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CLASSIFICATION OF CLASS I HAZARDOUS LOCATIONS FOR ELECTRICAL INSTALLATIONS IN CHEMICAL PLANTS

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NFPA®

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Recommended Practice for Classification of

Class I Hazardous Locations for Electrical Installations in Chemical Plants

NFPA 497–1975

Origin and Development of NFPA 497

The Sectional Committee on Electrical Equipment in Chemical Atmospheres obtained official adoption of this Recommended Practice at the Association's 1975 Annual Meeting, on May 15, 1975.

The text presented here contains those recommendations which the Sectional Committee believes to be essential for the classification of Class I hazardous locations in chemical plants.

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Those desiring an interpretation shall supply the Chairman with five identical copies of a statement in which shall appear specific reference to a single problem, paragraph, or section. Such a statement shall be on the business stationery of the inquirer and shall be duly signed.

When applications involve actual field situations they shall so state and all parties involved shall be named.

The Interpretations Committee will reserve the prerogative to refuse consideration of any application that refers specifically to proprietary items of equipment or devices. Generally inquiries should be confined to interpretation of the literal text or the intent thereof.

Requests for interpretations should be addressed to the National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210.

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Class I Hazardous Locations for Electrical Installations in Chemical Plants

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Chapter 1 Introduction

1-1 Purpose.

1-1.1 Electrical installations in locations hazardous because of flammable atmospheres can be suitably designed if the zones of potential hazard are clearly defined. It is the intent of this Recommended Practice to present a basis for the classification of such locations for electrical installations in chemical plants. As used here, a chemical plant is a large integrated plant or the portion of such a plant where flammable or combustible liquids are produced by chemical reactions or used in chemical reactions.[1]

1-1.2 If a location is to be classified correctly, certain questions need to be answered: Does a hazardous location exist? If it does, what type is it and how far does it extend? The purpose of this Recommended Practice is to provide assistance in answering those questions.

1-1.3 This Recommended Practice uses the criteria established by the *National Electrical Code, NFPA 70-1975,* for classifying hazardous locations. Once a location has been classified there should be little difficulty in making a proper electrical installation because the *National Electrical Code* specifies the type of equipment and wiring methods to be used.

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[1] Throughout this Recommended Practice reference is made to areas, spaces, locations, and zones. In general, the word "areas" has been used to designate a two-dimensional space. Spaces, locations, and zones should be considered interchangeable terms designating a three-dimensional space.

1-2 Scope.

1-2.1 This Recommended Practice applies to those locations where flammable liquids or gases are processed or handled in chemical plants.

1-2.2 Chemical and physical changes may occur during the handling and use of flammable liquids, gases and vapors. The composition and properties of materials may change drastically during processing or under abnormal conditions. Those properties and chemical changes were considered in the preparation of this Recommended Practice.

1-2.3 This Recommended Practice is not an attempt to rewrite or otherwise supersede the *National Electrical Code, NFPA 70-1975,* nor is it intended to supersede or be inconsistent with applicable sections of the *Flammable and Combustible Liquids Code, NFPA 30-1973*; the *Standard for the Storage and Handling of Liquefied Petroleum Gases, NFPA 58-1974*; *Standard for Spray Application Using Flammable and Combustible Materials, NFPA 33-1973*; *Standard for Dip Tanks Containing Flammable or Combustible Liquids, NFPA 34-1974*; *Standard for Solvent Extraction Plants, NFPA 36-1974*; *Standard for Gaseous Hydrogen Systems at Consumer Sites, NFPA 50A-1973*; and *Standard for Liquefied Hydrogen Systems at Consumer Sites, NFPA 50B-1973.*

1-2.4 This Recommended Practice is a guide to safe practices and should be applied with sound engineering judgment. When all factors are properly evaluated, a consistent classification can be developed.

Chapter 2 General Information

2-1 National Electrical Code Criteria and Equipment Considerations.

2-1.1 Article 500 of the *National Electrical Code, NFPA 70-1975,* defines Class I locations as those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitible mixtures; Class II locations are those which are hazardous because of the presence of combustible dust; and Class III locations are those which are hazardous because of the presence of easily ignitible fibers or flyings, but in which such fibers or flyings are not likely to be in suspension in air in quantities sufficient to produce ignitible mixtures.[1]

2-1.2 Within each location class, the *National Electrical Code* recognizes two divisions. Within Class I these divisions are:

2-1.2.1 Division 1. The criterion for these locations is that they are likely to have flammable mixtures present under normal conditions.

(a) Installations for Division 1 locations are designed so that operation or failure of any portion of the electrical system will not release flame or hot gases or have high enough surface temperatures to ignite the surrounding atmosphere.

2-1.2.2 Division 2. The criterion for these locations is that they are likely to have flammable mixtures present only under abnormal conditions, such as the failure or rupture of equipment.

(a) Installations for Division 2 locations use equipment arranged so that full operation of the electrical system (including arcing and similar devices) may occur without providing a source of ignition under normal conditions. Complete protection is

[1] These classes are unrelated to the National Fire Protection Association (NFPA) definitions covering flammable liquids as discussed in 2-3.3.

not provided against ignition due to electrical breakdown inasmuch as electrical breakdowns occur very rarely and equipment is usually de-energized automatically.

2-1.2.3 By inference, locations which cannot be classified as Division 1 or 2 are nonhazardous under the *National Electrical Code, NFPA 70-1975.*

2-1.3 Unfortunately, no single type of electrical equipment enclosure is best in all respects. Electrical installations must be designed to protect against power failures, accidental grounds, and electric shock resulting from personal contact with energized conductors, in addition to avoiding the probability of accidental ignition of flammable liquids, vapors, or gases released to the atmosphere. Explosionproof equipment—correctly designed, manufactured, installed, and maintained—provides the best protection against ignition when flammable mixtures are present. However, general-purpose equipment located outside the hazardous location provides the relaying and automatic controls which best insure against ignition due to electrical faults. Equipment with general purpose enclosures has features that permit easier maintenance with proper worker protection and with minimum power service interruption. The safest electrical systems would use to advantage the best features of each type.

2-1.4 Factors such as corrosion, weather, maintenance, equipment standardization and interchangeability, and possible process changes or expansion frequently dictate the use of special enclosures or installations for electrical systems. However, such factors are outside the scope of this publication, which is concerned entirely with the proper application of electrical equipment to avoid ignition of flammable mixtures.

2-1.5 Aside from considerations relative to enclosure integrity, other approaches can be taken in electrical design that may be equally effective.

2-1.5.1 It is also possible to locate electrical equipment, such as switchgear, transformers and starters, outside of the hazardous locations.

