DENIOS
ENVIRONMENTAL PROTECTION
& WORK SAFETY

Hazmat Manual – A Basic Guide for the Handling and Storage of Hazardous Materials

Everything you need to know about:

- Definitions
- Storage of Flammable Liquids in Quantities Exceeding 120 gal (460L)
- Storage of Organic Peroxides
- Electrical Requirements for Chemical Storage and Dispensing
- Chemical Spill Containment Requirements
- Storage of Compressed Gases in Storage Structures
- Third Party Approvals

Call us: **800-216-7776**

Guidance and information for using, handling and storing Hazardous and Flammable Chemicals in accordance with the U.S. Guidelines and Regulations.

This document is intended as a guide to the vast array of regulations concerning the storage and handling of flammable and combustible chemicals. As regulations and their interpretations change over time, your local Authority Having Jurisdiction (AHJ) should always be consulted when considering storing hazardous materials inside or outside your facility.

These next few paragraphs will provide brief insight to help you understand some of the fundamental parts of the Code of Federal Regulations, Title 29, Parts 1900 to 1910.999, and the Occupational Health and Safety Act of 1970 regarding the external storage of flammable liquids. In addition, data has been taken from the National Fire Protection Association's NFPA 30 "Flammable and Combustible Liquids Code", the 2018 edition of the "International Building Code" and the 2018 edition of the "International Fire Code."

National / International Authorities

- **International Fire Code (IFC)**
- **International Building Code (IBC)**
- **Code of Federal Regulations (CFR)**
- **Environmental Protection Act (EPA)**
- **National Fire Protection Assn (NFPA)**
- **Uniform Fire Code (UFC)**
- **Uniform Building Code (UBC)**

Know Your Hazard Symbols (Pictograms)

Hazard symbols have come a long way from the rudimentary drawings used to designate poison in the early 1800s.

As a result of updated OSHA chemical labeling requirements, 2016 marks the first full year of adoption of the Globally Harmonized System of Classification and Labeling of Chemicals (GHS) in the U.S.
The GHS system, part of OSHA's Hazard Communication Standard (HCS), consists of nine symbols, or pictograms, providing recognition of the hazards associated with certain substances. Use of eight of the nine are mandatory in the U.S., the exception being the environmental pictogram (see below).

Each pictogram covers a specific type of hazard and is designed to be immediately recognizable to anyone handling hazardous material.
In addition to pictograms, labels are required to include a signal word (“danger” or “warning”), a brief hazard statement and a precautionary statement outlining ways to prevent exposure.

Pictograms and Descriptions

Health Hazard

A cancer-causing agent (carcinogen) or substance with respiratory, reproductive or organ toxicity that causes damage over time (a chronic, or long-term, health hazard).

Flame

Flammable materials or substances liable to self ignite when exposed to water or air (pyrophoric), or which emit flammable gas.

Skull and Crossbones

Substances, such as poisons and highly concentrated acids, which have an immediate and severe toxic effect (acute toxicity).

Flame Over Circle

Identifies oxidizers. Oxidizers are chemicals that facilitate burning or make fires burn hotter and longer.

Corrosion

Materials causing skin corrosion/burns or eye damage on contact, or that are corrosive to metals.

Exploding Bomb

Explosives, including organic peroxides and highly unstable material at risk of exploding even without exposure to air (self-reactives).

Gas Cylinder

Gases stored under pressure, such as ammonia or liquid nitrogen.

Exclamation Mark

An immediate skin, eye or respiratory tract irritant, or narcotic.

Environmental Hazard

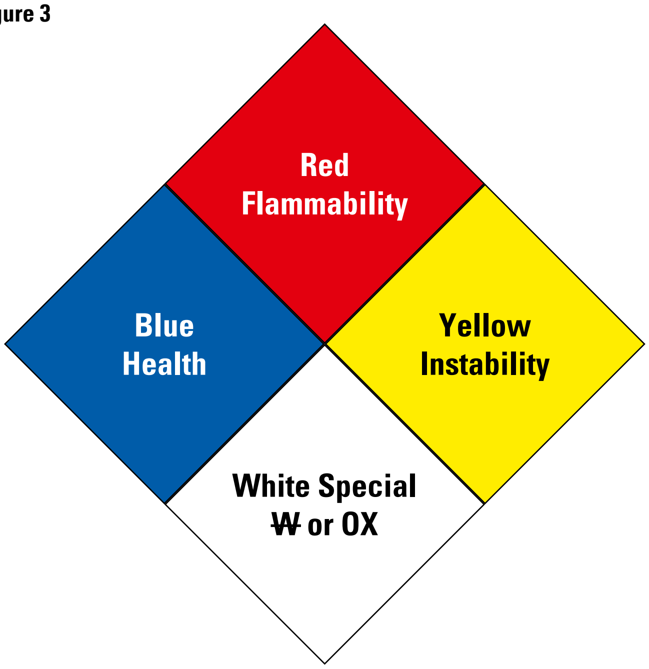
Chemicals toxic to aquatic wildlife. (Non-Mandatory)

Identification of the Hazards of Materials for Emergency Response – NFPA 704

NFPA 704 standard provides a readily recognized, easily understood placard system for identifying specific hazards along with their severity using spatial, visual, and numerical methods to describe in simple terms the relative hazards of a material. It addresses the health, flammability, instability, and related hazards that may be presented as short-term, acute exposures that are most likely to occur as a result of fire, spill, or similar emergency.

