Session 3

Hazardous Area Classification of Large Scale Plants

Presenter - Paul Spresser
EPEE Consulting

Abstract

The hazardous area classification of a large scale plants can be problematical. A preference to use the generalised method of classification exists and its use is easily substantiated, for most aspects of these plants. However, unless some clear cut guidelines are established and allowance is made for a certain level of exceptions to the main adopted methodology, impractical solutions can result. Room must be left for use of the Source of Release by example and calculation methods for a practical classification solution.

1. INTRODUCTION

This paper is not intended to present a rigorous discussion on Hazardous Area Classification, but rather to cover the basic concepts to allow discussion of classification methodology and its application to smaller and larger plants.

Installations, such as Refineries or LNG plants, in which flammable materials are processed and stored, should be designed to ensure that any releases of flammable material, are kept to a minimum to ensure the smallest possible resulting hazardous area. This is a consideration during Normal Operation or predictable Abnormal Modes (over pressure relief, for example).

The hazardous area classification study should be conducted at an early stage in the design of the plant, and adapted/updated as the plant is being constructed, to reflect the “as built” plant.

The hazardous area classification may not be valid during operational modes which are not predictable or designed, that is, abnormal modes that may occur during commissioning, maintenance or equipment failure.

The usual hierarchy of control measures when designing a plant which may produce an explosive gas or vapour atmosphere are as follows:

- eliminate or modify the hazard
- eliminate or modify the ignition sources (explosion protection techniques).

Flammable hazard/ignition source types and extents should be considered at the design stage and minimized wherever possible.

1.1 What is Hazardous Area Classification?

In essence, Hazardous Area Classification provides a means of determining the probability of a flammable/explosive atmosphere occurring and its probable extent (and persistence), under given environmental and process conditions.

Source of Release types, the nature of the released gas or vapour itself and environmental ventilation characteristics largely determine the types and extents of hazardous Zones.

1.2 Ventilation

Ventilation can be Adequate or Inadequate. Adequate ventilation results in smaller, less severe hazardous areas (Zones) with potentially less persistence. Inadequate ventilation results in larger, more severe hazardous areas (Zones) with greater persistence, encompassing the interior of some installations.

Type of Ventilation – Two types of ventilation are defined – Adequate and Inadequate.

- Adequate Ventilation – is defined as *"an open air situation with natural ventilation, without stagnant areas, and where vapours are rapidly dispersed by wind and natural convection. Air velocities should never be less than 0.5 m/s and frequently above 2.0 m/s"*.

- Inadequate Ventilation – is defined as *"natural ventilation limited by topography, nearby structures, structure design and weather conditions".*

Availability of Ventilation - Three levels of availability of ventilation are defined as follows:

- Good Availability – for ventilation which is available continuously.

- Fair Availability – for ventilation which is expected to be present in normal operation, more or less continuously.

- Poor Ventilation – for ventilation which is not present continuously, but lapses in ventilation are not expected to occur for long periods.

Degree of Ventilation – Three degrees of ventilation are defined:

- High Ventilation – can reduce the concentration at the source almost instantly, resulting in a concentration in air which is below the Lower Explosive Limit (LEL). A Zone of "negligible extent" can be said to exist, provided that the Availability of the ventilation is also *Good*.

- Medium Ventilation – can control the concentration resulting in a stable zone boundary, while the release is in progress. This also results in relatively low persistence time of the explosive atmosphere, after the source of release has ceased to contribute.

- Low Ventilation – cannot control the concentration while the release is in progress and cannot prevent undue persistence of the explosive atmosphere after the source of release has ceased to contribute.

Availability and Degree of Ventilation have a direct effect on Zone type and extent.

1.3 Sources of Release and Zones

Sources of release can be Continuous, Primary and Secondary. There is a tendency for:

- Continuous sources of release to give rise to Zone 0 areas,
- Primary sources of release to give rise to Zone 1 areas, and
- Secondary sources of release to give rise to Zone 2 areas.

