# ACETYLENE

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## 1.0 SCOPE

This document provides guidance on the use and manufacturing of acetylene gas.

### 1.1 Changes

January 2012. Terminology related to ignitable liquids has been revised to provide increased clarity and consistency with regard to FM Global's loss prevention recommendations for ignitable liquid hazards.

## 2.0 LOSS PREVENTION RECOMMENDATIONS

### 2.1 General

#### 2.1.1 Construction and Location

2.1.1.1 Locate acetylene reactors, generators and purification equipment in open structures or in noncombustible buildings of damage-limiting construction (Fig. 1). Provide at least 1 $ft^2$ of venting area for every 15 $ft^3$ (1 $m^2$/4.6 $m^3$) of room volume. The venting area may be corrugated metal, corrugated asbestos, or lightweight insulated-metal panels arranged to release when subjected to 20 lb/$ft^2$ (0.96 kPa) internal pressure, or FM Approved (see Appendix A for definition) explosion-venting windows.

#### 2.1.2 Occupancy

2.1.2.1 Ventilate by providing openings near the floor, and roof ventilators at the highest point in the room or building. These should be of sufficient size to provide liberal ventilation under normal operating conditions when doors and windows are closed.

2.1.2.2 Keep rooms clean, orderly, and free of combustible materials.

#### 2.1.3 Equipment and Processes

2.1.3.1 Pipe safety-relief-valve and rupture-disk discharge lines outdoors. Relief lines on portable generators may terminate within buildings.

2.1.3.2 Check and refill hydraulic flash arresters and anti-backflow devices with water to the proper liquid level frequently. Flash arresters on generators should be refilled at each recharge. Maintenance of the proper liquid level is essential to the effectiveness of the arresters.

#### 2.1.4 Ignition Source Control

2.1.4.1 Provide room heating by means of a steam or hot-water system.

2.1.4.2 Choose electrical equipment suitable for Class I, Division 2 locations in accordance with Article 501 of the National Electrical Code.

### 2.2 Hydrocarbon Reforming

#### 2.2.1 Construction and Location

Hydrocarbon-reforming processes should be safeguarded in accordance with accepted good practices for chemical reactors and for ignitable liquids and flammable gases, with special attention to the following items:

2.2.1.1 Locate reactors and associated equipment at least 75 ft (23 m) from other important buildings, structures, and utilities. Preferably, reactors should be separated from purification equipment by explosion-resistant walls.

#### 2.2.2 Equipment and Processes

2.2.2.1 Avoid high temperatures and pressures where gases with high acetylene content are involved.

2.2.2.2 In addition to normal control devices, provide excess limit sensors for temperatures, pressures, and flows, to safely shut down the process; or maintain conditions within safe limits, in accordance with Data Sheet 7-14, *Fire Protection for Chemical Plants*, Data Sheet 7-45, *Instrumentation and Control in Safety Applications*, and Data Sheet 7-46/17-11, *Chemical Reactors and Reactions*.