The system is characterized by a "diamond shape" that is actually a "square-on-point" shape consisting of four smaller diamond shapes. It identifies the hazards of a material and the degree of severity of the health, flammability, and instability hazards. The standard identification symbol for hazards of materials is shown in Figure 3 as follows:

Figure 3



In accordance with the identification symbol, the hazards are spatially arranged with four smaller diamonds as follows: flammability at twelve o'clock position (Red), instability at three o'clock position (Yellow), special hazards at six o'clock position (White) and health at nine o'clock position (Blue).

The special hazards in use are W and Ox. W indicates unusual reactivity with water and is a caution about the use of water in either fire fighting or spill control response and Ox indicates that the material is an oxidizer.

In addition, the numerical rating system describes the relative hazards of a material based upon the hazard severity rating as indicated below:

Fire Hazard (Red)
Flash Points
4 – Class IA liquids
3 – Class IB and/or IC liquids
2 – Class II and/or IIIA liquids
1 – Class IIIB liquids
0 – Will not burn

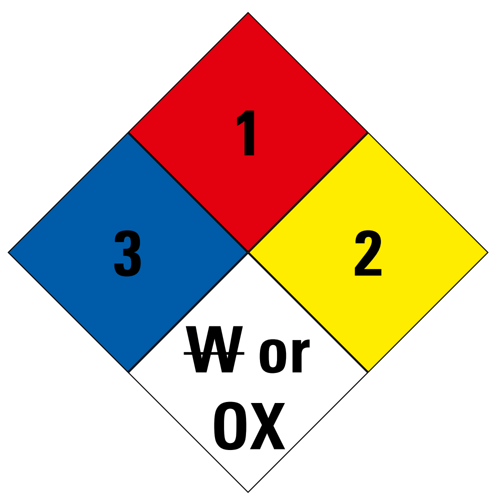
Reactivity (Yellow)
4 – May detonate
3 – Shock and heat may detonate
2 – Violent chemical change
1 – Unstable if heated
0 – Stable

Health Hazard (Blue)
4 – Deadly
3 – Extreme danger
2 – Hazardous
1 – Slightly hazardous
0 – Normal material

Specific Hazard (White)
Ox – Oxidizer
W – Use no water

The NFPA 704 Placard should be placed on the exterior face of storage systems where visible to emergency responders. A typical compliant placard is shown in Figure 4 below:

Figure 4



Chemical Spill Containment Requirements

Secondary Containment

Containment is described in the Fire Code, Flammable Liquids Code and the Code of Federal Regulations (CFR). In general the capacity of the containment must be 10% of the aggregate liquid volume stored or the volume of the largest container stored whichever is larger.

Where the storage is indoors and a sprinkler system is in place, the containment may be required to contain the above mentioned volume plus the volume discharged by the sprinkler system for 20 minutes. Local jurisdictions and third party certifiers may have more stringent requirements.

Flammable Cabinet sump provides added capacity bringing the sytem into spill compliance.

Storage of Flammable Liquids in Quantities not exceeding 120 gal (460L)

For this application, a flammable liquids storage cabinet as approved or listed by a recognized third party agency or constructed per NFPA 30 will suffice. The Local Authority Having Jurisdiction should be consulted regarding the number of cabinets allowed per control area (see definition above).

DENIOS' HAZMATTER: Typically, flammable liquids storage cabinets are designed to have a sump or spill containment volume of 5 gallons which is based upon storage of typical containers having a volume of 5 gallons or less. However, some of these cabinets are designed to store (2) 55 gallon drums (still within the 120 gallon limit) and DENIOS believes that these cabinets should be compliant under EPA and UFC regulations. Therefore, DENIOS offers a Flammable cabinet Sump that can be added to the Flammable cabinets bringing the complete system into EPA and UFC compliance.

Make sure to consult your local Authority Having Jurisdiction (AHJ).

All DENIOS Non-Occupancy Buildings, Occupancy Buildings, and lockers provide compliant secondary containment sumps below a grated surface.

Definitions

It is critical to understand the uniform system of defining and classifying flammable and combustible liquids and why it is important to take the necessary precautions to provide the correct methods of storage.

Authority Having Jurisdiction (AHJ)
An organization, office or individual responsible for enforcing code requirements or standards.