However, this is not always the case and the resulting Zone type and extent depends largely on the Ventilation available and the characteristics of the release itself. Table B.1 from AS/NZS 60079.10.1 demonstrates the effect of Ventilation Degree and Availability on probable Zone type and extent for various grades of release:

Grade of release	Ventilation						
	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]

Table B.1 – Influence of Independent Ventilation on Type of Zone
(Note: 'NE' refers to 'Negligible Extent')

1.4 Source of Release Table

The following parameters are entered into a Source of Release Table (SoRT). Using these data, the existence, type and extent of Zones can be determined and entered into the remaining columns of the SoRT.

References to paragraphs in the Hazardous Area Classification report as well as references to examples or clauses from applied standards are entered into the right most columns of the SoRT.

When determining the classification, most or all of the following parameters of the gas or vapour will need to be considered:

- Release mechanism,
- State (liquid, vapour or gas),
- Substance (Methane, Hydrogen, Hexane, etc.),
- Molecular Weight,
- Specific Gravity,

- Heavier or Lighter than air (noting that some vapours can act as though neutrally buoyant within certain specific gravity ranges and conditions),
- Flash Point,
- Auto Ignition Temperature,
- Pressure at which the flammable gas, liquid or vapour is being processed,
- Temperature at which the flammable gas, liquid or vapour is being processed,
- Grade of Release (secondary, primary or continuous), and
- Type, Degree and Availability of Ventilation.

1.5 Regarding Combustible Liquids

As an aside, it should also be noted that the vapour space in vessels used to store combustible liquids also presents a possible ignition hazard, with Zone 1 or Zone 0 being allocated to the vapour space (depending on the standards being referred to), irrespective of the flash point of the combustible liquid concerned.

Vents from such vessels will also form hazardous zones (again, type and extent depending on the standard or code adopted for the site).

The immediate assumption that combustible liquids do not present a hazard is an erroneous one, and entries for these sources of release must also be added to the SoRT.

Of particular concern is when the ambient or process temperature approaches the flash point of the combustible liquid within 6°C. After this point, the combustible liquid is treated as a flammable liquid (reference: AS/NZS 60079.10.1 ZA.5.1 Scope – “Note”).

1.6 Hazardous Area Classification Management

From IP 15, 3rd edition – Section 1.5:

> *Hazardous area classification should be incorporated into a company’s Health, Safety and Environmental Management System. The person responsible for the coordination of the hazardous area classification should be identified and be competent in this field.*
>
> *The work, which requires an interdisciplinary approach, should be carried out by persons who have full knowledge of the process systems and equipment, in consultation with safety, loss prevention and electrical engineering personnel, as appropriate.*
>
> *Agreements reached on the hazardous area classification should be formally recorded, continually reviewed and kept updated. Records, such as drawings and/or tabulated data sheets, should include details as to the type of protection selected to meet the zone requirements and the apparatus sub-group and temperature class.*

While Hazardous Area Classification is frequently conducted by Electrical/Instrumentation Engineers, a team of classifiers including Process

Engineers should be employed to review any existing classifications, as a plant is being constructed.

The Source of Release Table (SoRT), is commonly derived from Hazardous Area Classification reports for each area. The Hazardous Area Classification drawings are then derived from the SoRT, with plan and elevation views as required.

Vital data can and should be extracted from Process Flow Diagrams and associated Stream Tables, as well as Piping and Instrumentation Diagrams.

Access to the model of the plant (via designers/draftspeople) is also essential in determining the relative locations of sources of release and their possible impact on equipment not intended to operate within a hazardous area.

However, it should be noted that Vendor Packages on such models may not be rendered in sufficient detail, and the vendor drawings (and other data) will need to be accessed to determine what impact these packages make to the overall classification.

2. CLASSIFICATION METHODOLOGY

The classification methodology will dictate the applicable parts or clauses of the standards selected. For smaller plants where numerous potential sources of release are not grouped together into a comparatively small area, a Source of Release method, as described within AS/NZS 60079.10.1 Annex ZA may be the appropriate methodology.

