

Electrical Area Classification 101 An Introduction to Area Classification the Basics

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Safety Topic Active Shooter

RUN, HIDE, or FIGHT

RUN

- Know your exit path.
- Exit carefully.
- Assist others if you can.
- Maintain 360 degree circle of awareness at all times.
- Be prepared to hide or fight at any time.
- Silence your cell phone and try to remain calm at all times.

FIGHT

- Fight as a group if possible and overpower the gunman.
- Find the nearest weapon.
 - Fire extinguisher, pepper spray, etc.

HIDE

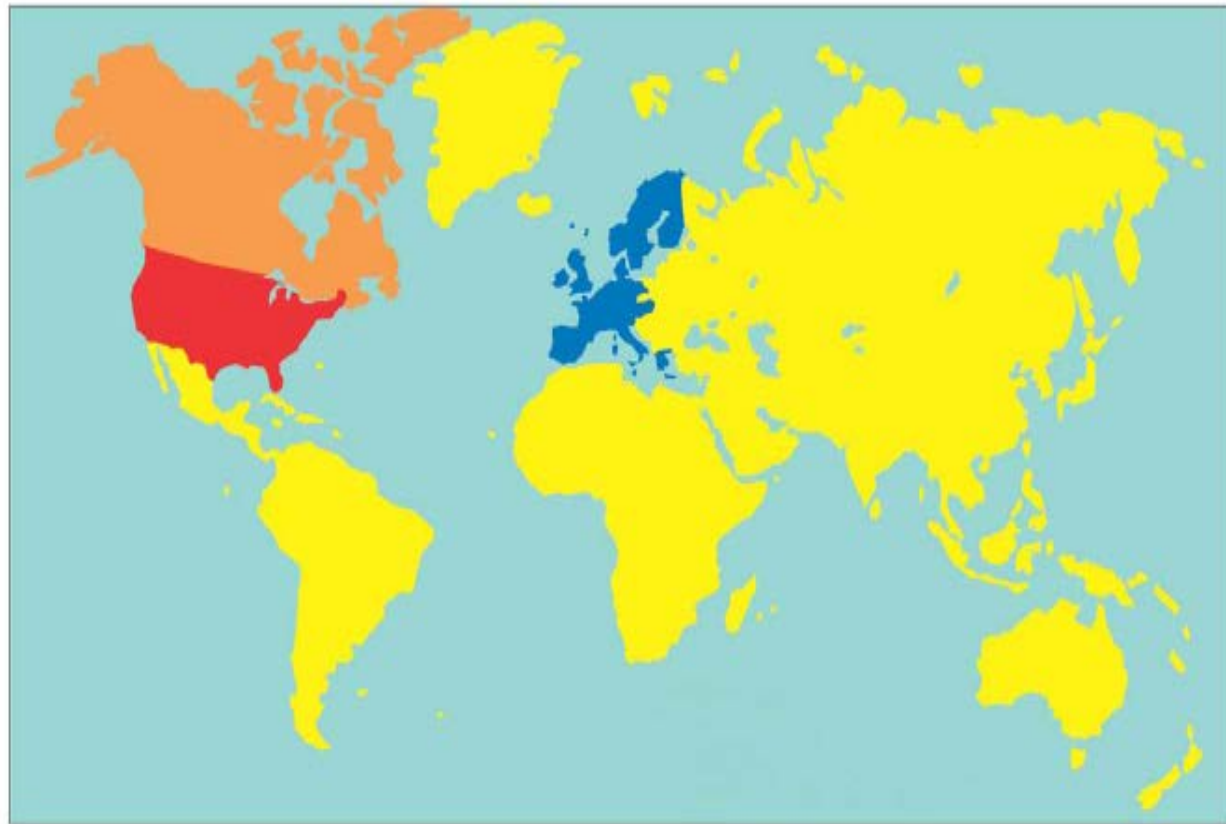
- Silence your cell phone.
- Take deep breaths and remain as calm as possible.
- Close and lock office door, if possible.
- Hide under desk and remain quiet and calm.

Last resort is to fight.

What will be covered in this course.

- ▶ Introduction to area classification terminology and standards.
- ▶ Identifying electrical equipment that can be used in different hazardous areas.
- ▶ Introduction to PIP ELEHA01 Specification
- ▶ Introduction to PIP ELEHA01 Form No. 1 Flammable Combustible.
- ▶ Introduction to PIP ELEHA01 Form No. 2 Sources of Release.

WHAT WE TYPICALLY USE IN THE USA:
API-500, NFPA 70, NFPA 496, NFPA 497



HISTORY OF STANDARDS

- **Originally published in 1955** American Petroleum Institute (API) Recommended Practice 500A concerns the classification of locations for electrical installations in petroleum refineries. It is a very widely used and respected document, though rather conservative in the application of distances.
- **Originally published in 1961** API Recommended Practice 500B deals with the classification of areas for electrical installations at drilling rigs and production facilities on land and on marine platforms. It is a widely used and respected document, very useful for platform design. It may be ready for some updating and conflicts with API RP500A and C with regard to aspects of artificial ventilation. It is less conservative when applying distances than API RP500 A and C.
- **Originally published in 1966** API Recommended Practice 500C outlines the classification of locations for electrical installations at pipeline transportation facilities. It is a widely used and respected document, recently updated, and introduces pressure levels.
- **(Current third edition 2012 API-500 it includes the 3 above A,B,C in one document)**

HISTORY OF STANDARDS

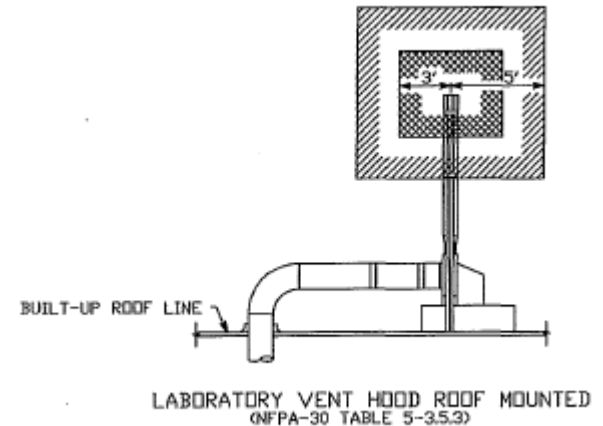
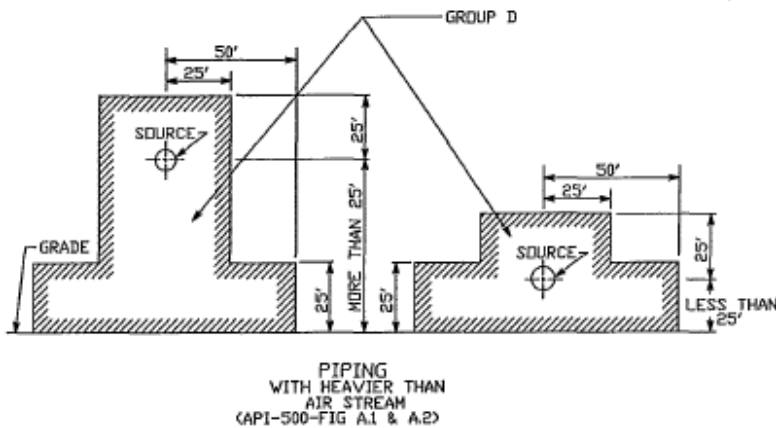
- National Fire Protection Association (NFPA) 497 concerns the classification of Class I hazardous locations for electrical installations in chemical plants. Currently undergoing extensive revision, this standard is to be replaced by NFPA 497A, Recommended Practice for the Classification of Class I Hazardous (Classified) Location for the Proper Installation of Electrical Equipment in Chemical Process Areas. NFPA 497 is a very useful document to be used in conjunction with API Recommended Practices; however, it appears to be conflicting in several instances.
 - NFPA 497 (we are currently at 2017 edition)
- NFPA 497M is a manual for the classification of gases, vapors, and dusts for electrical equipment in hazardous locations. It is a new document, extremely useful as a supplement to Underwriters' Laboratories (UL) for determining gas groups.
- In the National Electrical Code NFPA 70, articles 500, 501, tables 514-1, 515-2, and article 516 are essential for the satisfactory selection of electrical equipment and installation techniques for classified areas and cover specific details on area classification for gasoline dispensing and service stations, bulk storage plants, spray application, and dipping and coating processes.

HISTORICAL STANDARDS

- NFPA 321 outlines the basic classification of flammable and combustible liquids. It subdivides flammable and combustible liquids into classes.
- NFPA 325M describes the fire hazard properties of flammable liquids, gases, and volatile solids. This guide can help determine gas groups not specified in NFPA 497M or elsewhere.
- **Originally created in 1966;** NFPA 496 deals with purged and pressurized enclosures for electrical equipment in hazardous locations. **(we are currently at 2013 edition)**
- Instrument Society of America (ISA) S12.4 covers the same subject. NFPA 496 is currently being reviewed to cover situations where a source of flammable vapor exists within the purged enclosure.
- In NFPA 493 intrinsically safe apparatus and associated apparatus for use in Class 1, 2, 3, Division I hazardous locations are discussed. This standard is currently being reviewed for replacement by a new document which is intended to be prepared by a UL Technical Group.
- NFPA 30 on flammable and combustible liquids covers the subject of ventilation, handling, and storage of flammable and combustible liquids.

STANDARDS

- ▶ Before going to the step-by-step method for performing electrical area classification, it should be explained that a classified (hazardous) area is defined by three parameters;
- ▶ these being 1) class, 2) group, and 3) division.
- ▶ For example, an area containing gasoline could be classified Class I, Group D, Division 1, and these three parameters will define its classification.
- ▶ We will go into further detail on these three parameters later in this presentation.



The first step in area classification is to establish the relevant codes and standards and the authority having jurisdiction, and any permit or other licensing-type requirements.

Many of the larger US operating companies now have standards of their own, and these should be studied as a first step, followed by the other codes and standards dictated by the relevant authority.

At this point, a mention should be made to define the phrase "authority having jurisdiction." The NFPA defines this as follows. The authority having jurisdiction is the organization, office, or individual responsible for approving equipment, an installation, or a procedure.

1. THE CLASSIFICATION IS BASED ON API-500, THE NATIONAL ELECTRICAL CODE, NFPA 30 AND NRC CLASSIFICATION OF GASES.
2. EXAMPLES OF POSSIBLE LEAK SOURCES ARE VALVES, SEALS, FLANGES AND SCREWED FITTINGS.
3. IN SOME CASES THE CLASSIFIED AREA BOUNDARIES HAVE BEEN EXTENDED BEYOND STANDARD DISTANCES TO PROVIDE MORE UNIFORM EQUIPMENT SELECTION.
4. THIS DRAWING IS FOR ELECTRICAL CLASSIFICATION ONLY.
5. AREA CLASSIFICATION IS THIS UNIT OR PART CAN BE AFFECTED BY ADJACENT UNITS OR PARTS - CHECK MATCHLINE DRAWINGS.

THESE LINES ARE NOT CLASSIFIED. THEY CARRY NO. 2 FUEL OIL. THIS MATERIAL IS A CONDITIONAL GROUP D BECAUSE THE VAPOR PRESSURE IS LOW (NEC CLASSIFICATION OF GASES), AS THE TEMPERATURE OF THE MATERIAL IN THESE LINES IS BELOW ITS FLASH POINT AND IN ACCORDANCE WITH NFPA 30 FLAMMABLE LIQUID CODE, NO SPECIAL ELECTRICAL EQUIPMENT IS REQUIRED. CLASSIFICATION IS NOT SHOWN.

EAC drawings are used for a wide variety of purposes.

- ▶ Area classification drawings are used to help create a hot work map, which is used as a reference when completing hot work permits.
- ▶ Through management support, an extensive training and awareness program, and adjustments to the hot work permitting process, it is anticipated that workers will have greater awareness and respect for fire and explosion hazards associated with flammable fluids at operating facilities.
- ▶ This represents a new advance in application of the area classification methodology to not only protect workers through safe electrical designs, but also to increase the effectiveness of the hot work permitting process.

Hazardous (Classified) Locations

Confined spaces, toxic chemicals, and radiation exposure are often associated with the term *hazardous location*. While each of these may qualify as a hazardous location with the presence of the right type of material, they are not necessarily hazardous locations as defined by the NEC. A flammable or combustible concentration of a material must be available in order for a location to be considered hazardous within the scope of the NEC.

Employees should not carry flashlights, radios, cell phones, computers, multimeters, or other devices into a hazardous location unless the devices have been evaluated for use in the specific hazardous location.

THREE METHODS OF HAZARDOUS AREA CLASSIFICATION

- ▶ *ANSI Methodology to Hazardous Area Classification*
- ▶ There are two major philosophies used when developing HAC drawings and details per ANSI standards, and a third approach found in international standards.
- ▶ The first ANSI approach is *The Direct Example Approach*.
- ▶ The direct example approach is the most commonly used method to develop hazardous area classification plans and details, and is usually the most conservative approach. The diagrams found in API RP 500, API RP 505 and NFPA 497 are examples of the direct example approach method. This approach utilizes engineering judgment to determine the extent of the hazardous area classification. The diagrams and the boundary distances utilized are selected based on the type of installation, volume and properties of the hazardous gases/vapors.
- ▶ The second ANSI method, less commonly used, but usually less conservative, is the *Point Source Approach*. The point source approach determines the hazardous classified boundaries for each potential release source of flammable gases/vapors. The hazardous radius associated with all release sources (point source) are plotted together to develop an overall classified area for all sources combined. The hazardous radius of each source point is calculated based on process conditions and the nature of the release. This approach generally requires more engineering involvement than the direct example approach. The point source method can be found in Annex D of API RP 500 and API RP 505.

THREE METHODS OF HAZARDOUS AREA CLASSIFICATION

- ▶ *Risk-based Approach To Hazardous Area Classification (International Standards)*
- ▶ The *Risk-based Approach*, a third method, was introduced in the 2002 version of the Model Code of Safe Practice Part 15: Area Classification Code for Installations Handling Flammable Fluids (EI 15, formerly referred to as IP 15). EI 15 is an internationally accepted publication that covers all three methodologies discussed for hazardous area classification, including the two ANSI methods mentioned above.
- ▶ The risk-based approach is a method that defines the extent of a classified area based on a predefined acceptable level of risk to personnel. This is done by establishing a relationship between individual risks and the release frequency level of flammable material. The approach used to define this relationship is similar to those used to make technical and business decisions where there are unknown or varying risk factors.

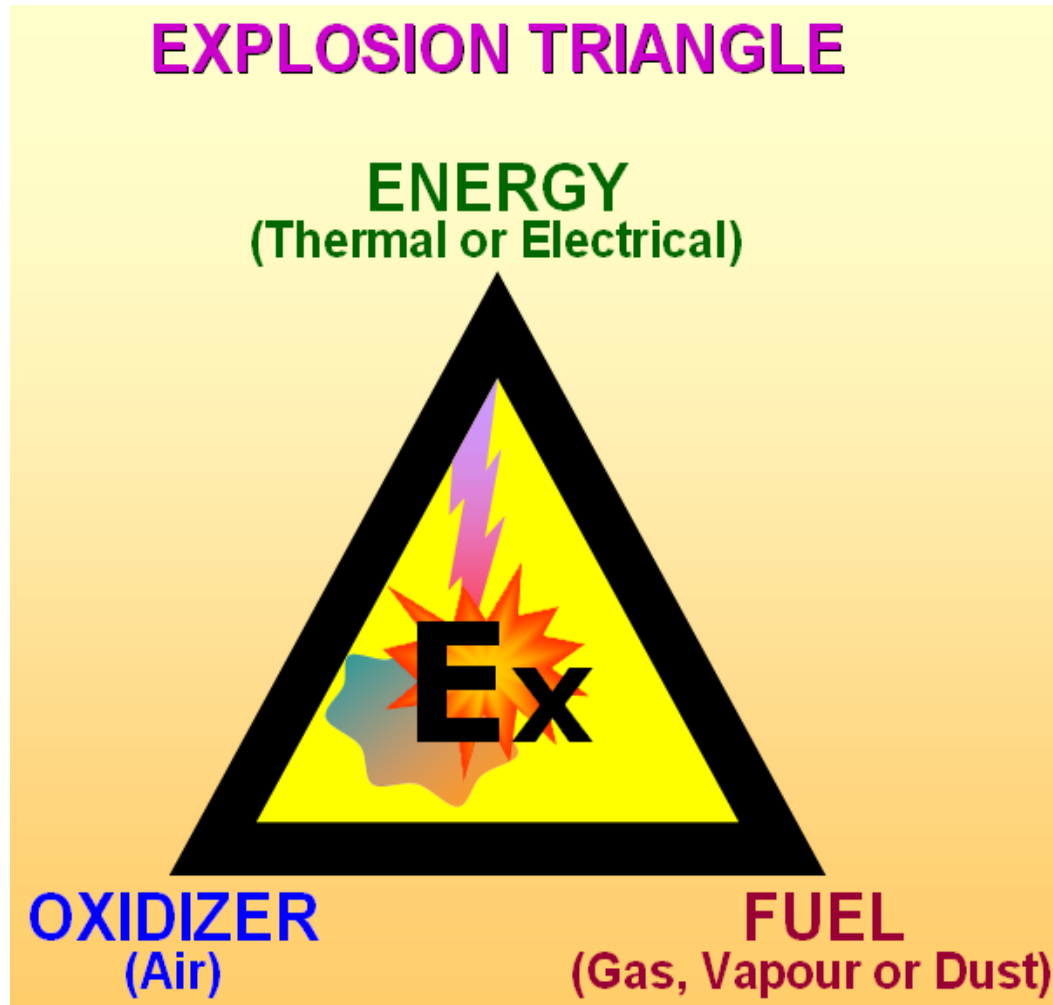
THREE METHODS OF HAZARDOUS AREA CLASSIFICATION

- ▶ EI 15 utilizes three levels of release frequency to determine the likelihood of having a flammable atmosphere near a potential release source.
- ▶ The three levels are based on a predefined acceptable level of risk (typical IEC projects are based on achieving an overall value of individual risk of less than 0.00001 fatalities per year; however, each end user or site may determine their own). The specific release frequency level used for an area is based on the exposure of the most exposed individual to flammable releases combined with the probability of ignition of those releases.
- ▶ Once the release frequency level is known, an equivalent hole size for a release can be determined. The hole size is then used to determine the release rate based on the composition of the flammable vapor/gas and its pressure. The hazardous radii are then determined by charts and/or calculations provided in EI 15. The risk-based approach outlined in EI 15 is applicable to secondary release sources (similar to a Class I Division 2 area) and electrical equipment only.

- ▶ The information derived from HAC drawings has traditionally been used to specify electrical equipment and electrical installations located in hazardous (classified) locations.
- ▶ One reason why operating companies may use HAC drawings for non-electrical purposes is because NFPA 30, Section 6.5.1 states: “...Precautions shall be taken to prevent the ignition of flammable vapors by sources such as the following: where the following includes open flames, radiant heat and hot surfaces, as well as other possible sources of ignition...”. It is very logical to assume that if hot electrical equipment can create an ignition, any piece of equipment will be able to do the same.

Explosion elements

Hazardous locations are required by the *NEC* to be documented. This document often shows the source of the material, process parameters (such as temperature, flow, pressure), hazardous location boundaries, and any other pertinent information. Personnel responsible for the design, installation, inspection, operation, and maintenance of electrical equipment are required to have access to this document.



Maintenance personnel must be trained to understand the explosive nature of the material, the type of protection employed, and how equipment maintenance is important to a safe environment. There are 15 different types of protection recognized by the NEC, and each prevents ignition of the atmosphere in a different manner. Misunderstanding the protection technique, or applying inappropriate maintenance methods, can be catastrophic.

N.E.C. Article 500 Code Sections

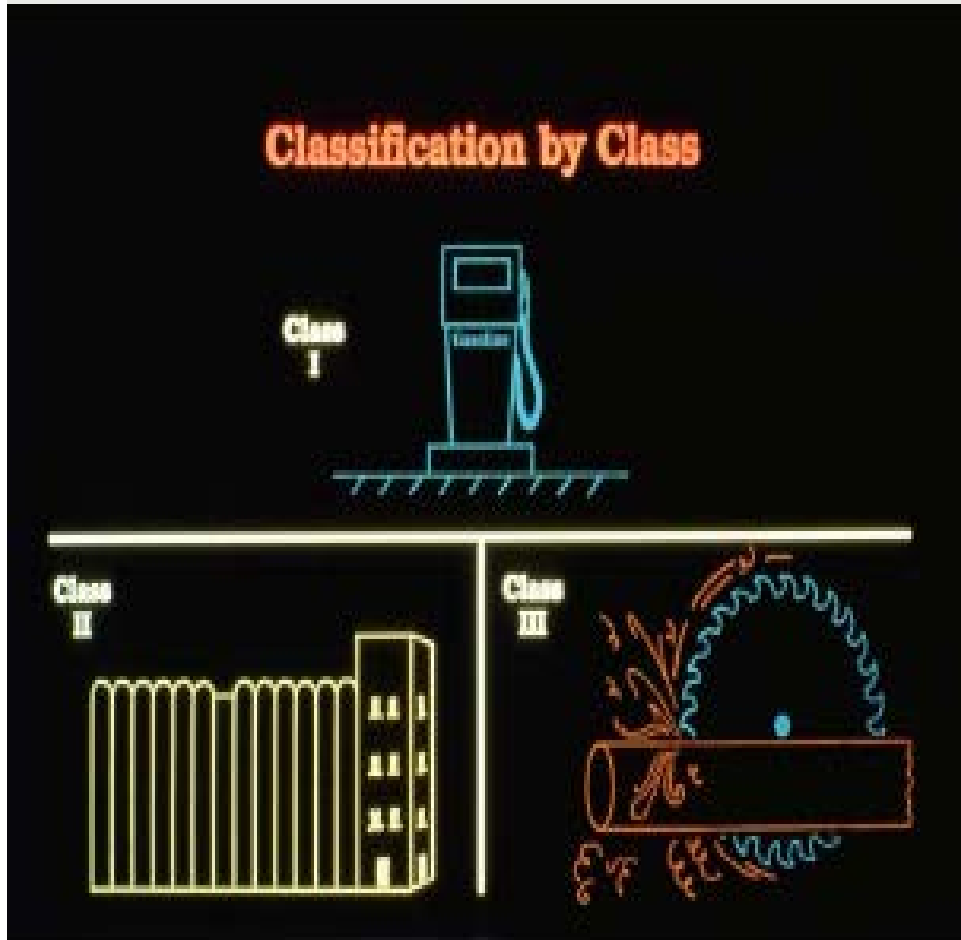
- ▶ Article 500 Hazardous Locations
- ▶ Article 501 Class I Locations
- ▶ Article 502 Class II Locations
- ▶ Article 503 Class III Locations
- ▶ Article 504 Intrinsically Safe Systems
- ▶ Article 505 Class 1, Zone 0, 1, and 2 Locations
- ▶ Article 510 Hazardous Location -Specific
- ▶ Article 511 Commercial Garages
- ▶ Article 513 Aircraft Hangars
- ▶ Article 514 Gasoline Service Stations
- ▶ Article 515 Bulk Storage Plants
- ▶ Article 516 Paint Spray Application



Troubleshooting equipment in a hazardous location presents a special problem. Most equipment cannot be opened while energized in the presence of explosive or combustible material. Most portable troubleshooting instruments are powered by a battery; however,

“battery operated” does not equate to being safe for use in a hazardous location. A spark is likely to occur when the testing device contacts a conductor, and an explosion is possible if an explosive atmosphere exists. Before using any of these devices in a hazardous area, it should be determined that an explosive atmosphere does not exist.

Class Locations



- ▶ N.E.C. Article 500.5 (B)
- ▶ An area where **FLAMMABLE GASES** or **VAPORS** are or may be present in the air in sufficient quantities to produce explosive or ignitable mixtures.

Class I Locations (Gases)

- ▶ N.E.C. Article 500.5 (B)
- ▶ An area where **FLAMMABLE GASES** or **VAPORS** are or may be present in the air in sufficient quantities to produce explosive or ignitable mixtures.



Class I Locations (Gases)

CLASS I INDUSTRIES AND APPLICATIONS

- ▶ Natural or liquefied gas storage facilities
- ▶ Chemical plants
- ▶ Petroleum refineries
- ▶ Bulk handling or storage facilities for gasoline
- ▶ Dip tanks
- ▶ Storage tanks for flammable liquids or gas
- ▶ Spraying areas for paints or plastics
- ▶ Aircraft fuel servicing areas or hangers
- ▶ Well drilling (oil and gas), offshore or on
- ▶ Pipeline pumping areas
- ▶ Printing machine areas

Class II Locations (Dust)

- ▶ N.E.C. Article 500.5 (C)
- ▶ An area where presence of COMBUSTIBLE DUST presents a fire or explosion hazard.



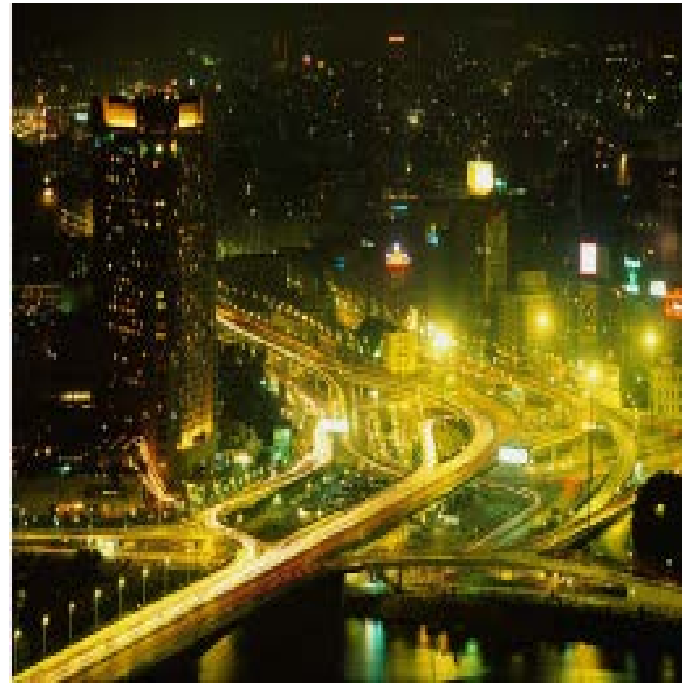
Class II Locations (Dust)

CLASS II INDUSTRIES AND APPLICATIONS

- ▶ Grain storage, handling or processing plants
- ▶ Coal storage, handling or processing facilities
- ▶ Metal grinding or metal powder producing facilities
- ▶ Gunpowder or explosive (fireworks) plants
- ▶ Sugar, cocoa, spice or starch production or handling facilities

Class III Locations (Fibers)

- ▶ NEC Article 500.5 (D)
- ▶ An area made hazardous because of the presence of easily ignitable FIBERS or FLYINGS, but in which such fibers or flying's are not likely to be in suspension in the air in quantities sufficient to produce ignitable mixtures.



