CHAPTER 3
AREA CLASSIFICATION

Many North American facilities using the Zone concept in the future will classify Hazardous Locations as Zone 2, which is equivalent to Division 2.

3.1 COMPARISON BETWEEN DIVISIONS & ZONES

Outside of the USA many countries are migrating to the use of the Zone classification system, which gives them greater flexibility for choices of equipment and wiring methods. Except for Switzerland and the United Kingdom, many of these facilities using the Zone concept outside of North America are classified as Zone 1. This is in direct conflict to areas in North America where over 90% of hazardous areas are classified as Zone 2 or Division 2. There were 3 primary catalysts for reclassifying areas as Division 2 from Division 1:

- Reduced cost—Division 2 installations are less expensive.
- Air pollution laws—These required the drastic reduction of fugitive emissions, which would normally escape in Division 1 areas.
- Safety—Most companies reduced emissions to create safer working environments.

It is logical to expect that most North American facilities using the Zone concept in the future will classify Hazardous Locations as Zone 2, which is equivalent to Division 2.

A comparison of the Division and Zone classification system is shown in Table 3.1. Division 2 is equivalent to Zone 2 while Division 1 is either Zone 0 or 1. Zone 0 is reserved for those areas continuously hazardous (e.g., inside a vented fuel tank), so other Division 1 areas would be classified as Zone 1.

Table 3.1
Classification System Comparison

Class I	Division System	Description	1996 *NEC* (Article 505) & 1998 *CEC* Zone System	Comments
Gases & Vapors	Division 1	Hazardous under normal operations	Zone 0 Zone 1	Division 1 is split into Zone 0 and 1. Zone 0 is a small percentage of locations usually confined to inside vented tanks.
	Division 2	Not normally hazardous	Zone 2	Zone 2 and Division 2 are essentially the same.

There is a large opportunity for additional, lower cost Zone 2 equipment as companies classify more areas as Zone 2 outside of North America.

3.2 PRESENT DAY HAZARDOUS AREA CLASSIFICATIONS AND PRODUCT MIX

It is estimated that less than 5% of hazardous areas in North America are classified as Division 1. The split of hazardous areas in Europe is just the opposite, with over 60% of the areas classified as Zone 1. See Table 3.2. Because of this, the percentage of products offered for Hazardous Locations also varies from North America to Europe. The majority of hazardous area products in North America are for Division 2 while in Europe they are for Zone 1 applications. One reason is that the product standards for Zone 2 apparatus have only recently been written.

Table 3.2
Comparison of Zones and Divisions

Classified Area		Time that hazardous gases are present in ignitable concentrations	Estimated % of Division areas in North America	Estimated % of Zone areas in Europe
Zone 0		Continuously		<2%
	Div. 1	Normally Present	<5%	
Zone 1		Occasionally in normal operations		>60%
Zone 2	Div. 2	Not normally present	>95%	<40%

Area classification is the determination of the probable frequency and duration of the presence of gas, vapor or mist in excess of 100% of the LEL.

3.3 AREA CLASSIFICATION—A PRACTICAL APPROACH

Area classification is the most important aspect of electrical design in Hazardous Locations. Historically, the process of classifying Hazardous Locations has not been well understood by many designers. As a consequence, the approach to "over-classify" to err on the side of safety has been the industry standard.

Most hazardous areas located indoors were classified as Division 1. (Old-style motor starters have been replaced by EBMs.)

While it was common practice prior to the early 1990s to classify most indoor Class I Hazardous Locations as Zone 1 (Division 1), many users now believe that most buildings function in accordance with the definition for Class I, Zone 2. It is important to remember that the Hazardous Location definitions in the *NEC* and *CEC* are the basic requirements. There are many other industry documents such as the *API Recommended Practice for Area Classification* which are only recommended means of meeting the *Code* definitions and are not *Code* requirements. Any method that demonstrates compliance with the area classification definitions meets the requirements of the respective *Code*.