For larger plants (such as refineries or LNG plants), where multiple instances of secondary sources of release may exist within a comparatively small area, the Generalised Method is more appropriate, as described in AS/NZS 60079.10.1 Annex ZB and supplemented with examples from API RP 505 where appropriate.

2.1 Other Standards – Normative References

AS/NZS 60079.10.1 refers to a number of other standards, some of which are referred to as Normative Standards. The word “Normative” when used in Australian standards has the meaning of “Mandatory” or “Integral”, in most cases. Those parts of standards which are referred to as “Informative” are intended to be “Advisory” or “For Guidance”, and are not mandatory.

With respect to “Normative References”, and to quote from AS/NZS 60079.10.1 Section 2 paragraph 1:

> *“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.”*

This is the case of API RP 505 and IP 15 (or EI 15 as it is now known). API RP 505 is widely used in large plant and contains a number of examples which are either identical or closely related to those (few) references quoted within AS/NZS 60079.10.1 Annex ZB - Generalised Method.

IP 15 can provide clarity when areas of AS/NZS 60079.10.1 are not clear or specific, but it is focussed on petroleum products in its application. API RP 505 covers a large number of general and specific installation types, and may be used in conjunction with AS/NZS 60079.10.1 Annex ZB when applying the generalised method.

It should be noted that while the standards referred to as Normative References within AS/NZS 60079.10.1 should be considered in conjunction with this standard in the first instance, there are other recognised families of standards which can be referred to should there be inadequate guidance from these primary references.

The use of these standards should be considered on a case by case basis, and justified by an analysis of the risks that they address. The usage of NFPA 59A for LNG storage tanks is such a case in point.

2.2 Source of Release Method

This method requires the consideration of each possible source of release to determine the resulting Zone type and extent (given the data within the SoRT).

Examples of Release types are:

- Secondary Sources of Release
  - *Flange Joints,*
  - *Valve Stems,*
  - *Threaded joints (including instrument connections to pipes).*
- Primary Sources of Release
  - *Vents,*
  - *Pressure relief devices.*
- Continuous Sources of Release
  - *Vapour spaces within vessels,*
  - *Open vessels,*
  - *Frequently operating sources.*

Each of these sources of release may be described by particular solutions within AS/NZS 60079.10.1 Annex ZA, which is generally acceptable for smaller installations or where larger plant has comparatively few sources of release and only in certain areas. That is, the handling or processing of flammable gases and vapours/liquids is only a small part of the overall process.

Examples of these specific solutions are as follows:

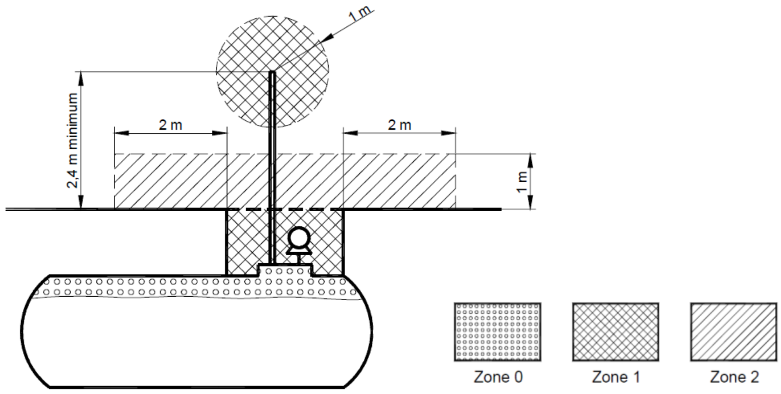

Figure 1 – Typical Classification of an Oil/Water Separator

Operating Pressure kPa		Radius from point of Potential Leakage Zone 2 Extents - m
	≤ 100	0.25
>100	≤ 700	0.50
>700	≤ 2000	1.00
>2000	≤ 5000	1.50
	> 5000	2.00

Table 1 – Piping with Valves, or Flanged/Threaded Joints

While classifying smaller plant or aspects of plants which have few hazardous areas may be completed satisfactorily using the Source of Release method as described in AS/NZS 60079.10.1 Annex ZA.