Auto-Ignition Temperature
The minimum temperature at or above which a material will spontaneously ignite (catch fire) without an external spark or flame. See following Table:

Auto-Ignition Temperatures for Some Common Chemicals or Fuels

Chemical or Fuel	Temperature	
	°C	°F
Acetone	465	869
Benzene	560	1,040
Diethyl Ether	160	320
Ethylene	490	914
Ethyl Alcohol	365	689
Fuel Oil No. 2	256	494
Gasoline	280	536
Kerosene	210	410
Isopropyl Alcohol	399	750
Methyl Alcohol	385	725
Propane	480	896
Toluene	480	896
Xylene	463	867

Boiling Point
The temperature at which the vapor pressure of a liquid equals the surrounding atmospheric pressure.

Flash Point
The minimum temperature of a liquid at which sufficient vapor is given off to form an ignitable mixture with air near the surface of the liquid.

Flammable Liquid
Any liquid that has a flash point below 100° F (37.8° C).

Flammable liquids are classified as Class I liquids with further sub-classification per the following and as shown in Figure 1:

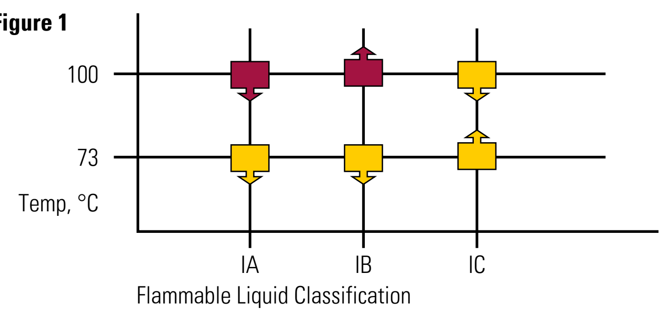
- **Class IA** – Any liquid that has a flash point below 73° F (22.8° C) and a boiling point below 100° F (37.8° C). Examples of this class are Ethyl Ether and Pentane.
- **Class IB** – Any liquid that has a flash point below 73° F (22.8° C) and a boiling point at or above 100° F (37.8° C). Examples of this class are Gasoline and Butanone (Methyl Ethyl Ketone).
- **Class IC** – Any liquid that has a flash point at or above 73° F (22.8° C) but below 100° F (37.8° C). Examples of this class are Xylene and Turpentine.
- *OSHA has different regulations

Classification of Flammable Liquids

Liquid Boiling Point

Liquid Flash Point

Figure 1



An Overview for Safely Separating and Segregating Stored Chemicals

Whenever storing chemicals of any kind it is important to consider which chemicals can be stored together and which should definitely be separated. There are a number of schemes for separating chemicals. Some with as many as fifteen different classifications.

While this may be too complicated for most situations, it does illustrate the potential complexities in storing multiple chemicals.

As a minimum, stored chemicals should be separated into the following categories:

I. Flammables
II. Oxidizers
III. Corrosives
IV. Acids
V. Bases
VI. Highly Reactives (such as organic peroxides)
VII. Extreme Toxics
VIII. Low Hazard

While this system is simple to implement, it is important to take the actual hazards of the various chemicals into account when determining storage hierarchy. Many chemicals have multiple hazards.

The required material safety data sheet (MSDS) should be consulted to determine the most severe hazard so the correct storage location can be determined. Flammability is the first component to consider. Flammables should always be segregated from other chemicals. In addition oxidizers and water reactives should be further segregated so they would not contribute to a potential fire and so any fire with common flammables can be extinguished using common suppression methods i.e. water. Attention should also be paid to any chemicals that have temperature sensitivity either high or low. This is especially true for organic peroxides some of which become instable at normal ambient temperatures.

Corrosives should be evaluated and separated accordingly. Acids and bases should be separated.

Toxics should be evaluated more stringently. This is especially true in the case of a flammable toxic which should be isolated even within its storage area to prevent accidental release.

Some chemicals do not fit neatly into a specific class but careful review of the MSD Sheet should give sufficient information to allow a measured decision as to how to segregate each chemical being stored.

Occupancy Building with multiple door sets. Separation walls were added to segregate incompatible chemicals.

Combustible Liquid

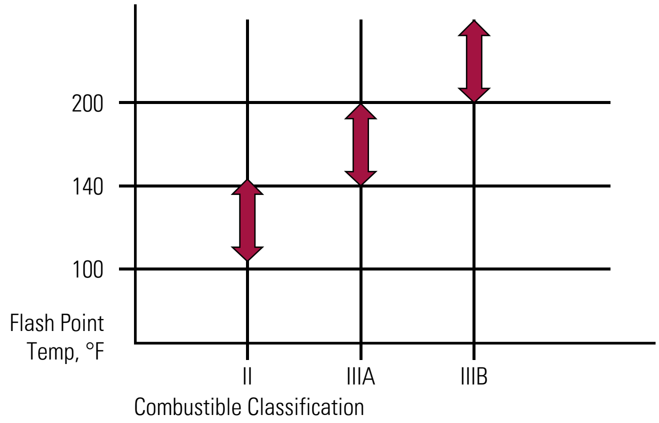
Any liquid that has a flash point at or above 100° F (37.8° C).