In most buildings the area classification choice is between Zone 1 and Zone 2. In making that choice there are a number of tools that may be used. If it can be demonstrated that a building is "adequately ventilated," it meets one of the main requirements of a Zone 2 classification. The other requirement for a Zone 2 classification is that in the event of an abnormal gas release approaching or exceeding explosive levels, action must be taken to correct the problem within a "short time." Many industrial users accept a 10-hour/per year "rule of thumb" limit on exposure to "explosive gas atmospheres" for Zone 2 Hazardous Locations. If the building is on a site that is continuously manned, or it is monitored by gas detection to shut down the process, or alarmed to allow operating personnel to correct the problem, the requirements for a Zone 2 classification are often effectively met.

3.4 ADEQUATE VENTILATION

API RP505 — *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2* outlines a number of methods for demonstrating or meeting the requirement for "adequate ventilation." One method that has been used for many years is to provide a minimum of six continuous air changes per hour. Another method is to carry out a fugitive emissions study as outlined in Appendix B of the API standard. For existing buildings a third method would be to measure the gas concentration in various areas of the building to determine if the requirement for "adequate ventilation" is actually met. Permanently installed gas detection system records are often available to provide historical data. In recent years a combination of fugitive emission studies and measurement have been used to demonstrate a building is adequately ventilated.

Gas detectors in process plants detect the presence of volatile vapors.

While past practices achieved Zone 2 (Division 2) area classification by providing six air changes per hour by mechanical means, recent experience has shown that in many Class I buildings, "adequate ventilation" often requires less than one air change per hour, and can be provided by the naturally occurring ventilation. Often the reduced ventilation requirement eliminates the need for complicated and expensive ventilation systems and reduces the energy required to heat the building. (Calculation formulas are also given in IEC 60079-10) However, there are many instances where buildings such as pumping stations are remotely located and not manned on a 24-hour basis. The buildings are designed as Zone 1 to accommodate any unforeseen problems.

Many skid platforms are not manned and are classified as Zone 1.

3.5 WHO CLASSIFIES HAZARDOUS LOCATIONS?

There is considerable debate around the world as to who is responsible for the classification of Hazardous Locations. The general consensus of opinion is that it is a task for chemical and/or process engineers, but should include the advice of electrical and mechanical engineers in the analysis.

If the North American Division method of area classification has been used on an existing plant then reference can be made to Appendix J of the Canadian Code, the National Electric Code Article 500-503 and the American Petroleum Institute Publications RP 500B and RP 500C. Articles 500-505 of the NEC, Section 18 of the Canadian Code and the IEC Standard 79-10 publication provide guidance on classifying Hazardous Locations for the Zone system. In any case a thorough analysis should be undertaken by the responsible designers, chemical or electrical engineers to determine the correct Hazardous Locations classification. The following portions in this section define the classifications and provide insight on how the rest of the world classifies Hazardous Locations.

Article 501.1 of the NEC permits properly marked Class I, Zone 0,1 or 2 equipment to be installed in Division 2.

3.6 CLASS I HAZARDOUS LOCATIONS

The classification of Hazardous Locations is a complex subject. It would be ideal if all electrical equipment could be installed in safe areas so that no danger from electrical ignition was possible in the process plant, but this situation is seldom likely. Therefore the classification of areas is an essential design consideration.

Area classification in Class I locations is the determination of the probable frequency and duration of the presence of an explosive gas atmosphere in a Hazardous Location.

An **explosive gas atmosphere** is defined as:
"A mixture with air, under atmospheric conditions, of flammable substances in the form of gas, vapor, or mist in which, after ignition, combustion spreads throughout the unconsumed mixture."

In other words, area classification is the determination of the probable frequency and duration of the presence of gas, vapor or mist in excess of 100% of the LEL. Areas where an explosive gas atmosphere is likely to be present more frequently or for longer periods will have "higher" area classification than areas where explosive gas atmospheres occur less frequently or for shorter periods.

3.7 DEFINITION OF DIVISIONS

North American Hazardous Locations are divided into Class and Divisions:

A **Class I, Division 1** location is one where an explosive atmosphere is presumed to be present in normal operation either all or part of the time. These are typically manufacturing areas such as a pharmaceutical plant where volatile gases escape from vessels during fermentation. In theory, Division 1 locations encompass both Zones 0 and 1 as designated in IEC Standards.

Division 1 areas encompass Zones 0, 1 & 2.

A **Class I, Division 2** location is one where volatile flammable liquids or flammable gases are handled, processed or used, but which are normally enclosed in containers from which they can only escape in the case of accidental rupturing or abnormal operation of equipment. A storage room which houses 55-gallon drums of volatile solvents would be a typical example of a Division 2 location. This classification approximates Zone 2 in IEC Standards.