Class III Locations (Fibers)

- ▶ CLASS III INDUSTRIES AND APPLICATIONS
- ▶ Cotton, textile or flax producing or handling facilities
- ▶ Wood cutting, pulverizing or shaping plants
- ▶ Clothing manufacturing facilities

Locations



- ▶ Division 1
- ▶ Division 2

Division 1 Location

- ▶ NEC Articles 500.5(B)(1), 500.5(C)(1) and 500.5(D)(1)
- ▶ An area where the HAZARD EXIST UNDER NORMAL OPERATING CONDITIONS. This also includes locations where the hazard is caused by frequent maintenance or repair work or frequent equipment failure.



Division 1 Location

(good engineering practice)

- ▶ Consider that there are 8,760 hours in a year. It is proposed that a Division I location would be one that is within the flammable range more than 0.1% of the time, that is more than 8.76 hrs/yr.
- ▶ From a practical viewpoint on this basis, we would suggest that any area in the flammable range 10 hrs/yr. or more should be classified as Division 1.

Division 2 Location

- ▶ NEC Articles 500.5(B)(2) , 500.5(C)(2), and 500.5(D)(2)
- ▶ An area where ignitable gases, vapors, dust, or fibers are handled, processed, or used, but which **EXIST ONLY UNDER ABNORMAL CONDITIONS**, such as containers or closed systems from which they can only escape through accidental rupture or breakdown.
- ▶ Note: No electrically conductive dust are included in Class II, Division 2 atmospheres.



Division 2 Location (good engineering practice)

- ▶ A Division 2 location would be one that is within the range more than 0.01% and up to 0.1 % of the time (0.876 hours to 8.76 hours).
- ▶ From a practical viewpoint on this basis, we would suggest that any area in the flammable range classified as Division 2, would be in the range between 1-10 hrs/yr.

235.2 Maintenance Requirements for Hazardous (Classified) Locations.

Equipment and installations in these locations shall be maintained such that the following criteria are met:

(1) No energized parts are exposed.

Exception to (1): Intrinsically safe and nonincendive circuits.

(2) There are no breaks in conduit systems, fittings, or enclosures from damage, corrosion, or other causes.

(3) All bonding jumpers are securely fastened and intact.

(4) All fittings, boxes, and enclosures with bolted covers have all bolts installed and bolted tight.

(5) All threaded conduit are wrenchtight and enclosure covers are tightened in accordance with the manufacturer's instructions.

(6) There are no open entries into fittings, boxes, or enclosures that would compromise the protection characteristics.

(7) All close-up plugs, breathers, seals, and drains are securely in place.

(8) Marking of luminaires (lighting fixtures) for maximum lamp wattage and temperature rating is legible and not exceeded.

(9) Required markings are secure and legible.

Comparison of Div 1 and Div 2 for Gases

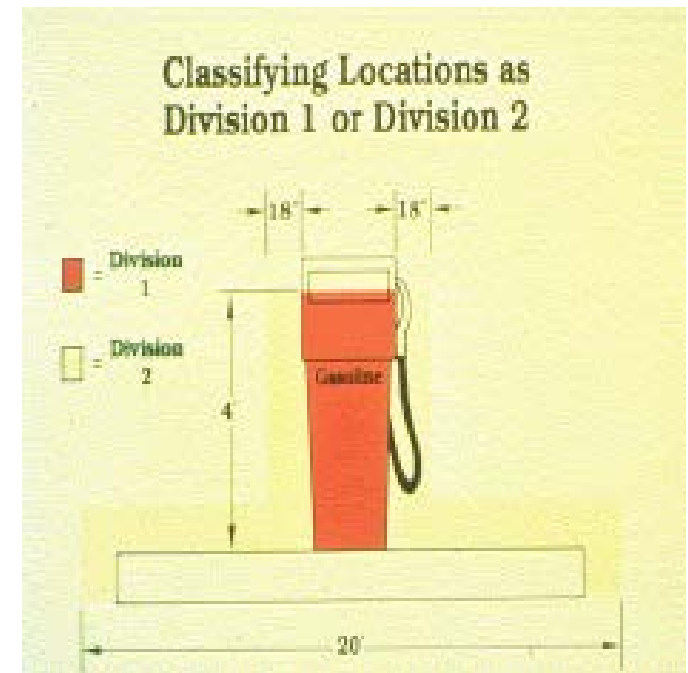
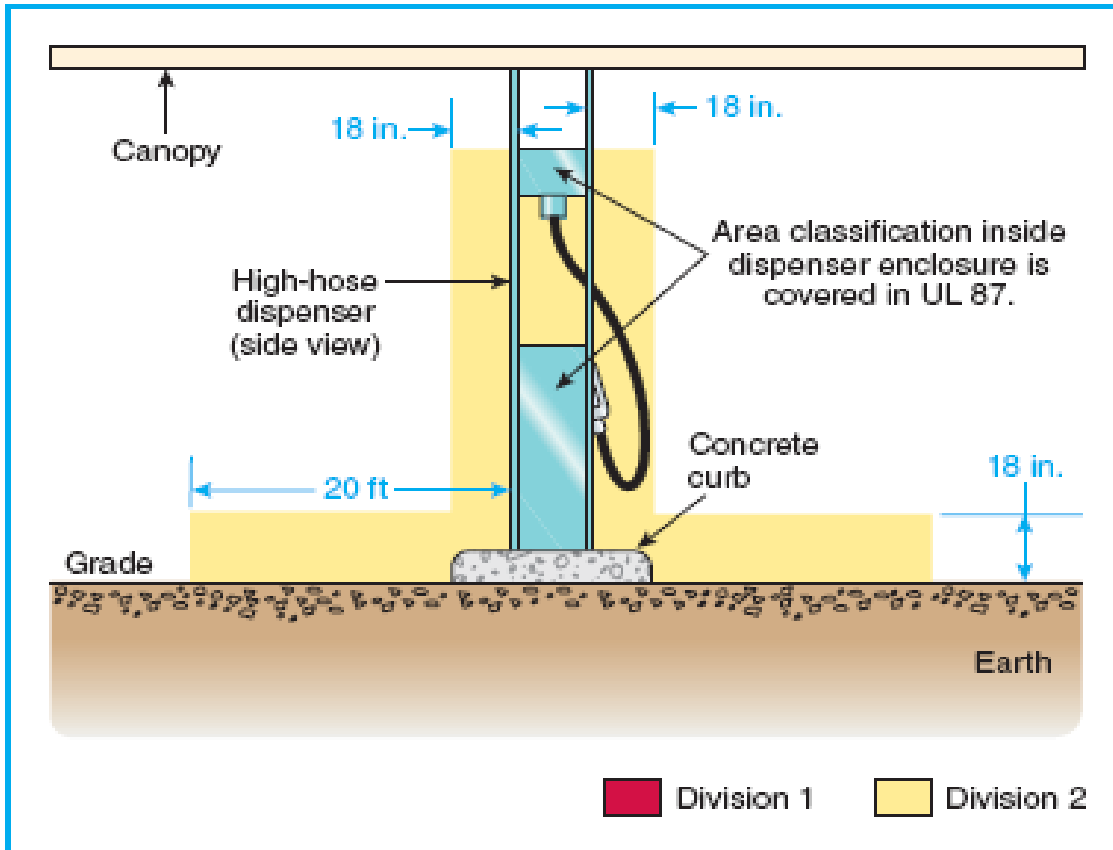


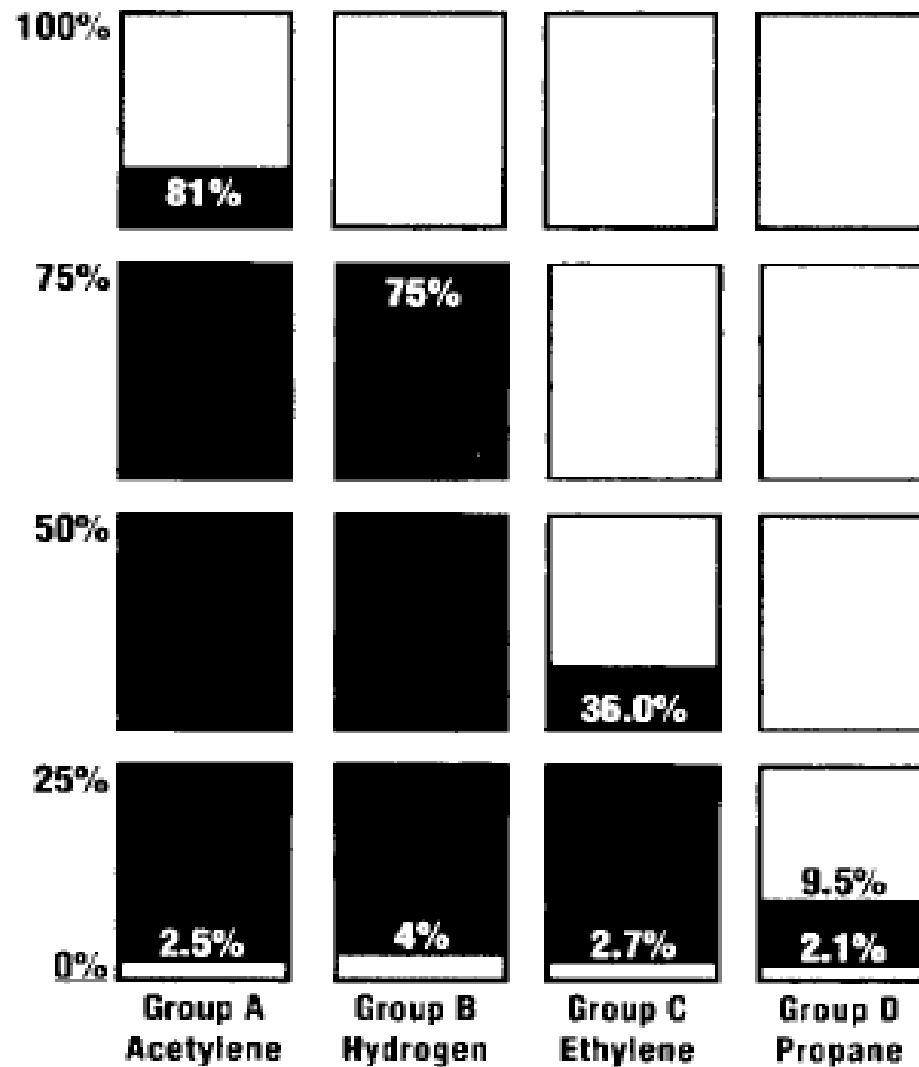
Exhibit 514.1 Extent of Class I location around overhead motor fuel dispensing units, in accordance with Table 514.3(B)(1).

Groups A, B, C, and D (Gases)

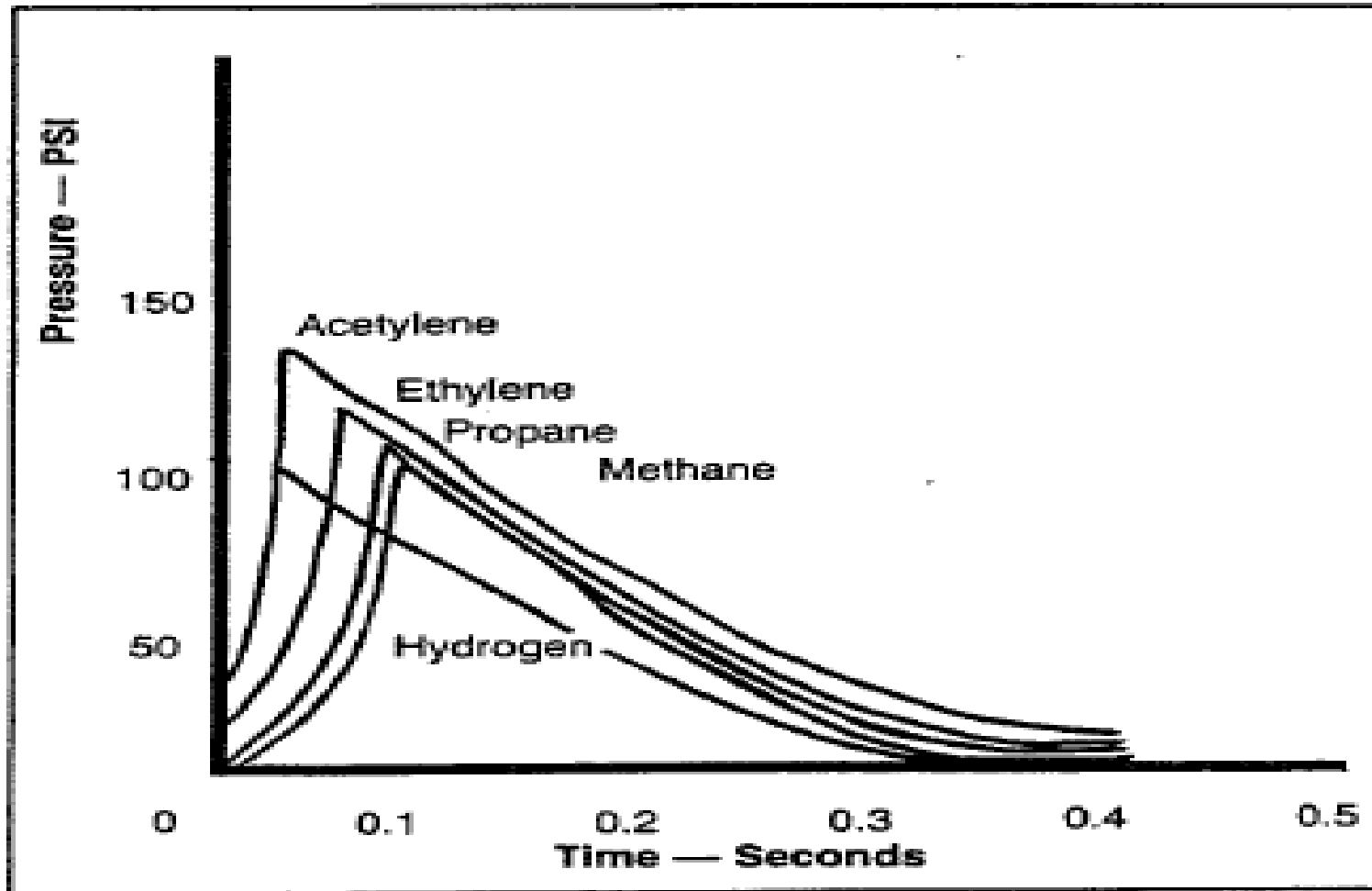
NEC Article 500.6(A)

- ▶ Groups indicates the DEGREE OF THE HAZARD.
- ▶ GROUPS A, B, C and D are classified by chemical families as shown in NFPA 497M-1986 and 325M-1984.
- ▶ The important factor in classifying a gas or vapor by Group is how much PRESSURE is created during an explosion. Group A (Acetylene) creates the most pressure, with Group B (Hydrogen) next.

Groups A, B, C, and D (Gases)



Groups A, B, C, and D (Gases)

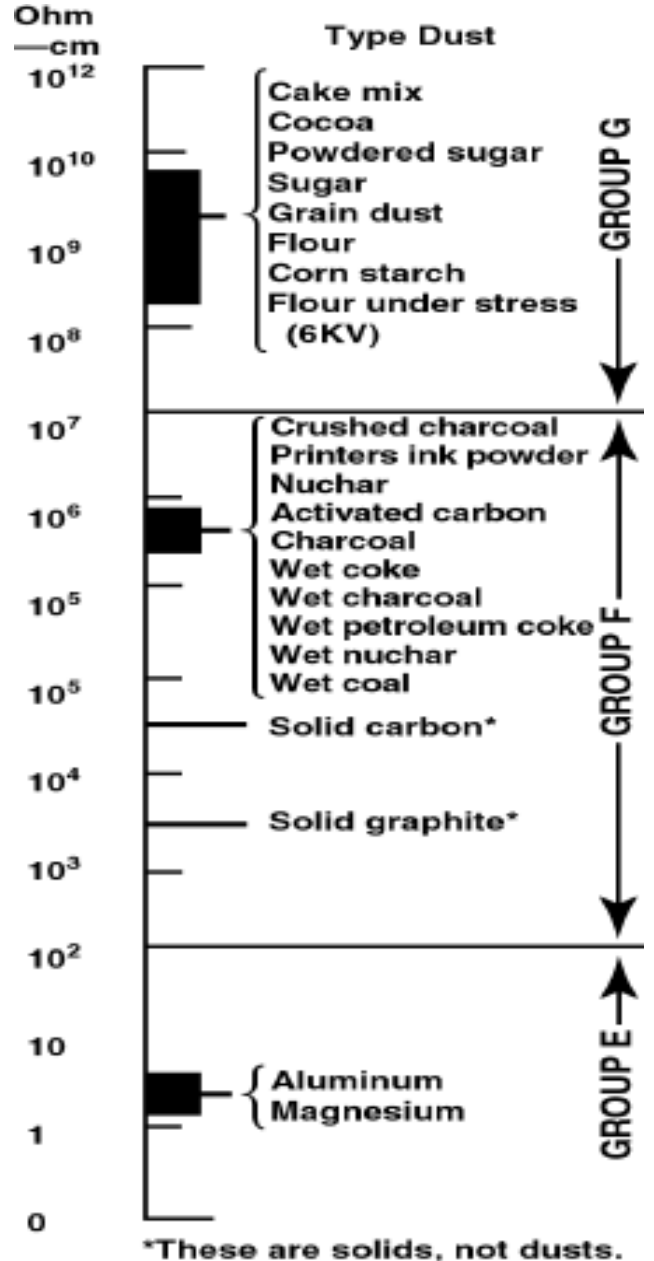


Relative speed and maximum pressure of five test gases: acetylene, hydrogen, ethylene, propane, and methane.

Groups E, F and G (Dust)

NEC Article 500.6(B)

- ▶ Groups indicates the DEGREE OF THE HAZARD, based on Electrical Resistivity from Table on right (Source: ANSI/ISA-S12.10-1988)
- ▶ GROUP E -Atmospheres containing combustible METAL DUST.
- ▶ GROUP F -Atmospheres containing CARBON BLACK, CHARCOAL, COAL, or COKE DUST.
- ▶ GROUP G -Atmospheres containing AGRICULTURAL and other dusts



Summary of Classes and Groups

CLASS I:FLAMMABLE VAPORS & GASSES (Volatile gas or vapor present in sufficient quantity to produce ignition or explosion).

GROUP A: ACETYLENE

GROUP B: HYDROGEN

GROUP C: ETHYLENE

GROUP D: GASOLINE

CLASS II:COMBUSTIBLE DUSTS (Combustible dusts present in sufficient quantity to present a fire or explosion hazard).

GROUP E: METAL DUSTS

GROUP F: CARBON DUSTS -COAL

GROUP G: GRAIN DUSTS

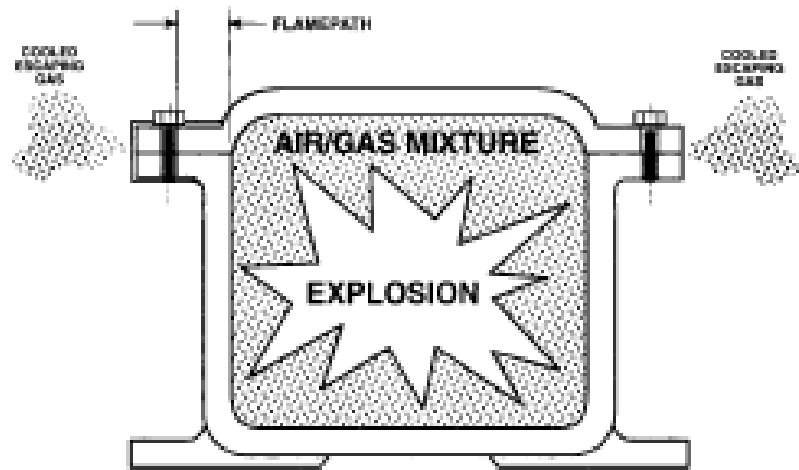
CLASS III:FIBERS & FLYINGS (Easily ignitable fibers or flyings present but not likely to be suspended in the air).

Identifying electrical equipment that can be used in different hazardous areas.

- ▶ UL Explosion proof Apparatus Definition NEMA 7 Enclosures.
- ▶ Purging/Pressurization Systems.
- ▶ Intrinsically Safe Equipment.

UL Explosion proof Apparatus Definition (NEMA 7 Enclosures)

- ▶ Class I, Division 1
- ▶ An enclosure that will withstand an internal explosion of gases or vapors and prevent those gases or vapors from igniting gases or vapors in the surrounding atmosphere outside of the enclosure.



Explosion proof Equipment -Joints

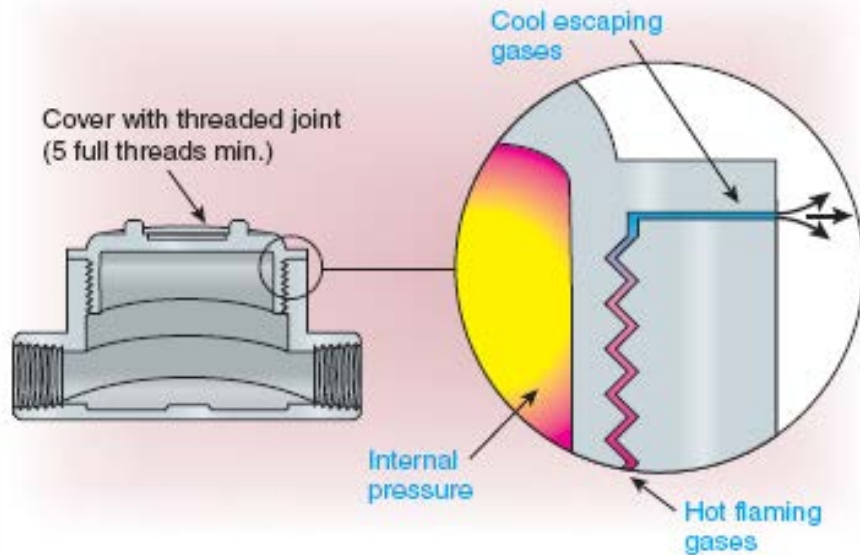


Exhibit 501.1 Cooling of hot gases as they pass through the threads of a screw-type cover of an explosionproof junction box.

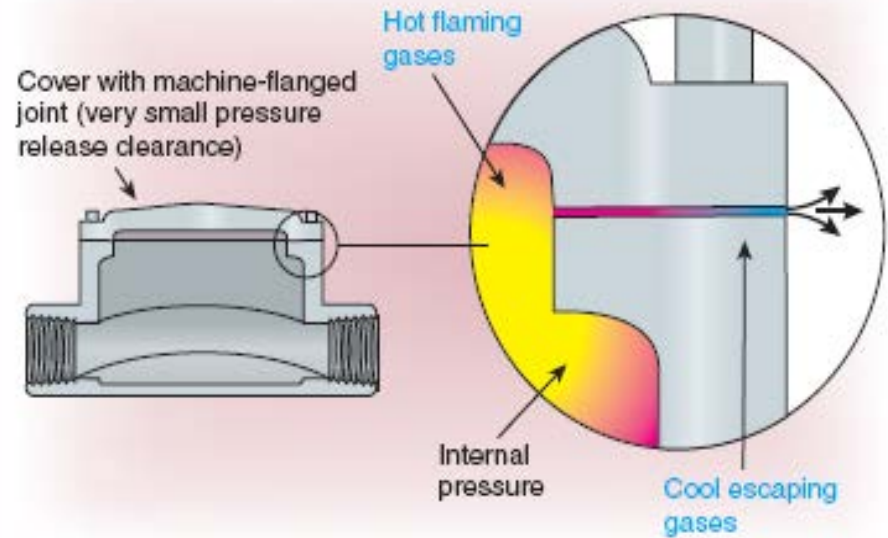
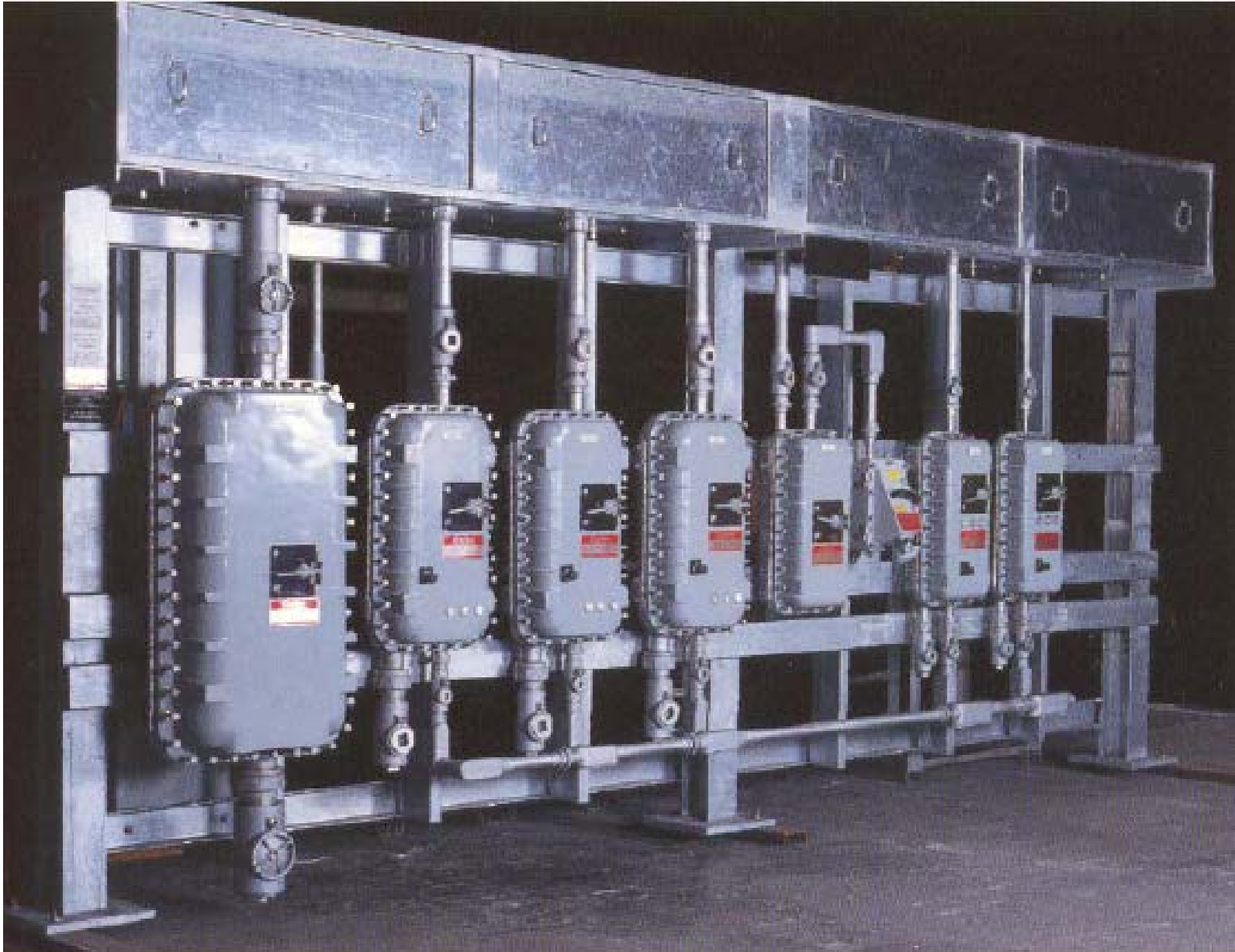


Exhibit 501.2 Cooling of hot gases as they pass across a machine-flanged joint. The clearance between the machined surfaces is kept very small.