2-1.5.2 Positive pressure (above atmospheric) of an enclosure or rooms from a source of clean air is permissible by the *National Electrical Code* (Section 500-1) if adequate safeguards are incorporated in the installation. Part A of the *Standard for Purged and Pressurized Enclosures for Electrical Equipment in Hazardous Locations, NFPA 496-1974*, contains requirements for pressurized enclosures and rooms.

2-1.5.3 An approach that is effective where power levels are low is to use intrinsically safe electrical systems, which are also recognized by the *National Electrical Code*. Requirements for intrinsically safe installations are contained in the *Standard for Intrinsically Safe Process Control Equipment for Use in Class I Hazardous Locations, NFPA 493-1969.*

2-2 Conditions Necessary for a Fire or Explosion.

2-2.1 Three basic conditions must be satisfied for the occurrence of a fire or explosion. These are:

1. A flammable gas or vapor must be present.
2. It must be mixed with air in the proportions required to produce a flammable or ignitible mixture. Further, within the context of this publication, there must be a sufficient amount of this mixture to provide an ignitible atmosphere surrounding the electrical installation.
3. There must be an ignition of this mixture. Within the context of this publication, the source of ignition is understood to be the electrical installation operating at energy levels sufficient to release incendiary energy.

2-2.2 In classifying a particular location, the first basic condition, presence of a flammable gas or vapor, is a significant factor in determining the division classification. The decision is based principally on whether the flammable mixture may be present: a, under normal operating conditions; or, b, only under abnormal operating conditions or equipment breakdown.

2-2.3 The second basic condition is important in determining the limit or extent of the hazardous location. The quantity of the substance that might be liberated, its physical characteristics, and the natural tendency of gases and vapors to disperse in the atmosphere must be recognized. Conditions 1 and 2 will be considered (*see 2-4, 2-5, and 2-6*) following a discussion of volatility and flammability characteristics of the gases and liquids.

2-3 Flammable Liquids, Gases and Vapors.

2-3.1 Lighter-than-air Gases.

2-3.1.1 Lighter-than-air gases released from an opening will often dissipate rapidly because of their low relative density and will not usually affect as wide an area as the vapors of flammable liquids or heavier-than-air gases. Except in enclosed spaces, these lighter-than-air gases seldom produce hazardous mixtures in the zones close to grade where most electrical installations are made.

2-3.2 Compressed Liquefied Flammable Gases.

2-3.2.1 Vapor pressures of these gases exceed 40 psia at 100°F (37.8°C). Compressed flammable gases released as liquids are highly volatile and have low boiling temperatures so that they readily pick up heat and vaporize, creating large volumes of cold gas. Especially when released at or near ground level, gases normally heavier than air and also those heavier only because they are cold will travel along the ground for long distances if air currents do not assist diffusion. When the gases are released at some distance above ground level, or upward at substantial velocity, diffusion is faster and the spread from point of release is usually much less.

2-3.3 Flammable and Combustible Liquids.

2-3.3.1 Flammable liquids vary in volatility and are defined in the *Standard on Basic Classification of Flammable and Combustible Liquids, NFPA 321-1973,* as being any liquid having a closed cup flash point below 100°F (37.8°C) and a vapor pressure not exceeding 40 pounds per square inch absolute (2068.5 mm) at 100°F (37.8°C). Combustible liquids are defined as those having a closed cup flash point at or above 100°F (37.8°C).

2-3.3.2 NFPA 321-1973 subdivides flammable and combustible liquids as follows:[1]

Class I: Those having flash points below 100°F (37.8°C).
Class II: Those having flash points at or above 100°F (37.8°C) and below 140°F (60°C).

[1] Classes I, II and III as used here to identify flammable and combustible liquids should not be confused with the same terms in the *National Electrical Code (see 2-1.1).*

Class III: Those having flash points at or above 140°F (60°C).

2-3.3.3 Densities of air saturated with vapors of flammable liquids at ordinary atmospheric temperatures are generally less than 1.5 times that of air. However, when these vapors are diluted with sufficient air to make a flammable mixture, the density of the mixture approaches that of air.

2-3.3.4 Class I liquids, where released in appreciable quantities to the open, may produce large volumes of vapor. This is particularly the case with more volatile flammable liquids in this class. The less volatile liquids in this class release vapors more slowly at normal temperatures and are hazardous only near the surface of the liquids. At elevated temperatures, however, these heavier liquids give off larger volumes of vapor that can spread farther. These vapors, even when evolved rapidly, have a natural tendency to disperse into the atmosphere and, thus, rapidly become diluted to concentrations below the lower limit of the ignitible range. This tendency is greatly accelerated by air movement. Experience has confirmed that outdoor locations requiring classification are only a small fraction of those that might theoretically be hazardous, based on a given rate of release of a flammable gas or liquid.

2-3.3.5 With Class II liquids the degree of hazard is low because the rate of vapor release is almost nil at normal temperatures of handling and storage. When these liquids are heated, more vapor is released and the hazard may be increased near the point of release. But, the chances of ignition by electrical equipment is not as great as for Class I liquids because the vapors will not travel as far since they tend to condense as they are cooled by the surrounding air. If heated to extremely high temperatures, the vapors may ignite spontaneously when released to the atmosphere; electrical ignition sources are not involved in this case.

2-3.3.6 Normally, Class I liquids will produce vapors considered to be in the flammable range for electrical design purposes. Class II liquids should be considered as producing flammable vapors in the atmosphere near the point of release when handled, processed, or stored under conditions that may cause the temperature of the liquid to exceed its flash point.

2-3.3.7 Liquids having flash points at or above 140°F (60°C) are designated Class III. Such liquids may release vapor at their surface if heated above the flash point, but the extent of the hazardous zone will ordinarily be very small. These combustible liquids seldom evolve sufficient quantities of vapor to render any significant zone hazardous.

2-4 Division 1 Hazardous Locations.

2-4.1 The decision to classify a location as hazardous is based upon the possibility that a flammable mixture may be present. Having decided that a location should be classified hazardous, the next step is to determine the degree of hazard: Is the location Division 1 or Division 2?

2-4.2 As stated in 2-1.2.1, the criterion for Division 1 is whether the location is likely to have flammable mixtures present under normal conditions. For instance, the presence of flammable vapors in the vicinity of flammable liquid tank trucks is normal and requires a Division 1 classification. However, normal does not necessarily mean the situation which prevails when everything is working properly. For instance, a process procedure might be so sensitive to control that relief valves frequently open. This can be considered normal. If these valves release flammable liquid or vapor to the atmosphere, the zone adjacent to the point of release is classified as Division 1. However, if the operation of the relief valves occurs infrequently under unusual conditions, it is not to be considered normal.

2-4.3 Similarly, there may be cases in which frequent maintenance and repair are necessary. These are viewed as normal and, if quantities of flammable liquid, gas or vapor are released as a result of the maintenance, the location is Division 1. However, if repairs are not usually required between turnarounds, the need to do repair work is considered abnormal. In any event, the classification of the location, as related to equipment maintenance work, is influenced by the maintenance procedures and frequencies.