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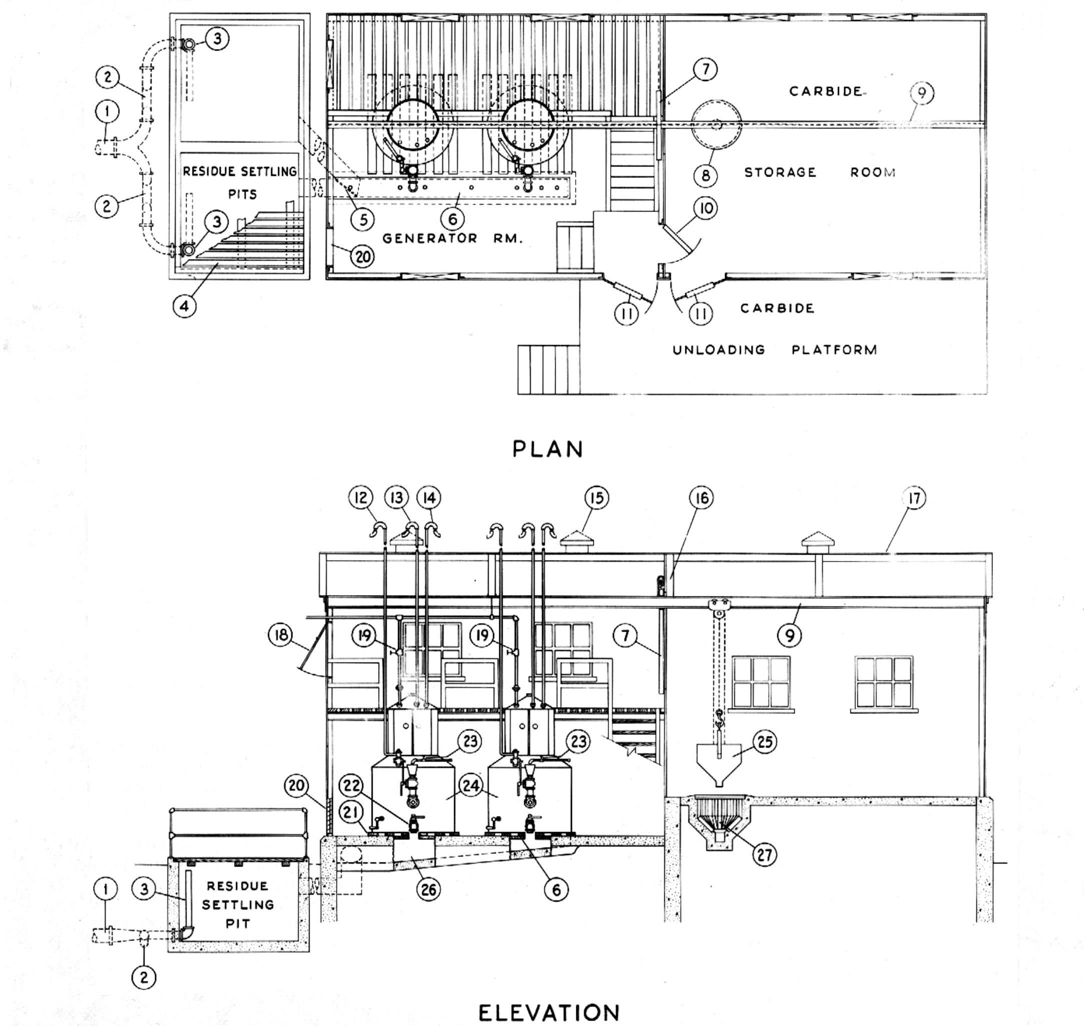


1. Tile drain to sewer
2. Bell trap
3. Clear-water drawoff, swing type for adjustable level
4. Pit cover; planks separated ½ in (13 mm) for ventilation
5. Swing gate to direct residue to either pit
6. Plank cover over residue-grain gutter
7. Approved automatic-closing fire door; notched to fit around monorail carbide conveyor
8. Pit for carbide-charging hopper
9. Monorail carbide conveyor
10. Automatic-closing fire door
11. Ventilating louvers in doors
12. Vent pipe from generator vent valve
13. Vent pipe from generator hydraulic flash arrester
14. Vent pipe from generator pressure-relief valves
15. Roof ventilators
16. Roof trusses
17. Corrugated-iron or asbestos roof
18. Explosion-venting window
19. Service valve
20. Ventilating louvers near floor
21. Planks to raise generators above floor for ventilation and drainage
22. Residue-drain cock
23. Water-filling valve, not directly connected to generator
24. Acetylene generators
25. Carbide-charging hopper
26. Residue-drain gutter
27. Wood lining of carbide-charging hopper pit

*Fig. 1. Typical acetylene-generator house. Walls, roof, and interior partitions of corrugated iron or asbestos on steel frame.*

2.2.2.3 Provide hydraulic flash arresters and hydraulic anti-backflow devices to protect major pieces of processing equipment.