Explosion proof Equipment - Joints





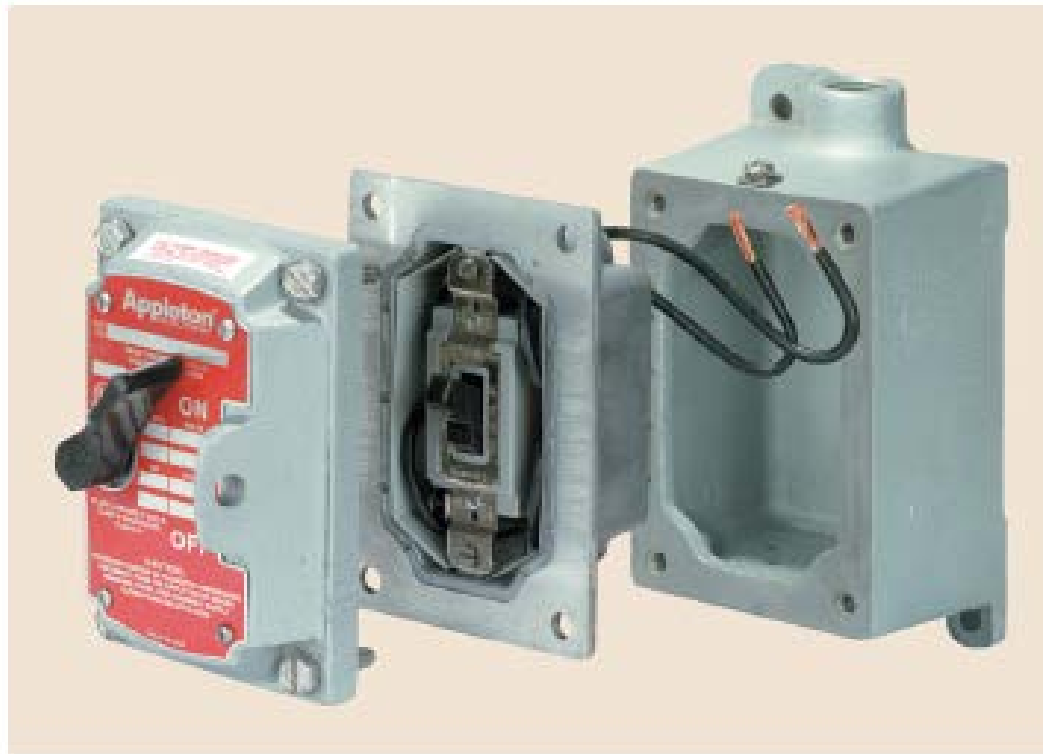


Exhibit 501.17 A standard toggle switch in an explosionproof enclosure. (Courtesy of Appleton Electric Co., EGS Electrical Group)



Figure 91. Inlet Air Heating Piping Running Through Enclosure Left Side Wall

Equipment maintenance in hazardous locations should be performed only by personnel trained to maintain the special electrical equipment. Workers should be trained to identify and eliminate ignition sources, such as high surface temperatures, stored electrical energy, and the buildup of static charges, and to identify the need for special tools, equipment, and tests. These individuals should be familiar with the requirements for the electrical installation of the equipment and protection technique employed. For example, they should understand that joint compound or tape may weaken an explosionproof fitting during an ignition or may interrupt the required ground path.

NEMA 7 Designs

▶ Advantages

- ▶ Explosion Containment
- ▶ No Electronics
- ▶ Low Maintenance
- ▶ No Moving Parts
- ▶ High-Powered Equipment

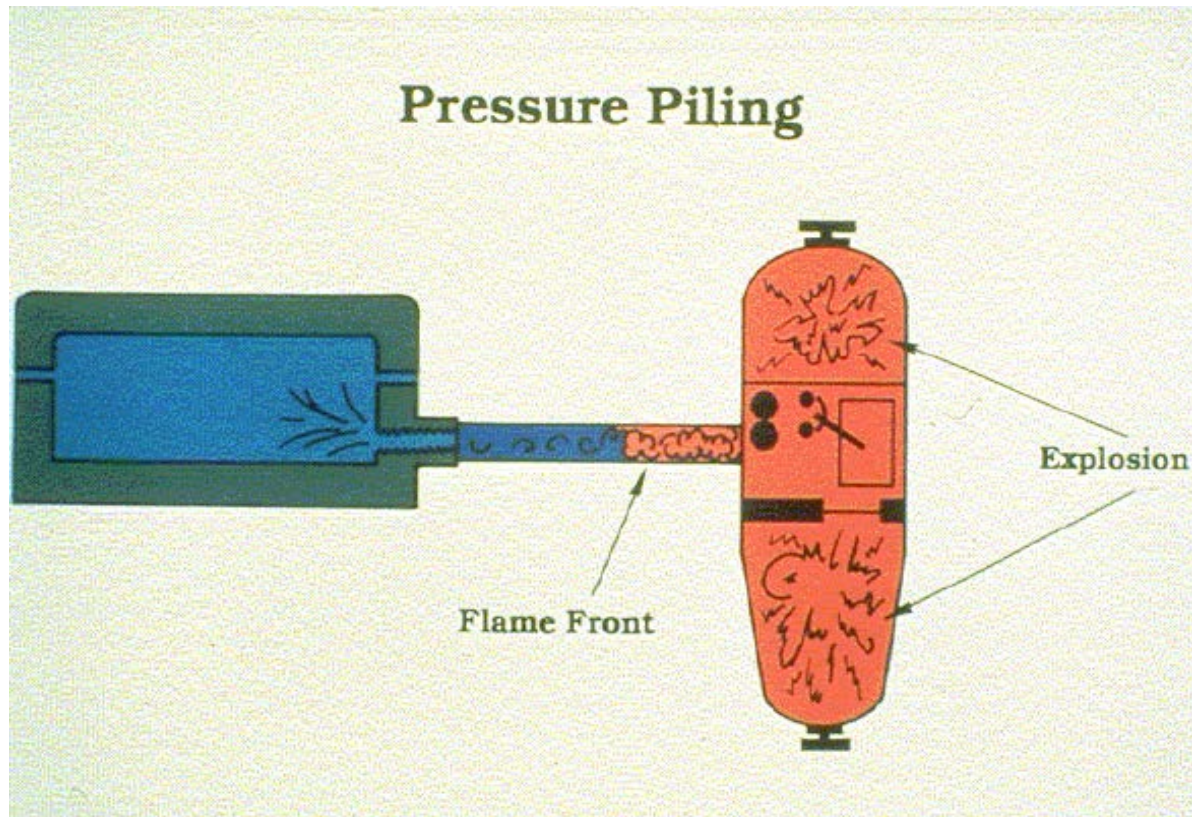
▶ Disadvantages

- ▶ No warning mechanism for containment failure
- ▶ Danger to Equipment After Explosions
- ▶ Possibility of Installation/Maintenance Errors
- ▶ Cost of Protection per ft³ Increases With Enclosure Size
- ▶ Windows are Limited
- ▶ Condensation buildup is common
- ▶ Few sizes to choose from
- ▶ Cumbersome, Limited Access
- ▶ Bulky Designs
- ▶ Causes Harmful Heat Build up
- ▶ Excessive Weight



Failure to properly tighten all bolts and screw covers
puts people and equipment at risk

Purpose of the Conduit Seals



Maintenance personnel should be trained to look for cracked viewing windows, missing fasteners, and damaged threads that may affect the integrity of the protection system. All bolts, screws, fittings, and covers must be properly installed. Every missing or damaged fastener must be replaced with those specified by the manufacturer to provide sufficient strength to withstand an internal ignition.

Conduit Seal Fittings

Required within 18 inches of an enclosure containing arcing or high temperature device. (Class I, Division 1 & 2 locations)

Required in Class I, Division 1 locations where 2 inch or larger conduit enters enclosures that house terminals, splices, or taps.

Required at Class I boundary where conduit leaves the hazardous area.

U.L. requires that sealing compound and sealing fitting be of the same manufacturer.

Depth of sealing compound should be equal to trade size of conduit, having minimum thickness of 5/8 in.



Conduit Seal Fittings

Expanded fill conduit seal fittings can be used with a conduit system allowing up to 40% conduit fill. Standard conduit seal fittings are limited to 25% fill.

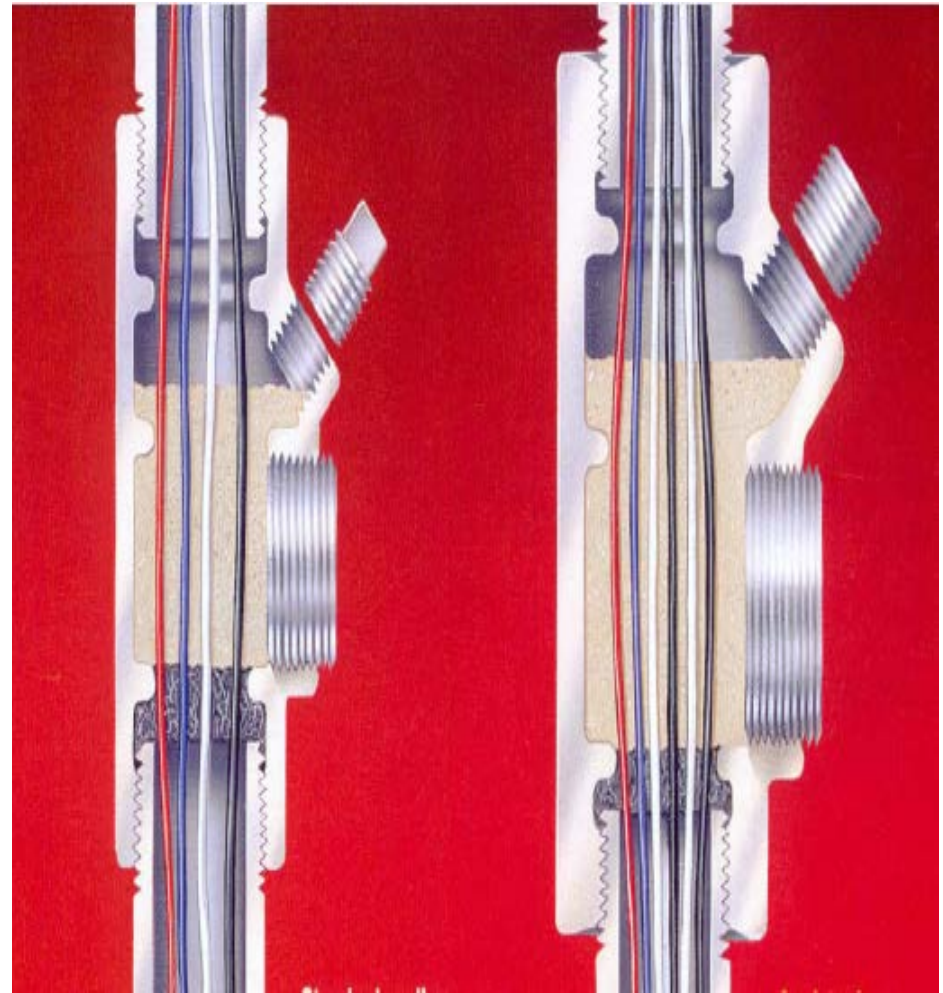
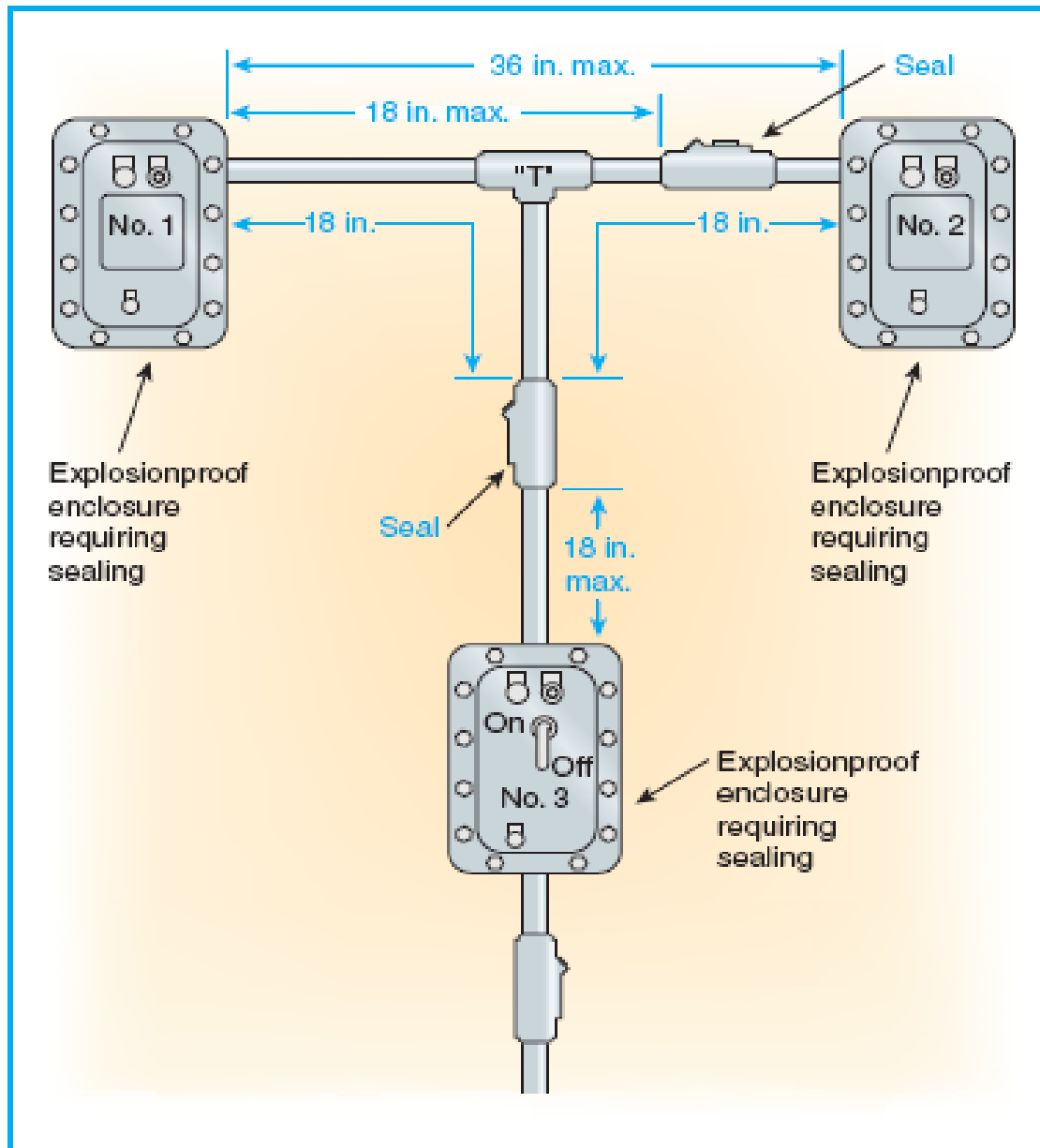




Exhibit 501.9 A sealing fitting placed in a run of conduit to minimize the passage of gases from one portion of the electrical installation to another. (Courtesy of Appleton Electric Co., EGS Electrical Group)



6F EYSR Retrofit Sealing Fitting

Chico Sealing Compound and Fiber see pages 155–156

Cl. I, Div. 2, Groups C, D
Cl. II, Div. 2, Groups E, F, G
Explosionproof
Dust-Ignitionproof

6F

Applications:

- EYSR retrofit sealing fittings are installed:
- In rigid metal conduit systems in Class I, Division 2 hazardous locations
 - To replace installed Eaton's Crouse-Hinds type EYS or EYD sealing fittings
 - Without disassembly of the conduit system
 - In vertical or horizontal positions, indoors or outdoors
 - To restrict the passage of gases, vapors, or flames from one portion of the electrical system to another at atmospheric pressures and normal ambient temperatures
 - To limit explosions to the sealed-off enclosure
 - To limit precompression or "pressure piling" in the conduit system
 - To prevent accumulation of water in the conduit system when installed with an ECD15 drain

Features:

- Seal may be installed in the existing conduit run without disassembly of the conduit system saving time and labor
- Overall length and spacing requirements do not exceed those of standard EYS seals; permits close nesting of seals
- Pipe plugs permit the installation of a standard ECD15 drain fitting (order separately) for use in vertical conduit runs to drain any water that might accumulate in the conduit system
- Steel set screws provide grounding continuity
- Suitable for vertical and horizontal installations for indoor and outdoor applications
- Available in 1/4" to 4" NPT sizes

Certifications and Complies:

- NEC:
 - Class I, Division 2, Groups C, D
 - Class II, Division 2, Groups E, F, G
- UL Standard: 1203
- CEC:
 - Class I, Division 1, Groups C, D
 - Class II, Division 1, Groups E, F, G
- CSA Standard: C22.2 No. 30

EYSR sealing fittings are approved for use in hazardous locations only when Chico® A sealing compound and Chico X fiber are used to make the seal.

Standard Materials:

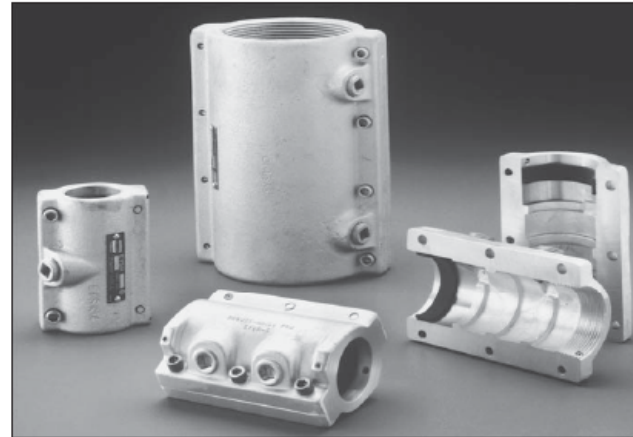
- Body – Feraloy® iron alloy
- Pipe plugs, bolts and set screws – steel
- Gasket – neoprene

Standard Finishes:

- Feraloy iron alloy – electrogalvanized and aluminum acrylic paint
- Steel – electrogalvanized
- Gasket – natural

Size Ranges:

- 1/4" – 4"



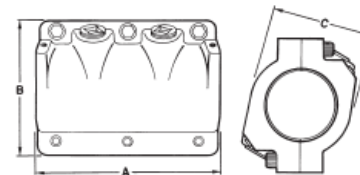
Ordering Information

Hub Size	Cat. #	Approximate Internal Volume in Cubic Inches*		Approximate Amount (oz.) of Fiber per Hub	
		Vert.	Horiz.	Vert.	Horiz.
1/4	EYSR2	3 1/2	5 1/4	1/8	1/8
1	EYSR3	4 1/4	9 1/2	1/4	1/4
1 1/4	EYSR4	7	13 1/2	1/2	1/2
1 1/2	EYSR5	12 1/4	24 1/4	1	1
2	EYSR6	25 1/4	40 1/2	1	2
2 1/2	EYSR7	48	75 1/2	1 1/2	3
3	EYSR8	86 1/2	126	2	4
3 1/2	EYSR9	147	210	4 1/2	9
4	EYSR10	186	252	4 1/2	9

*Use the approximate internal volume in cubic inches to determine how much Chico A sealing compound is required.

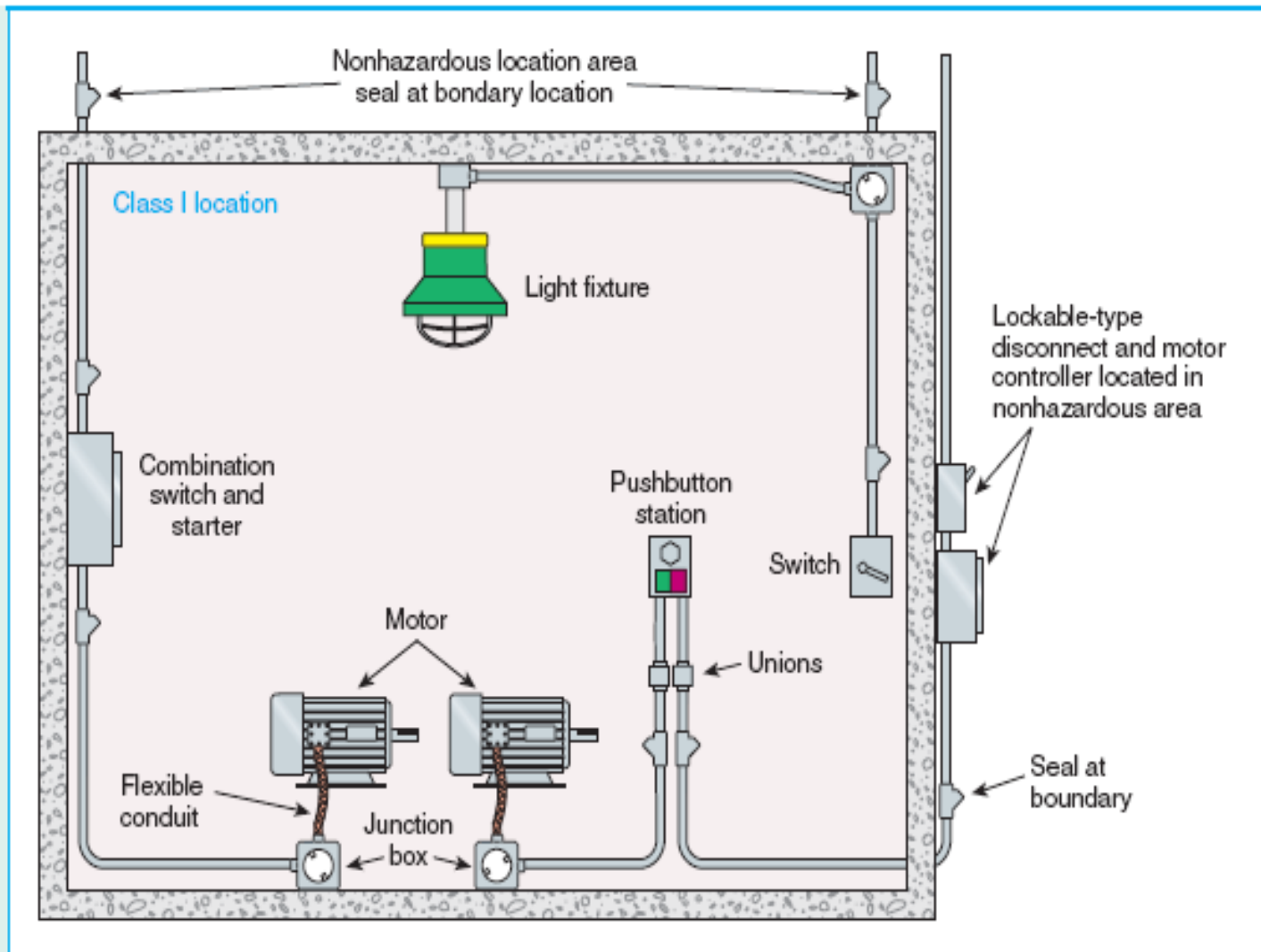
Dimensions

In Inches:



Cat. #	A	B	C	Cat. #	A	B	C
EYSR2	3 11/16	2 1/2	1 1/2	EYSR7	7 1/2	5	3 1/4
EYSR3	4 1/4	3 1/4	3 1/4	EYSR8	8 1/2	5 1/2	4 1/4
EYSR4	5	3 3/4	3	EYSR9	9 11/16	6 1/16	4 1/4
EYSR5	5 1/4	3 3/4	3	EYSR10	9 1/4	6 1/4	5 1/4
EYSR6	6 1/4	4	3				

Exhibit 501.8 A Class I, Division 1 location where threaded metal conduits, sealing fittings, explosionproof fittings, and equipment for power and lights are used.



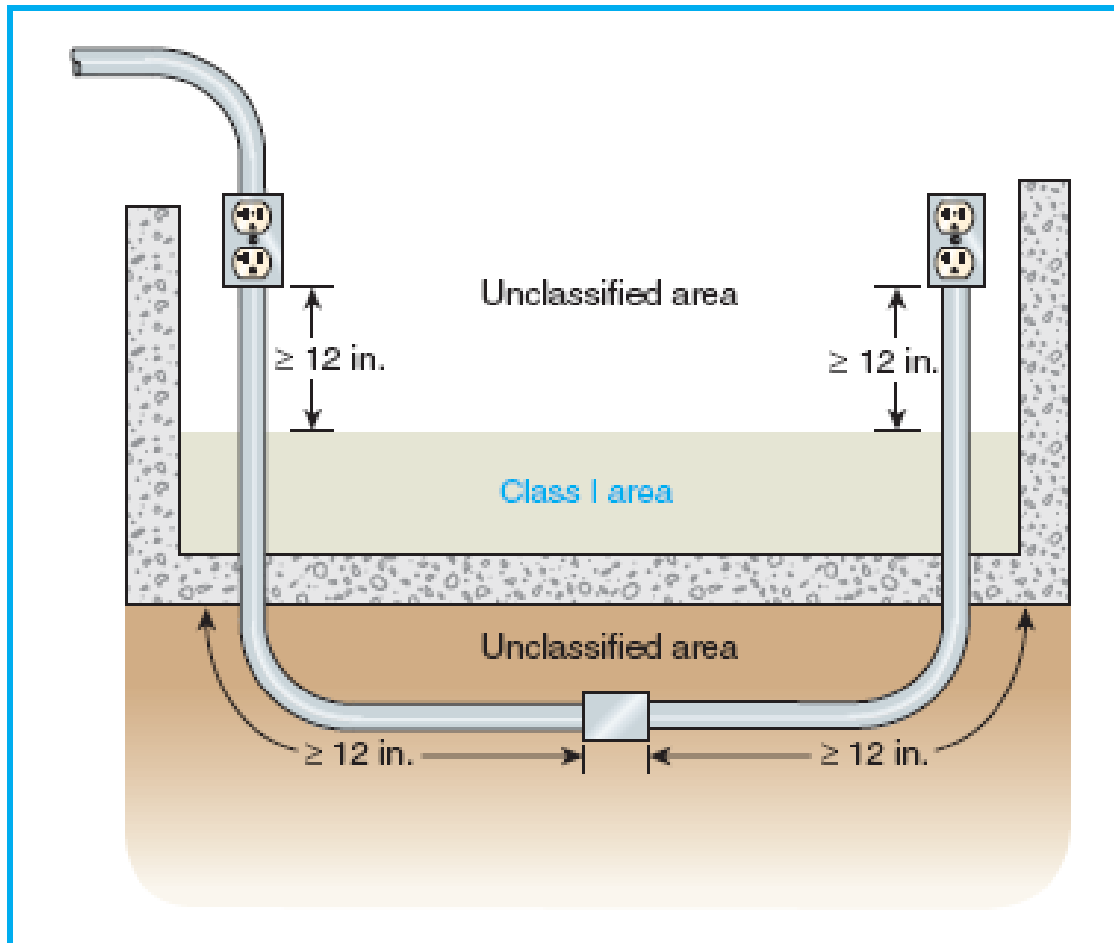


Exhibit 511.1 Seals not required for conduits that pass unbroken through the Class I location.