2-5 Division 2 Hazardous Locations.

2-5.1 The criterion for Division 2 locations is whether the location is likely to have flammable mixtures present only under abnormal conditions. The term "abnormal" is used here in a limited sense and does not include a major catastrophe.

2-5.2 As an example, consider a vessel containing hydrocarbons to be a source which releases flammable material only under abnormal conditions. In this case, there is no Division 1 location because the vessel is normally tight. To release vapor, the vessel would have to leak, and that would not be normal. Thus, the vessel is surrounded by a Division 2 zone. Everything outside that zone is classified nonhazardous.

2-5.3 Process equipment does not fail very often. Furthermore, the *National Electrical Code* requirements for electrical installations in Division 2 locations are such that an ignition-capable spark can occur in a flammable vapor-air mixture only in an explosionproof enclosure, or in the event of a breakdown of electrical equipment. On a realistic basis, the possibility of simultaneous abnormal conditions is very remote; this consideration justifies the recognition and acceptance of the Division 2 concept (erroneously called semihazardous areas).

2-5.4 The Division 2 classification is equally applicable to a condition not involving equipment failure. Consider for example the situation wherein a Division 1 location exists because of the normal presence of flammable mixtures. Here, Division 2 is the classification applied to the zone which normally exists between a Division 1 location and a nonhazardous location. Obviously one side of an imaginary line cannot be normally hazardous and the opposite side never hazardous. Consider the case of a source which releases flammable material during normal operation. This source is surrounded by a Division 1 location which, in turn, is surrounded by a larger concentric Division 2 location. Division 2 is the transition zone, and the area outside the Division 2 location is classified nonhazardous.

2-5.5 There could, of course, be cases in which an unpierced barrier, such as a blank wall, might serve completely to prevent vapor spread. In such a case, this concept would not apply and there would be no Division 2 location.

2-6 Nonhazardous Locations.

2-6.1 Experience has shown that the occurrence of flammable material liberation from some operations and apparatus is so infrequent that it is not necessary to classify the surrounding locations hazardous. For example, it has not been found generally necessary to classify as hazardous the following locations where flammable gases and liquids are processed, stored, or handled:

1. Locations that are adequately ventilated where flammable substances are contained in suitable, well-maintained, closed piping systems which include only the pipe, valves, fittings, flanges, and meters.

2. Locations that are not adequately ventilated, and where the piping systems for flammable substances are without valves, fittings, flanges, and similar accessories.

3. Locations where the flammable liquids or gases are stored in suitable containers. Regulations of the U. S. Department of Transportation specify containers that may be used to ship flammable liquids and gases (*Title 49, Chapter I, Parts 170-189, Code of Federal Regulations*). Container requirements for storing flammable and combustible liquids will be found in the *Flammable and Combustible Liquids Code, NFPA 30-1973,* Chapter IV.

2-6.2 An adequately ventilated location is any building, room, or space which is substantially open and free from obstruction to the natural passage of air through it, vertically or horizontally. Such locations may be roofed over with no walls or may be closed on one side.

2-6.3 An enclosed or partly enclosed space may be considered as adequately ventilated if it is provided with artificial ventilation in an amount equivalent to natural ventilation under low-wind-velocity conditions and there are adequate safeguards against the failure of the ventilation equipment. Adequate ventilation is defined in NFPA No. 30 as that which is sufficient to prevent accumulations of significant quantities of vapor-air mixtures in concentrations over one-fourth of the lower flammable limit.

2-6.4 Improper exhaust provisions constitute inadequate ventilation. For example, if the vapors to be removed are heavier than air, exhaust openings should be near the floor.

2-6.5 In locations containing thermal ignition sources (such as open flames), electrical installation design will not eliminate ignition sources. Thus, these locations are classified electrically as nonhazardous. Fire and explosion prevention depends upon the avoidance of flammable mixtures.

2-7 Extent of Hazardous Locations.

2-7.1 The extent of a Division 1 or Division 2 zone requires careful consideration. Perhaps a good beginning is to start with the fact that hydrocarbons are generally heavier than air. This leads to the following conclusions:

1. In the absence of walls, enclosures, or other barriers, and in the absence of air currents or similar disturbing forces, it must be assumed that a vapor will disperse in all directions, as governed by the vapor density and velocity (e.g., heavier-than-air vapors principally downward and outward, lighter-than-air vapors principally upward and outward). Thus, if the source of hazard were a single point, the horizontal area covered by the vapor would be a circle.

2. For heavier-than-air vapors released at or near grade level, the locations where potentially hazardous concentrations are most likely to be found are below grade; those at grade are next most likely; and, as the height above grade increases, the potential hazard decreases. In open locations away from the immediate point of release, freely drifting vapors from a source near grade seldom have reached ignition sources at elevations more than six feet or eight feet above grade. For lighter-than-air gases the opposite is true; there is little or no potential hazard at and below grade, and greater potential hazard above grade.

3. Elevated or depressed sources of vapor release, or release of flammable vapor under pressure, may substantially alter the outline of the limits of the hazardous location. Also, a very mild breeze may extend these

limits in the direction of air movement. However, a stronger breeze can so accelerate the dispersion of vapors that the extent of the hazardous location would be greatly reduced. Thus, dimensional limits recommended for Division 1 or Division 2 locations must be recognized from experience, rather than being based on any theoretical diffusion of vapors of the type concerned.

2-7.2 The degree to which breeze and volatility combine to affect the extent of the hazardous location can be illustrated by two experiences, checked by combustible gas detectors. Gasoline spilled in a sizable open manifold pit gave no indication of flammable mixtures beyond three feet or four feet from the pit when the breeze was 8 mph to 10 mph. A slightly smaller area of a more volatile liquid from a pool blocked on one side was checked during a gentle breeze. At grade, vapors could be detected for approximately 100 feet downwind; however, at 18 inches above grade, there was no indication of vapor as close as 30 feet from the pool.

2-7.2.1 Such examples show that even heavy vapor is rapidly dispersed in an adequately ventilated location; for this reason, outdoor locations or locations having ventilation equivalent to normal outdoor conditions are generally classified as Division 2. However, wherever ventilation is inadequate, flammable mixtures can develop and the situation may justify a much larger zone being classified as Division 1.

2-7.3 The size and type of construction of a building may have considerable influence on the hazard classification of the enclosed volume.

2-7.3.1 In the case of small sampling or testing rooms, well-constructed but with inadequate ventilation, it might be appropriate to classify the entire internal volume as Division 1.