### 2.2.3 Protection

2.2.3.1 Provide automatic sprinklers on water-spray protection for equipment, structures, and buildings in accordance with Data Sheet 7-14, *Fire Protection for Chemical Plants.*


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### 2.3 Carbide-Water Generators

#### 2.3.1 Construction and Location

2.3.1.1 A portable generator that has been permanently installed and piped to a fixed system so that it cannot be taken outdoors for recharging or repairs should be enclosed and vented to outdoors in the same manner as a stationary generator of equal capacity.

2.3.1.2 Locate stationary generators having an aggregate capacity of over 150 lb (68 kg) of carbide in a separate building at least 50 ft (15 m) from important buildings.

a) If the aggregate capacity of stationary generators is less than 150 lb (68 kg) carbide capacity, they may be located in a main building in a noncombustible room at an outside wall, cut off from the remainder of the building by a 2 in. thick (50 mm) plaster on metal lath.

b) If stationary generators cannot be installed in an outside detached building or in a cut-off room within a main building, they may be located in a noncombustible steelframe enclosure on a building roof if the roof is of fire-resistive construction.

c) Generators for portable service of more than 50 lb (23 kg) carbide capacity should not be used indoors.

2.3.1.3 Store portable generators in well-ventilated buildings of noncombustible occupancy and construction. Once placed in operation, they should never be moved unless they are filled with water and unless the carbide-feed mechanism is locked. They should not be used in confined spaces but only in well-ventilated buildings.

#### 2.3.2 Operation and Maintenance

2.3.2.1 Arrange stationary generators so that any leakage of water will be easily discovered.

Do not discharge residue (calcium hydroxide) from generators into sewer pipes, as it contains some dissolved acetylene and usually small quantities of unspent carbide. Provide a settling pit entirely outside the generator house (Fig. 1) for the residue from stationary generators so that any waste acetylene generated from unspent carbide or given up by the water will escape outdoors through the spaces in the plank cover. Residue from portable generators should be disposed of in an outdoor area free from ignition sources.

2.3.2.2 Place a competent operator in charge of all generators, and permit only competent personnel familiar with the hazards to enter the generator room. Operators of acetylene generators should adhere rigidly to the manufacturer's detailed instructions for operation and charging of the generators. Instructions should be conspicuously posted or otherwise kept convenient for ready reference by the operator.

2.3.2.3 Do not withdraw acetylene faster than the rating of the generator. Withdrawal at an excessive rate is likely to cause water carryover, soaking the gas filter and causing water to enter the discharge piping. This may cause operating difficulties, and in cold weather, dangerous freezeups. If two generators are manifolded together to supply a single system, the maximum system demand should not exceed their combined generating capacity. Care should be taken to see that the maximum capacity of one is not dangerously exceeded while the other is shut down for charging or maintenance.

2.3.2.4 Do not remove or render inoperative interference mechanisms. They are provided on most acetylene generators to prevent improper operation of valves or improper sequencing of recharging operations.

2.3.2.5 Portable generators should always be taken outdoors when they are opened for charging, repairs, or maintenance.

2.3.2.6 Generators should be thoroughly inspected and overhauled at least four times a year. Before making any repairs involving spark- or heat-producing operations, remove all carbide and completely purge the generator shell of acetylene by water displacement.

2.3.2.7 Open windows or otherwise provide adequate ventilation in the generator room while the generator is being recharged.

2.3.2.8 Before intermittent generators are refilled with carbide, they should be shut off from the connected equipment, the carbide-feed mechanism locked up, the water and residue drained, and the generator chamber completely flushed and refilled with water to the proper level.

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2.3.2.9 Always fill the generator and hydraulic flash arrester to the proper level with water before placing a carbide charge in the generator hopper. Use only safety tools, preferably a wooden stick, in placing the charge.

2.3.2.10 Generators containing any carbide should be kept filled with water to the proper level. Even when not in use and empty of carbide, it is safest to keep water chambers filled.

2.3.2.11 Before using a generator that has been out of service, examine it carefully for any defects. Consult the manufacturer regarding repairs.