3.8 DEFINITION OF ZONES

Class I locations can be further divided into three Zones based upon frequency of occurrence and duration of an explosive gas atmosphere as follows:

3.8.1 ZONE 0

(a) Zone 0, comprising Class I locations in which explosive gas atmospheres are present continuously or are present for long periods;

Zone 0 locations are typically locations such as the vapor space above the liquid in a tank. In Zone 0 locations it is probable that the gas concentration will exceed 100% of LEL for very long periods. Table 3 in paragraph 6.5.8.3 of API-RP505—Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2, suggests Zone 0 locations are those where there is a flammable mixture typically more than 1,000 hours per year. Zone 0 locations typically do not exist outside of enclosed spaces except for the area immediately around vents which are venting from a Zone 0 location.

The inside of a vented storage tank is typically Zone 0.

3.8.2 ZONE 1

(b) Zone 1, comprising Class I locations in which:
(i) Explosive gas atmospheres are likely to occur in normal operation; or

Table 3 in paragraph 6.5.8.3 of API-RP505—Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2, suggests Zone 1 locations are those where there is a flammable mixture more than 10 hours per year and less than 1,000 hours per year. Zone 1 locations normally occur around vents or in enclosed areas where there are intermittent or continuously open processes (for example, a

paint spray booth). When classifying indoor locations it is common to treat them as Zone 1 if it cannot be demonstrated the conditions for a Zone 2 location exist. An example of this situation would be a remote unattended gas compressor building where there is no gas monitoring. An abnormal leak resulting in gas concentration exceeding 100% of LEL could conceivably persist for well above the 10-hour threshold for Zone 1 locations.

Remote pumping stations should have gas monitors installed to detect gas leaks.

(ii) Explosive gas atmospheres may exist frequently because of repair or maintenance operations or because of leakage;

Examples of Zone 1 locations that exist as the result of repair or maintenance are the areas around a pig trap where gas or vapor is released each time the trap is opened or the area around a filter where gas is released each time the filter is changed. These areas are typically limited to the immediate area of the equipment as the amount of gas released is relatively small and is diluted to safe concentrations a short distance from the equipment.

Wellhead and gas detector.

(iii) The location is adjacent to a Class I, Zone 0 location, from which explosive gas atmospheres could be communicated.

Typically these areas would exist around a vent from a Zone 0 location. The size of the Zone 1 area around the Zone 0 area will depend upon the rate of release of the gas or vapor, the vapor density of the material released and the conditions in the area where it is released.

Outside the Zone 0 area is a Zone 1 area.

3.8.3 ZONE 2

(c) Zone 2, comprising Class I locations in which:
(i) Explosive gas atmospheres are not likely to occur in normal operation and, if they do occur, they will exist for a short time only; or

Explosive gas atmospheres will not occur in the air except as the result of an abnormal situation such as a failed pump packing, flange leak, etc. Also when an abnormal situation does occur it will be corrected within a short time. API-RP505—Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2 suggests Zone 2 locations are those where explosive gas atmospheres will exist for less than 10 hours per year. Most Inspection Authorities require that indoor locations be classified as Zone 1 unless it can be demonstrated the conditions for Zone 2 exist. Indoor locations in remote unattended and unmonitored facilities most often cannot meet the 10-hour per year rule of thumb. The most common means of meeting the 10-hour rule of thumb in remote facilities is to install gas detection to shut down and depressurize the facility or to send an alarm to alert personnel to take corrective action.

It is important that means to ensure the limited exposure time is met in Zone 2 locations as the design requirements for equipment acceptable in Zone 2 locations are based on limited exposure time.

(ii) Flammable volatile liquids, flammable gases, or vapors are handled, processed, or used, but in which liquids, gases, or vapors are normally 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 systems or the abnormal operation of the equipment by which the liquids or gases are handled, processed, or used; or

This is the original wording for Class I, Division 2 locations prior to the addition of the IEC definition above in the 1998 Code. It has similar meaning to (i) except it does not clearly outline the limited exposure time.

Areas where volatile liquids are stored are normally classified as Zone 2 or Division 2.