Combustible liquids are classified per the following and as shown in Figure 2:

- **Class II** – Any liquid that has a flash point at or above 100° F (37.8° C) and below 140° F (60° C). Examples of this class are Kerosene and Oil-Based paints.

- **Class III** – Any liquid that has a flash point above 140° F (60° C)
  [1] Class IIIA Liquid – Any liquid that has a flash point at or above 140° F (60° C), but below 200° F (93° C). An example of this is Mineral Spirits.
  [2] Class IIIB Liquid – Any liquid that has a flash point at or above 200° F (93° C). Examples of this class are Hydraulic Brake/Transmission fluids and lube oils.

Figure 2



Flammable Range (Explosive Range)

The range of a concentration of a gas or vapor that will burn (or explode) if an ignition source is introduced.

MAQ (Maximum Allowable Quantity)

The maximum quantity of flammable or combustible liquids allowed to be stored in a given occupancy. The MAQ varies per the occupancy class and the fire protection systems available. But in general it begins at 120 gallons of liquid.

Control Area

Defined in NFPA 30, Section 9.7 and generally defined as follows:

[1] A building or portion of a building within which flammable and combustible liquids are allowed to be stored, dispensed and used or handled in quantities of liquids that do not exceed those listed in NFPA 30 Table 9.6.1 or Table 9.6.2 for all liquid Classes I, II and III.
[2] An area separated from each other by fire barriers per NFPA Table 9.7.2.

"H" Occupancy

Occupancy where the quantity of flammable liquid or other hazardous material stored exceeds the MAQ. Storing quantities above MAQ generally makes the occupancy a "hazardous occupancy" (H1-H5).

Most DENIOS Lockers, Non-Occupancy Buildings and "walk in" style Occupancy Buildings fall into these two categories:

- **H-2** – Class I, II or IIIA flammable or combustible liquids which are used or stored in NORMALLY OPEN containers or systems, or in closed containers pressured at more than 15 psig.
- **H-3** – Class I, II or IIIA flammable or combustible liquids which are used or stored in NORMALLY CLOSED containers

4-Drum locker with fire rated construction for storage of flammable liquid chemicals.

Storage of Flammable Liquids in Quantities Exceeding 120 gal (460L)

The storing of Class I, II and IIIA liquids in individual containers shall meet all the applicable requirements of NFPA 30.

Where the quantity of flammable or combustible liquids stored exceeds the MAQ, the material must be separated from the rest of the occupancy either by distance or by fire rated walls. DENIOS Lockers, Non-Occupancy Buildings and "walk in" style Occupancy Buildings are designed for this purpose.

Table 2 adjacent is designed to provide general guidance as to separation distances relative to required fire ratings. It should be used as a guideline, however, the applicable local code and the local code enforcement officials should be consulted before placing any chemical storage structure.

Table 2

Minimum Separation Distance from Storage Structure to Property Line or other Important Building	
Fire Rating (hrs)	**Distance (ft)**
4	0
2	10
0	30

Storage of Flammable Liquids in Chemical Storage Structures Inside an Existing Building

When flammable or combustible liquids are stored in a chemical storage structure that is less than 1500 ft² and is located inside of an existing structure, the chemical storage structure is classified as a Liquid Storage Room and must meet the requirements prescribed for same including the fire ratings in Table 2 above.

Ventilation

Chemical storage structures used for storing combustible and flammable liquids should be ventilated. The ventilation method can be either passive (natural) or mechanical (forced). When flammable or combustible liquids are being dispensed, creating vapors, then mechanical ventilation should be provided at a rate not less than 1 cu ft/min of floor area with a minimum of 150 sq ft/min.

When designing ventilation systems, be aware of the specific gravity of the actual gas/vapor. In most cases air should be drawn from a location within 12-18" of the floor as the majority of flammable liquids give off vapors that are heavier than air.

Deflagration control

Where flammable liquids are dispensed, deflagration panels or control should be provided. Where deflagration panels are provided, the exterior wall containing the panels should be a minimum of 30 feet from another building and the area adjacent to the panels should be kept clear of pedestrian traffic for 30 feet as well.

Deflagration panels may not be vented to the interior of a structure and should be directed out special shafts to the exterior or positioned on an exterior wall.

Explosion prevention systems can be provided which include LEL detectors, multiple fans and associated controls to maintain the vapor level at or below 25% of the Lower Explosive Limit (LEL).

Organic Peroxides present special challenges for storage and handling as they are temperature sensitive and can combust spontaneously if they reach certain temperatures unique to each material.

