equal to 0.80.

Group IIA - Atmospheres containing acetone, ammonia, ethyl alcohol, gasoline, methane, propane, or flammable gas, flammable liquid produced vapor, or combustible liquid produced vapor mixed with air that may burn or explode having either a maximum experimental safe gap (MESG) value greater than 0.90 mm or a minimum igniting current ratio (MIC ratio) greater than 0.80.

NOTE 1 — The gas and vapor sub-division as described above is based on the maximum experimental safe gap (MESG), minimum igniting current (MIC), or both. Test equipment for determining the MESG is described in Construction and Verification Tests of Flameproof Enclosures of Electrical Apparatus, IEC 79-1A (Amendment No. 1) and UL Technical Report No. 58. The test equipment for determining MIC is described in Spark-Test Apparatus For Intrinsically-Safe Circuits, IEC 79-3. The classification of gases or vapors according to their maximum experimental safe gaps and minimum igniting currents is described in Classification of Mixtures of Gases or Vapours With Air According To Their Maximum Experimental Safe Gaps and Minimum Igniting Currents, IEC 79-12.

NOTE 2 — Verification of electrical equipment utilizing protection techniques "e," "m," "p," and "q," due to design technique, does not require tests involving MESG or MIC. Therefore, Group II is not required to be sub-divided for these protection techniques.

NOTE 3 — It is necessary that the meanings of the different equipment markings and Group II classifications be carefully observed to avoid confusion with Class I, Divisions 1 and 2, Groups A, B, C, and D.

2.5 source of release:

a point or location from which a flammable gas, vapor, or liquid may be released into the atmosphere such that an explosive gas atmosphere could be formed. [IEV 426-03-06, modified]

2.6 grades of release:

there are three basic grades of release, as listed below in order of decreasing 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.

2.6.1 continuous grade of release:

a release which is continuous or is expected to occur for long periods.

2.6.2 primary grade of release:

a release which can be expected to occur periodically or occasionally during normal operation.

2.6.3 secondary grade of release:

a 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.

2.7 release rate:

the quantity of flammable gas or vapor emitted per unit time from the source of release.

2.8 normal operation:

the 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.

NOTE 3 — Unless otherwise specified, normal operation for motors is assumed to be rated full-load steady conditions.

2.9 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).

2.10 explosive limits

2.10.1 lower explosive limit (LEL):

the concentration of flammable gas or vapor in air, below which the gas atmosphere is not explosive. [IEV 426-02-09, modified].

2.10.2 upper explosive limit (UEL):

the concentration of flammable gas or vapor in air, above which the gas atmosphere is non-explosive. [IEV 426-02-10, modified]

NOTE — For the purpose of this standard, the terms 'explosive' and 'flammable' should be considered synonymous. The term "explosive" as it relates to atmospheres and mixtures is in the process of being replaced with the more technically correct "flammable" throughout many national and international standards. This document, however, continues to use the term "explosive" in many of the definitions that are repeated here as those definitions have been derived from documents that have yet to be updated

2.11 relative density of a gas or a vapor:

the density of a gas or a vapor relative to the density of air at the same pressure and at the same temperature (air is equal to 1.0).

2.12 flammable material:

a material which is flammable of itself, or is capable of producing a flammable gas, vapor or mist.

2.13 flammable liquid (class IA, IB, and IC):

a liquid having a flash point below 100°F (37.8°C) and having a Reid vapor pressure not exceeding 40 pounds per square inch absolute (2068.6 mm Hg or 276 kilopascals) at 100°F (37.8°C). Flammable (Class I) liquids are subdivided into Classes IA, IB, and IC. (Reference NFPA No. 30). ~~A liquid capable of producing a flammable vapor under any foreseeable operating conditions.~~

2.14 flammable gas or vapor:

gas or vapor which, when mixed with air in certain proportions, will form an explosive gas atmosphere.

2.15 flammable mist:

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

2.16 flashpoint:

the lowest liquid temperature at which, under certain standardized conditions, a liquid gives off vapors in a quantity such as to be capable of forming an ignitable vapor/air mixture. [IEV 426-02-141]

2.17 boiling point:

the temperature of a liquid boiling at an ambient pressure of 101.3 kPa (1.013 mbar).

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

2.18 vapor pressure:

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

2.19 ignition temperature of an explosive gas atmosphere:

the lowest temperature of a heated surface at which, under specified conditions, the ignition of a flammable substance in the form of a gas or vapor mixture with air will occur.

NOTE — IEC 79-4 and IEC 79-4A standardize a method for the determination of this temperature. [IEV 426-02-01, modified]. To determine properties of specific flammable liquids, flammable gases and volatile solids, refer to ASTM E-659, *Test for Autoignition Temperature of Liquid Chemicals*. To obtain the autoignition temperature of specific flammable liquids, flammable gases, and volatile solids, refer to NFPA 497.

2.20 combustible liquid (class II, IIIA, and IIIB):

a liquid having a flash point at or above 100°F (37.8°C).