However, this becomes impractical with larger plants which have many sources or release, often grouped together, and where most of the processed material is either flammable or combustible. For such large plant (refineries or LNG plant) the Generalised Method is more appropriate.

2.3 Generalized Method

While the Source of Release method may be used for a number of sources of release, large plants dealing with flammables or combustibles could conceivably have thousands of individual sources, with literally dozens of sources of release in close proximity (for example, on the same package or "skid").

The example in **Figure 2** provides an example of one such source for a heavier than air gas or vapour with adequate ventilation. With a number of such sources in relatively close proximity, the Zone 2 areas simply merge (and are not additive). Zone 2 + Zone 2 gives rise to Zone 2.

However, caution must be used when there are a greater number of Zone 2 sources in close proximity, reduced ventilation and heavier than air vapours or gases (persisting for longer periods), all of which indicate that further investigation is required, with a Zone 1 hazardous area possibly resulting.

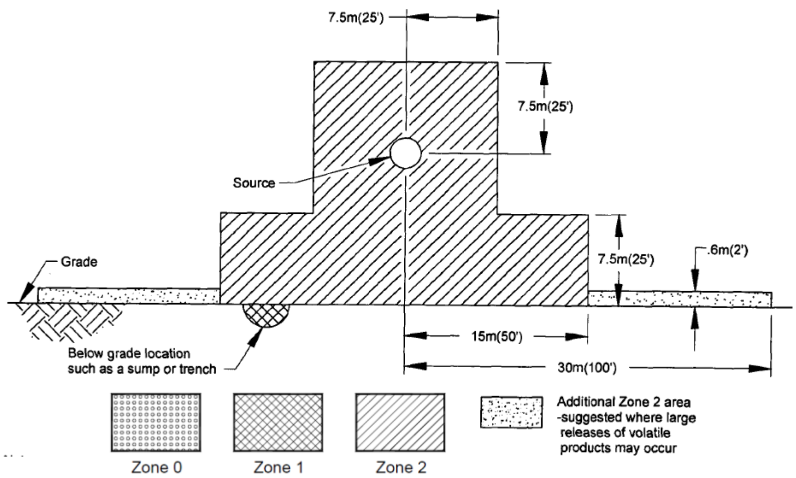

Figure 2 – Generalised Method Solution for Heavier than Air Gas or Vapour from Secondary Sources of Release

Figure 3 provides examples of the result of the addition of the Generalised Method Zone 2 areas for a large scale facility.