2-7.3.2 On the other hand, some large buildings used for such diverse operations as warehousing, processing, canning, and shipping often have substantial artificial ventilation provided, or the building has many doors and windows which are in intermittent use or are continuously open. Building construction design may permit a substantial degree of natural ventilation which, coupled with such factors as volumetric content of the building, floor area, lineal dimensions of walls and ceiling height, would readily justify consideration of that building as an adequately ventilated indoor location. Here, certain portions of the enclosed location may be classified as Division 1 (surrounded by a larger Division 2 location), or Division 2, with the remainder of the building enclosure designated as nonhazardous.

2-7.4 When classifying buildings there should be careful evaluation of prior experience with the same or related types of installations. It is not enough to merely point to a potential source of vapor within the building and proceed immediately with the definition of the extent of the Division 1 and Division 2 locations. Where experience has indicated that a particular design concept is sound, a more hazardous classification for similar installations is not justified. Furthermore, it is conceivable that a location might be reclassified from Division 1 to Division 2, or from Division 2 to nonhazardous, based on experience.

2-7.5 Correctly evaluated, an installation will be found to be a multiplicity of Division 1 locations of extremely limited extent. Probably the most numerous of offenders are packing glands. A gland leaking a quart a minute (360 gallons per day) certainly could not be commonplace; yet, if a quart bottle were emptied every minute outdoors, the zone made hazardous would be hard to locate with a combustible gas detector.

2-7.6 Volume of liquid or vapor released is of extreme importance in determining the extent of a hazardous location, and it is this consideration which necessitates the greatest application of sound engineering judgment. However, one cannot lose sight of the purpose of this judgment, i.e., the location is classified solely for the installation of electrical equipment.

Chapter 3 Method of Determining Degree and Extent of Hazardous Locations

3-1 Basis for Recommendations.

3-1.1 Some of the following recommendations for determining the degree and extent of hazardous locations have been developed by survey and analysis of the practices of a large segment of the petroleum refining industry, by use of available experimental data, and by careful weighing of pertinent factors. These recommended limits of hazardous locations for refinery installations may be more restrictive than are warranted for other types of facilities handling hydrocarbons. Other of the recommendations are based on NFPA documents that represent many hundreds of man-years of experience. The difference between the experience of the petroleum refining industry and other sources are basically related to quantities of material in process, use and storage.

3-1.2 Throughout this chapter references are made to small (low), moderate and large (high) pressures, and process equipment. Table 3-1.2 defines those terms as used in this chapter.

Table 3-1.2 Relative Magnitude*

	Small (Low)	Moderate	Large (High)
Pressure Range	Less than 100 psi	100 psi to less than 500 psi	500 psi or greater
Process Equipment Size	Less than 5,000 gallons	5,000 gallons to less than 25,000 gallons	25,000 gallons or greater

* Experience with similar installations may justify deviation from the definition in the Table. See 2-7.4.

3-2 Vapors Assumed to be Heavier than Air.

3-2.1 In setting limits, it is generally assumed that flammable vapors are heavier than air. Classification on this basis is normally conservative for lighter-than-air gases or vapors. However, some modification of the limits may be necessary to accommodate certain lighter-than-air situations.

3-3 Procedures for Classifying Locations.

3-3.1 The following procedure requires answers to a series of questions. Each room, section, or zone should be considered individually in determining its classification.

3-3.2 Step 1—Need for Classification. The need for classification is indicated by an affirmative answer to one of the following questions:

(a) Are flammable liquids, vapors or gases likely to be present?

(b) Are liquids having flash points at or above 100°F (37.8°C) likely to be handled, processed, or stored at temperatures above their flash points?

3-3.3 Step 2—Assignment of Classification. Assuming an affirmative answer results from Step 1, the following questions should be used to determine the assignment of classification.

3-3.3.1 Division 1 locations may be distinguished by an affirmative answer to any one of the following questions:

(a) Is a flammable mixture likely to exist under normal operating conditions?

(b) Is a flammable mixture likely to occur frequently because of maintenance, repairs, or leakage?

(c) Would a failure of process, storage, or other equipment be likely to cause an electrical failure simultaneously with the release of flammable gas or liquid?

(d) Is the flammable liquid or vapor piping system in an inadequately ventilated location, and does the piping system contain valves, meters, or screwed or flanged fittings that are likely to leak?

(e) Is the zone below the surrounding elevation or grade such that flammable liquids or vapors may accumulate therein?

3-3.3.2 Division 2 locations may be distinguished by an affimative answer to any one of the following questions:

(a) Is the flammable liquid or vapor piping system in an inadequately ventilated location, and is the piping system (containing valves, meters, or screwed or flanged fittings) not likely to leak?

(b) Is the flammable liquid or vapor being handled in an adequately ventilated location, and can liquid or vapor escape only during abnormal conditions, such as failure of a gasket or packing?

(c) Is the location adjacent to a Division 1 location, or can vapor be conducted to the location as through trenches, pipe, or ducts?

(d) If positive mechanical ventilation is used, could failure or abnormal operation of ventilating equipment permit mixtures to build up to flammable concentrations?

3-3.3.3 Step 3—Extent of Hazardous Locations. The extent of a hazardous location may be determined by applying with sound engineering judgment the distances recommended in the diagrams in Figures 3-5.1(a) through 3-5.11(c).

3-4 Use of Diagrams.

3-4.1 The diagrams in this chapter show hazardous zones surrounding typical sources of flammable liquids, vapors and gases. Some of the illustrations apply to a single source; others apply to an enclosed space or to an operating unit. The intended use of these diagrams is to develop classification maps of operating units, buildings, departments, or plant locations. Elevations or sections will be required where different classifications apply at different levels.

3-4.2 An operating department will have many interacting sources of flammable liquid, vapor or gas, including pumps, compressors, exchangers, vessel flanges, sampling stations, meters, operating and control valves. Accordingly, it requires judgment to set the boundaries of zones for electrical classification.

3-4.3 Use the Index to Diagrams, in 3-5, to select the diagram or diagrams which apply to each source or condition. Determine the applicable Divisions, their extent, and their layout in light of the local environmental conditions. It is recommended that a layout be made of each hazardous zone based on the interaction of individual sources described in 3-4.2.

3-4.4 It may be found that individual classification of a great number of sources in a location is neither feasible nor economical. Classification of an entire building or location as a single zone should be considered only after evaluation of the extent and interaction of various sources and zones within the location, or adjacent to it.

3-5 Index to Diagrams.

3-5.1 Figures 3-5.1(a) through 3-5.1(c) show hazardous zones around pumps and similar devices handling flammable liquids at low pressures.

Figure 3-5.1(a) Outdoors at grade.
Figure 3-5.1(b) Indoors at grade with adequate ventilation.
Figure 3-5.1(c) Indoors above grade in building with adequate ventilation.

3-5.2 Figures 3-5.2(a) through 3-5.2(d) show hazardous zones around pumps and similar devices handling flammable liquids at moderate pressures.