Exhibit 501.18 Terminal housing of a motor listed for use in specific hazardous locations. Note integral sealing of the motor. (Courtesy of General Electric Co.)

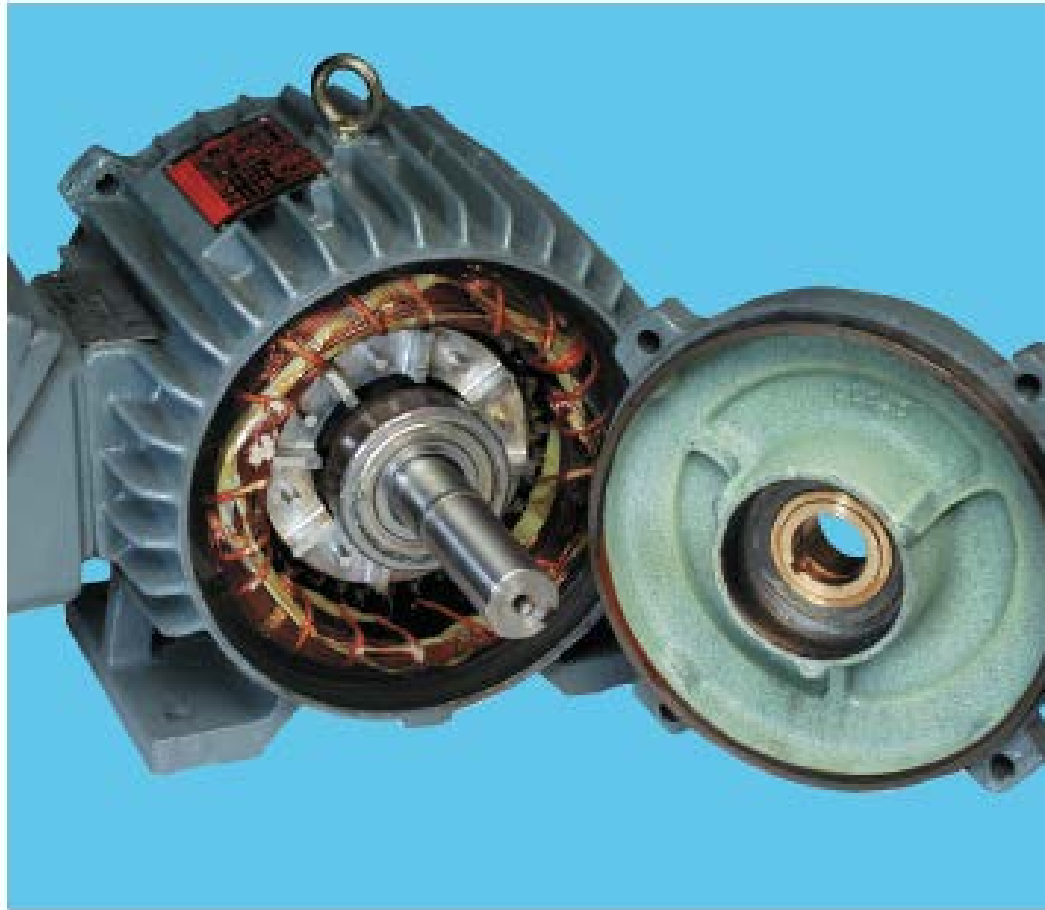


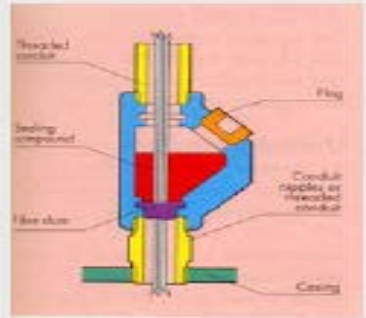
Exhibit 501.19 View showing internal fan of motor in Exhibit 501.18. (Courtesy of General Electric Co.)



Exhibit 501.10 An explosionproof sealing fitting for Type MC-HL cable. (Courtesy of Cooper Crouse-Hinds)

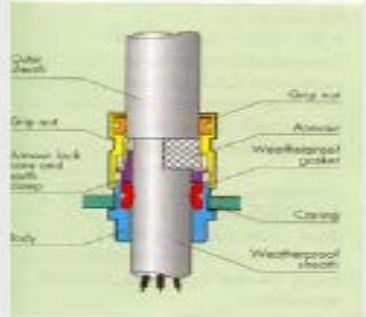
Conductors placed in a rigid threaded conduit :
connection via fire barrier

Method used in the following countries :
United States,
Canada, part of
South America,
Middle East, Far
East



Armoured braid, wire or steel tape cable :
connection via cable gland with earth continuity

Method used in the following countries :
United Kingdom,
Commonwealth
countries, Spain



Non armoured cable :
connection via cable gland

Methods used in the following countries :
France, Germany,
Italy, Eastern
European countries,
part of Africa,
Middle East, Far East

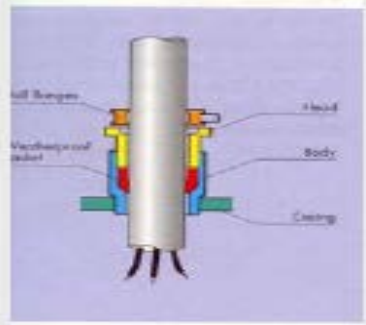




Exhibit 501.22 A receptacle and attachment plug of the explosionproof type with an interlocking switch. The switch must be in the off position before the attachment plug can be removed. (Courtesy of Appleton Electric Co., EGS Electrical Group)



Exhibit 501.24 An audible signaling device for use in hazardous (classified) locations. (Courtesy of Cooper Crouse-Hinds)

UL Temperature Test

Class I, Division 1 Lighting

- Class I, Division 1 - Explosionproof Fixtures
- **TEMPERATURE TEST:** The "T" number is established for the maximum SURFACE fixture temperature in a 40°C and elevated ambients.
- **DESIGN:** Explosionproof, the maximum may not exceed the Ignition Temperature of the hazardous atmosphere.

- U.L./NEC Explosionproof Design
- Exterior "T" number rating, Class & Groups shown on label.
- Maximum Exterior Fixture Temperature



Hazardous Lighting -T Rating

Degree C	Degree F	ID#
450	842	T1
300	572	T2
280	536	T2A
260	500	T2B
230	446	T2C
215	419	T2D
200	392	T3
180	356	T3A
165	329	T3B
160	320	T3C
135	275	T4
120	248	T4A
100	212	T5
85	185	T6

A lighting fixture (or any heat producing device) for a specific hazardous location must have a 'T' rating that does not exceed the AIT (Autoignition Temperature) of the materials present in the air at that location



Exhibit 502.5 A typical luminaire for use in Class II, Division 1 locations. (Courtesy of Cooper Crouse-Hinds)



Exhibit 501.20 A typical lighting fixture for use in Class I, Group C and D locations. (Courtesy of Appleton Electric Co., EGS Electrical Group)

TABLE 1
 OPEN AIR AUTOIGNITION TESTS UNDER NORMAL WIND
 AND CONVECTION CURRENT
 (Extracted from API RP 2216) [1]

Hydrocarbon	Published Ignition Temperatures (Approximate at Time of Test)		Hot Surface Temperature Without Ignition Occurring	
	°C	°F	°C	°F
Gasoline	280 – 425	540 – 800	540 – 725	1000 – 1335
Turbine Oil	370	700	650	1200
Light Naphtha	330	625	650	1200
Ethyl Ether	160	320	565	1050

TYPICAL NON-ELECTRICAL PROCESS TEMPERATURES
IN A REFINERY

Equipment Type	Hot Surface Temperature Range (Note 1)	
	°C	°F
150 psig Steam Line	186	366
300 psig Steam Line	227	440
600 psig Steam Line	316-371	600-700
1,200 psig Steam Line	371-427	700-800
Crude Atmospheric Tower	343-399	650-750
Crude Unit Vacuum Tower	399-441	750-825
Delayed Coke Drum	427-510	800-950
Gasoline Hydrotreater	343	650
Catalytic Reformer	454-549	850-1020

- ▶ It is also worth noting that the hot surfaces considered above have no flames or sparks associated with them. They are simply surfaces of process equipment and piping at temperatures above ambient.

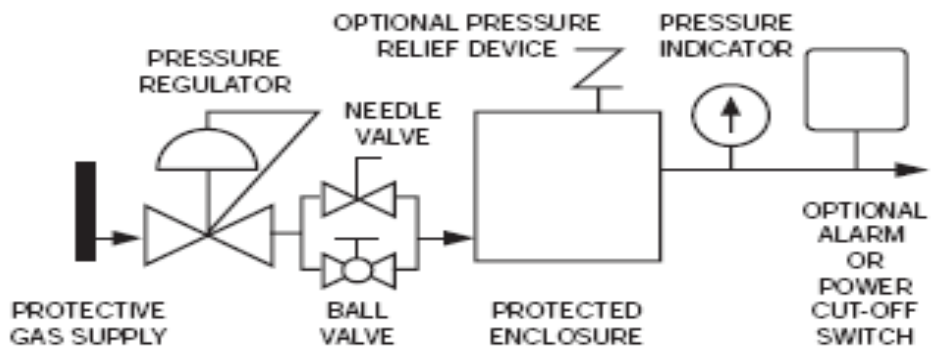
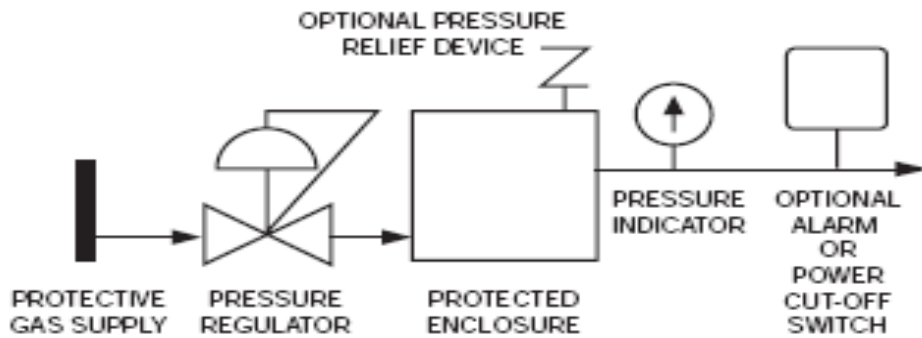
- ▶ Hot surfaces are generally covered with insulation for heat conservation purposes, but not always.
- ▶ Exceptions include:
 1. Insulation for personnel protection
 2. Removable Insulation
 3. Damaged insulation or insulation in disrepair.

- ▶ All of the above are examples of hot surfaces which, either intentionally or by disrepair, are exposed. These examples are typical of hydrocarbon processing facilities throughout the globe. The application of insulation is also never assumed to provide an effective barrier to prevent or inhibit hot surface ignition. Even properly applied insulation is not designed to provide a vapor barrier between the hot surface and the ambient environment. Further, insulation can trap leaked hydrocarbons against a hot surface, potentially increasing the likelihood of hot surface ignition.

AUTOIGNITION TEMPERATURES VS. HOT SURFACE IGNITION TEMPERATURES

- ▶ AIT is a parameter for a material which can be tested with good repeatability under properly controlled laboratory conditions. However, AIT does not translate well to a plant environment, and as demonstrated in API RP 2216, is not a reliable predictor of the surface temperature expected to initiate combustion.
- ▶ HSITs can be measured in a laboratory setting, but a plant environment is far more complex, involving numerous uncontrolled parameters making it extremely difficult, if not impossible, to derive a mathematical formula to reliably predict HSITs.
- ▶ T-Codes have been used successfully for electrical equipment in development of the HAC and this current practice should be retained rather than attempt a method which utilizes HSITs.
- ▶ Assigning T-Codes to all equipment within the process unit (such as ISO 80079 appears to propose) is one way to address all hot surfaces. However, this approach may prove impractical and very costly.
- ▶ A collaborative, risk-based approach such as PHA and LOPA can adequately identify, document and assure corrective action to mitigate potential hazards associated with hot surfaces of non-electrical process equipment, thereby eliminating the need to assign T-Codes to non-electrical equipment with hot surface temperatures.
- ▶ Area classification studies and subsequent plans should be completed by HSE or process engineers, and not just electrical engineers.

- ▶ API RP 500 defines AIT as “The minimum temperature required, at normal atmospheric pressure, to initiate or cause self-sustained combustion (independent of any externally heated element).”
- ▶ NFPA 497 defines AIT as “The minimum temperature required to initiate or cause self-sustained combustion of a solid, liquid, or gas independently of the heating or heated element.”
- ▶ When developing HAC drawings, the traditional thought is that any electrical equipment in the area which has a surface temperature that exceeds the AIT of the gas or vapor that may be present (either normally or due to an upset condition) may cause self-sustained combustion of the gas or vapor.
- ▶ This is reinforced by the NEC because NEC 500.8(D)(1) does not allow electrical equipment in Class I areas to have any exposed surface temperature that exceeds the marked temperature rating in NEC 500.8(C) [3].

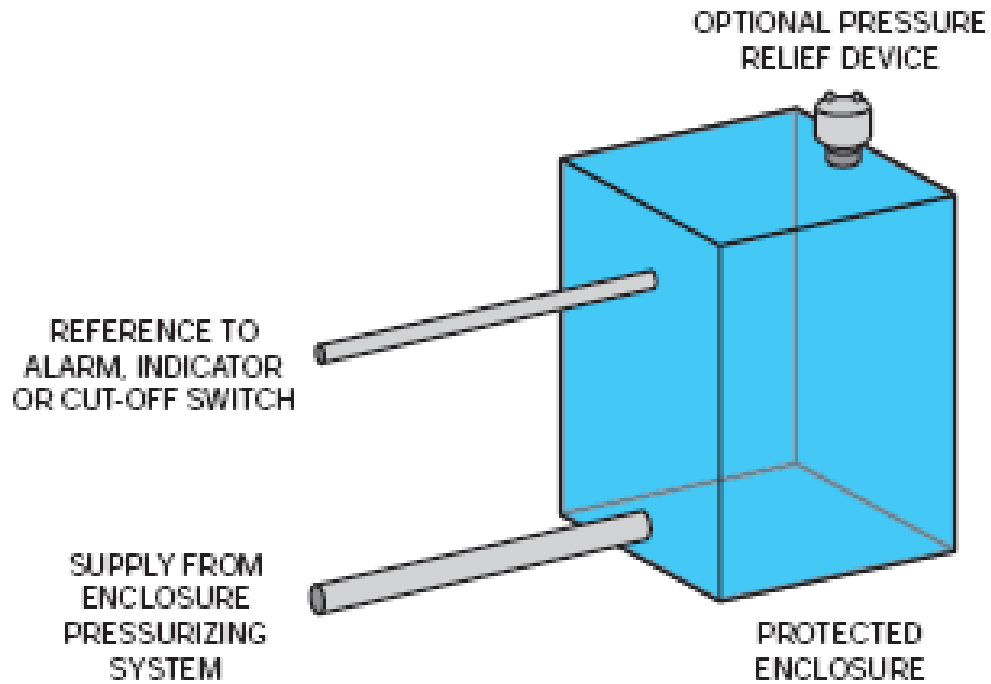


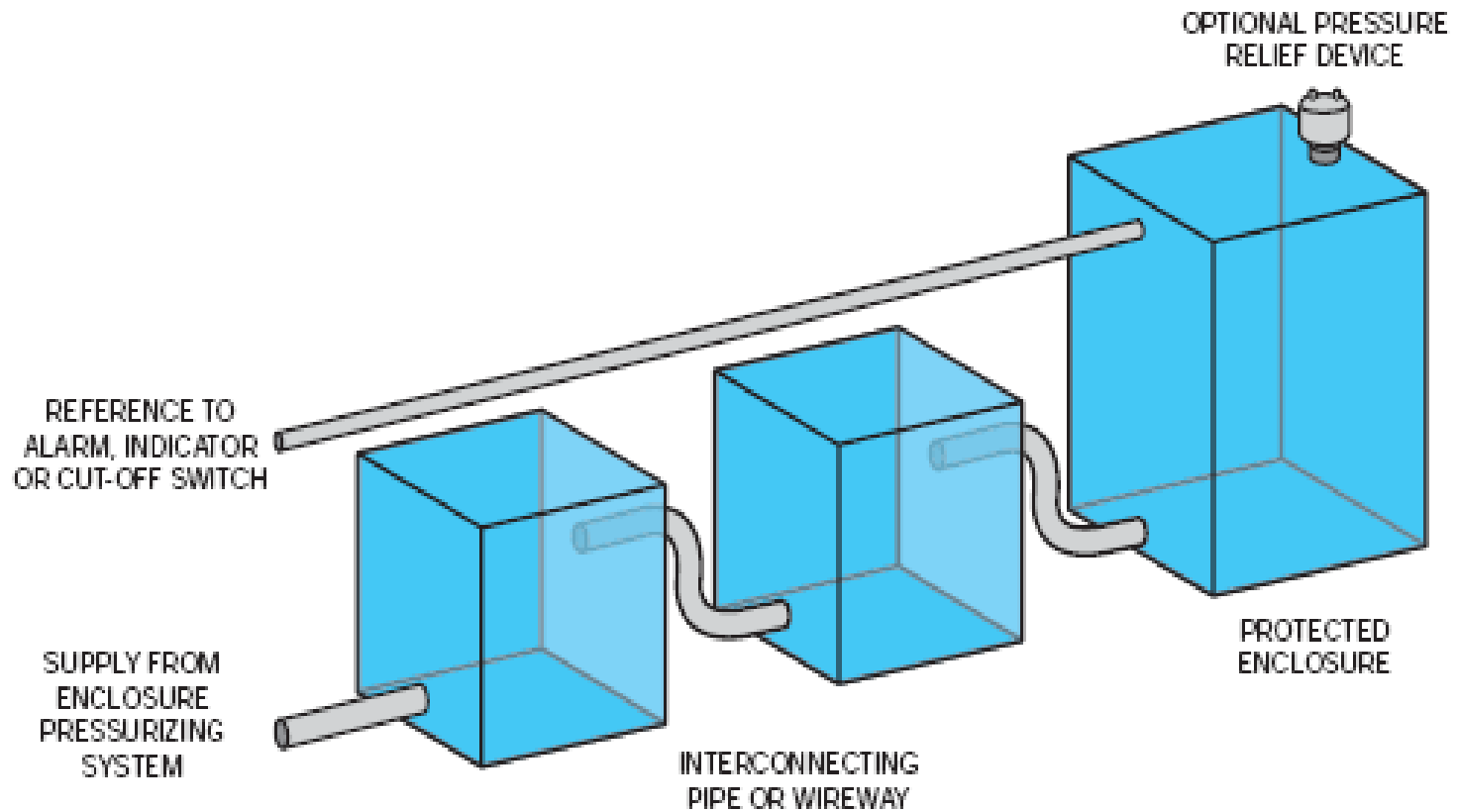
These pressurization system diagrams represent the basic designs of modern pneumatic systems.





1. Type X pressurizing reduces the classification within a protected enclosure from Division 1 or Zone 1 to unclassified.
2. Type Y pressurizing reduces the classification within a protected enclosure from Division 1 to Division 2 or from Zone 1 to Zone 2.
3. Type Z pressurizing reduces the classification within a protected enclosure from Division 2 or Zone 2 to unclassified.





http://www.bebcoeps.com/pdf/purge_tech_review.pdf

Purge Designs

▶ Advantages

- ▶ Reduces Heat Build up
- ▶ Inhibits Metal Corrosion
- ▶ Low Maintenance
- ▶ Increases Equipment Longevity
- ▶ No Special Enclosures Required
- ▶ Allows Fast Access to Equipment
- ▶ Reduces Moisture & Dust Build up
- ▶ Reduces Classification Within the Enclosure
- ▶ Continuous System Status Indication
- ▶ Protects Enclosures up to 450 ft³
- ▶ Allows use of any Enclosure Shape
- ▶ Cost of Protection per ft³ Decreases With Enclosure Size
- ▶ No immediate danger if system failure occurs

▶ Disadvantages

- ▶ Contains Moving Parts
- ▶ Requires Instrument Air Supply
- ▶ Some Systems Require Electronics
- ▶ Hot Permits Required



Exhibit 504.1 A typical intrinsic safety barrier that limits the energy available to the hazardous location. (Courtesy of Cooper Crouse-Hinds)

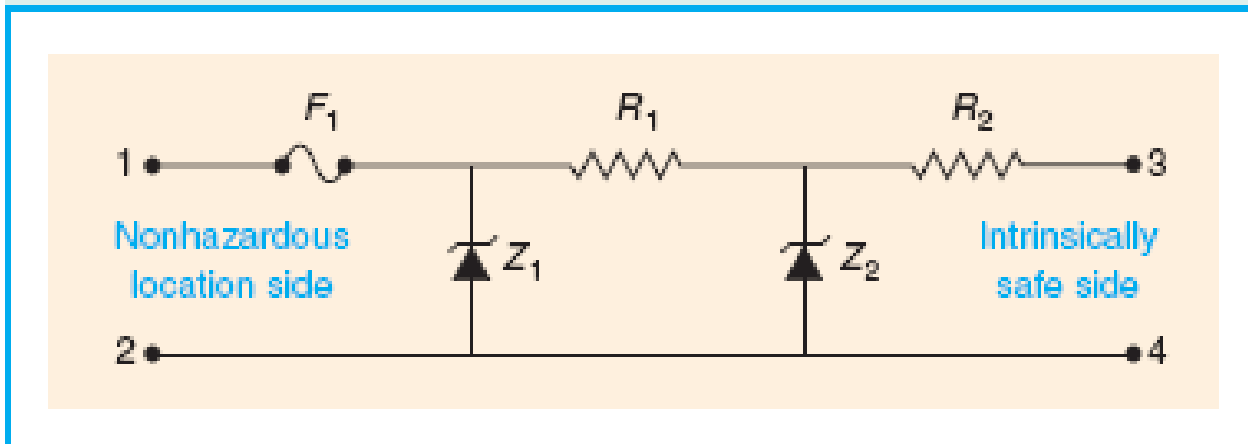


Exhibit 504.2 Fused zener diode barrier.

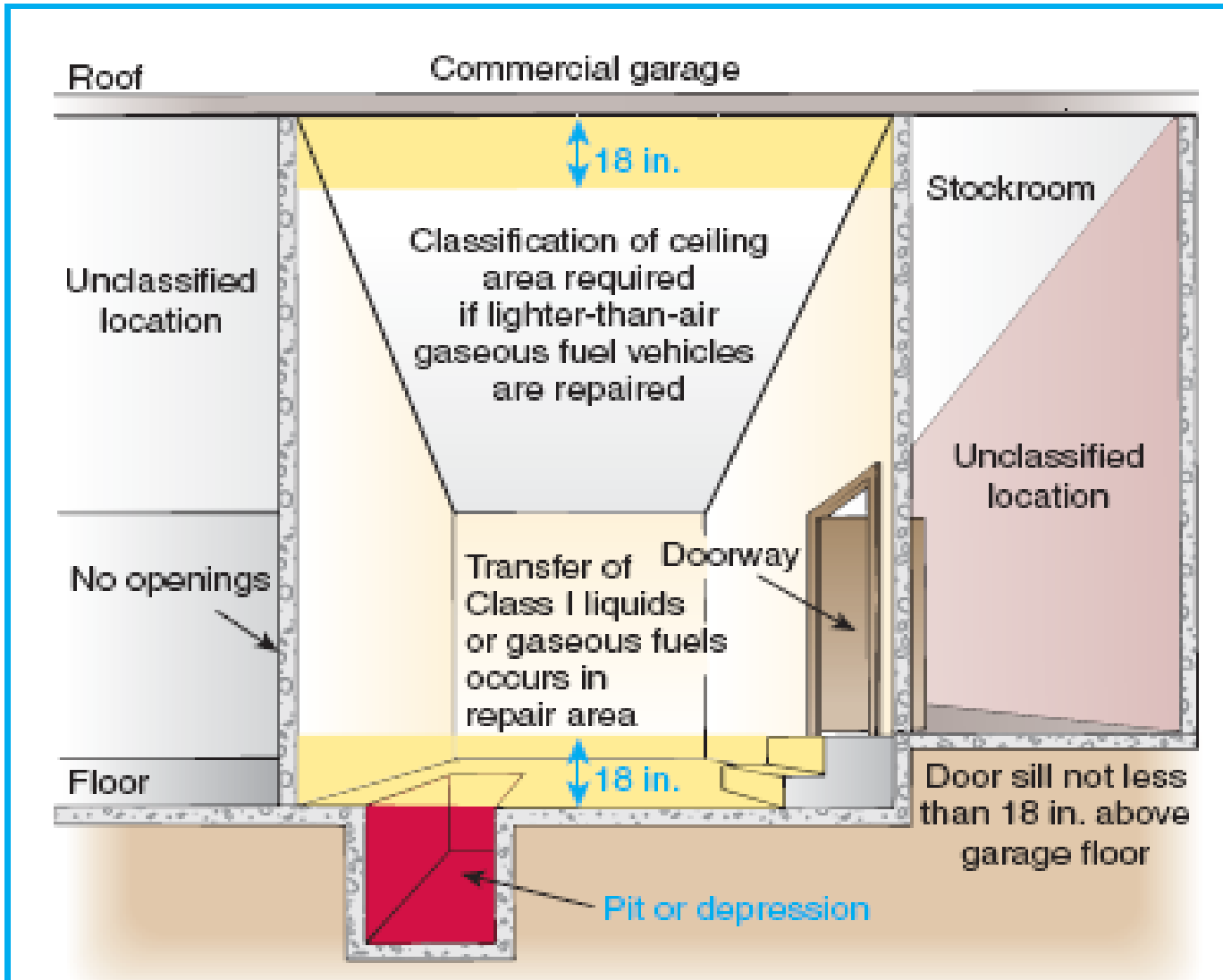
Intrinsically Safe Circuits

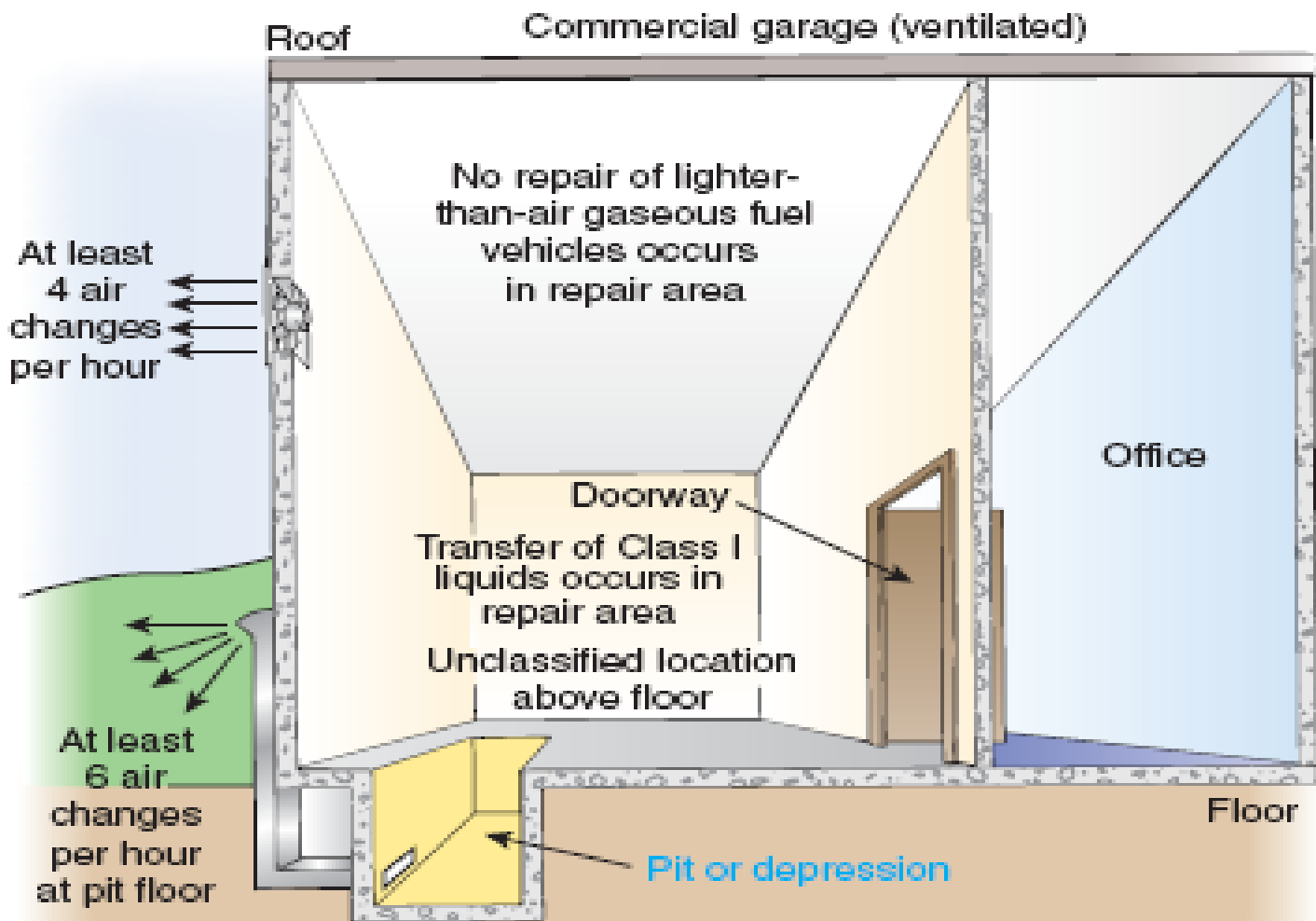
▶ Advantages

- ▶ The Only Protection Allowed for Zone 0
- ▶ Eliminates Possibility of Explosion
- ▶ No Hot Permits
- ▶ Low Maintenance
- ▶ No Special Cables
- ▶ Ideal for Low-Power Devices
- ▶ Limits Energy to the Device