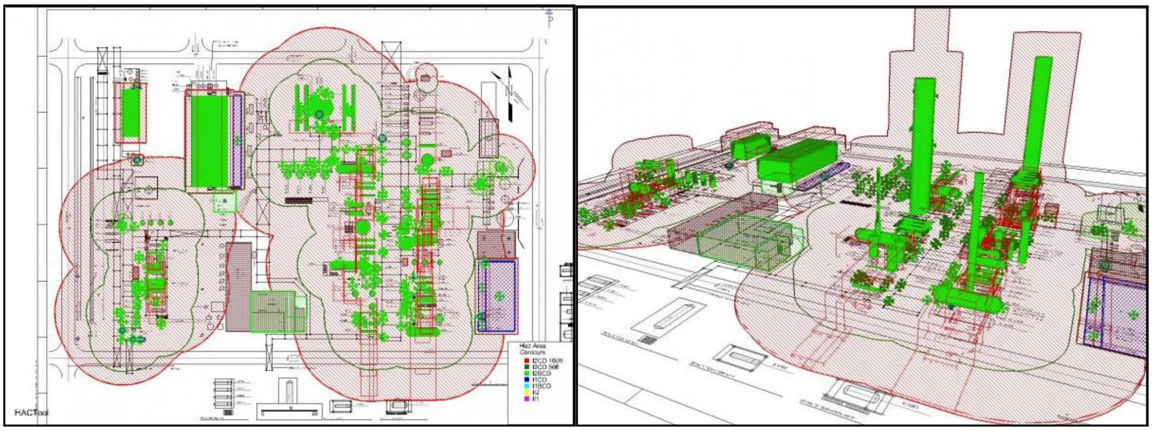

Figure 3 – Plant Classification using the Generalised Method

The left hand portion of **Figure 3** depicts the individual sources of release (green areas) while the right hand portion of **Figure 3** provides a three dimensional view of the overall classification.

While the application of the large overall Zone 2 areas may appear to be excessive, it should be considered that as there are quite a number of potential sources of release depicted in **Figure 3**, the use of the Source of Release method would have resulted in much more time being spent determining the classification, and may not have added to the overall safety of the classification in reality.

Using the Source of Release method on such an installation tends to give rise to “white areas”. These are islands of “Safe” or “Non-hazardous” areas exist only theoretically, but in practice could not exist under actual ventilation conditions.

3. CONCLUSIONS

3.1 The Source of Release method is well suited to the classification of smaller plant, or particular aspects of larger plant in some circumstances.

3.2 The Generalised Method is a safe, practical, time efficient method of ensuring a safe, fit for purpose classification for large plants such as refineries or LNG facilities.

3.3 The gathering of essential data as required for the Source of Release Table (SoRT) is essential for the successful application of either classification methodology.

3.4 Combustible as well as Flammable liquids must always be investigated when classifying any plant, due to hazardous areas forming in vapour spaces and from vents.

Definitions

Terms	Definition
Combustible Liquid	Any liquid, other than a flammable liquid, that has a flash point, and has a fire point that is less than its boiling point. For the purpose of this document, combustible liquids are divided into two classes as follows: (AS 1940:2004 Clause 1.4.9) *Class C1* - A combustible liquid that has a flash point of ≤ 150°, *Class C2* - A combustible liquid that has a flash point > 150°C.
EPL	Equipment Protection Level (AS/NZS 60079.10.1:2009 (+A1) Annex ZC; AS/NZS 60079.27:2007 Annex A).
Explosive Gas Atmosphere	A mixture with air, under atmospheric conditions, of flammable substances in the form of gas or vapour which, after ignition, permits self-sustaining propagation. (AS/NZS 60079.10.1 Clause 3.2)
Explosive Limits	
Lower Explosive Limit (LEL)	A concentration of flammable gas, vapour or mist in air below which an explosive atmosphere won't be formed. (AS/NZS 60079.10.1 Clause 3.17).
Upper Explosive Limit (UEL)	A concentration of flammable gas, vapour or mist in air above which an explosive atmosphere won't be formed. (AS/NZS 60079.10.1 Clause 3.18).
Flammable Gas or Vapour	A gas or vapour which, when mixed with air in certain proportions, will form an explosive gas atmosphere. (AS/NZS 60079.10.1 Clause 3.22)
Flammable Liquid	Liquids, or mixtures of liquids, or liquids containing solids in solution or suspension (e.g. paints, varnishes, lacquers, etc., but not including substances otherwise classified on account of their dangerous characteristics) which give off a flammable vapour at temperatures of not more than 60.5°C, closed cup test, or not more than 65.6°C, open cup test, normally referred to as the flash point. (AS 1940:2004 Clause 1.4.28) This class also includes— (a) liquids offered for transport at temperatures at or above their flash point; and (b) substances that are transported or offered for transport at elevated temperatures in a liquid state and which give off a flammable vapour. Class 3 flammable liquids are divided into 3 Packing Groups, as follows and as summarized below: – *PG I* - high danger; initial boiling point ≤ 35°C. – *PG II* - medium danger; flash point (closed cup) < 23°C; initial boiling point >35°C. – *PG III* - low danger; flash point (closed cup) ≥ 23°C ≤ 60.5°C; initial boiling point >35°C.
Flammable Mists	Droplets of liquid, dispersed in air so as to form an explosive atmosphere. Note that flammable mists can be formed by liquids which are under their flash points (combustible liquids) (AS/NZS 60079.10.1 Clause 3.23 and Annex D).
Flash Point	The lowest temperature, corrected to a barometric pressure of 101.3 kPa, at which application of a test flame causes the vapour of the test portion to ignite under the specified conditions of test. (AS 1940:2004 Clause 1.4.29).
Group	Group II – Electrical equipment of Group II is subdivided according to the nature of the explosive gas atmosphere for which it is intended (AS/NZS 60079.0Clause 4.2). – *IIA*, a typical gas is propane (other examples: acetone, methane, butane, ammonia, benzene, ethanol, hexane) – *IIB*, a typical gas is ethylene (other examples: diethyl ether, formaldehyde, hydrogen sulphide) – *IIC*, a typical gas is hydrogen (other examples acetylene, carbon disulphide).