Figure 3-5.2(a) Outdoors at grade.
Figure 3-5.2(b) Indoors with adequate ventilation.
Figure 3-5.2(c) Indoors with adequate ventilation and with a pierced wall or full wall opening.
Figure 3-5.2(d) Indoors with inadequate ventilation and with a pierced wall or full wall opening.

3-5.3 Figures 3-5.3(a) through 3-5.3(d) show hazardous zones around pumps and similar devices handling flammable liquids at high pressures or handling compressed liquefied flammable gases.

Figure 3-5.3(a) Outdoors at grade.
Figure 3-5.3(b) Outdoors above grade.
Figure 3-5.3(c) In an equipment shelter with inadequate ventilation.
Figure 3-5.3(d) Indoors with adequate ventilation.

3-5.4 Figures 3-5.4(a) through 3-5.4(h) show hazardous zones around process vessels and dryers handling flammable liquids at high, moderate and low pressures.

Figure 3-5.4(a)	Outdoor process plant, high pressure.
Figure 3-5.4(b)	Outdoor process plant, moderate pressure.
Figure 3-5.4(c)	Indoor process area with adequate ventilation. Source at or near grade.
Figure 3-5.4(d)	Indoor process area with adequate ventilation. Source above grade.
Figure 3-5.4(e)	Indoor process area, high pressures, inadequate ventilation. Source above grade.
Figure 3-5.4(f)	Outdoor kettle installation.
Figure 3-5.4(g)	Indoor kettle installation, adequate ventilation.
Figure 3-5.4(h)	Product dryer in totally enclosed system, adequate ventilation.

3-5.5 Figures 3-5.5(a) and 3-5.5(b) show hazardous zones around storage tanks.

Figure 3-5.5(a)	Outdoors at grade.
Figure 3-5.5(b)	Open tanks or tanks with hatches normally open.

3-5.6 Figures 3-5.6(a) through 3-5.6(e) show hazardous zones during tank car and tank truck loading and unloading.

Figure 3-5.6(a)	Through closed dome with vapor recovery.
Figure 3-5.6(b)	Through bottom with vapor recovery.
Figure 3-5.6(c)	Through open dome, or through closed dome with atmospheric vent.
Figure 3-5.6(d)	Through bottom with atmospheric vent.
Figure 3-5.6(e)	Compressed flammable gases such as liquefied petroleum gas.

3-5.7 Figures 3-5.7(a) and 3-5.7(b) show hazardous zones during drum and container loading and unloading and at drum storage areas.

Figure 3-5.7(a)	Loading, unloading outdoors and indoors with adequate ventilation.
Figure 3-5.7(b)	Storage indoors, opening between storage room and classified area.

3-5.8 Figure 3-5.8(a) shows hazardous zones around drainage ditches, separators, and impounding basins outdoors and in which flammable liquids are likely to be present.

3-5.9 Figure 3-5.9(a) shows hazardous zones around a dip tank that is indoors in an adequately ventilated location.

3-5.10 Figure 3-5.10(a) shows hazardous zones in a paint spray booth where flammable liquids are being handled.

3-5.11 Figures 3-5.11(a) through 3-5.11(c) show hazardous zones in special situations where lighter-than-air gases are being handled.

Figure 3-5.11(a) Liquid hydrogen.

Figure 3-5.11(b) Gaseous hydrogen.

Figure 3-5.11(c) Gas compressor in an inadequately ventilated shelter.

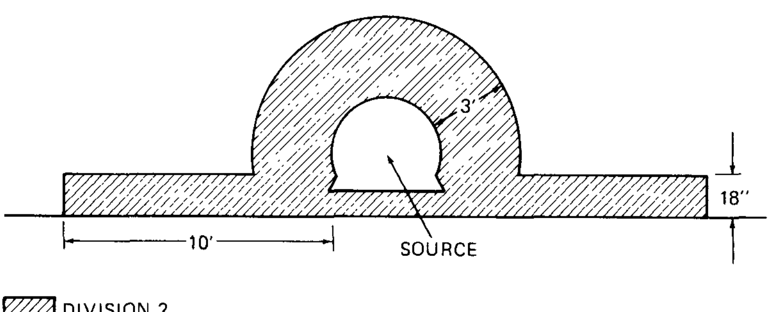


Figure 3-5.1(a). Pumps and similar devices handling flammable liquids at low pressures, outdoors at grade.

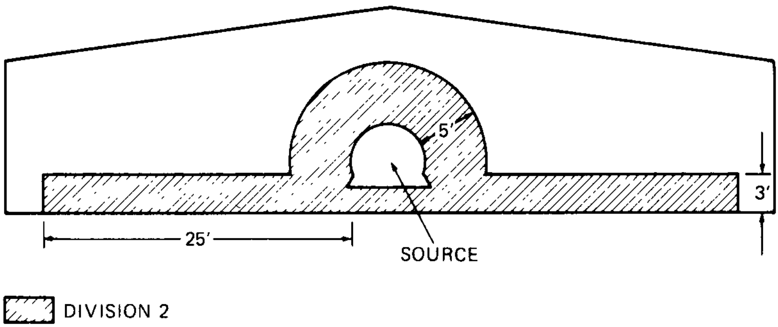


Figure 3-5.1(b). Pumps and similar devices handling flammable liquids at low pressures, indoors with adequate ventilation.

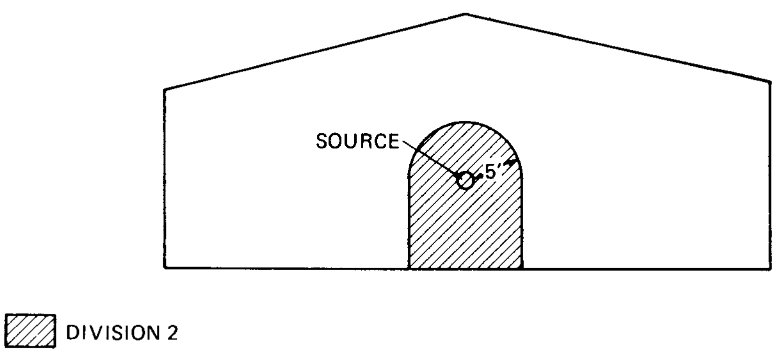


Figure 3-5.1(c). Pumps and similar devices handling flammable liquids at low pressures, indoors above grade in a building with adequate ventilation.

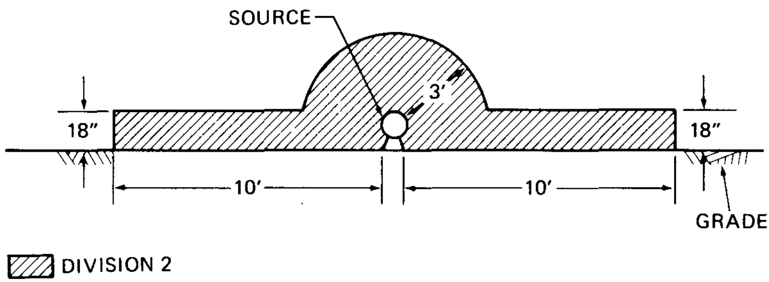


Figure 3-5.2(a). Pumps and similar devices handling flammable liquids at moderate pressures, outdoors at grade.