2.3.2.12 Do not allow generators to become frozen. Maintain temperatures above 40°F (4°C) in the generator room. Carbide on ice reacts rapidly and the heat evolved may ignite acetylene in the generator. Salt or other substances should not be added to the water in the generator to prevent freezing. Most manufacturers furnish instructions for cold-weather care of their generators.

2.3.2.13 If small gasholders that are a part of the generating system are installed inside buildings, prevent water seals from blowing out by providing a vent to outdoors that will allow the escape of acetylene when the holder bell reaches its top position.

### 2.4 Calcium Carbide

Calcium carbide is a gray crystalline material of rocklike appearance, produced by the reaction of lime and coke in an electric furnace. It is shipped in special watertight 100 lb (45 kg) metal drums.

Calcium carbide is stable in dry air, but in the presence of moisture it reacts to form acetylene. When treated with water, it evolves acetylene in large quantities, 1 lb of carbide generating between 4 and 5 $ft^3$ (3.2 to 4 $kg/m^3$) of gas at atmospheric pressure. If gas thus liberated is ignited, the further application of water to the carbide does not extinguish the flame, but greatly increases it by generating more gas. Tests indicate that under sprinkler protection, unopened shipping containers of calcium carbide will not rupture in an exposure fire and that the water discharged from sprinklers and hose streams does not create a hazard.

#### 2.4.1 Construction and Location

2.4.1.1 Store carbide in the original unopened shipping containers in a dry, noncombustible room located out of reach of flood waters. Under these conditions, sprinklers will not be necessary.

2.4.1.2 Up to 600 lb (272 kg) of carbide may be stored in main building areas or inside generator rooms.

2.4.1.3 Up to 5,000 lb (2270 kg) of carbide may be stored in main buildings in a room at an exterior wall and cut off by a watertight noncombustible partition.

2.4.1.4 Storage of more than 5,000 lb (2270 kg) of carbide should be located in a noncombustible building 50 ft (15 m) or more from important buildings. Storage may be located in an outside acetylene-generator house if the storage room is cut off from the generator room. The partition separating these rooms should be noncombustible and reasonably watertight.

#### 2.4.2 Occupancy

2.4.2.1 Provide ventilation in carbide-storage rooms by installing roof ventilators and providing louvers at floor level.

2.4.2.2 Do not store oxygen cylinders or combustibles in the same area with carbide.

2.4.2.3 Open only one container at a time. After the required amount of carbide has been removed, promptly replace the top of the container.

#### 2.4.3 Ignition Source Control

2.4.3.1 Room heating should be by steam or hot-water system.

2.4.3.2 Lighting, wiring, and other electrical equipment should be Class I, Division 2.

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### 2.4.4 Protection

2.4.4.1 Water may be used to protect buildings against fire damage, but it should never be applied directly to calcium carbide. Where only a small quantity of water or moisture from the air is in contact with the carbide, a fire in it can be extinguished with carbon dioxide, but $CO_2$ will not stop acetylene generation. After such a fire is extinguished, ventilate the building and take precautions to avoid igniting residual acetylene. Move the reacting material outdoors.

## 2.5 Acetylene Piping Systems

Fixed acetylene piping systems supplied by generators or manifolded cylinders are superior to portable cylinders or portable generators from the standpoint of both fire hazard and operating efficiency. The systems are so arranged that the acetylene passes through one hydraulic arrester in addition to that at the generator, gasholder, or manifold, enroute to any torch (Fig. 2).