(iii) Explosive gas atmospheres are normally prevented by adequate ventilation but which may occur as a result of failure or abnormal operation of the ventilation system; or

Adequate ventilation is defined as "natural or artificial ventilation that is sufficient to prevent the accumulation of significant quantities of vapor-air or gas-air mixtures in concentrations above 25% of their lower explosive limit." During "normal operation" there are small gas and vapor releases from various components of the piping system such as pump seals, valve packing and flange gaskets. These releases are relatively small in comparison to abnormal releases due to equipment failures. These releases are referred to as "fugitive emissions." Adequate ventilation for an enclosed area is therefore the amount of ventilation required to continuously dilute the fugitive emissions in that enclosed area to concentrations below 25% of their LEL. (In practice it is uncommon to encounter gas concentrations above 1 or 2% of LEL.)

Appendix B of API-RP505—Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2 outlines a procedure for determining the fugitive emissions in an enclosed area and calculating the amount of ventilation required to achieve "adequate ventilation." For existing facilities it is also possible to determine whether an enclosed area is adequately ventilated by measurement of the emissions in the area during "normal operation."

Adequate ventilation deals only with the ventilation required to dilute the normal or fugitive emissions. It is not intended to ensure that gas concentrations during an abnormal release will not reach concentrations above 100% of the LEL. In an "adequately ventilated area," explosive gas atmospheres may be experienced as the result of a loss of ventilation or an abnormal gas or vapor release. In addition to "adequate ventilation," it is also important to ensure that measures are in place to ensure that explosive concentrations of gas exist for "a short time only." As outlined above, API RP500 suggests a short time to be less than 10 hours per year in total. For unattended facilities, it is usually necessary to install gas detection systems to either shut down the facilities or to send an alarm to alert personnel to take corrective action when an abnormal release of gas or vapor occurs. Typical industry practice is to alarm and initiate additional ventilation when the LEL in a building reaches 20% and to shut down the process in the building if the LEL reaches 40%.

(iv) The location is adjacent to a Class I, Zone 1 location from which explosive gas atmospheres 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.

Similar to (b)(iii), there will normally be a Zone 2 area classified around a Zone 1 area surrounding a vent. It is also common for there to be a Zone 2 location around enclosed areas classified as Zone 1 unless there is a "vapor-tight barrier" around the Zone 1 area. For example, a process building with doors windows and other openings in the walls will typically have a Zone 2 area around all or portions of the building.

Outside the Zone 1 area is a Zone 2 area.

As outlined above, area classification is based on the probable frequency and duration of the occurrence of "explosive gas atmospheres at a location." It is done primarily to determine the type of equipment that is suitable for use in the area. The design of Hazardous Location equipment is based on the likely exposure time to "explosive gas atmospheres" as defined above.

3.9 ZONE CLASSIFICATION SUMMARY

The primary activity for Area Classification is to list the process equipment in the area under consideration and identify all potential sources of flammable material. An estimate must be made of the duration and frequency of each release in order to classify the emission as Continuous, Primary or Secondary and the rate of potentially explosive atmosphere into the surrounding area.

- Continuous Grade (1000 hours/year) leads to a Zone 0.
- Primary Grade (100 hours/year) leads to a Zone 1.
- Secondary Grade (10 hour/year in total) leads to a Zone 2.

3.10 EXAMPLES OF HAZARDOUS AREA ZONE CLASSIFICATION

ZONE 0

- Areas within process equipment developing flammable gas or vapors.
- Areas within enclosed pressure vessels or storage tanks.
- Areas around vent pipes which discharge continually or for long periods.
- Areas over or near the surface of flammable materials.

ZONE 1

- Areas above roofs outside storage tanks.
- Areas above floating storage tanks.
- Areas within a specified radius around the outlet pipes and safety valves.
- Rooms without ventilation openings from a Zone 1 area.
- Areas around flexible pipelines and hoses.
- Areas around sample taking points.
- Areas around seals of pumps, compressors and similar primary sources.

ZONE 2

- Areas around flanges and connecting valves.
- Areas outside Zone 1 around outlet pipes and safety valves.
- Areas around vent openings from Zone 2.

Typical Zone designation.

Zone 0 is inside the vented tank and near the vent.
Zone 1 is a perimeter around the vent.
Zone 2 is the area outside the tank.

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