▶ Disadvantages

- ▶ Requires Documentation of I.S. Circuits and Installation
- ▶ Can be Used Only With Low-Power Devices





Division 1

Division 2

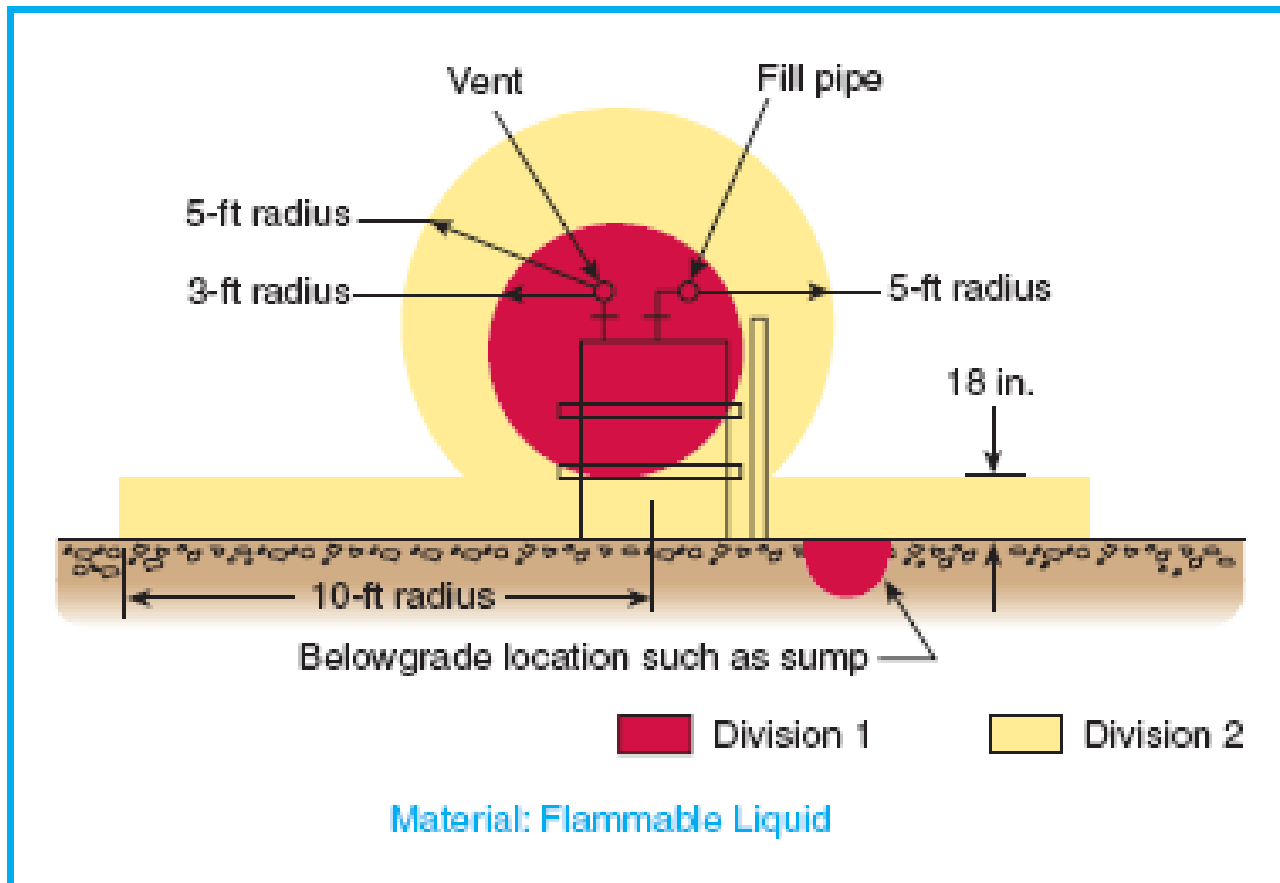


Exhibit 515.5 Drum filling station, outdoors or indoors, with adequate ventilation.

Commentary Table 5.1 Selected Chemicals

Chemical	CAS No.	Class I		Flash				Vapor	Vapor	Class I			
		Division	Type ^a	Point (°C)	AIT (°C)	%LFL	%UFL	Density (Air = 1)	Pressure ^b (mm Hg)	Zone	MIE (mJ)	MIC Ratio	MESG (mm)
Acetaldehyde	75-07-0	C ^d	I	-38	175	4.0	60.0	1.5	874.9	IIA	0.37	0.98	0.92
Acetic Acid	64-19-7	D ^d	II	43	464	4.0	19.9	2.1	15.6	IIA		2.67	1.76
Acetic Acid-tert-Butyl Ester	540-88-5	D	II			1.7	9.8	4.0	40.6				
Acetic Anhydride	108-24-7	D	II	54	316	2.7	10.3	3.5	4.9				1.02

Notes:

^aType is used to designate if the material is a gas, flammable liquid, or combustible liquid. (See 4.2.6 and 4.2.7.)

^bVapor pressure reflected in units of mm Hg at 25°C (77°F) unless stated otherwise.

^cClass I, Zone Groups are based on 1996 IEC TR3 60079-20, *Electrical apparatus for explosive gas atmospheres — Part 20: Data for flammable gases and vapors, relating to the use of electrical apparatus*, which contains additional data on MESG and group classifications.

^dMaterial has been classified by test.

- ▶ VAPOR barriers may be used to separate nonhazardous locations from classified hazardous locations. The concept is based on using an air-tight physical barrier to prevent the migration of flammable gases or vapors from a classified location to an unclassified location.
- ▶ The use of this concept often raises the questions “What design specifications and performance criteria are appropriate for a vapor tight barrier installation?” and
- ▶ “How should the installation be constructed and tested for safety and integrity?”
- ▶ These issues are not fully addressed in the relevant hazardous area classification standards and recommended practices. It is left up to the user to employ engineering judgment to determine the appropriate design criteria for installation and to decide the appropriate tests for the application.

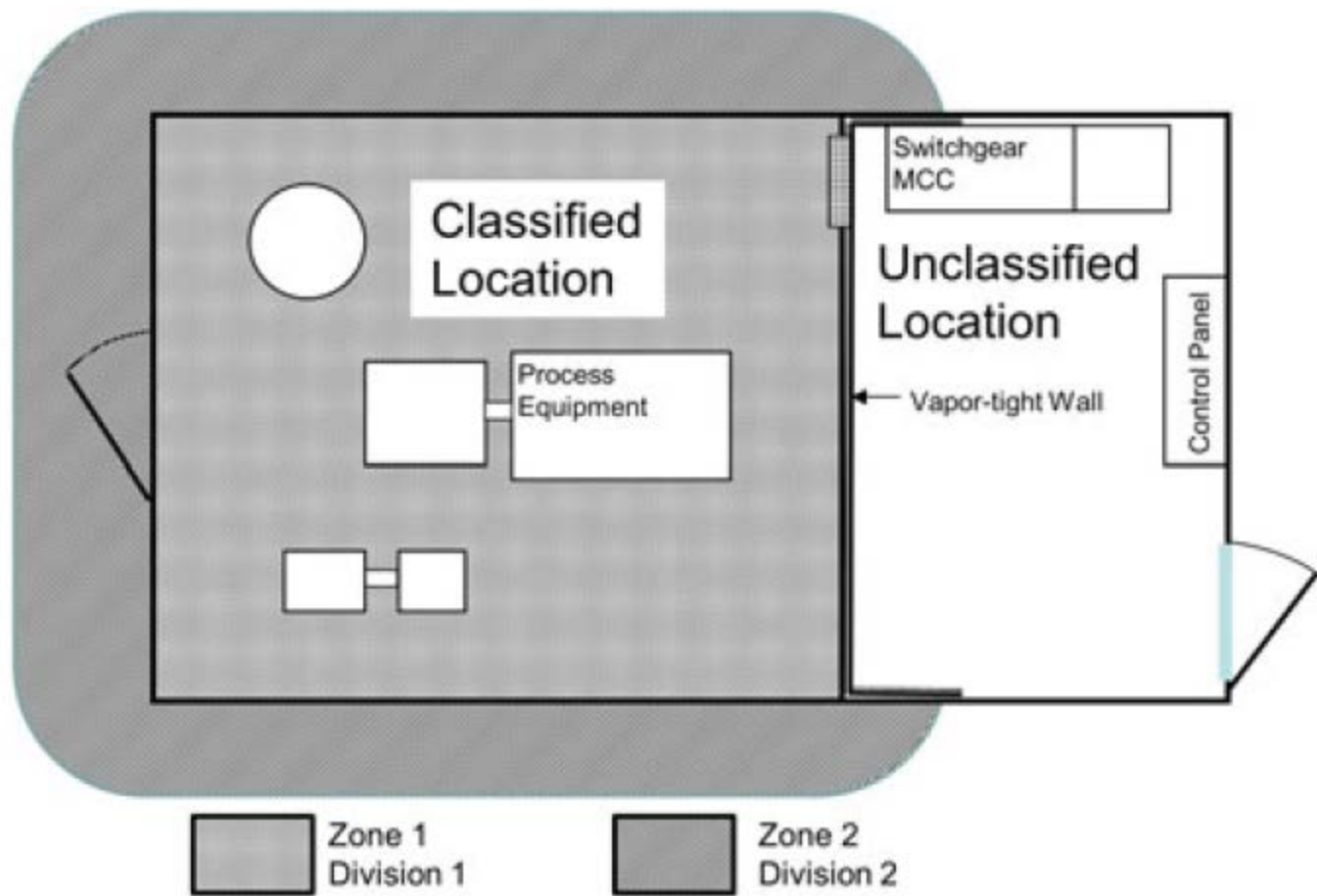


Fig. 1. Vaportight wall application.

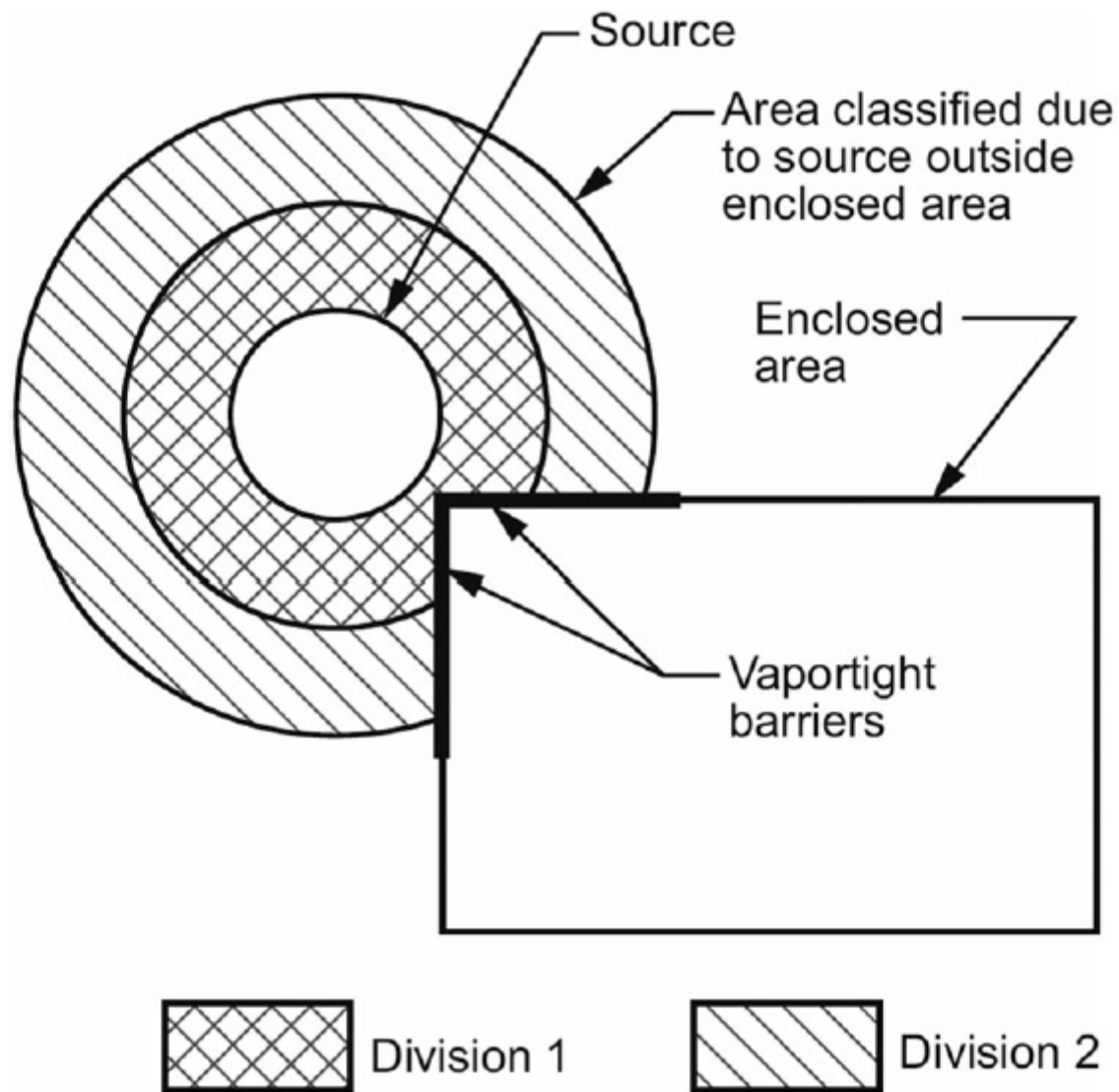


Fig. 2. Excerpt from API RP 500—Enclosed area adjacent.

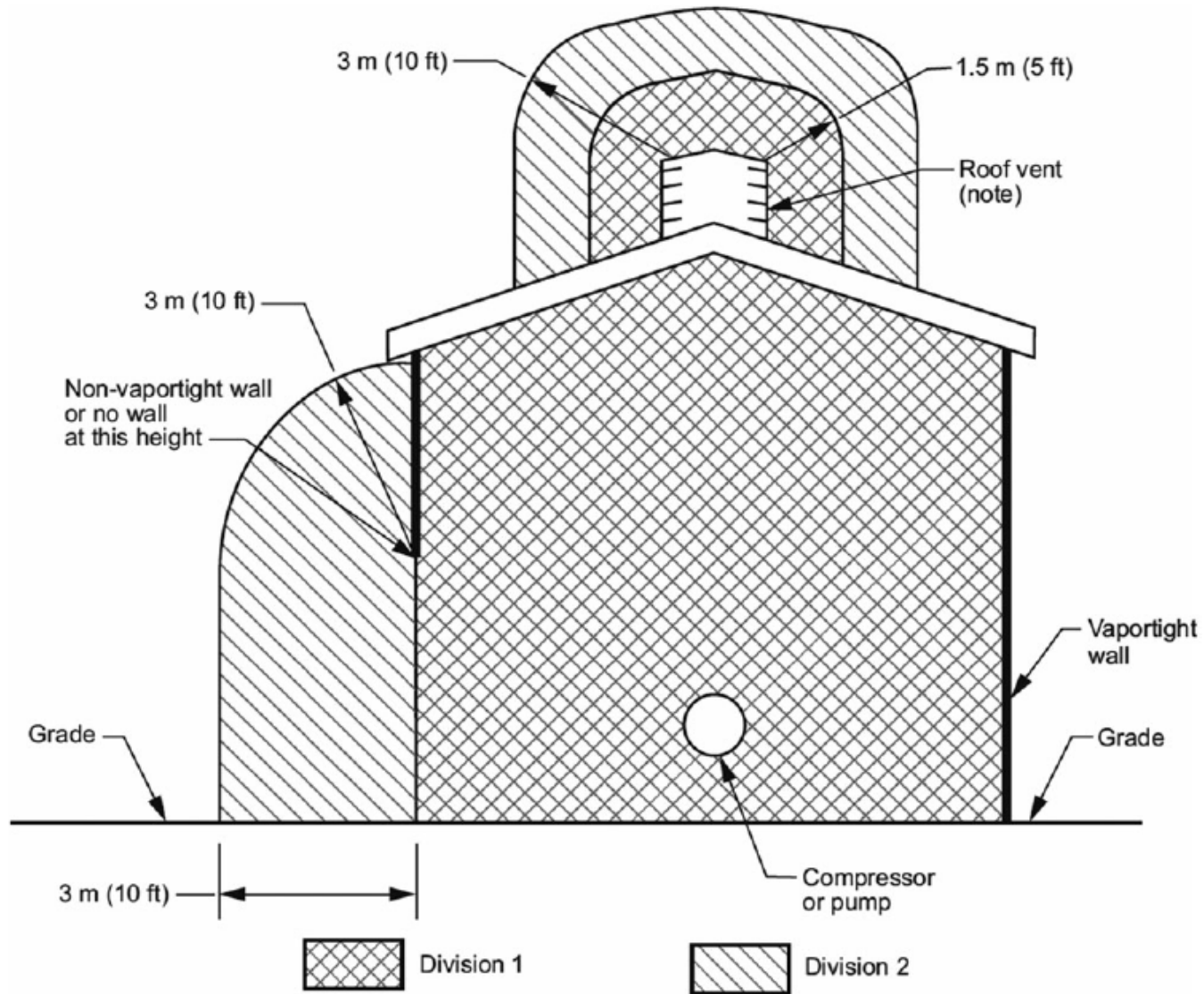


Fig. 4. Excerpt from API RP 500 (Section 10.9.3)—Compressor or pump in an inadequately ventilated enclosed area.

The formal definition for a vapor tight barrier as defined in the 2012 version of API RP 500 is as follows: “a wall or other obstruction that will limit the passage of gas or vapor at atmospheric pressure, thus preventing the accumulation of vapor-air or gas-air mixtures in concentrations above 25% of their lower flammable (explosive) limit, LFL (LEL).”

The definition is performance based; meaning that instead of providing specific construction techniques or materials the definition describes the intent of the vapor tight barrier which is to limit migration of the air from the classified area to the nonhazardous area and prevent accumulations of vapor-air or gas–air mixtures above 25% lower flammable limit (LFL).

The 25% LFL criteria for defining an unclassified area is used in clause 5.4.1(4) of NFPA 497 and is intended to provide a safety factor when dealing with flammable materials with respect to hazardous locations.



Fig. 12. Walls showing joints with caulking.

VIII. CARE AND MAINTENANCE OF VAPORTIGHT BARRIERS

The care and maintenance of the vapor barrier over the life of the facility is critical for the safety of the installation. Improper penetration of the barrier, deterioration of the barrier from weather-related elements, and operational procedures can compromise the integrity of a vaportight barrier. Following are the some guidelines to help in maintaining the integrity of a vapor barrier.



Fig. 13. Pipe wall penetration sealed.

VII. PERFORMANCE TESTING OF VAPORTIGHT BARRIERS

The decision to performance test a vaportight barrier should be based on the adjacent zone or division classification to the nonhazardous area, the potential for any pressure differences between a classified and a nonhazardous location, and if the nonhazardous area is surrounded by a classification similar to Fig 10.

A. Visual Inspections

In all the cases, a visual inspection should be performed. This consists of visually inspecting seams and joints during construction of a vapor barrier to ensure full coverage of adhesive sealants and verifying that there are no breaks or gaps. Particular attention should be given to the wall/floor joints.

In situations where a nonhazardous location is segregated from Zone 2/Division 2 classified location with both locations at ambient pressures, a visual inspection is required. This is based on the premise that a flammable atmosphere is “unlikely to exist and will exist for a short time only” in the Zone 2/Division 2 location and the probability of flammable gas/vapors migrating across a vapor barrier at atmospheric pressure conditions is very low.

B. Smoke Test

In situations where a Zone 1 or Division 1 location is operating at a higher pressure differential to a nonhazardous location, smoke or fog can be used to identify leaks in a vapor barrier. Commercially available foggers emitting a noncontaminating vapor consisting of distilled or deionized water droplets allow for easy visual identification of leak points. Other methods use CO₂ or other tracer gas in conjunction with a hand-held gas detector to locate leaks.

C. Air tightness Test

In situations where a designated nonhazardous building is completely surrounded by a classified area, an air tightness test commonly used to test building envelopes in accordance with the relevant building codes may be appropriate. The test procedures are outlined in ASTM E779-10 [10] and CAN/CGSB-149.10 [11]. The tests are usually performed using door mounted fans and will determine if a building envelop can maintain the 75 Pa pressure envelope consistent with the building code specifications.

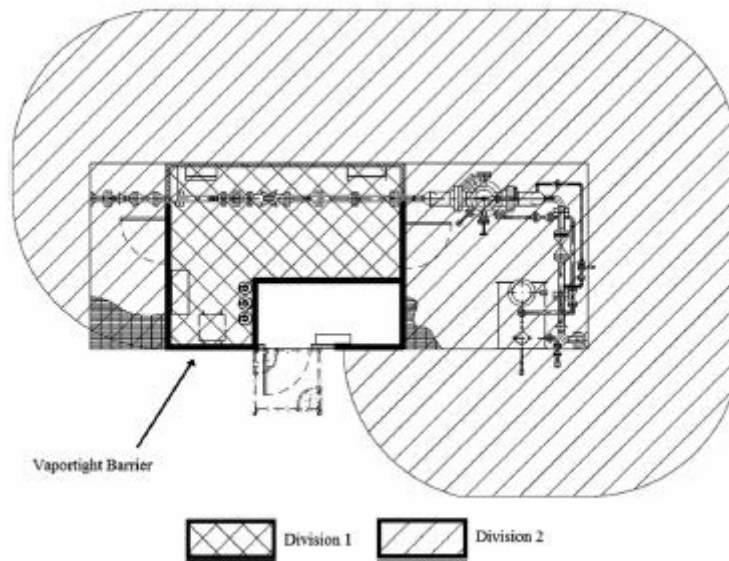
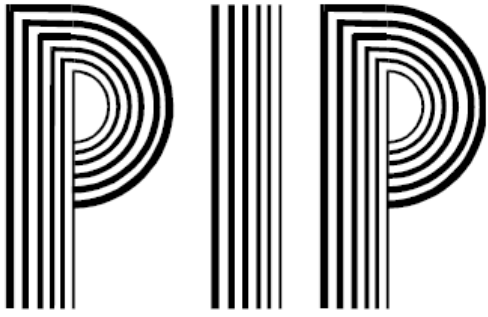


Fig. 11. Area classification drawing for a meter skid.



Process Industry Practices
Electrical

PIP ELEHA01
Engineering Guide for Determining
Electrical Area Classification

1. Selection of Project Specific Reference Material (in our case it is the PIP ELEHA01
2. Data Requirements (conduct a site survey determine if the area is hazardous)
3. Material and Properties (fill in PIP ELEHA01 Form 1.
4. Release Sources (fill in PIP ELEHA01 Form 2)
5. Create a Classification Document (a drawing showing the different areas and their hazardous classifications).

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Table 1 lists the suggested industry standards for assessing area classification:

Type of Installation*	Method of Classification		
	Class I, Division	Class I, Zone	Class II, Division
All		<i>ISA-TR12.24.01</i>	<i>NFPA 499</i>
Petroleum Facilities (including Refineries)	<i>API RP 500</i>	<i>API RP 505</i>	<i>NFPA 499</i>
Chemical Process Areas	<i>NFPA 497**</i>	<i>NFPA 497**</i>	<i>NFPA 499</i>

Introduction to PIP ELEHA01 Form No. 1 Flammable Combustible.