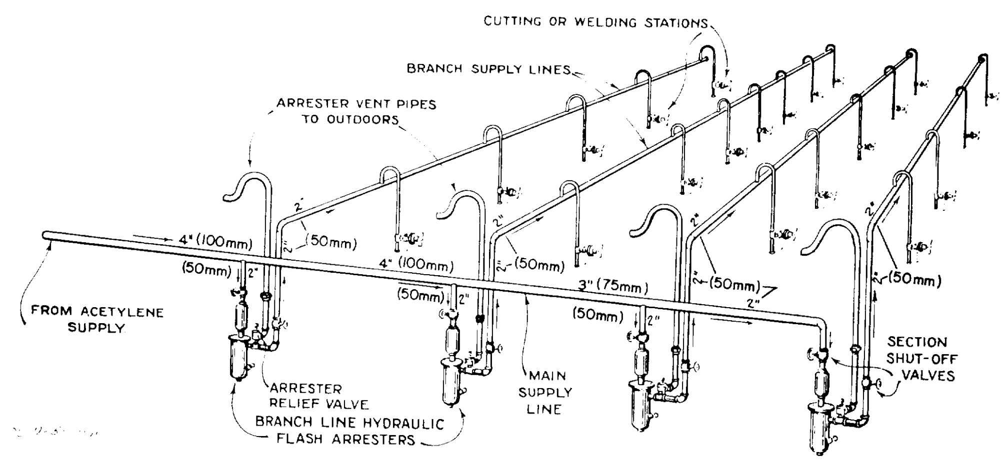


*Fig. 2. Medium-pressure acetylene distribution system with station regulators. Station regulators and check valves are installed at each torch connection. The system is divided into four sections, each supplied through a branch-line hydraulic flash arrester.*

In piping supplying cutting and welding operations, explosions from the decomposition of acetylene are rare. They usually result from ignition of oxy-acetylene or air-acetylene mixtures by lightning or by a flashback from a connected torch. If the tip of the torch becomes temporarily obstructed by molten metal or slag, oxygen at a higher pressure may back up through an unprotected station outlet into the acetylene piping.

Experience has shown that FM Approved hydraulic arresters (Fig. 3) are more dependable in preventing flashbacks than station pressure regulators plus check valves (Fig. 4).

### 2.5.1 Equipment and Processes

2.5.1.1 Acetylene piping pressures should not exceed 15 psig (1.0 b) (103 kPa) except where necessary for cylinder charging or special processes. For high pressure piping, see also safeguards for acetylene cylinder charging.

2.5.1.2 Locate permanent cutting and welding operations in noncombustible buildings at stations served by properly protected, designed, and installed distribution systems.

2.5.1.3 Use wrought-iron or steel pipe and steel or malleable-iron fittings. Welded joints are preferable because of the reduced probability of leakage. Alloys containing more than 67% copper should not be used for piping, valves, or fittings (with the exception of the torch tip, which is pure copper). Use lubricated plug cocks or globe valves with fiber or metal seats.

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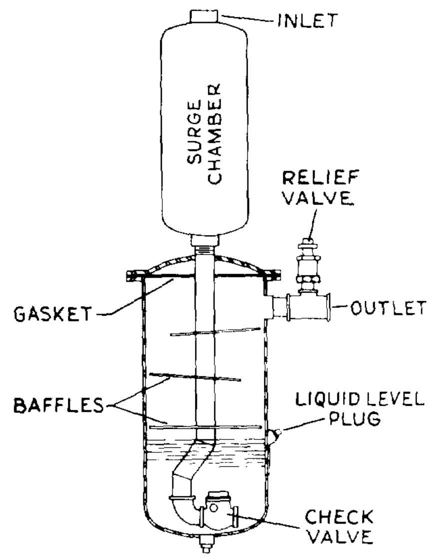


*Fig. 3. Branch-line medium-pressure hydraulic flame arrester. In normal operation acetylene enters the top of the surge chamber, flows through the inlet pipe of the baffle assembly and through the check valve. It then bubbles up through the water seal, flows through the baffle system and is discharged through the outlet piping. In event of flashback in the service line, the water seal and check valve will arrest the flame and the relief valve will operate to lower the system pressure to normal.*

2.5.1.4 Locate inside piping overhead and away from exposure to excessive heat or vibration. Protection from breakage by mechanical injury is very important, and may be obtained by locating the pipe adjacent to ceilings, walls, beams, or columns. Support indoor pipe rigidly, well above floor level, by suitable hangers. Arrange fastenings to allow for thermal expansion. Space hangers properly to prevent sags.

2.5.1.5 Outdoor piping, well supported and protected from mechanical damage, should preferably be installed above ground, especially where higher pressures are used. If necessary to prevent moisture condensate from freezing, bury outdoor piping below frost level. To prevent breakage, encase pipes leading to the surface of the ground or provide guards.