Self Accelerating Decomposition Temperature

Organic Peroxides decompose at various temperatures giving off heat that can cause or contribute to a fire. This temperature is called Self Accelerating Decomposition Temperature, or SADT, and can be anywhere between 14°F to 392°F depending upon the material. At the SADT, the heat lost to surroundings is surpassed by the heat generated and the temperature of the material begins to rise.

The rate of decomposition increases as the temperature increases and may reach a point where it is so rapid that large quantities of heat are produced which further increase the rate. In addition to producing heat, the decomposition process can cause pressure build up. If allowed to continue, it may become uncontrollable, leading to fire or combustion. Copious amounts of water are required when fighting organic peroxides on fire in order to cool the material back below its SADT to stop the acceleration and then extinguish the fire.

Control Temperature

Another important temperature is the CT or Control Temperature. This is the temperature at which the material can be stored or transported over a long periods of time. This temperature varies between 32°F and 68 °F less than the SADT depending upon the SADT.

- CT=SADT - 4 °F if SADT < 68 °F
- CT=SADT 5 °F if SADT > 68 °F but < 95 °F
- CT=SADT 14 °F if SADT > 95 °F but < 122 °F
- IF SADT > 122 °F then there is no CT.

The CT can also be thought of as the alarm temperature when storing given materials. Since it is well below the SADT it may be exceeded for short time periods due to maintenance or until alternative cooling methods are available. Still another temperature may come in to play. That is the recommended storage temperature from the manufacturer of the material. This may be even lower than the CT to prevent the material from degrading, decreasing its usefulness.

Thus the key to managing organic peroxides is temperature. If they are maintained at the appropriate temperature in accordance with the manufacturer's instructions, they can be handled and stored safely.

Redundant cooling system ensures temperature stability should primary system fail.

Proper Storage of Organic Peroxides

Storage areas for organic peroxides must also be separated from other chemicals including flammables, oxidizers, acids and alkalis by a minimum of 25 feet or a liquid tight one hour fire barrier. Class I (see definitions below) peroxides provide extra challenges as they are considered explosive. Deflagration panels and special building reinforcement are called for when storing these materials. Areas where organic peroxides are stored should be electrically classified as CL I Div 1 or Div 2 as designated by NFPA 400.

In addition controls on the refrigeration system should include over temperature alarms (usually set at the Control Temperature) and a smoke or heat detector to notify the appropriate response of a problem in the storage area. Redundant temperature control equipment or approved alternate means should be available in the event of equipment failure. Standby or emergency power should also be considered per NFPA 400.

Organic Peroxides by Definition

Organic Peroxides may be divided into five classes for informational purposes:

Class I is the most dangerous class of Organic Peroxides and describes those materials that present a hazard of deflagration through rapid explosive decomposition. Such materials are safe only under strictly controlled temperatures. Dibenzoyl peroxide 98% is one such material.

Class II formulations present a fire hazard similar to Class I flammable liquids such as acetone or toluene.

Class III formulations burn rapidly and present a moderate reactivity hazard. They are similar to combustible liquids such as #2 fuel oil.

Class IV describes those formulations that burn in a manner similar to ordinary combustibles. These fires are easily controlled.

Class V materials burn with less intensity than ordinary combustibles and do not present a severe fire hazard.

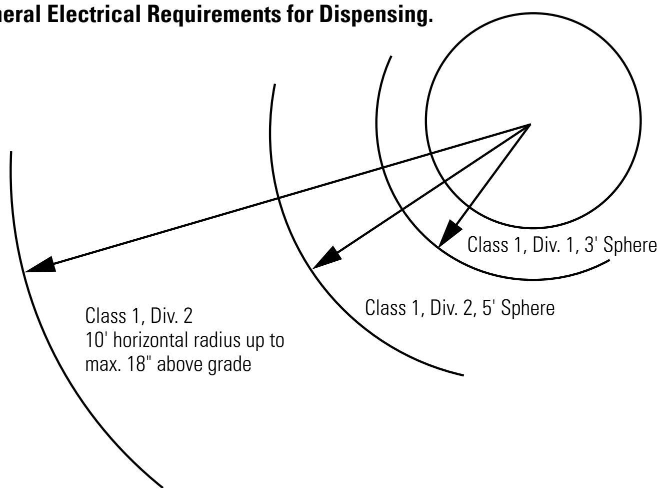
Class 1 Organic Peroxide Storage Enclosures can require deflagration panels due to the explosive hazards of the material stored.