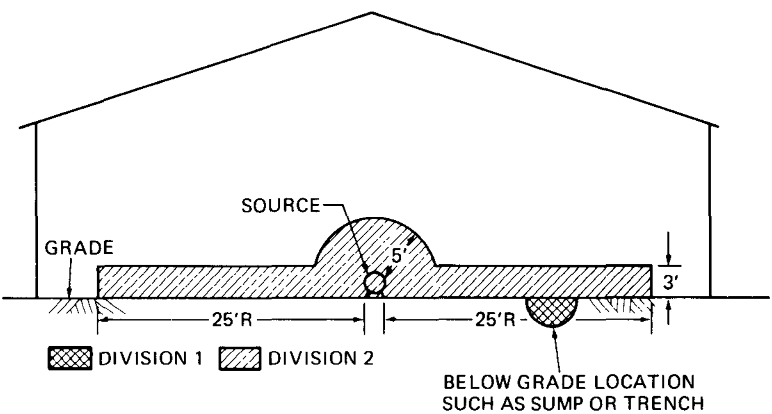


Figure 3-5.2(b). Pumps and similar devices handling flammable liquids at moderate pressures, indoors with adequate ventilation.

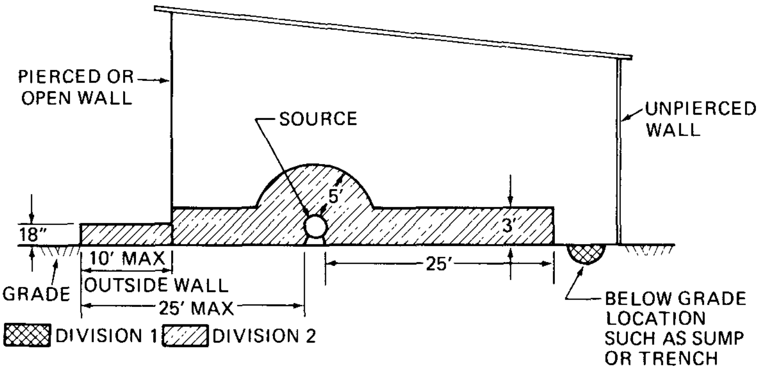


Figure 3-5.2(c). Pumps and similar devices handling flammable liquids at moderate pressures, indoors with adequate ventilation and with a pierced wall or full wall opening.

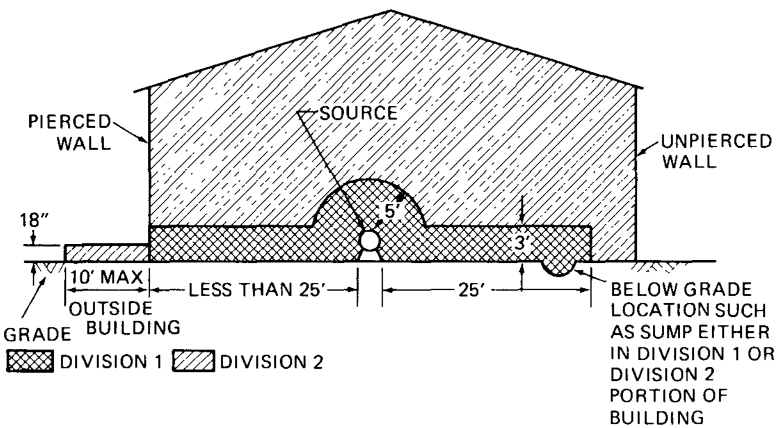


Figure 3-5.2(d). Pumps and similar devices handling flammable liquids at moderate pressures, indoors with inadequate ventilation and with a pierced wall or full wall opening.

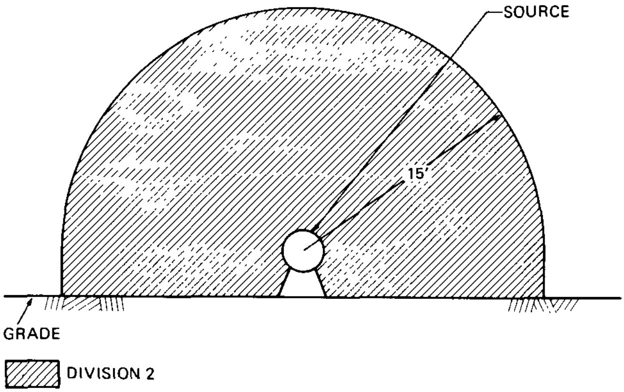


Figure 3-5.3(a). Pumps and similar devices, outdoors at grade, handling flammable liquids at high pressures or handling liquefied flammable gases, but from which leakage is likely to be small.

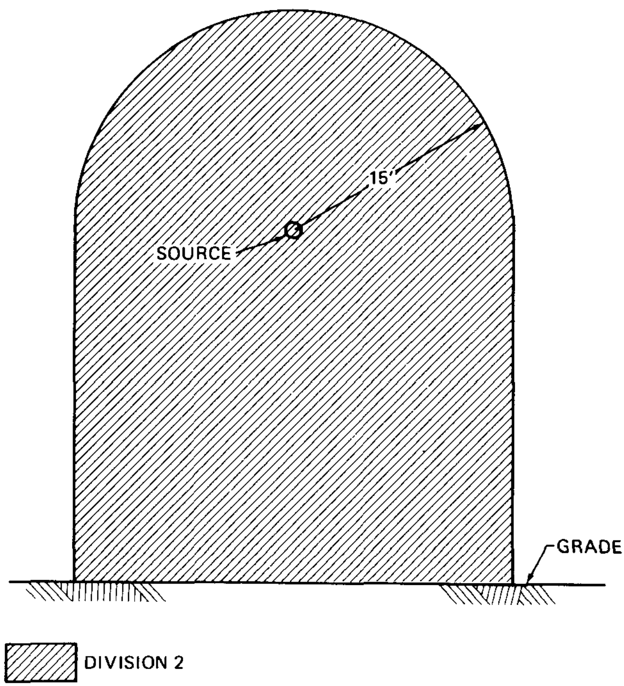


Figure 3-5.3(b). Pumps and similar devices, outdoors above grade, handling flammable liquids at high pressures or handling compressed liquefied flammable gases, but from which leakage is likely to be small.