2.5.1.6 On supply mains larger than 2 in. (50 mm) diameter, make all connections perpendicular to the longitudinal axis and on the top of the main. Use crosses for any necessary turns in the mains. Provide rupture disks at all dead ends. Provide hydraulic flash arresters in connections between mains and process equipment.

2.5.1.7 Protect all overhead and buried piping against corrosion. The finish coat on overhead piping should have a distinguishing color.

2.5.1.8 If moisture is present, pitch overhead piping to drain to the generator, hydraulic flash arresters, or drip pots. Pitch underground piping in the direction of acetylene flow and to drain into drip pots.

2.5.1.9 Provide control valves so that any selection of the distribution system can be shut off readily in an emergency. They should be accessible, conspicuously labeled, and their location known to key employees.

2.5.1.10 Where meters are needed, use steel-case or orifice-type flowmeters. Install a hydraulic flash arrester to protect the meters against damage from flashback.

2.5.1.11 Before placing acetylene piping in service and before backfilling buried pipe, subject pipe to air or inert-gas pressure of at least 150% of maximum working pressure and check for loss in pressure. Leaks may be located by painting the joints with soapy water. After a satisfactory test, blow out the pipe to remove all dirt and scale. Then thoroughly purge the pipe by blowing out the air with inert gas through all station outlets. Similar leakage tests should be made periodically after the distribution system has been in service, as a matter of maintenance and safety.

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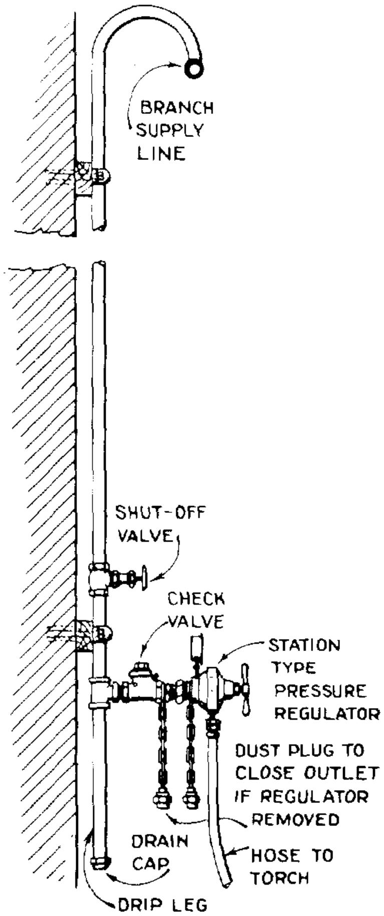


*Fig. 4. Station medium-pressure regulator and check valve. This arrangement will usually prevent a flashback from entering the acetylene-supply piping if carefully maintained and properly operated. Turning in the adjusting screw so far that the device cannot act as a regulator will nullify its effectiveness as a flash arrester. The connection is made from the top of the supply line in order to prevent appreciable amounts of moisture from reaching the station.*

2.5.1.12 On cutting and welding systems provide the following protection to prevent reverse flow of oxygen or the passage of a flashback:

a) **Low-pressure Systems.** The safest method, usually preferable from an operating standpoint, is to install an Approved low-pressure hydraulic flash arrester at each station outlet. However, several torches may be connected to a single FM Approved hydraulic arrester if the rated capacity of the arrester is not exceeded.

b) **Medium-pressure Systems.** Provide either a medium-pressure station hydraulic arrester or an acetylene-pressure regulator and check valve at each station outlet. If the regulator and check valve are used, the distribution system should be sectionalized, and each section protected by a branch-line hydraulic arrester located where the sections connect to piping over 2 in. (50 mm) in size.

2.5.1.13 The relief-vent pipes of all hydraulic arresters should lead to a safe location outdoors where they will not be exposed to ignition sources and where no burst of flames will be directed onto a building, combustibles, or personnel. Branch-line arresters should have individual relief-vent pipes, but vent pipes for station hydraulic arresters may be manifolded.