EPL table (within the EPL definition):

Acceptable Adjustment Range for EPLs	
Zone	**Acceptable EPL Range**
0	Ga, Gb
1	Ga, Gb, Gc
2	Ga, Gb, Gc
Non-hazardous	Ga, Gb, Gc or none

Terms	Definition
HAC	Hazardous Area Classification
Hazardous Area	An area in which an explosive gas or vapour atmosphere is or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of equipment. (AS/NZS 60079.10.1 Clause 3.3).
Hazardous Area Classification	Area classification is a method of analysing and classifying the environment where explosive gas (or combustible dust) atmospheres may occur so as to facilitate the proper selection and installation of equipment to be used safely in that environment. (AS/NZS 60079.10.1 Clause 4.2 para. 1). NOTE: Classification also takes into account the ignition characteristics of the gas or vapour such as ignition energy (gas group) and ignition temperature (temperature class).
Ignition Sources	A source of energy sufficient to ignite an explosive atmosphere. Including but, not limited to flames, incandescent material, electrical sparks, hot surfaces & mechanical impact sparks. (AS/NZS 60079.10.1 Clause 3.30.11).
Ignition Temperature	Also called “Auto-Ignition temperature”. This is the lowest temperature of a heated surface which, under specified conditions according to AS/NZS 60079.20.1, will ignite a flammable substance in the form of a gas or vapour mixture in air. (AS/NZS 60079.20.1 clause 5.1.7 & Annex A).
Informative	For Information or Guidance. “An informative Annex (or reference) is only for information and guidance”. (AS/NZS 60079.10.1 Preface: last paragraph)
LOC	Limiting Oxygen Concentration – The concentration of oxygen in a flammable mixture, below which combustion is not possible, independent of the concentration of flammable substance. It is expressed in units of volume percent of oxygen. The LOC varies with pressure and temperature. It is also dependent on the type of inert (non-flammable) gas. Example: LOC for Methane is approximately 12%.
LNG	Liquefied Natural Gas – A hydrocarbon fluid composed predominantly of methane (CH_4), refrigerated to the liquid phase at atmospheric pressure. (AS 3961 – 2005 Clause 1.3.18).
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 equipment. (AS/NZS 60079.10.1Clause 3.4).
Normative	A Mandatory Requirement. “A normative Annex (or reference) is an integral part of the Standard”. (AS/NZS 60079.10.1 Preface: last paragraph).
Operational Modes	
Normal Operation	*Normal Operation* is the operating mode which is established when the plant is operating within its design parameters. This includes minor releases of flammable material. For example, releases from seals which rely on wetting by the fluid which is being pumped are considered to be minor releases.
Abnormal Operation	*Abnormal Operation* includes the following modes: • Failures, such as the breakdown of pump seals, flange gaskets or spillages caused by accidents, which involve urgent repair or shutdown, but which are not catastrophic failures, • Initial start-up and maintenance shutdown conditions, • The operation of pressure relief devices, and • The operation of the plant in secondary or backup modes which serve to protect the plant, but are not usual or normal modes of operation. Hazardous area classifications may be invalid during Abnormal Operation. Operation under foreseeable Abnormal Modes should be subject to a Risk Analysis and HAZOP process before energisation with conditions of control being imposed during such an operational mode.
Catastrophic Failure	*Catastrophic Failure* is a mode of operation where control and/or containment of the process has been lost, beyond the design parameters of any backup systems. Control/containment may be unrecoverable. Hazardous area classifications are invalid in this case.
Release Rate	The quantity of flammable gas, vapour or mist emitted per unit time from the source of release.
Relative Density of a Gas or Vapour	The density of a gas or a vapour relative to the density of air at the same pressure at the same temperature (air = 1.0). (AS/NZS 60079.10.1 Clause 3.19).