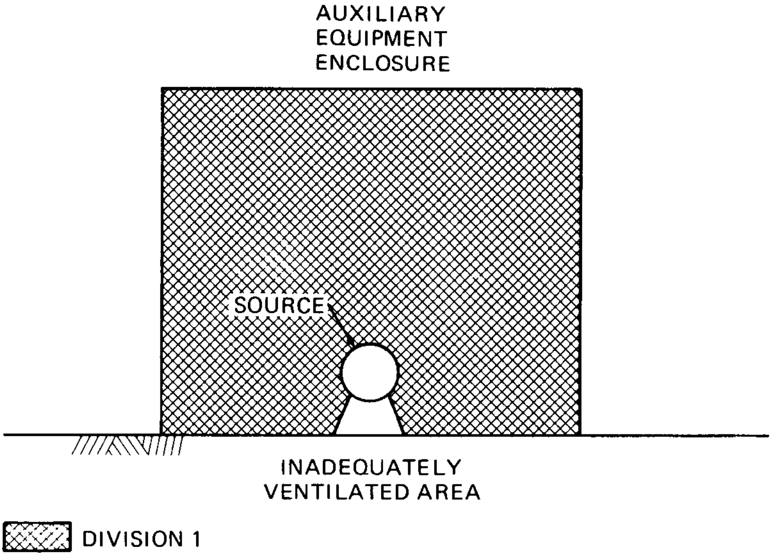


Figure 3-5.3(c). Pumps and similar devices handling flammable liquids at high pressures or compressed liquefied flammable gases, in an equipment shelter with inadequate ventilation.

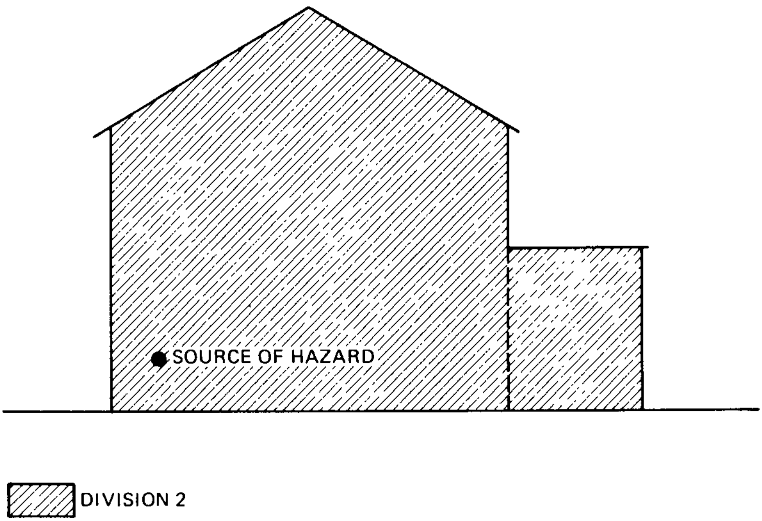


Figure 3-5.3(d). Pumps and similar devices handling flammable liquids or compressed liquefied flammable gases at high pressures, indoors with adequate ventilation.

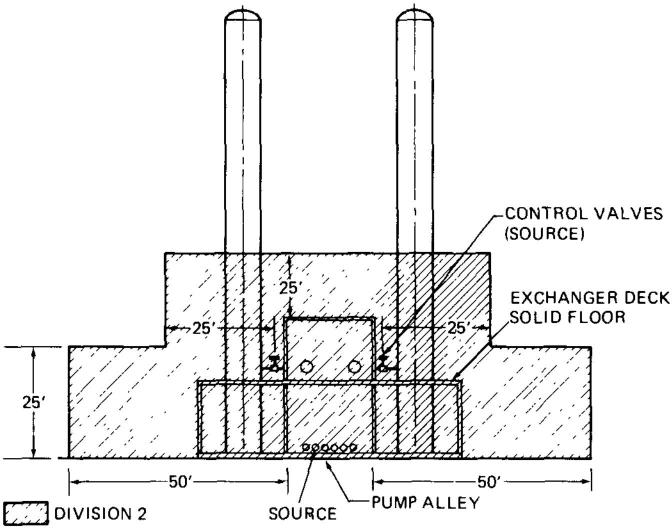


Figure 3-5.4(a). Process plant handling flammable liquids at high pressures, outdoors.

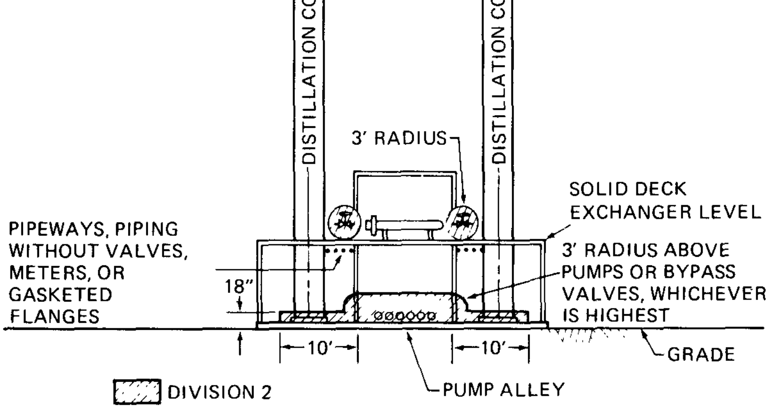


Figure 3-5.4(b). Process plant handling flammable liquids at moderate pressures, outdoors.

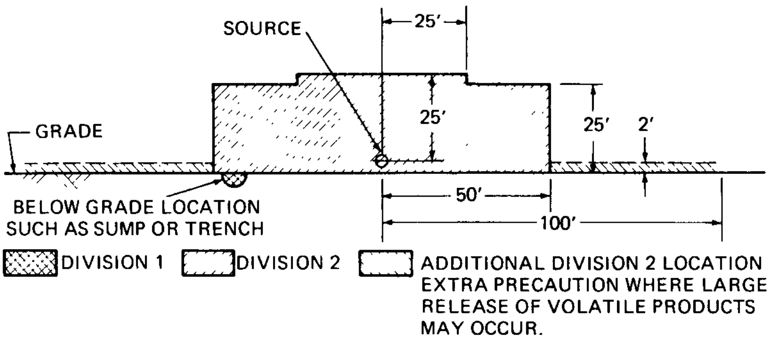


Figure 3-5.4(c). Flammable liquids handled at high pressures, within an adequately ventilated process area. Source of hazard located near grade. (See API RP 500A-April 1966.)