2.5.1.14 Check the liquid of all hydraulic arresters weekly, and add water if necessary. Protect hydraulic arresters from freezing either by locating in heated buildings or enclosures or by using an antifreeze solution.

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Ethylene glycol and water solution is suitable and will not cause deterioration of metals or rubber. It can be used the year round and usually requires less frequent replacement than water alone.

2.5.1.15 Check relief valves of medium-pressure hydraulic arresters periodically to ensure that the rubber-faced disk is not adhering to the metal seat.

2.5.1.16 Booster pumps are sometimes used to deliver acetylene from generators or gasholders to shop piping. Provide the following:

a) Use booster pumps that will not build up pressure in excess of 15 psi (1.0 b)(103 kPa), or provide a relief valve set at 15 psi (1.0 b) (103 kPa) piped back into the pump suction.

b) Use a pump that is water-cooled, and provide interlocks to shut down the pump if the cooling water supply fails.

c) If booster pumps are supplied from a gasholder, provide a hydraulic arrester on the pump discharge with the relief valve set to operate at 15 psi (1.0 b) (103 kPa).

d) If booster pumps are supplied from a gasholder, provide a limit switch to stop the pump when the gasholder bell is within 1 ft (300 mm) of its lowest position, to prevent the pump from drawing air through the seals of the holder. Mercury-tube switches should be used, and wiring should be in conduit.

### 2.6 Acetylene Cylinder Charging

Acetylene is dissolved in acetone at about 250 psi (17 b) (1.7 MPa) in cylinders with a porous filler. Under these conditions the acetylene is stable.

However, in order to charge the cylinders, the acetylene must be compressed by standard-type compressors, cooled, dried, and piped to the charging area. Under high pressure, before it is dissolved in acetone, the acetylene is highly unstable. Special precautions must be taken to minimize the possibility of acetylene decomposition and the resulting damage potential.

#### 2.6.1 Construction and Location

2.6.1.1 For high pressure acetylene piping, provide the following safeguards in addition to those outlined above:

a) Copper alloys containing more than 50% copper should not be used.

b) Pipe of size ¾ in. (18 mm) or less should be at least Schedule 80.

c) Pipe of sizes 1 to 1-½ in. (25-37 mm) should be at least Schedule 160.

d) All pipe and fittings should have a minimum working pressure of 3000 psig (210 b)(21 MPa). Cylinder charging leads should have a minimum burst rating of 10,000 psig (690 b) (69 MPa) and should be of materials suitable for acetylene service.

2.6.1.2 Charged cylinders should be stored outside the charging room, in accordance with Data Sheet 7-50, *Compressed Gases in Portable Cylinders and Bulk Storage*. If storage inside the charging room is necessary, it should be as far as practicable from the charging manifolds.

#### 2.6.2 Equipment and Processes

2.6.2.1 For acetylene compressors, see the applicable safeguards in Data Sheet 7-95, *Compressors.*

2.6.2.2 At each cylinder charging manifold, provide a shutoff valve, one or more check valves, a pressure gauge located downstream from the shutoff valve, and a blow-down valve vented outdoors or to the low pressure system.

2.6.2.3 Arrange acetone storage in accordance with FM recommended practice for ignitable liquid storage (see Data Sheet 7-29, *Ignitable Liquid Storage in Portable Containers).*

#### 2.6.3 Protection

2.6.3.1 Provide automatic sprinkler or water spray protection in acetylene cylinder areas. Provide water supplies in accordance with Data Sheet 7-32, *Ignitable Liquid Operations,* Table 2 for ignitable liquids that have an associated room/equipment explosion hazard.

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## 3.0 SUPPORT FOR RECOMMENDATIONS

### 3.1 Acetylene

Acetylene is a colorless gas with a distinctive garlic-like odor. It is flammable with a normal explosive range with air of 2.3 to 80% acetylene. However, pure acetylene tends to decompose into carbon and hydrogen, liberating its energy of formation (3800 Btu/lb) (8.8 MJ/kg) when subject to shock or other ignition source. Therefore, the explosive range is considered to extend up to 100% acetylene.