Terms	**Definition**
Lighter than air	Buoyancy of release - a gas or vapour should be considered as (being) buoyant and lighter than air if its density on release to atmosphere from a non-pressurised source would be less than 0.75/0.80 relative to the ambient air. (IP 15 – Edition 3 Annex H & AS/NZS 60079.10.1 Clause 5.4.4).
Neutrally buoyant	Care should be taken in the application of vapour densities where they are in the range of about 0.75/0.80 to 1.20/1.25. (HB 13 Clause 1.5.2.8 & AS/NZS 60079.10.1 Clause 5.4.4). Gases or vapours in this range, particularly if released slowly, may be rapidly diluted to a low concentration and their movement will be similar to that of the air in which they are effectively suspended.
Heavier than air	Generally, any gas or vapour which has a relative density of greater than 1.0, with particular reference to those that have a relative density of 1.20/1.25 and above. (IP 15 – Edition 3 Annex H & AS/NZS 60079.10.1 Clause 5.4.4).
SoRT	Source of Release Table
Source of Ignition	A source of energy sufficient to ignite an explosive atmosphere. Such sources include but are not limited to flames, incandescent material, electrical sparks, hot surfaces and mechanical impact sparks. (AS/NZS 60079.10.1 Clause 3.30.11).
Source of Release	A point or location from which a gas, vapour, mist or liquid may be released into the atmosphere so that an explosive gas atmosphere could be formed. There are three basic grades of release, as listed below in order of decreasing frequency and likelihood of the explosive gas atmosphere being present. (AS/NZS 60079.10.1Clause 3.9, 3.10). NOTE: A source of release may give rise to any one of these grades of release, or to a combination of more than one.
Continuous Grade	A release which is continuous or is expected to occur frequently or for long periods. (AS/NZS 60079.10.1 Clause 3.11). IP15 3rd edition also states “A release should be regarded as continuous grade if it is likely to be present for more than 1000 hours per year”.
Primary Grade	A release which can be expected to occur periodically or occasionally during normal operation. (AS/NZS 60079.10.1 Clause 3.12). IP15 3rd edition also states “primary grade if it is likely to be present for between 10 and 1000 hours per year”
Secondary Grade	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. (AS/NZS 60079.10.1 Clause 3.13). IP15 3rd edition also states “secondary grade if it is likely to be present for between 1 and 10 hours per year and for short periods”.
Release Rate	The quantity of flammable gas, vapour or mist emitted per unit time from the source of release. (AS/NZS 60079.10.1 Clause 3.14).
Temperature Classification	See table below. (AS/NZS 60079.0 Clause 5.3.2.2)
Vapour Barrier	A wall or other barrier (which is used) to prevent the passage of vapour between adjacent areas. (AS/NZS 60079.10.1 Clause 3.30.13).
Vapour Pressure	The pressure exerted when a solid or liquid is in equilibrium with its own vapour. A function of the substance and of the temperature. (AS/NZS 60079.10.1 Clause 3.26).
Vapour Space	The space, within a closed vessel or tank, above a flammable or combustible liquid, which can form a hazardous area if oxygen is also present. For the purposes of Project Gorgon, combustible liquids form a Zone 1 hazardous area within an oxygenated vapour space, and flammable liquids form a Zone 0 hazardous area within an oxygenated vapour space. However, if oxygen has been effectively excluded, the vapour space is classified as Non-Hazardous. Example – LNG Tank interiors.