Combustible Liquids are subdivided as follows:

Class II liquids, those having flash points at or above 100°F (37.8°C) and below 140°F (60°C).

Class IIIA liquids, those having flash points at or above 140°F (60°C) and below 200°F (93°C).

Class IIIB liquids, those having flash points at or above 200°F (93°C).

2.21 flammable highly volatile liquids (HVLs):

liquids whose Reid vapor pressure exceeds 40 pounds per square inch absolute (2068.6 mm Hg or 276 kPa) at 100°F (37.8°C).

2.22 location:

throughout this recommended practice, reference is made to areas, spaces, and locations. These terms should be considered interchangeable terms designating a three-dimensional space.

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.

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 emergency situations, reliance should be placed on the isolation of unsuitable electrical equipment, shut-down of the process, isolation of process vessels, containment of spillages and, if possible, the provision of additional emergency ventilation.

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 analyzing 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 ~~facility plant~~ or ~~facility plant~~ design to decide which parts of the ~~facility plant~~ can be equated to the three zonal definitions (Class I, 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 Class I, 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~~ or extent of the zone, or both, 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, Class I, Zone 0 or Zone 1 areas should be minimized in number and extent by design or suitable operating procedures. In other words, ~~facilities plants~~ and installations ~~shall~~ should be mainly Class I, 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 ~~facility 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 and other engineering personnel.

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

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 vapor 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 vapors (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 ~~facility plant~~, or where a release of flammable materials can create a flammable atmosphere outside a process ~~facility plant~~.

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

4.2.1 Experience has shown that certain locations may be unclassified regardless of the ventilation rate since the occurrence of flammable gas or vapor liberation from some apparatus is so infrequent. Examples of such locations include the following:

a) Locations where flammable substances are contained in:

- 1) all-welded closed piping systems without valves, flanges or similar devices. or
- 2) continuous metallic tubing without valves, fittings, flanges, or similar devices.

b) Locations where flammable liquids, gases or vapors are transported or stored in certain containers or vessels (Refer to NFPA recommendations and Department of Transportation (DOT) regulations specifying containers for flammable liquids and gases).

4.2.2 Adequately ventilated locations surrounding equipment that has continuous flame sources (e.g., unprotected fired vessels and flare tips) need not be classified solely by reason of the fuel gas being considered as a source of release for area classification purposes.

NOTE 1 — It may be prudent to classify portions of these locations. For example, electrical equipment may be exposed to flammable gas during a purge cycle of a fired heater or furnace.

NOTE 2 — The lack of classification around unprotected fired vessels and flare tips does not imply the safe placement of fired vessels and flare tips in the proximity to other sources of release because unprotected fired vessels and flare tips are themselves sources of ignition.

4.2.3 Other locations may be non-hazardous depending on the degree of ventilation and other factors.

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.

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 — A continuous grade of release normally leads to a Class I, Zone 0, a primary grade to Class I, Zone 1 and a secondary grade to Class I, Zone 2 (see Annex B).

4.4 Extent of Zone

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 vapor

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 vapor is determined by the rate of flammable vapor release and the rate of dispersion. Gas and vapor flowing from a leak at high velocity will develop a coneshaped jet which will entrain air and be self-diluting. The extent of the explosive atmosphere will be almost independent of wind velocity. If the release is at low velocity or if its velocity is destroyed 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 vapor or gas in the released mixture.

d) Volatility of a flammable liquid

The volatility of a flammable liquid is related principally to the vapor pressure, and the heat of vaporization. If the vapor pressure is not known, the boiling point and flashpoint can be used as a guide.

An explosive 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 vapor 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.

4.4.3 Ventilation

With increased ventilation, the extent of the zone will be reduced. Obstacles which impede the ventilation may increase the extent of the zone. On the other hand, some obstacles (for example, dikes, walls or ceilings) may limit the extent.

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

If the gas or vapor 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 vapor 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 — Experience has shown that ammonia is hard to ignite and a gas release will dissipate rapidly in the open air, so any explosive gas atmosphere will be of negligible extent.

4.4.5 Other parameters to be considered

a) Climatic conditions.

b) Topography.

4.4.6 Illustrative examples

Some ways in which the above-mentioned parameters affect the vapor 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 vapor release rate will depend principally on the following parameters:

- liquid temperature;
- vapor pressure of the liquid at its surface temperature; and
- dimensions of the evaporation surface.

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 vapor release rate is equal to the liquid flow rate, and this depends on the following parameters:

- liquid pressure; and
- 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; and
- concentration of flammable gas in the released mixture.

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

4.5 Extent of zone — general comments

4.5.1 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 that is lighter than air may be retained at high level (for example, in a roof space).

4.5.2 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 vapor into the area can be prevented by suitable means such as:

- physical barriers;
- maintaining a static overpressure in the area relative to the adjacent hazardous areas, so preventing the ingress of the hazardous atmosphere;
- purging the area with a significant flow of air, so ensuring that the air escapes from all openings where the hazardous gas or vapor may enter.