FORM NO. 1 FLAMMABLE/COMBUSTIBLE MATERIALS								
PLANT	PROJECT #	PREPARED BY			DATE			
Process Unit or Building No.								
Material	Applicable for Class I Only			Class II Only	Applicable for Class I or Class II			
	Vapor Density (Air=1)	Flash Point	Lower Flammable Limit (LFL)	Particle Density	Ignition Temp.	Class	Group	NEC T-Code (Note 1)
		°C (°F)	vol. %					
1								
2								
3								

- Notes:
- Quote the number of list in region specific materials list.
 - G=Gas; L=Liquid; LG=Liquefied Gas; S=Solid
 - N=Natural; A=Artificial

No.	Source of Release		Flammable Material				Ventilation			Hazardous Area		Other Information/Remarks	
	Description	Location	Reference (Note 1)	Operating Temperature and Pressure		State (Note 2) G/L/LG/S	Type (Note 3) N/A	Adequate (Y/N)	Div. 1 or 2	Div. Extent Meters or Feet			Reference
				°C (°F)	kPa					Vertical	Horizontal		
19	Tank Vent	Control Bldg North Wall	19	Amb	Amb	L	N	Y	2	25	50	API RP500 9.2.1.1	
20	Tank Vent	Unit 12 South	19	Amb	Amb	L	N	Y	2	25	50	API RP500 9.2.1.1	
21	Tank Vent	Unit 12 West	20	Amb	Amb	L	N	Y	1 & 2	5 & 10	5 & 10	API RP500 5.2.3.3 When temperature exceeds 100F	

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

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

FORM NO. 2			
SOURCES OF RELEASE			
PLANT		PROJECT #	
Process Unit or Building No.			
PREPARED BY			

Classification Method: **Zone** **Division**

Extent Dimensions: **m** **ft**

1	2	3	4	5	6		7	8			9	
Source of release			Flammable material				Ventilation					
No	Description	Location	Grade of release ¹⁾	Reference ²⁾	Operating temperature and pressure		State ³⁾	Type ⁴⁾	Degree ⁵⁾	Availability	Div. or Zone Type 0-1-2	
					°C (°F)	kPa						

2.6.1 continuous grade of release:

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

2.6.2 primary grade of release:

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

2.6.3 secondary grade of release:

a release which is not expected to occur in normal operation and if it does occur, is likely to do so only infrequently and for short periods.

PREPARED BY		DATE	

9	10	11	12	13
Hazardous area				
Div. or Zone Type 0-1-2	Div. or Zone extent m or ft		Reference	Any other relevant information and remarks
	Vertical	Horizontal		

4.1 Selection of Project-Specific Reference Materials

See Figure 1 – Item 1, “Assemble Data References and Government Regulations.”

The first step in performing an area classification is to determine whether zones or divisions will be used and the selection of the appropriate reference standards for the project. “New Area Classification Guidelines,” *IEEE Industry Applications Society Magazine*, provides additional background on the development of *API RP 500* and *API RP 505* and the criteria for the selection of either the division or the zone method of classification.

Comment: The NEC prohibits the overlap of the two classification methods in a facility. For existing facilities that were classified using the division method, there is little incentive for reclassifying unless major revisions are planned. For new facilities or stand-alone units in which there is no overlap, the use of the zone method recognizes additional methods of protection.

Table 1 lists the suggested industry standards for assessing area classification:

	Method of Classification		
Type of Installation*	Class I, Division	Class I, Zone	Class II, Division
All		<i>ISA-TR12.24.01</i>	<i>NFPA 499</i>
Petroleum Facilities (including Refineries)	<i>API RP 500</i>	<i>API RP 505</i>	<i>NFPA 499</i>
Chemical Process Areas	<i>NFPA 497**</i>	<i>NFPA 497**</i>	<i>NFPA 499</i>

Table 1 – Suggested Industry Standards for Assessing Area Classification

* *In addition, the classification of laboratories using chemicals may fall under the guidance of NFPA 45.*

** *For large, high-pressure plants, the API recommendations are more suitable (refer to NFPA 497-1997, Para. 3-6.4).*

4.2 Data Requirements

See Figure 1 – Item 2, “List All Material Properties Class I, II, and III Materials.”

The next task in the work process is to obtain pertinent information, e.g., process descriptions, process flow diagrams (PFDs), material balance sheets (MBSs), piping and instrumentation diagrams (P&IDs), Material Safety Data Sheets (MSDSs), equipment lists, and an up-to-date plot plan for all locations to be considered for area classification. The plot plan should indicate the location of major process equipment, roads, and all below-grade locations.

Any existing electrical area classification drawings and supporting documentation should be obtained. Review the areas adjacent to the project to determine possible sources of leaks that could impact the area classification within the “scope of work area.” An actual walk-through of the area is highly recommended.

4.3 Materials and Properties

See Figure 1 – Item 2, “List all Material Properties Class I, II, and III Materials” and Item 3, “Determine Class and Group.”

Using process data, list all Class I and Class II flammable/combustible materials for the area under study on Form No. 1. For Class I materials, fill in the material properties, such as flash point, ignition temperature, T-Codes, lower flammable limit (LFL), and vapor density. For Class II materials, fill in the material properties, such as layered or cloud ignition temperature and particle density. When there are variations in the properties of flammable materials, note the reference source on the form.

NFPA 497-1997, Appendix B, provides one example for dealing with mixtures of materials. For gas mixtures containing hydrogen sulfide, reference *API RP 500* or *API RP 505*, as appropriate.

Using the appropriate references and standards, determine and enter the class and group of the materials on Form No. 1.

Release Sources

See Figure 1 – Item 4, “Locate All Hazardous Material Release Sources.”

Review all potential flammable and combustible material release sources. On the PFD, P&ID, and/or plot plan, mark those sources that the team agrees need to be considered for area classification purposes. The API and NFPA standards provide a limited amount of guidance on the selection of appropriate “sources” for the purpose of area classification. However, as noted in “Volatility and Mists – Electrical Area Classification’s Important Variables,” *IEEE Industry Applications Society Transactions*, “Within the petrochemical industry there is significant controversy and disagreement on what should and should not be considered a source of release when developing area classification recommendations—probably more than on any other aspect of the task.”

While *API RP 500* and *NFPA 497* do not provide quantitative guidance on the identification of potential sources, *API RP 505* provides additional guidance on the relationship between the grade of release and the zone classification in Section 6.5.8

and Table 2. Table 2 indicates that a continuous grade of release has a flammable mixture present 1,000 or more hours per year, a primary release has a flammable mixture present between 10 hours and 1,000 hours per year, and a secondary release has a flammable mixture present less than 10 hours per year. *API RP 505* goes on to indicate that while “there are no firm relationships relating the time that flammable mixture occurs in zones, many use the rule-of-thumb shown in Table 3.” Table 3 in *API RP 505* shows the typical relationship between zone classification and the presence of flammable material and indicates Zone 0 as having flammable mixtures present 1,000 hours or more per year (> 10%), Zone 1 as having flammable mixtures present 10 hours to 1,000 hours per year (0.1% to 10%), Zone 2 as having flammable mixtures present 1 hour to 10 hours per year (0.01% to 0.1%), and unclassified as having flammable mixtures present less than 1 hour per year (0.01%).

With today’s environmental regulations and restrictions and the impact that it has had on process equipment design, criteria used in the past for selecting potential sources may need to be reviewed and updated for each facility. Additional factors such as maintenance practices, monitoring, response facilities, and past experience with similar process facilities may influence the selection of potential release sources.

5. Class I Materials

Potential Class I release sources are discussed in *API RP 500*, Appendix D and *API RP 505*, Appendix D. Other documents and company practices may also be applicable.

Review the PFD and P&ID documents and identify possible flammable and combustible material release sources. Mark those sources that need to be considered for area classification purposes on the appropriate physical plan drawings and tabulate them on Form No. 2.

From the information on Form No. 2 and the reference codes and standards, determine and indicate the extent of the divisions (or zones, as applicable) on the appropriate physical plan drawings.

Comment: Minimizing the extent of the classified area may lower the initial electrical equipment and installation costs, but certainly safety should not be reduced. However, it is prudent to evaluate the grouping of overlapping or near-by areas into a single, readily defined classified area. It may be cost-effective to lump multiple-point sources within close proximity into one classified area if conduit versus cable is used to reduce the number of sealing fittings required at area classification boundary crossings. Also, the area classification of future project additions and modifications in adjacent areas might require the upgrade of the electrical equipment and installations. It may also be prudent to extend the classified area to coincide with other easily identified boundaries or equipment. For example, it may clarify the extent of the classified area for a particular facility by extending the area to the edge of unit paving or adjacent roadway boundaries.

Review the plan drawings and determine if physical items such as barriers, dikes, sumps, and elevation changes may influence the extent of the division or zone.

Refer to Section 7 of this Practice for methods of reducing area classification.

Appendix 1 of this Practice provides a process for evaluating individual point sources for Class I hazardous area assessment. This process is, in general, based on a process displayed in Figure C.2 in *ISA-TR12.24.01*. The process has been modified to address both divisions and zones and has also been modified to address the requirement for transition zones as described in *API RP 500* and *API RP 505*.

6. Class II Materials

NFPA 499 provides guidance in the classification of areas where combustible dusts are produced, processed, or handled, and where dust released into the atmosphere or accumulated on surfaces could easily be ignited by electrical systems or equipment.

Review the PFD and P&ID documents and identify possible combustible dust release sources. Mark those sources that need to be considered for area classification purposes on the appropriate physical plan drawings.

Indicate the extent of the boundaries on the appropriate physical plan drawings using the guidelines of *NFPA 499*.

Evaluate the plan drawings and determine if physical items such as barriers may influence the extent of the division classification.

Refer to Section 7 of this Practice for methods of reducing area classification.

Appendix 2 of this Practice provides a process for evaluating individual point sources for Class II hazardous area assessment. This process is based on the criteria for evaluating areas described in *NFPA 499*.

7. Classification Alternatives

See Figure 1, Item 25, "Evaluate Class I Classification Alternatives."

7.1 General

It is prudent to consider alternatives for reducing classified areas to improve safe operability, and maintainability.

7.2 Pressurization

Pressurization is a method for reducing area classification within enclosures, rooms or buildings in Class I and Class II locations. Refer to *NFPA 496* for details.

The requirements for pressurization are stringent, and some types require automatic de-energization of electrical equipment. However, in some instances, pressurization may be the only practical method for installing some types of electrical equipment in classified locations, particularly Group A or Group B locations. Consideration must be given to the volume to be pressurized and to the operating costs, such as utilities and maintenance. Also, in locations with high humidity, it may be necessary to condition the air used for pressurization or to use an alternative purging gas such as nitrogen to avoid damage to enclosed electrical equipment. In some cases, the use of combustible gas detectors may be an alternative to pressurization.

7.3 Equipment Location

When possible, locate electrical equipment in a reduced or unclassified area.

Comment: For areas containing heavier-than-air gases, consider reducing the risk of ignition by locating electrical equipment at least 18 inches above grade.

7.4 Vapor Tight Walls and Barriers

Vapor tight walls or barriers that cover the full extent of the classified area boundary can be used to limit the extent of classified areas. This alternative applies to both Class I and Class II locations.

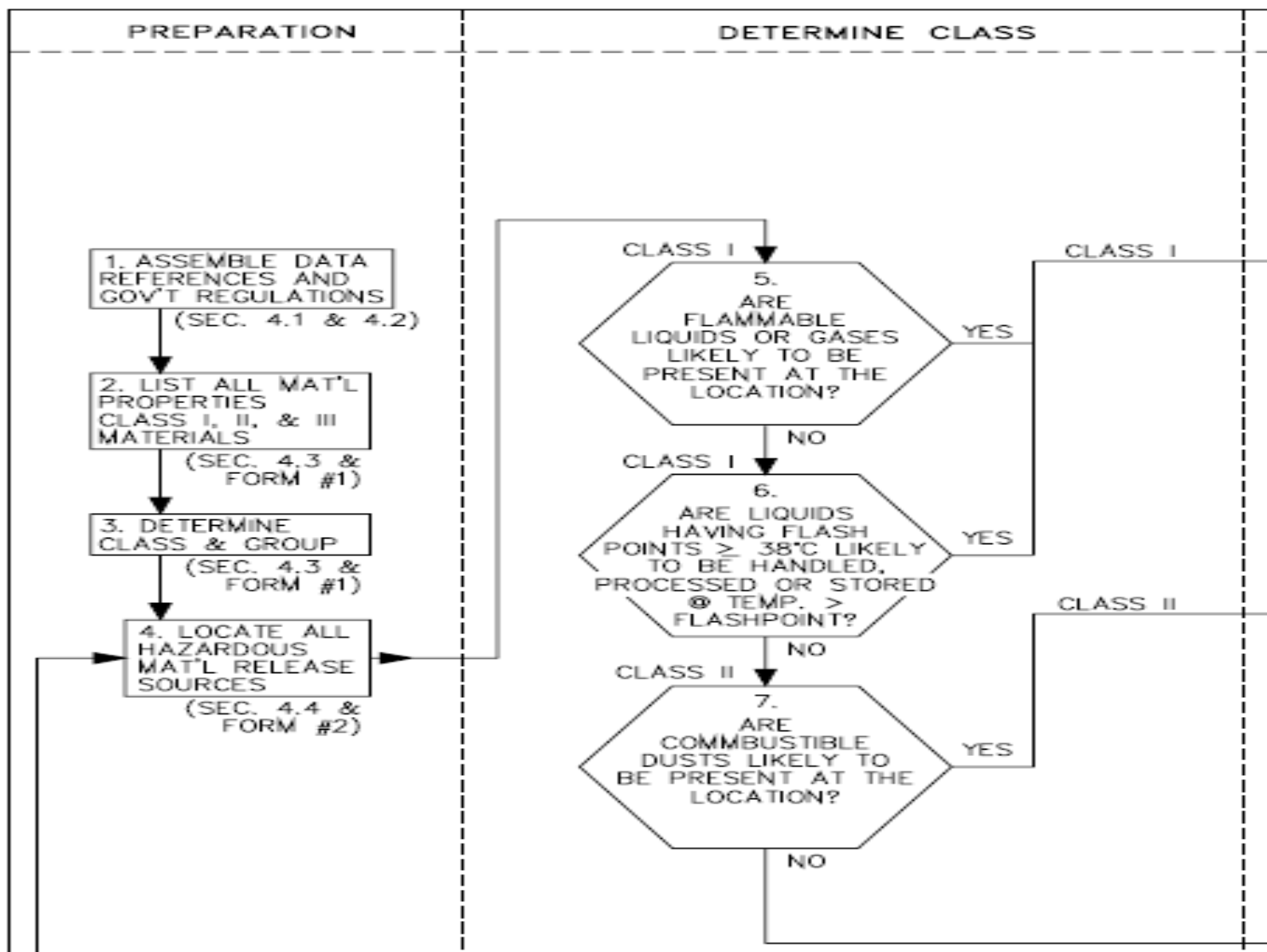
7.5 Ventilation

Natural or mechanical ventilation can be used to reduce the classification in Class I locations. This technique is often applied to indoor applications. Refer to *API RP 500-1997*, Section 6.3; *API RP 505-1997*, Section 6.6; *NFPA 30-2000*, Section 5.3.4; and *ISA 12.24.01-1998*, Section 5 for additional guidance.

Comment: It is cautioned that ventilation can increase the risk of ignition in Class II locations by causing combustible dust to be placed in suspension in the air.

7.6 Gas Detection

For the application of gas detection as a method of protection for Class I sources, refer to *API RP 500-1997*, Section 6.5; *API RP 505-1997*, Section 6.8; and *ISA-TR12.24.01-1998*, Annex D. Gas detection is now an NEC-recognized method of protection for industrial locations when applied in accordance with the requirements described in *NEC*, Article 500 and Article 505.



SS

DETERMINE GROUP

CLASS I

9. USE NFPA 497 OR API RP 500 OR API RP 505 AND
NEC ARTICLES 500-505

S

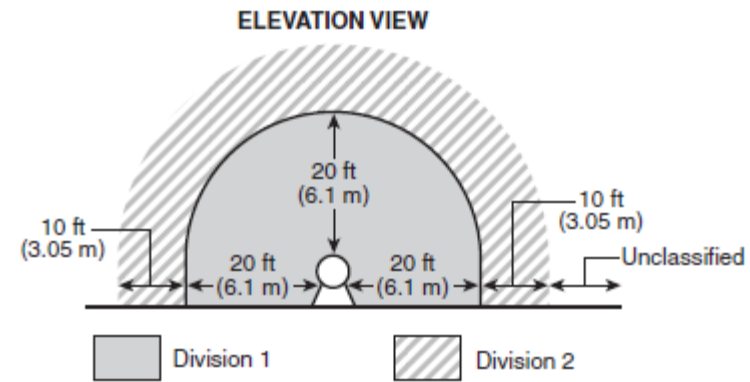
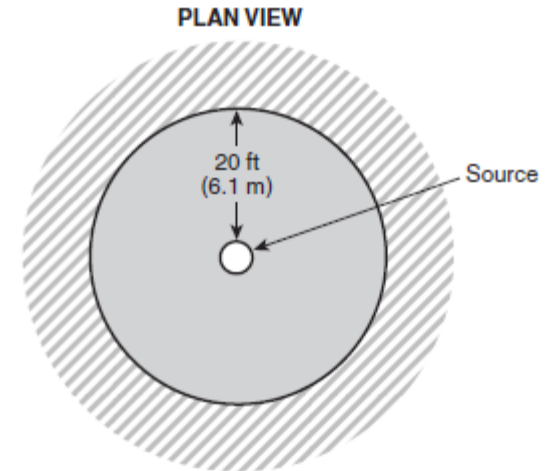
	IEC GROUP DESIGNATION NEC ARTICLE 505 GROUP DESIGNATION	NEC ARTICLE 500 GROUP DESIGNATION	TYPICAL GAS
10	IIC	A	ACETYLENE
11	(IIB + H2)	B	HYDROGEN
12	IIB	C	ETHYLENE
13	IIA	D	PROPANE

S

CLASS II

14. USE NFPA 499 AND NFPA ARTICLES 500 AND 502

	NEC ARTICLE 500 GROUP DESIGNATION	TYPE OF DUST	EXAMPLE
15	E	METAL	ALUMINUM, MAGNESIUM
16	F	CARBONACEOUS	COAL, CARBON BLACK, COKE
17	G	OTHER COMBUSTIBLE	FLOUR, GRAIN, PLASTIC, CHEMICALS



Description of dust condition

Division 1

Moderate or dense dust cloud. Dust layer greater than 1/8 in. (3.0 mm).

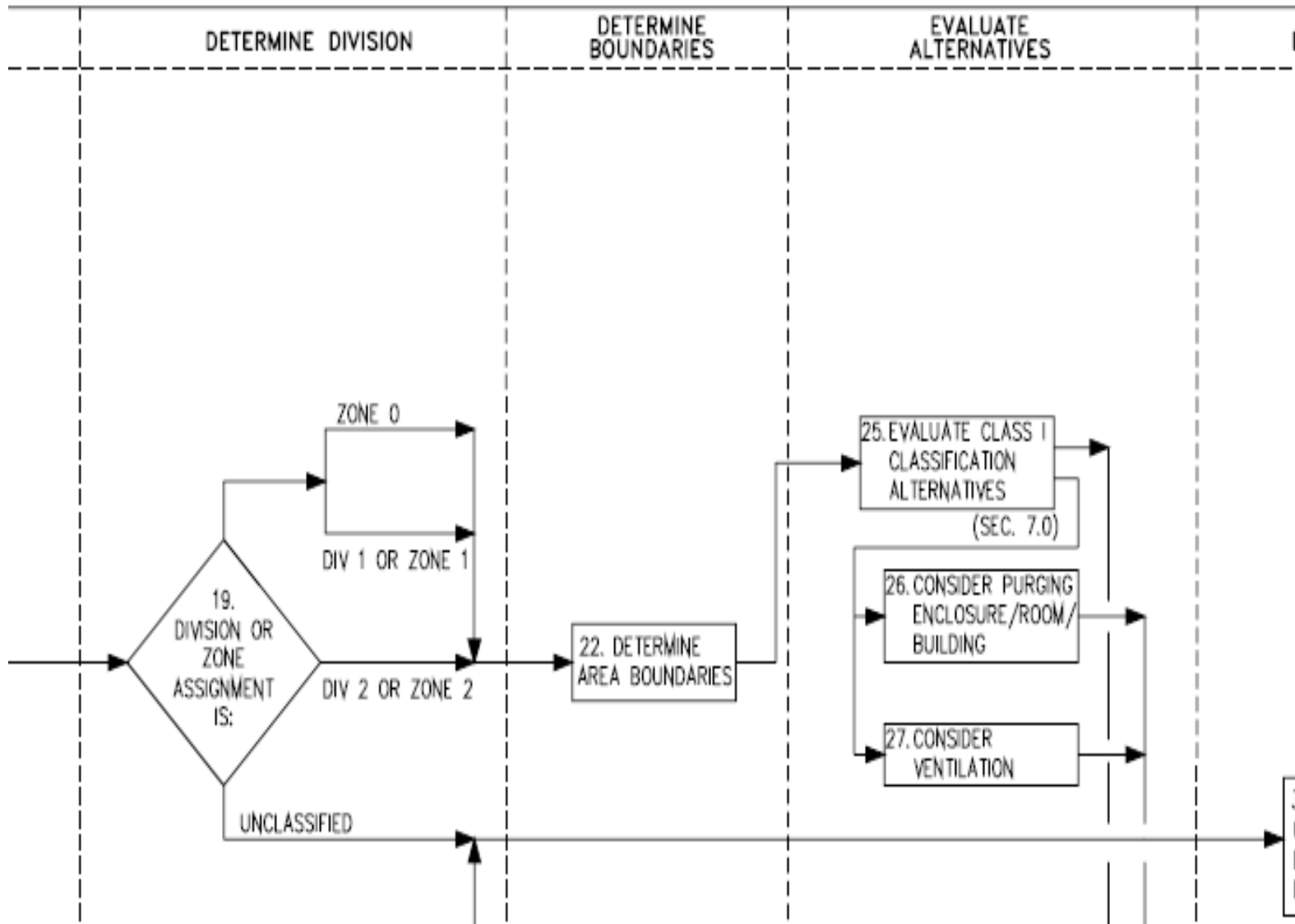
Division 2

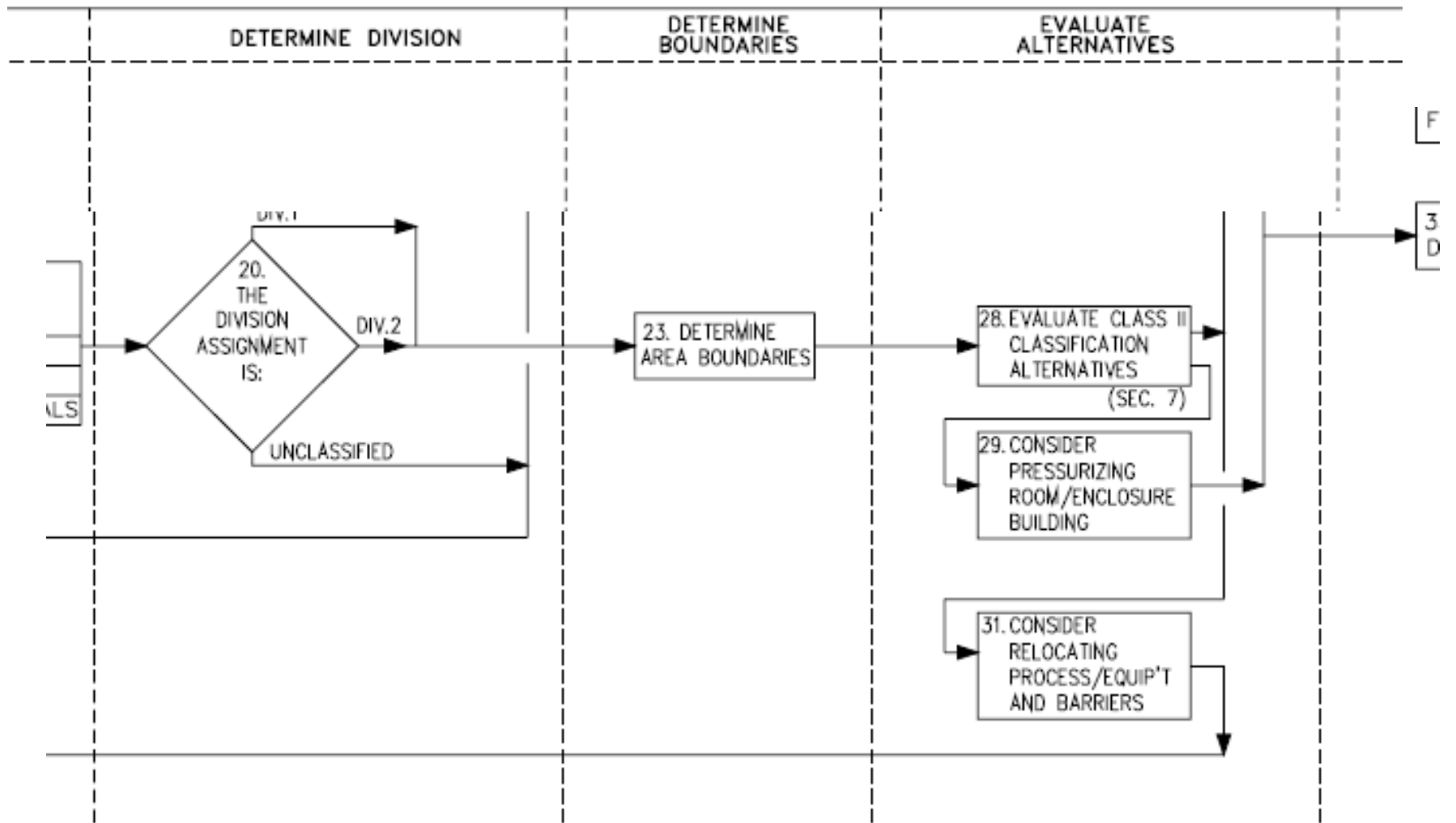
No visible dust cloud. Dust layer less than 1/8 in. (3.0 mm) and surface color not discernible.

FIGURE 5.8(a) Group F or Group G Dust — Indoor, Unrestricted Area; Open or Semi-Enclosed Operating Equipment.

- Color Dust Explosion
- Recent Dust Explosions
- Dust Explosion Pentagon
- What Causes Dust Explosions
- Dust Explosion Hazards
- Dust Collector Explosion
- Silo Explosion
- Building Explosion
- Dust Explosion
- Sc...