Temperature Class	**Maximum Surface Temperature °C**
T1	450
T2	300
T3	200
T4	135
T5	100
T6	85

(AS/NZS 60079.0 Clause 5.3.2.2)

Terms	Definition
Ventilation	The 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). (AS/NZS 60079.10.1 Clause 3.16).
Adequate	An open-air situation with natural ventilation, without stagnant areas, and where vapours are rapidly dispersed by wind and natural convection. Air velocities should rarely be less than 0.5 m/sec and should frequently be above 2 m/s. (AS/NZS 60079.10.1 Table ZA.1).
Inadequate	Natural ventilation limited by topography, nearby structures, weather conditions. (AS/NZS 60079.10.1 Table ZA.1).
Types of	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. (AS/NZS 60079.10.1 Clause 6.2).
Degree of	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. Degrees of ventilation may be <u>High</u>, <u>Medium</u> or <u>Low</u>. (AS/NZS 60079.10.1 Clause B.4).
Availability of	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. Availabilities can be: <u>Good</u>, <u>Fair</u> and <u>Poor</u>. (AS/NZS 60079.10.1 Clause B.6).
Zones	Hazardous areas are classified into zones based upon the frequency of the occurrence and duration of an explosive gas atmosphere, as follows: (AS/NZS 60079.10.1 Clause 3.5)
Zone 0	an area in which an explosive gas atmosphere is present continuously or for long periods or frequently (AS/NZS 60079.10.1 Clause 3.6). Associated with continuous sources of release.
Zone 1	an area in which an explosive gas atmosphere is likely to occur in normal operation occasionally (AS/NZS 60079.10.1 Clause 3.7). Associated with primary sources of release.
Zone 2	an area in which an explosive gas atmosphere is not likely to occur in normal operation but, if it does occur, it will exist for a short period only (AS/NZS 60079.10.1 Clause 3.8). Associated with secondary sources of release.

Standards Referenced

Standard/Document	Description
API RP 505 First Edition November 1997	API RECOMMENDED PRACTICE Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class 1, Zone 0, Zone 1, and Zone 2", November 1997 Edition (R2002).
AS 1940 – 2004 (+A1, +A2)	The storage and handling of flammable and combustible liquids
AS/NZS 3000:2007 (+A1, +A2)	Electrical installations (the "Wiring Rules")
AS 3961 – 2005	The storage and handling of liquefied natural gas.
AS/NZS 60079.10.1:2009 (+A1)	Explosive atmospheres – Part 10-1: Classification of areas – Explosive gas atmospheres
AS/NZS 60079.20.1:2009	Explosive atmospheres – Material characteristics for gas and vapour classification – Test methods and data
EI (IP) 15 July 2005 (3rd Edition)	Area Classification Code for Installations Handling Flammable Fluids – Part 15 of the IP Model Code of Safe Practice in the Petroleum Industry
EI (IP) 15 March 2002 (2nd Edition)	Research Report: Dispersion Modelling and Calculations in Support of EI Model Code of Safe Practice Part 15 (formerly IP 15): Area Classification Code for Installations Handling Flammable Liquids.
NFPA 59A 2013 Edition	Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)

Other References

[1] A Common Sense Approach to Hazardous Area Classification for Electronic Instrumentation

Jim Johnston, Sr. Instrument/Electrical Engineer

[2] Introduction to Hazardous Electrical Location Classifications

White Paper - Cougar Industries

[3] Hazardous Area Classification Fact Sheet

Electrical Projects Australia Pty Limited

[4] Hazardous Area Classification

Fortis BC

[5] Hazardous Area Classification (Generalized Method Figures used)

BakerRisk – Baker Engineering and Risk Consultants.

[6] Various Standards (national and international) – Listed in "Standards Referenced" above.