Electrical Requirements for Chemical Storage and Dispensing

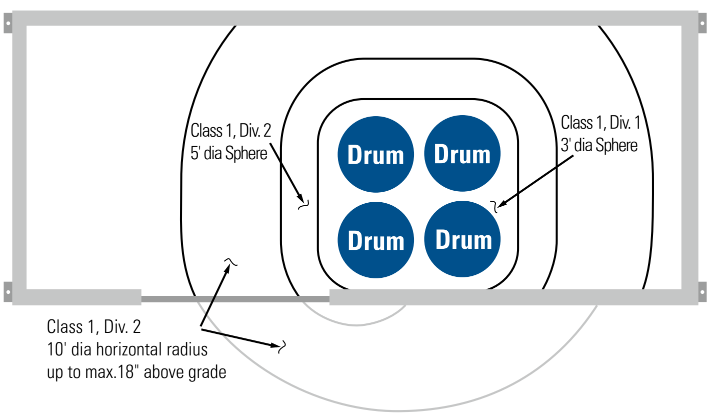
Where hazardous chemicals are stored or dispensed, special electrical requirements apply. In general for "storage only" applications where vapors may be present only in the case of a spill, the electrical classification of Class 1, Division 2 is acceptable.

In cases where dispensing of flammable liquids is taking place, the electrical requirements vary according to the distance from the point of dispensing (where the vapors are created). The diagrams below illustrate the requirements. A sphere is created around the dispensing point with a radius of 3'. Class 1, division 1 electrical requirements prevail within the sphere. A second sphere is created around the dispensing point with a radius of 5'. Everything within this sphere and outside of the 3' radius sphere is required to be class 1, Division 2. An area from the floor up to 18" above the floor and extending 10' in all directions is further included in the Class 1, Division 2 area. These principles are illustrated in the sketches below.

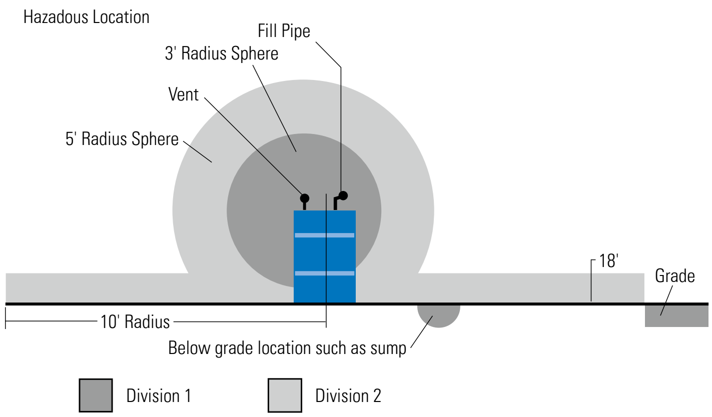
General Electrical Requirements for Dispensing.



Plan view of typical dispensing location and electrical requirements.



Elevation view of electrical requirements for dispensing.



Heating of Flammable and Combustible Liquids

Heating of flammable and combustible liquids is sometimes required to prevent freezing, manage viscosity, or condition the material for process use. Heaters used for this purpose should be explosion proof electric, steam, heated liquid or other system. Where explosion proof electric heaters are used, their set temperature is limited to 104° F by the NEC (National Electrical Code).

Explosion Proof Heaters (and other electrical appliances) should be chosen by their temperature classification, which should always be lower than the lowest auto-ignition temperature of all of the materials being stored. The table below shows the various temperature ratings available and their "T" number.

Temperature Ratings for Class I and Class II Heaters

Maximum Degrees (°C)	Temperature Degrees (°F)	Identification "T" Number
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

For over 30 years, DENIOS staff have studied chemical safety. We pride ourselves on being the experts in the industry you can partner with for your chemical storage and handling needs. We promise to deliver quality products that protect people and the environment.

On the next few pages we will explain some of the many different types of gases and some of their storage requirements.There are many different OSHA standards that apply to storage and handling of compressed gas cylinders. The Compressed Gas Association (CGA) also has regulations in regards to gas cylinders.The NFPA is another association that has codes dealing with flammable materials.

How do you know what regulations you need to comply with, or where to start?Let one of our friendly trained staff members help take the headache out of shifting through all the rules and regulations.We can help you come up with a comprehensive plan to meet your compressed gas cylinder storage and handling needs while staying safe and compliant.

Definitions:

Flammable Gas

A material that is a gas at 68°F or less at 14.7 psia, that is ignitable at 14.7 psia when in a mixture of 13% or less by volume with air, or that has a flammable range at 14.7 psia with air of at least 12% regardless of LFL.

Corrosive Gas

A gas that causes visible destruction of or irreversible alterations in living tissue by chemical action at the site of contact.

Pyrophoric Gas

A gas with an auto-ignition temperature in air at or below 130°F. Refer to NFPA 55 standard for the installation, storage, use and handling of compressed gases in portable or stationary cylinders. Compressed gas containers, cylinders and tanks in use or in storage shall be secured to prevent them from falling or being knocked over.

All tank valves shall be protected from physical damage by means of protective caps or similar devices.

Cylinders, containers and tanks containing liquid, flammable gases shall be stored in an upright position unless container capacity is 1.3 gal (5L) or less in which case horizontal stored position is allowed.
Where the quantities of compressed gases stored or used within an indoor control area exceed that shown in the following Table 3, the area shall require special provisions.