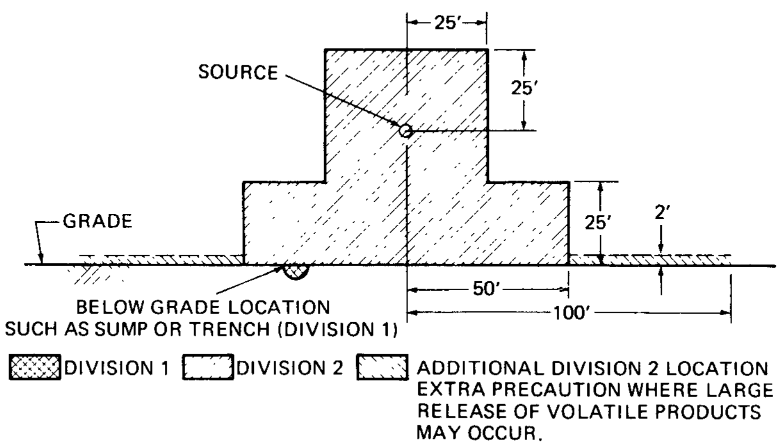
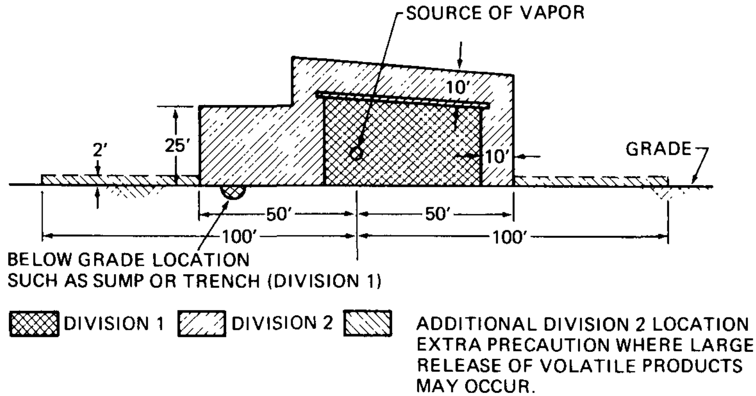


Figure 3-5.4(d). Flammable liquids handled at high pressures, with source of hazard located above grade within an adequately ventilated process location. (See API RP 500A-April 1966.)



Apply horizontal clearances of 50 ft from source of vapor or 10 ft beyond perimeter of building, whichever is greater; except beyond unpierced vaportight walls, the zone is classified nonhazardous.

Figure 3-5.4(e). Indoor process area, flammable liquids handled at high pressures, with source of hazard located above grade within an inadequately ventilated location. (See API RP 500A-April 1966.)

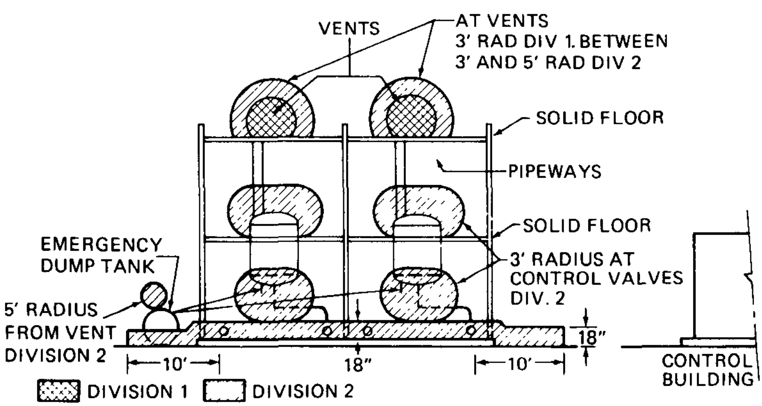


Figure 3-5.4(f). Kettles handling flammable liquids, outdoors. Vents discharge upward.

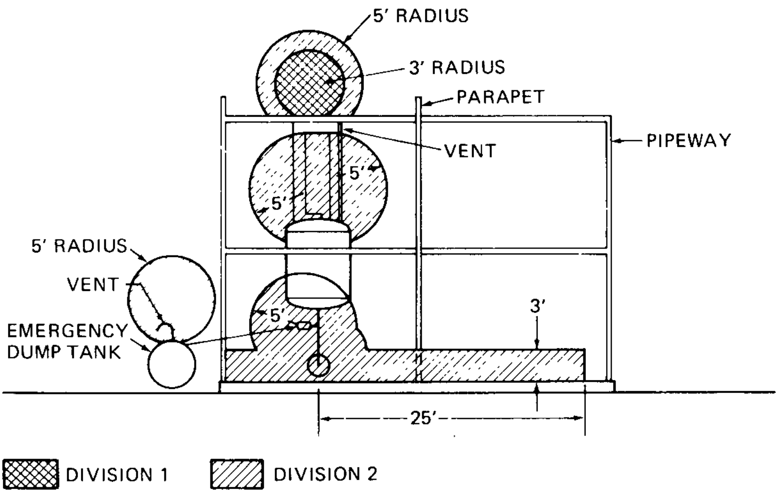
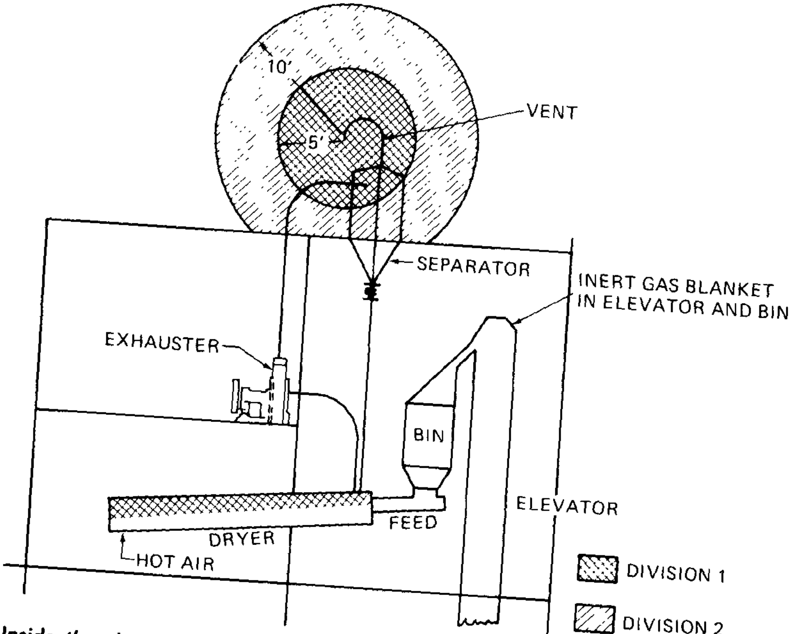


Figure 3-5.4(g). Kettles handling flammable liquids at low or moderate pressures indoors with adequate ventilation.



Inside the elevator and feed bin when blanketed with inert gas for preventing ignition from other sources, may be classified Division 2. Without inerting it will be classified Division 1. Inside the dryer above the bed shall be Division 1. Normally the air flow would keep the volume below the flammable limit, but due to the unknowns of vapor quantity and flow restrictions in the bed the safe classification is Divison 1.

Figure 3-5.4(h). Product dryer in totally enclosed system, with adequate ventilation. (See NFPA No. 30-1973, Table 5650.)