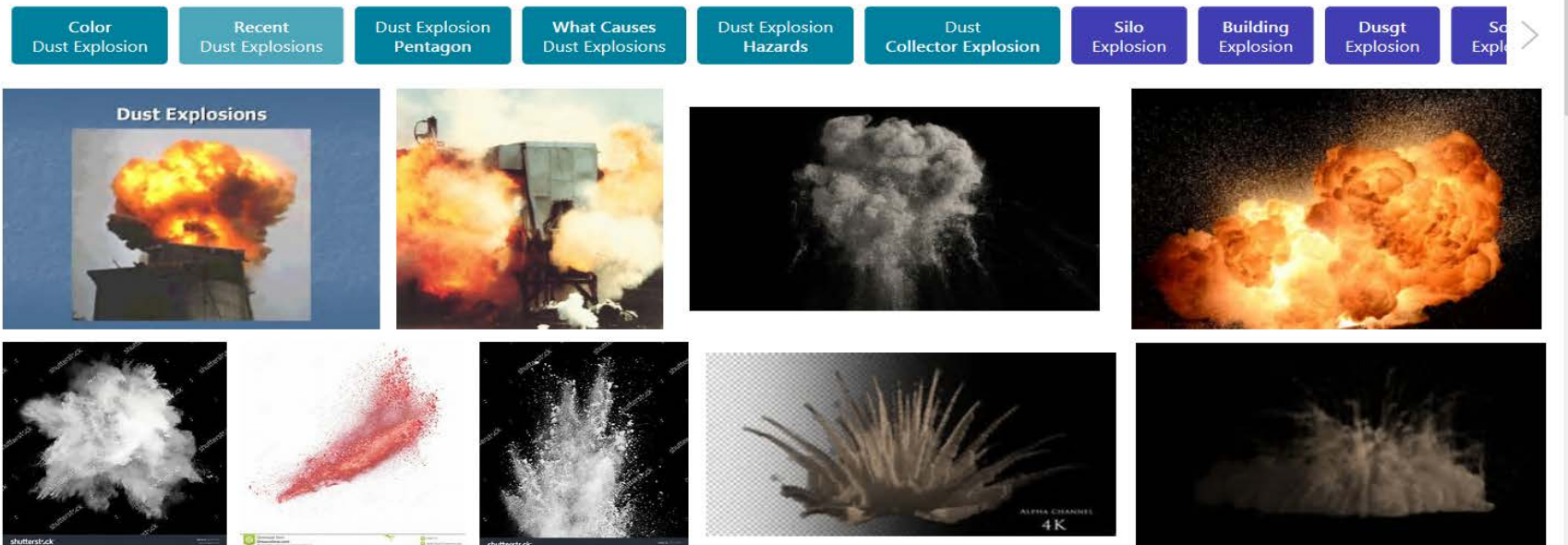


7.7 Dust Source Control

For Class II locations, consider the following options to control dust:

- Housekeeping
- Sealing of sources to minimize leaks
- Dust removal systems
- Sloped surfaces to prevent accumulation

Refer to *NFPA 499-1997*, Section 3-4 for additional methods of dust control.



8. Unclassified Locations

Those locations that have not been classified as Division 1 or Division 2; or Zone 0, Zone 1, or Zone 2 are unclassified locations.

Comment: Under certain specific conditions, a location may contain flammable or combustible materials and still be unclassified. Also, certain locations can be both Class I and Class II locations, requiring special considerations.

Refer to *API RP 505-1997*, Section 6.5.9; *API RP 500-1997*, Section 6.2.4; *NFPA 497-1997*, Section 3-3; and *ISA-TR12.24.10-1998*, Section 4.2 for additional criteria for the evaluation of unclassified locations.

9. Documentation

The electrical area classification documentation should include the following information:

- Material data with Class, Group, ignition temperature and T-Code recorded on Form No. 1
- Source data with Zone or Division classification and extent recorded on Form No. 2
- Class II assignment of Division classification and extent (when appropriate)
- Ventilation or pressurization considerations (may be a drawing note)

The general procedure is to prepare a classification drawing(s). However, a drawing may not be necessary if the other assembled documentation is sufficient to adequately define and support the area classification.

Practical Example—Worksheet

Step 1—Governing Codes, Standards, Authority

- 1.1 Codes NFPA-70 (NEC) [7], [9], [10], [6], [2], [4].
- 1.2 Standard “XYZ” OIL Co., Eng. Std. 30P-111 (01/15/85).
- 1.3 Authorities Fire Marshall, State of XYX.

TABLE I
GAS PROPERTIES

Component	Mole ¹ (Percent)	Flash ² Point (°F)	Ignition (°F)	Temp ² (°C)	Flammable Low (Percent)	Limit High (Percent)	Vapor ² Density (Air = 1)	Group ³
Water (H ₂ O)	0.01							
Nitrogen (N ₂)	0.47							
Carbon dioxide	12.66							
Hydrogen sulfide	0.02	gas	500	260	4	44	1.2	C
Methane ^a	74.57	gas	999	537	5	15	0.6	D
Ethane ^a	6.25	gas	882	472	3	12.5	1.0	D
Propane ^a	3.34	gas	842	432	2.1	9.5	1.6	D
Iso-butane	0.49	gas	860	460	1.8	8.4	2.0	
Normal butane	1.08	gas	550	287	1.6	—	2.0	D
Iso-pentane	0.2	-60(-51)	788	420	1.4	7.61	n/a	
Normal pentane	0.54	-40(-40)	500	260	1.5	7.8	2.5	D
Normal hexane	0.19	-7(-22)	432	223	1.1	7.5	3.0	D
Normal heptane	0.14	25(-4)	399	204	1.05	6.7	3.5	D
Normal octane	0.03	56(13)	403	206	1.0	6.5	3.9	D
Normal nonane	0.1	83(31)	401	205	0.8	2.9	4.4	D

¹ From project process data.

² See [9].

³ See [6].

⁴ See [7, table 500-2(b)].

^a Methane, ethane, and propane are the only gases in the mixture that are within the flammable range. All these gases are in Group D. The lowest ignition temperature is 842°F (432°C) for propane; the classification is Group D (T2)⁴, except for hydrogen (932°F, 500°C), which is Group B (T1)⁴.

Step 2—Flammable Materials

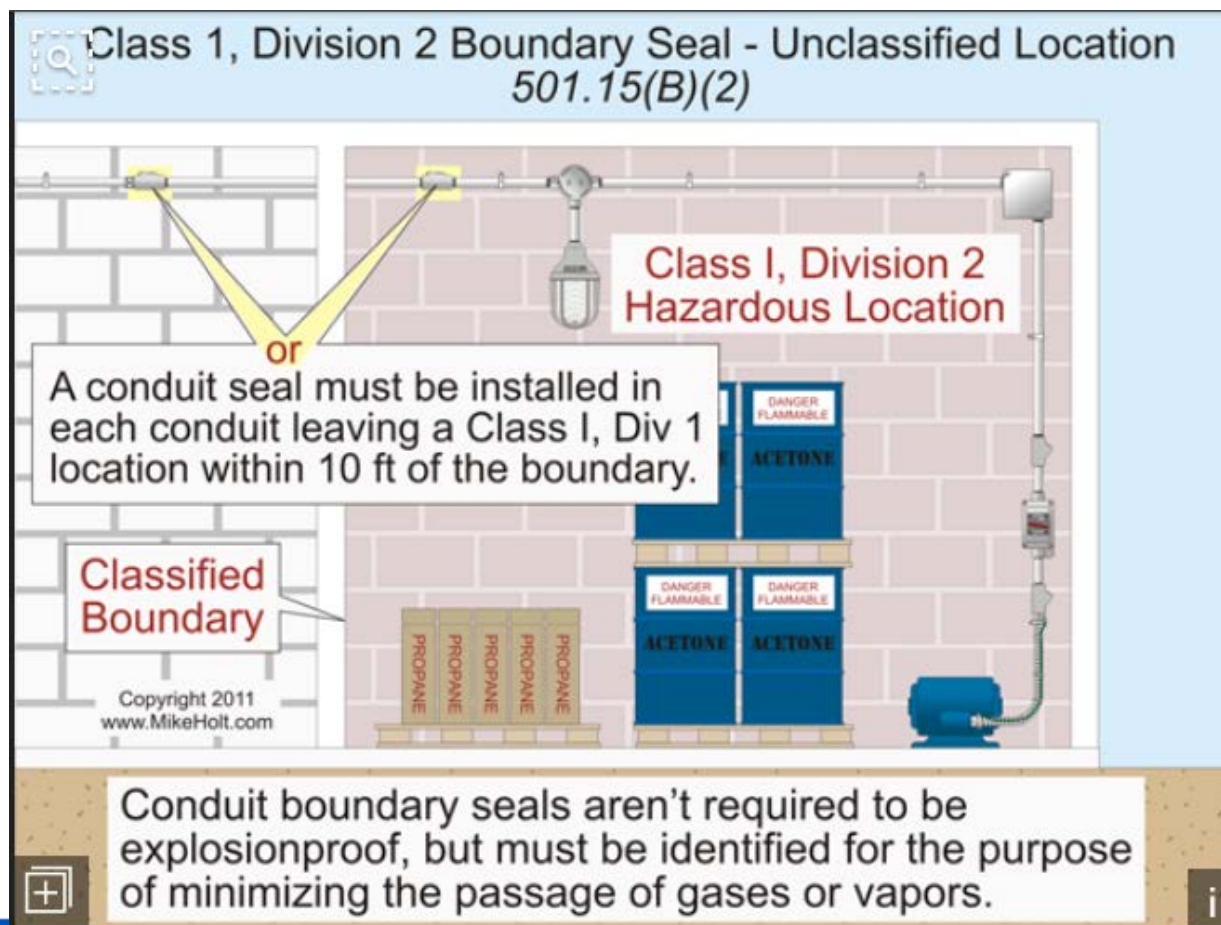
2.1 Liquids Class:

Class IA	flash point < 73°F,
Class IB	flash point 73–100°F,
Class II	flash point 100–140°F,
Class IIIA	flash point 140–200°F,
Class IIIB	flash point > 200°F.

2.2 Highly Volatile Liquids (HVL): Methane, ethane, propane present (see Table I).

Step 3—Class

- Class I flammable gas and vapors.
- Class II combustible dusts.
- Class III easily ignitable fibers or flyings.
- Class I present.



Step 4—Group

4.1 Hydrogen

Group B.

4.2 Ethane, propane, methane
(See Table I.)

Group D.

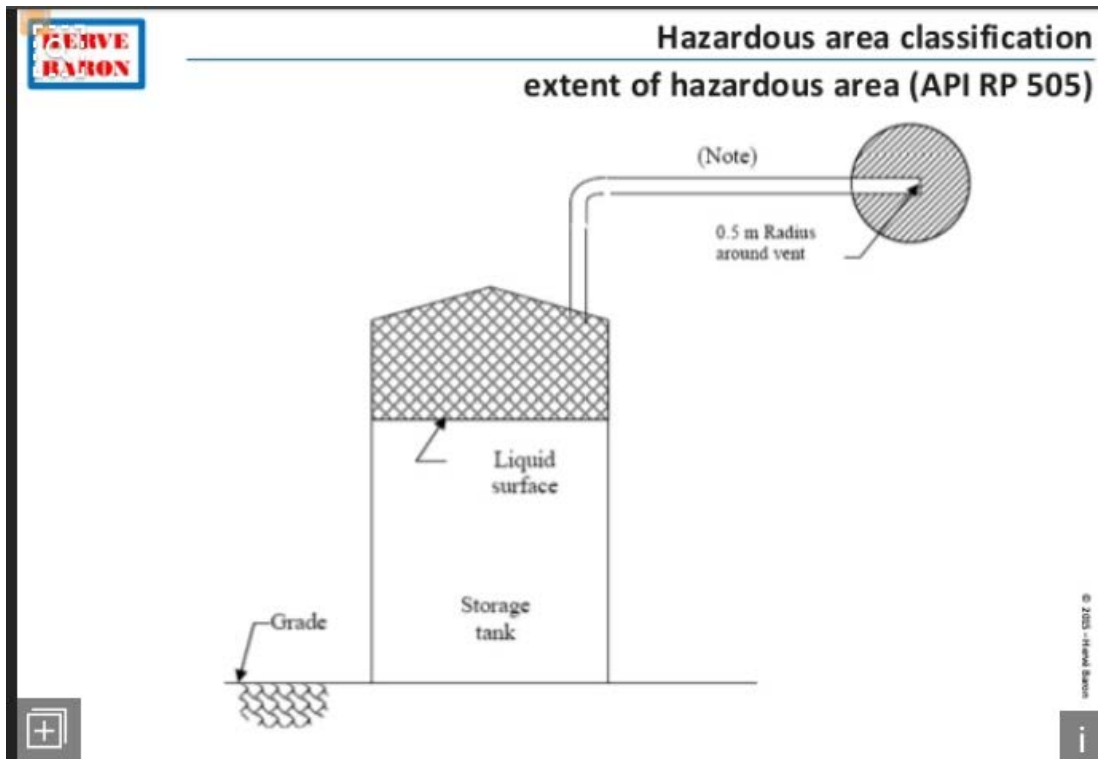
CLASS	DIVISION	GROUP	
<p>Class 1 Locations in which flammable gases or vapors are (or may be) present in the air in quantities great enough to produce explosive or ignitable mixtures.</p>	<p>Division 1 Locations in which hazardous concentrations of flammable gases or vapors exist continuously, intermittently, or periodically under normal conditions. -or- Locations in which hazardous concentrations of flammable gases or vapors may exist frequently because of repair or maintenance operations or because of leakage. -or- Locations in which breakdown or faulty operation of equipment or processes might release hazardous concentrations of flammable gases or vapors</p> <p>Division 2 Locations in which volatile flammable liquids or flammable gases are handled, processed, or used, but are normally kept in closed containers and can only escape due to accidental rupture. -or- Locations in which hazardous concentrations of gases or vapors are normally prevented by mechanical ventilation and might become hazardous due to failure of the ventilating equipment. -or- Locations which are adjacent to Class 1, Division 1 locations.</p>	<p>Group A: Atmospheres containing: Acetylene</p> <p>Group B: Atmospheres containing: Acrolein (inhibited) Butadiene Ethylene oxide Hydrogen Gases containing more than 30% hydrogen by volume Propylene oxide</p> <p>Group C: Atmospheres containing: Allyl alcohol Carbon monoxide Cyclopropane Diethyl ether Ethylene Hydrogen sulfide Methyl ether n-Propyl ether or gases or vapors of equivalent hazard</p>	<p>Group D: Atmospheres containing: Acetone Ammonia Benzene Butane Butyl alcohol Ethane Ethyl alcohol Gasoline Heptanes Hexanes Methane (natural gas) Methyl alcohol Methyl ethyl ketone Naphtha Octanes Pentanes Propane Styrene Toluene Xylenes or gases or vapors of equivalent hazard</p>

Step 5—Division

5.1 Division 1 hydrogen plant—sump, below grade in tank farm.

5.2 Division 2 outdoor areas—open areas are considered adequately ventilated.

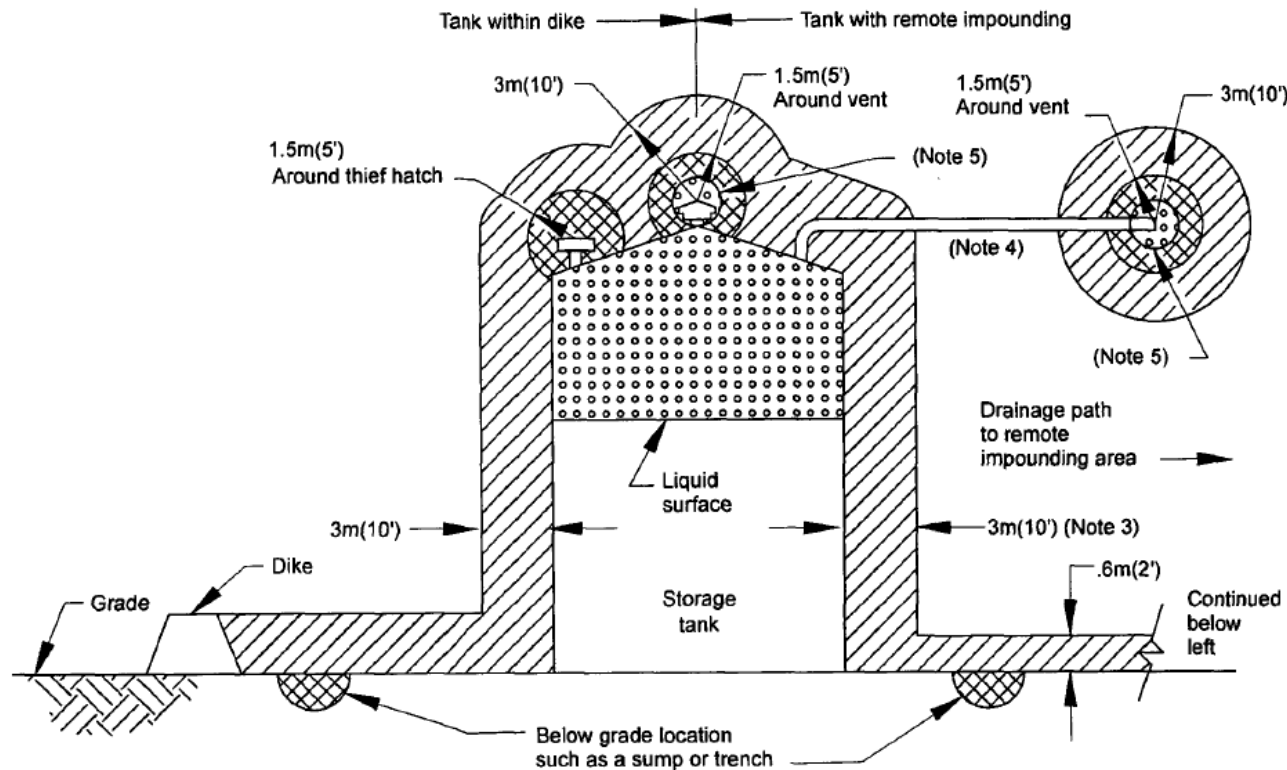
Process plant, compressor plant: Adequately ventilated (1 ft³/min/ft² of solid floor area per [2, App. B]). In addition, 12 air changes per hour supplied at 20 percent LEL alarm.



5.3 Nonclassified:

Electrical room: Ventilated, located outside classified area.

Analyzer house: pressurized (type Z purging), air intake outside classified area.



Step 6—Extent (Boundaries) of Classified Areas

Due to the high pressure (above 500 lb/in²) handled at this plant, the distance criteria of 25 ft and 50 ft per [2] has been adopted for outdoor areas. Indoor areas have been classified dependent on type of ventilation.

Adequately ventilated areas are classified Division 2. Inadequately ventilated areas are classified Division 1.

Adequately ventilated indoor areas are provided with continuous ventilation of 1 ft³/ft² of solid floor area. In addition, 12 air changes per hour are provided when the LEL level approaches 20 percent.

Class I, Division 1, Group B: Hydrogen plant—indoors.

Class I, Division 2, Group B: Hydrogen plant—10 ft around building.

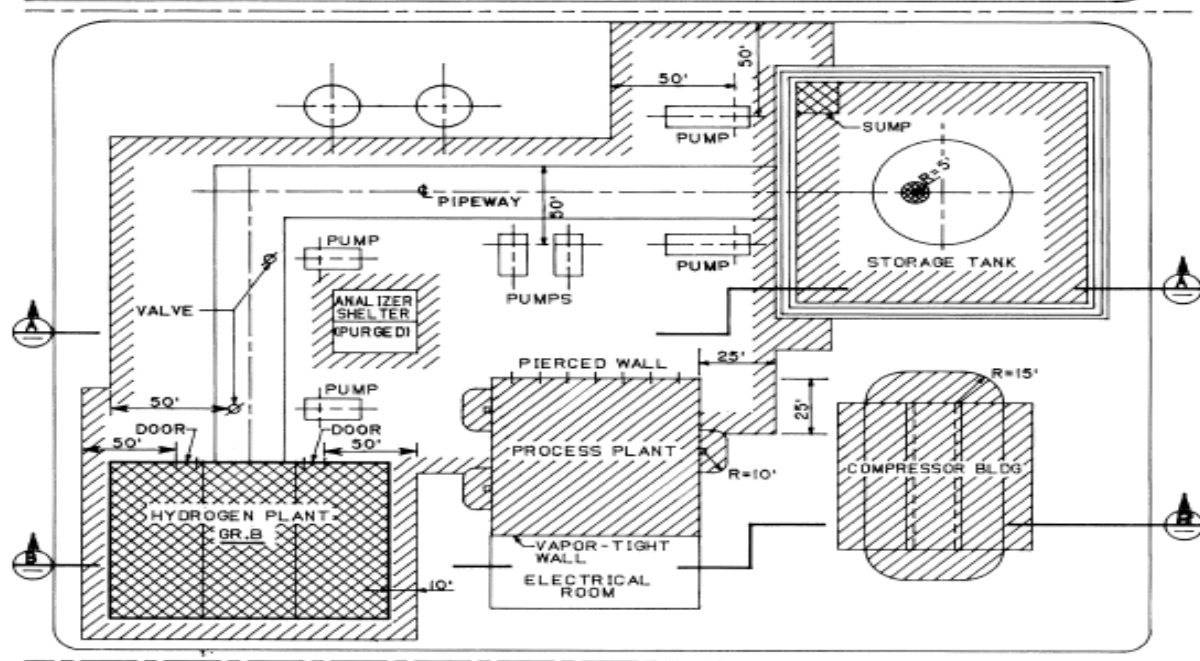
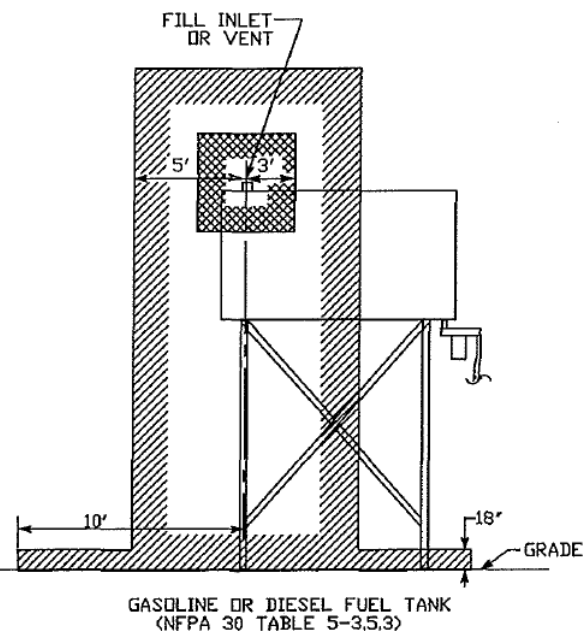
Class I, Division 1, Group D: Inside storage tank—above liquid level, and 5 ft around vent.

Class I, Division 2, Group D: Outdoor area—50 ft around and 25 ft above equipment handling flammable materials. Indoor areas—process plant, compressor building.

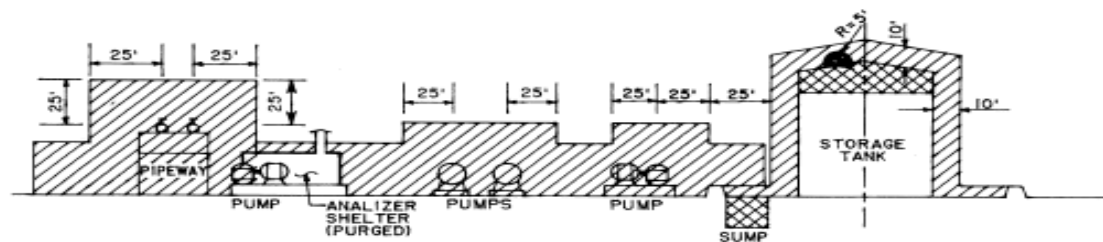
Nonclassified Areas: Outdoor areas—outside Class I, Division 2, boundaries. Indoor areas—electrical room (ventilated), analyzer shelter (type Z purging).

Step 7—Prepare Plans and Specifications

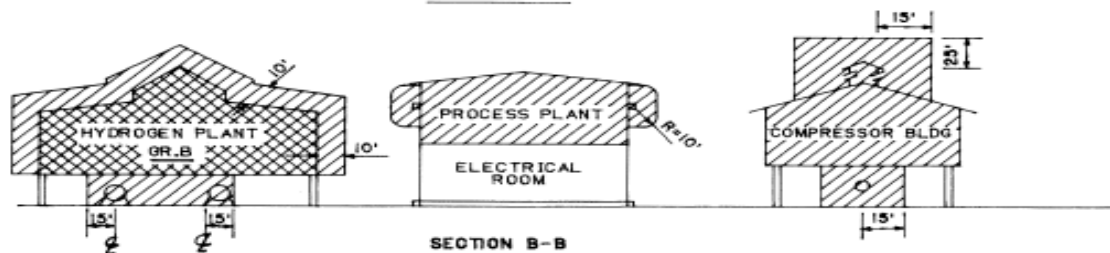
See Fig. 2: area classification, plan, and sections.



AREA CLASSIFICATION - PLAN



SECTION A-A



SECTION B-B

NOTE: CLASSIFIED AREAS ARE GROUP D, UNLESS NOTED OTHERWISE.



AREA CLASSIFICATION - SECTIONS

Fig. 2.

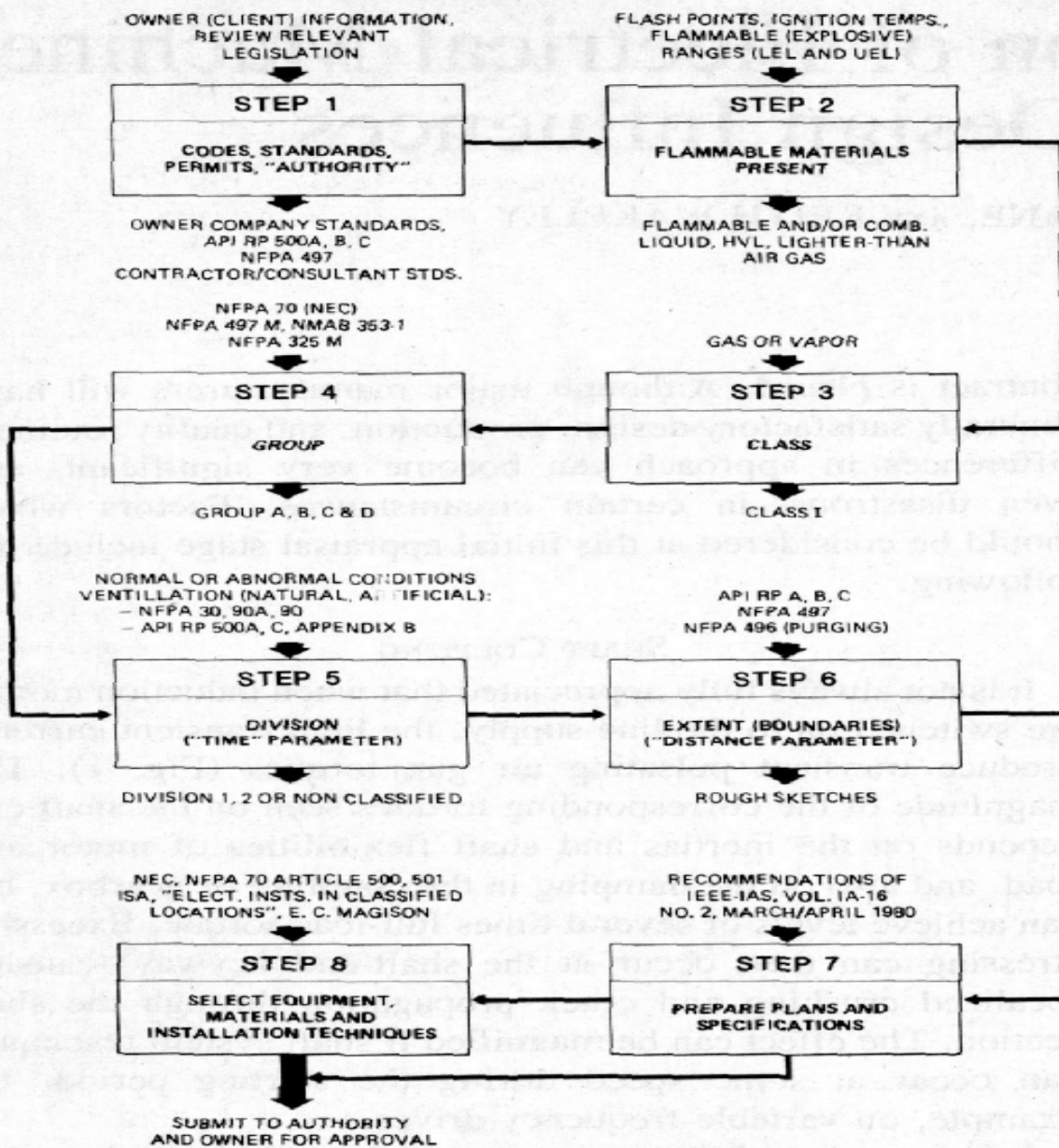


Fig. 3. Flow sheet for summarizing step-by-step method of establishing electrical area classification.