The special provisions include meeting requirements for Protection Level 1 through 5 in accordance with the building code and based on the hazard class of material involved. The values in the table are maximum quantities per control area. When multiple control areas are required, they must be separated by not less than a 1-hour fire-resistive separation. In addition, the number and design of control areas must be in accordance with the International Building Code Section 414 and Table 414.2.2 and the local AHJ.

Detached buildings for storing compressed gases are required when quantities of materials exceed the amounts shown in the following table 4:

Table 4

Minimum Material Allowable Quantities Requiring Detached Buildings		
Gas	**Class**	**Quantity of Material m^3 (ft3)**
Unstable Reactive (Detonable)	4 or 3	Quantity thresholds for gases requiring special provisions
Unstable Reactive (Nondetonable)	3	57 (2000)
	2	283 (3000)
Pyrophoric Gas	N/A	57 (2000)

Table 3

Quantity Thresholds for Gases Requiring Special Provisions				
	Unsprinklered Areas		**Sprinklered Areas**	
Material	**No Gas Cabinet, Gas Room or Exhausted Enclosure**	**Gas Cabinet, Gas Room or Exhausted Enclosure**	**No Gas Cabinet, Gas Room or Exhausted Enclosure**	**Gas Cabinet, Gas Room or Exhausted Enclosure**
Flammable Gas Liquified Nonliquified	30 lb 1,000 ft3	60 lb 2,000 ft3	60 lb 2,000 ft3	120 Lb 4,000 ft3
Oxidizing Gas Liquified Nonliquified	30 lb 1,500 ft3	60 lb 3,000 ft3	60 lb 3,000 ft3	120 Lb 6,000 ft3
Pyrophoric Gas Liquified Nonliquified	0 lb 0 ft3	0 lb 0 ft3	4 lb 50 ft3	8 lb 100 ft3

Outdoor storage for Corrosive Gases shall not be within 20 ft (6m) of other structures unless it has a 2-hour fire barrier in which case shall be permitted in lieu of the 20 ft (6m) requirement.

The 2-hour fire barrier shall be designed per requirements of NFPA 55 and local codes.

Outdoor storage buildings for Flammable Gases shall be located in accordance with Table 7.6.2.

If the building has a minimum 2-hour fire rating interrupting the line of sight between the container and exposure, then the minimum required distance is 5 ft (1.5m).

NFPA Table 7.6.2

Distance from Storage to Exposures for Flammable Gases		
Average Quantity per Storage Area	Minimum Distances to Buildings, Storage Areas or Property Lines	
ft3	m	ft
0 - 4,225	1.5	5
4,226 - 21,125	3	10
21,126 - 50,700	4.5	15
50,701 - 84,500	6	20
84,501 or >	7.5	25

NFPA Table 7.7.2

Distance from Storage to Exposures for Flammable Gases		
Average Quantity per Storage Area	Minimum Distances to Buildings, Storage Areas or Property Lines	
ft3	m	ft
0 - 4,225	1.5	5
4,226 - 21,125	3	10
21,126 - 50,700	4.5	15
50,701 - 84,500	6	20
84,501 or >	7.5	25

Outdoor storage buildings for Oxidizing Gases shall be located in accordance with Table 7.7.2.

If the building has a minimum 2-hour fire rating interrupting the line of sight between the container and exposure, then the minimum required distance is 5 ft (1.5m).

Outdoor storage buildings for Pyrophoric Gases shall be located in accordance with Table 7.8.3.

If the building has a minimum 2-hour fire rating interrupting the line of sight between the container and exposure, then the minimum required distance is 5 ft (1.5m).

Pyrophoric gases have auto ignition temperatures at or below 130°F. Some typical examples of pyrophoric gases are Silane, Diborane or Arsine.

DENIOS Gas Cylinder storage structure utilizing 2-hr fire rated walls.

NFPA Table 7.8.3

Distance from Storage to Exposures for Pyrophoric Gases				
Maximum Gas Quantity per Storage Area (x 3.785 for L)	Minimum Distances between	Gas Non-Occupancy Building, Gas Room or Exhausted Enclosure	Minimum Distance to Buildings on Same Property and No Openings within 25 ft	
ft^3	ft	ft	2 hr	4 hr
0 - 250	5	25	0	0
250.1 - 2,500	10	50	5	0
2500.1 - 7,500	20	100	10	0

What they are and why they are important. Setting the record straight.

Third party approvals for Hazardous Material Occupancy Buildings have been around since 1991 in the form of FM class 6049. FM began approving hazardous material storage buildings with the first edition of CLASS 6049 in that year. This FM "standard" has remained the defacto standard in the US, unchallenged since that time. Manufacturers that receive FM approval have submitted their designs to a third party and then to FM for review in accordance with the standard. This includes reviewing the structural integrity including floor and snow loads in accordance with the standards and the ability of the building to withstand a specific wind which is especially important in coastal areas of the US. The standard further evaluates the integrity of fire rated walls and ceiling and certifies the stated containment sump capacity. Contrary to popular opinion, UL (Underwriters Laboratories) does not have a standard for these buildings, so no manufacturer can use the "UL listed" moniker with reference to their buildings.

A FM approved Occupancy Building should be labeled as such by the manufacturer. The text of the approval document prescribes what must be on the label. This includes place of manufacture, model no., design floor, wind and snow loads, and if applicable, the fire rating of the walls. It also includes whether the building is constructed with damage limiting construction (DLC) also known as deflagration panelsas well as the electrical classification and temperature classification of any and all electrical equipment installed on the building.

FM APPROVED

DENIOS' FM Approved fire rated Non-Occupancy Building.

It is important to note that, even though a manufacturer has multiple items in their approval listing, there may be variations of those products that cannot be labeled as "approved". This is because the approval listing contains specific construction parameters and characteristics that may or may not be available in a particular model series or combination of accessories.

A third party approval is important because it sets a standard of consistent quality, performance, and construction that is guaranteed by the fact that the building carries the approval. Further, the case of FM, periodic follow up inspections of the approved company's manufacturing site(s) are conducted by FM engineers to assure that the approved products are being manufactured in the same manner as was initially examined. Repeated violations can result in the withdrawal of the approval. While the third party approval certifies a level of engineering, quality and construction, it does not certify a fitness for a specific use nor placement in a specific location. Suitability for use and location are best determined in consultation with your local authority having jurisdiction.

While significant, the approval should be considered a minimum acceptable standard as many manufacturers go above and beyond which is required for the approval. At the same time, all FM approved manufacturers may not be equal. While the FM approved moniker denotes a specific level of manufacture for basic standard Occupancy Buildings, the manufacturer's expertise in building the actual requirements dictated by the application should also be taken into account when evaluating a particular project. For instance, experience in building heated enclosures with specific heating mediums i.e. steam, electric or oil should be evaluated if these characteristics are requirements of the project as they are not a part of the FM approval process. Furthermore, experience in cooled or refrigerated units should be evaluated if these features are needed in the scope of the contemplated project. These characteristics are also not contemplated by the FM Approval Process.

16 x 8 storage Occupancy Building can be engineered for the storage of chemicals or housing of chemical processes.

Other drum/IBC storage enclosures approved by FM include Lockers (left) and modular Occupancy Buildings

Looking Ahead

While the previous section details the importance and the role of 3rd party approval agencies such as FM Global, there are applications that can be contradictive.
For example, FM Global's Standard 6049-2013 has greatly impacted indoor placement of chemical storage buildings. The standard calls for:

- 1-Hour Fire Rated Construction (Minimum Required)
- 25% Sump Capacity with Drain Valve
- Piping and Sprinkler Heads for Hook-Up to Plant's Fire Suppression System
- All Stored Chemicals to be Kept at Least Half the Storage Height of the Container from Any Door Opening
- An Acceptable Means of Egress by Way of a Man Door (Roll Up Doors can be Used for Loading/Unloading purposes but is not Consider a Means of Egress)

On its face, these requirements for indoor placement could be viewed as contradicting NFPA and other accepted guidelines which only require 10% sump capacity and allow for the use of dry chemical fire suppression systems . This could be quite problematic for FM Global customers.
Chemical Storage Occupancy Building manufacturers can offer solutions to meet these challenges. But the impetus falls on the end-user to make certain what is going in the facility receives the approval of the Local Authority.
Again, presumably, the solution, which will satisfy both Local Authorities and FM Global, is for the chemical storage building to be placed outside of the facility.

Under the new 6049, building designs like this will no longer be approved for interior placement by FM due to the use of dry chemical fire suppression.

Other Conflicts

As chemical storage enclosures have advanced, industry has developed many novel approaches to storing hazardous chemicals and processes. But as the role of the enclosure goes beyond basic storage, confusion can arise as to what regulations should be followed. This is becoming particularly common with storage enclosures designed for occupancy by personnel. Building manufacturers typically lean towards NFPA, which tends to provide more detailed/in-depth direction. But certain Authorities now are referencing the International Building Code (IBC)- which takes a more general viewpoint and, as such, fails to make certain distinctions in their rules (ie storage versus occupancy buildings).

Additionally, many RFQs are still citing outdated specifications.

This particularly common (and troubling) with government contracts. Recent findings have held that it is the responsibility of the supplier/manufacturer to clearly point out to the purchaser where specification will not be met and show where the alternative spec is as good or better than which is shown in the RFQ. Should the supplier/manufacturer simply provide their specs in the proposal, it will not constitute disclosure should a conflict arise. The supplier/manufacturer is required to identify any off-spec instances.

As modular buildings become more sophisticated and customized to address hazardous chemical processing applications while exposing personnel to dangerous environments, conflicts and contradictions between governing codes and inconsistent application by local authorities are becoming more common.

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