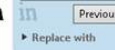
This section still exists in the latest edition of API-500

normally conservative for lighter-than-air gases such as hydrogen. However, some modification of the limits may be necessary to accommodate certain situations involving lighter-than-air gases.

9.1.5 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 areas. An example of such an area is an adequately ventilated location where flammable substances are contained in suitable, well maintained closed piping systems that include only the pipe, fittings, flanges, meters, and small valves.

9.1.6 The figures in Section 9.2 show classified locations surrounding typical sources of flammable liquids, vapors and gases. The intended use of these diagrams is to develop area classification documentation used for the selection of and proper installation methods for electrical equipment. Area classification drawings or other documentation may be required by certain regulatory agencies. Elevations or sections may also be required where different classifications apply at different elevations.

9.2.1.2.2 Extent of Division 2: Distances as shown Figure 22.



9.2.2 Locations where lighter-than-air flammable gases or vapors are handled should be classified in accordance with 9.2.2.1 and 9.2.2.2.

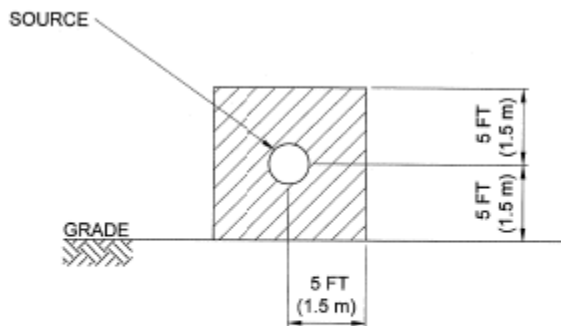
9.2.2.1 Within adequately ventilated locations containing closed systems, refer to Figures 23 and 24.

9.2.2.1.1 Extent of Division 1: Normally no Division 1 unless gases may be trapped. There is little or no potential hazard at or below grade.

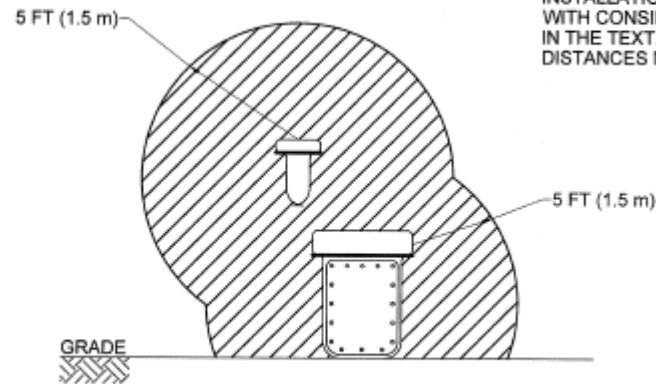
9.2.2.1.2 Extent of Division 2: Distances as shown in Figure 24. For roofed locations such as compressor shelters, distances are shown in Figure 23.

9.2.2.2 Within inadequately ventilated refinery process areas containing closed systems, refer to Figures 25 and 26.

9.2.2.2.1 Extent of Division 1: The entire location to the extent of the enclosed area.



ISOLATED POINT SOURCE WITH ADEQUATELY VENTILATED PROCESS LOCATION WITH LIGHTER-THAN-AIR GAS OR VAPOR SOURCE. SEE NOTE 5.



HYDROGEN METER WITH FILTER

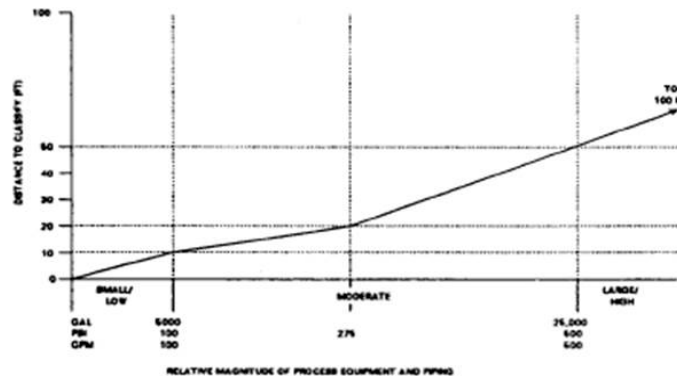
DISTANCES GIVEN ARE FOR TYPICAL COGENERATION INSTALLATIONS. THEY MUST BE USED WITH JUDGEMENT, WITH CONSIDERATION GIVEN TO ALL FACTORS DISCUSSED IN THE TEXT. IN SOME INSTANCES, GREATER OR LESSER DISTANCES MAY BE JUSTIFIED.

right, where the largest quantities of flammable liquids and flammable gases exist. An examination of the data from Figures A.1^[2] and C.1^[2] and Table 3-2^[3] supports these ordinate feet dimensions. In addition Figure C.1^[2] also shows a 10' dimension for 275 psi liquids and below so this dimension can be applied to the left third of the new figure. Figure C.4^[2] also shows a maximum 20' Division 2 surround for the piping situation where pressures are lower than at the pump in C.1^[2]. Considering this information (reduced pressure due to pipe resistance) there is also a 20' dimension in the left third of the new figure. The 0' dimension comes from RP 500, Paragraph A.1.5. This paragraph states: Experience has shown that the occurrences of flammable material liberation from some operations is so infrequent that it is not necessary to classify the surrounding areas. An example of such an area is an adequately ventilated location where flammable substances are contained in suitable, well maintained closed piping systems that include only the pipe, fittings, flanges, meters, and small valves." There is now enough information to produce the Chart.

100'. Clearly more information is needed before the distances shown in the Chart can be directly applied to specific situations or processes. However if the "variables" discussed in this paper are applied the distances shown in the Chart can be adjusted appropriately. Thus the Chart provides an aid to understanding how and why the Division 2 distances vary and, in simple cases, may apply directly to situations or processes or, in complex cases, the Chart may be adjusted according to the impact of the applicable variables described above.

REFERENCES

- ^[1] *National Electrical Code*, ANSI/NFPA 70 - 1993
- ^[2] *Recommended Practice for Classification of Locations at Petroleum Facilities*, ANSI/API RP 500 - 1991
- ^[3] *Classification of Class I Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*, ANSI/NFPA 497A - 1986



A process vent consists of any pipe or tubing that releases full pipeline pressure gas. This would include such devices as station blowdowns, vents, or relief valves. Enclosed areas that contain process vents are classified Class I, Division 1 to the extent of the enclosed area.

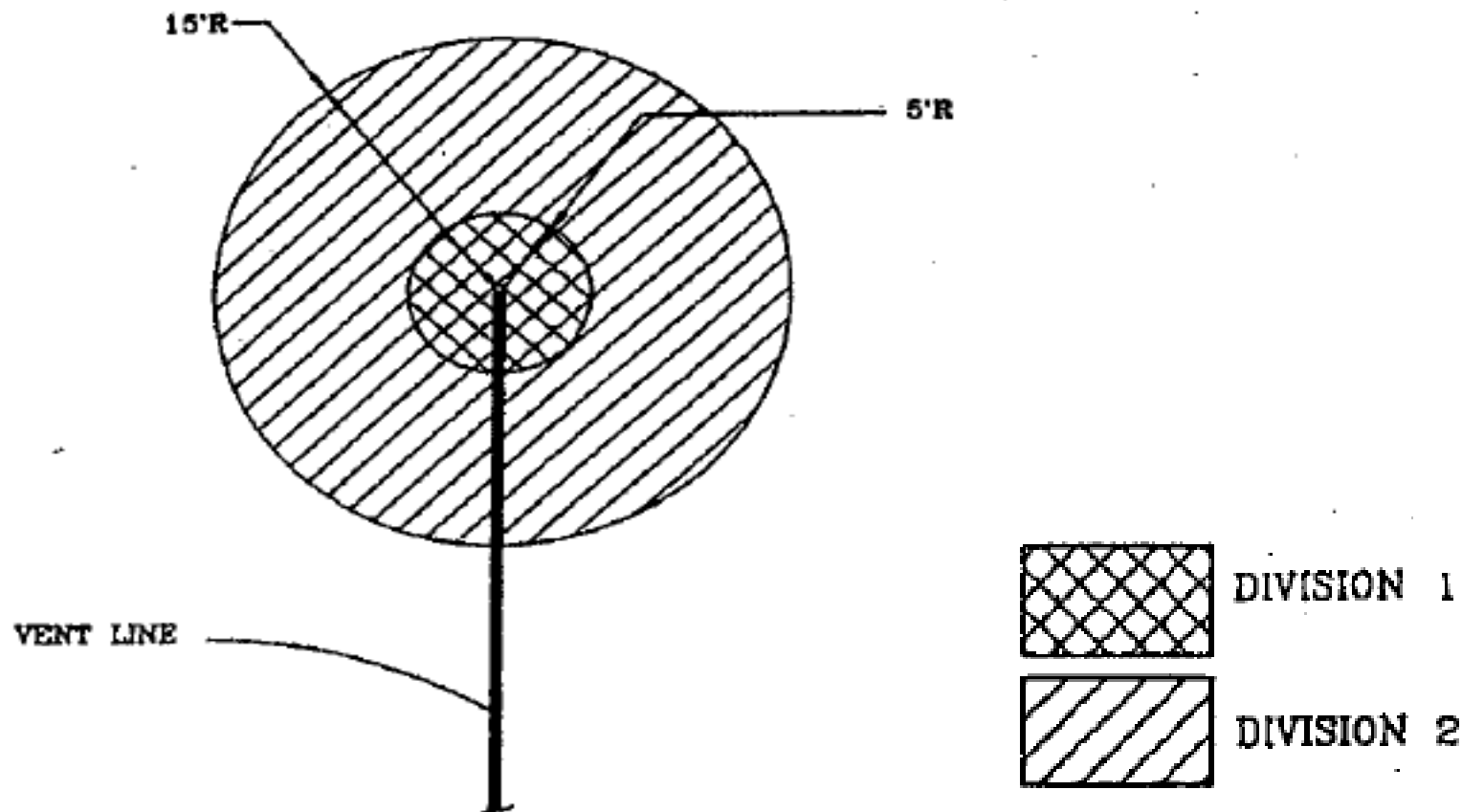


FIG.1: ADEQUATELY VENTILATED NON-ENCLOSED AREA

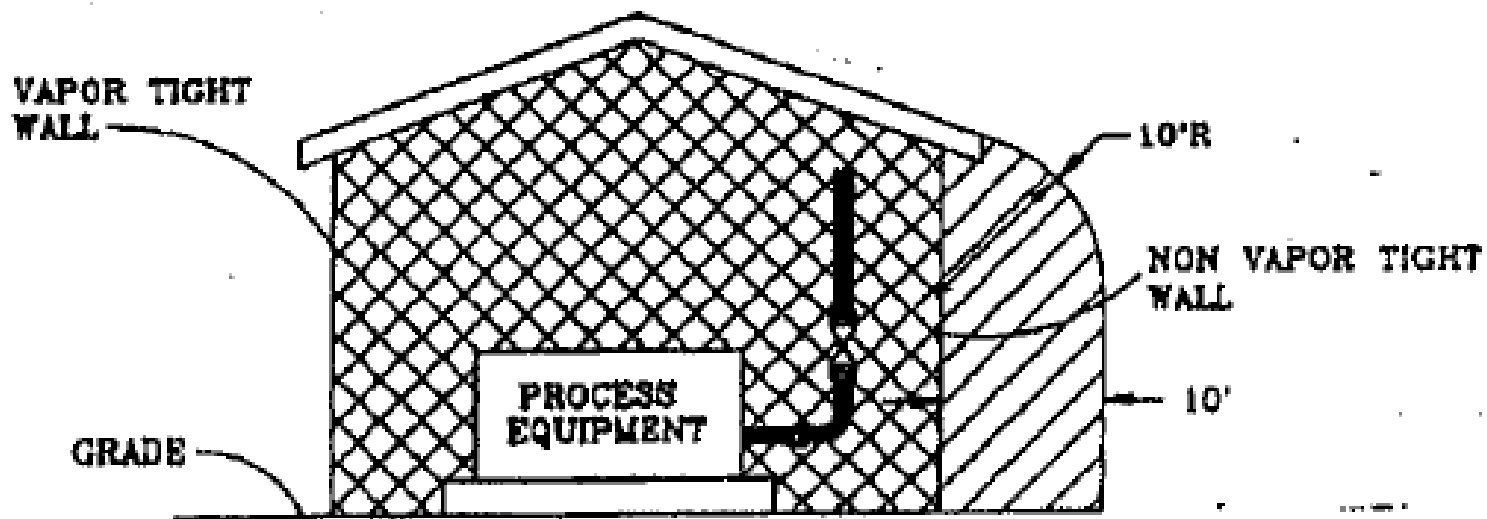
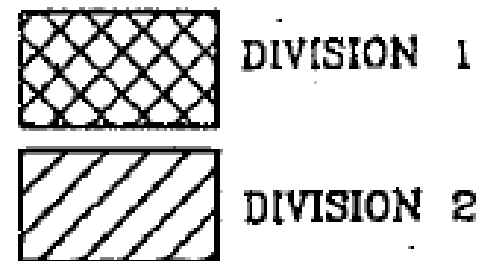


FIG.2: INADEQUATELY VENTILATED ENCLOSED AREA



Process valves are used for open/close and throttling applications. They include but are not limited to block valves, check valves, control valves and regulators. Valves require classification regardless of the type of end connections. Classification is based on possible leakage through the stem packing, flange connections, screwed connections, or the bolted top works in the case of check valves.

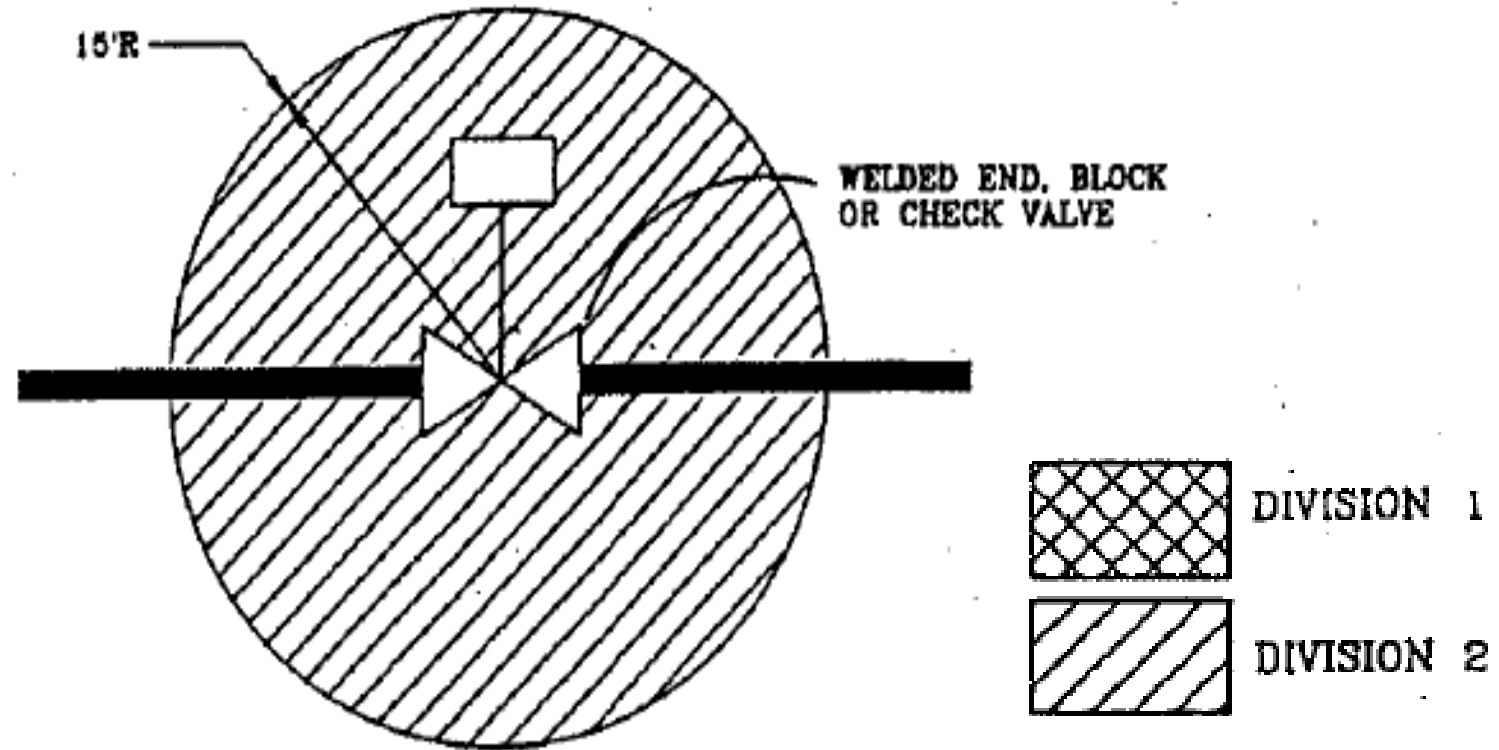
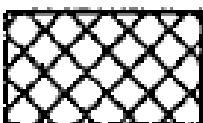


FIG.3: ADEQUATELY VENTILATED NON-ENCLOSED AREA



DIVISION 1



DIVISION 2

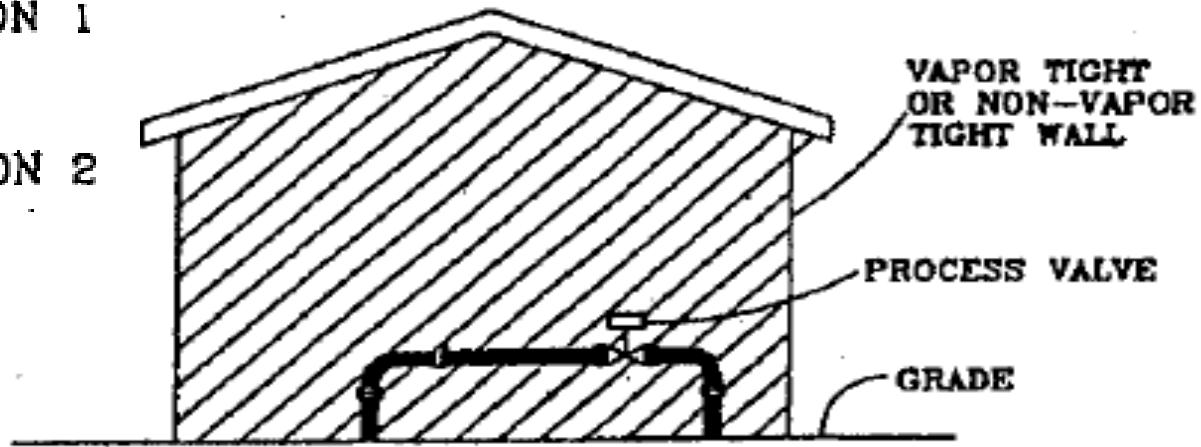


FIG.4: ADEQUATELY VENTILATED ENCLOSED AREA

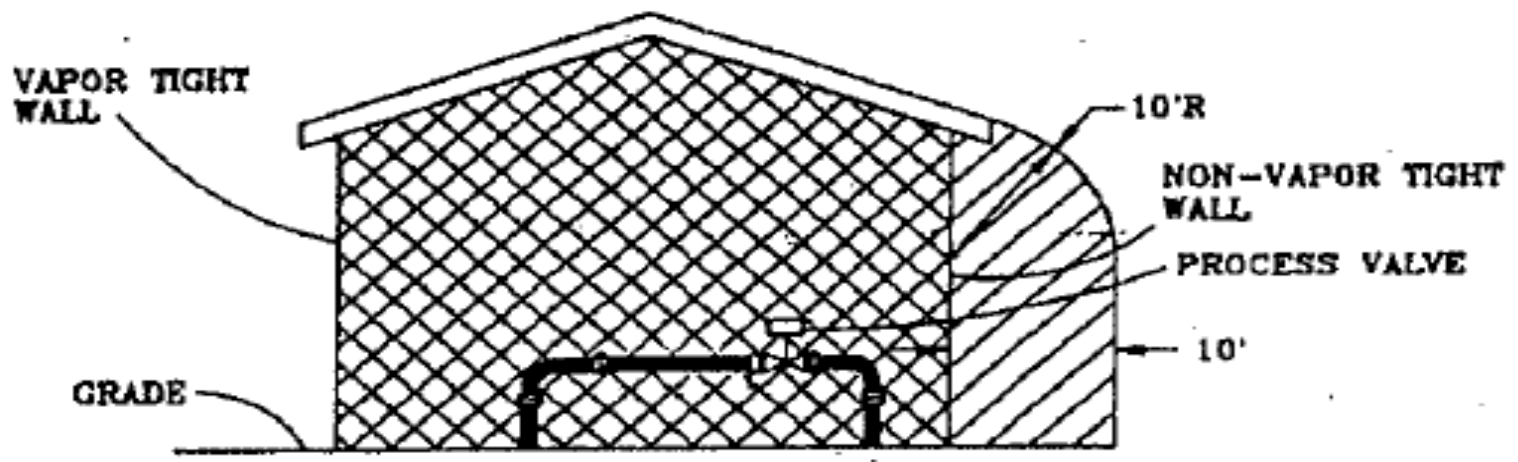
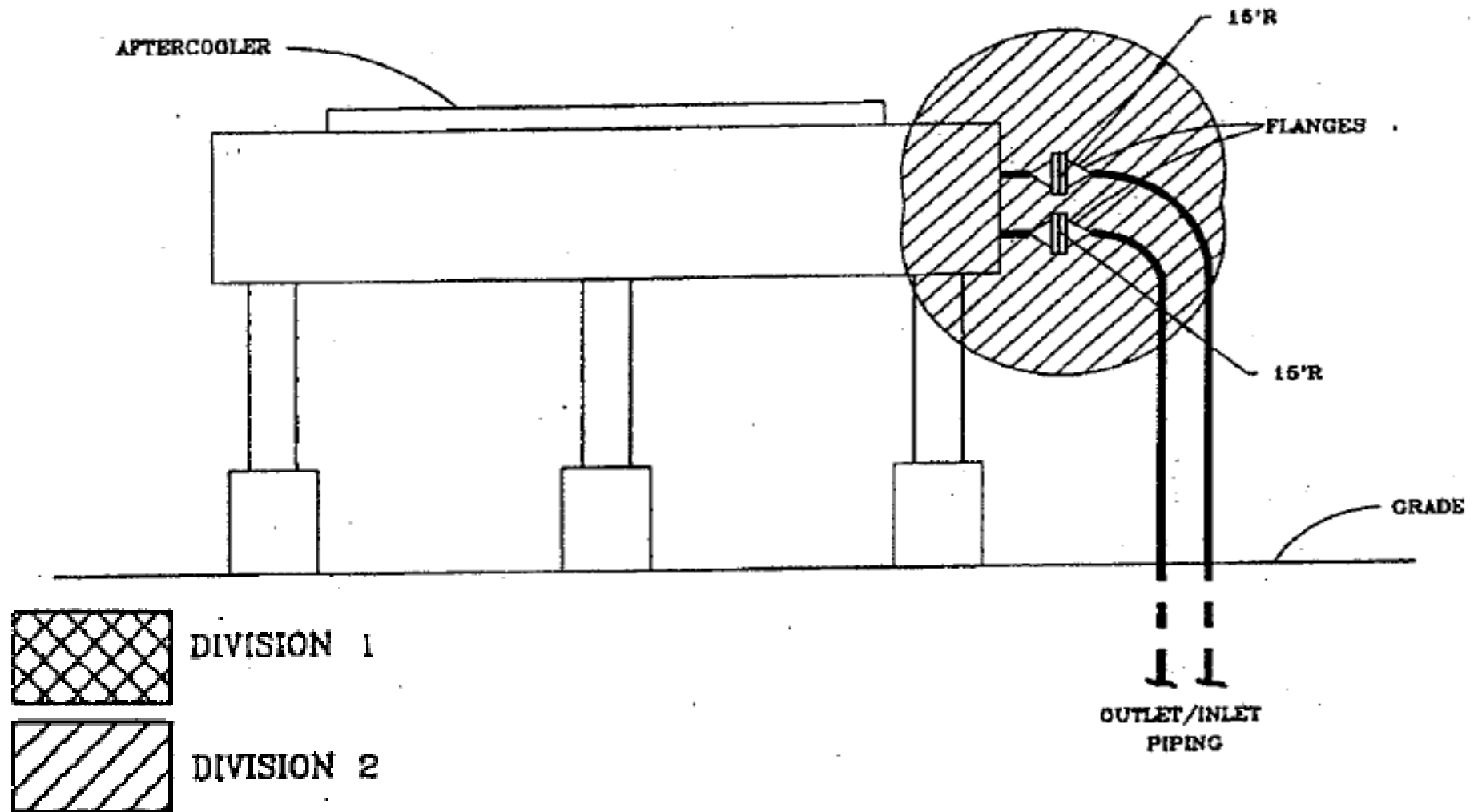


FIG.5: INADEQUATELY VENTILATED ENCLOSED AREA

The tubing bundle inside the cooler is considered a continuous pipe, and that portion does not require classification. The inlet/outlet flanged connections and the tubing connections into the header box are potential leak sources and require classification.



- ▶ Questions?
- ▶ References:
- ▶ NFPA, IEC, IEEE, Appleton EGS, PIP, GE, Bebcos, Crouse Hinds, CEAG.

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