Because of its tendency to break down, releasing energy, acetylene is highly reactive and is widely used in chemical processes. The temperature of the oxyacetylene flame, 5400 to 6300°F (3000 to 3500°C), is the highest for any commercially practical mixture of gases. Acetylene is, therefore, widely used for cutting and welding operations.

The minimum autoignition temperature for acetylene-air mixtures, using clean surfaces, is about 571°F (300°C). The presence of catalytic impurities such as rusts, scale, silica gel, charcoal, or potassium hydroxide can lower the ignition temperature substantially. The presence of copper, silver, or mercury acetylides combined with light shock can result in ignition or decomposition of acetylene at room temperatures. Acetylides can form by reactions of acetylene with copper, silver, or mercury metals or their rich alloys, especially in the presence of moisture and impurities.

At pressures below 15 psig (1.0 b) (103 kPa), the ignition (decomposition) temperature of 100% acetylene ranges from 1000 to 1190°F (540 to 640°C), depending upon pressure, temperature, and moisture content. At pressures above 15 psig (1.0 b) (103 kPa), the tendency for decomposition increases so substantially that pure acetylene is practically never used at these pressures. Acetylene may be dissolved in acetone or diluted with butane, propane, or natural gas in accordance with Table 1 to prevent explosive decomposition at higher pressures.

*Table 1. Stable Acetylene Mixtures*

| *Initial Pressure* | | | *Hydrocarbon Percent by Volume* | | |
|---|---|---|---|---|---|
| *psig* | *(kPa)* | *(bars)* | *Butane* | *Propane* | *Natural Gas* |
| 15 | (103) | (1.0) | 8.4 | 9.2 | 13.8 |
| 25 | (172) | (1.7) | 11.0 | 13.0 | 21.0 |
| 50 | (344) | (3.4) | 17.0 | 20.0 | 31.0 |
| 75 | (517) | (5.2) | 19.0 | 24.0 | 36.0 |
| 100 | (690) | (6.9) | 21.0 | 26.0 | 39.0 |

### 3.2 Hydrocarbon Reforming

Much of the acetylene used in the chemical-process industries is made from reforming hydrocarbons such as methane (natural gas), propane, and naphtha. The three most important processes are:

1. *Thermal Cracking*. Methane, ethane, or propane is heated to approximately 2500°F (1370°C) at low pressure, generally by flowing over regeneratively heated ceramic surfaces.

2. *Partial Oxidation*. Hydrocarbons and oxygen are preheated from 930 to 1200°F (500 to 650°C) and then mixed. The reaction temperature is approximately 2800°F (1540°C) and pressures of up to five atmospheres are used.

3. *Electric Arc*. Hydrocarbon gases or vapors at low pressure are passed through an electric arc. Although very high temperatures are attained in the arc, most of the conversion to acetylene takes place in the 2700 to 2800°F (1480 to 1540°C) zone.

The temperatures in all processes are so high that the hydrocarbons would completely dissociate to hydrogen and carbon if allowed to remain at the reaction temperatures. Therefore, in all processes, the reaction products must be cooled below 1000°F (540°C) within 1/1000 sec by quenching with water or liquid hydrocarbons. The reaction products contain 5 to 20% acetylene by volume, considerable quantities of ethylene and methane, large quantities of hydrogen, small amounts of various higher hydrocarbons, and carbon black. Partial oxidation processes also produce carbon monoxide, carbon dioxide, and water.

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Temperatures can vary several hundred degrees and pressure can vary from high vacuum to 300 psi (20 b) (2 MPa) in various stages of the process equipment. Materials are often recycled in various parts of the processes.

### 3.3 Carbide-Water Generators

The action of water on calcium carbide ($CaC_2$) produces acetylene ($C_2H_2$) and unslaked lime (CaO), which is immediately slaked by the water to form calcium hydroxide [$Ca(OH)_2$] with evolution of 900 Btu/lb (2.1 MJ/kg) of carbide.

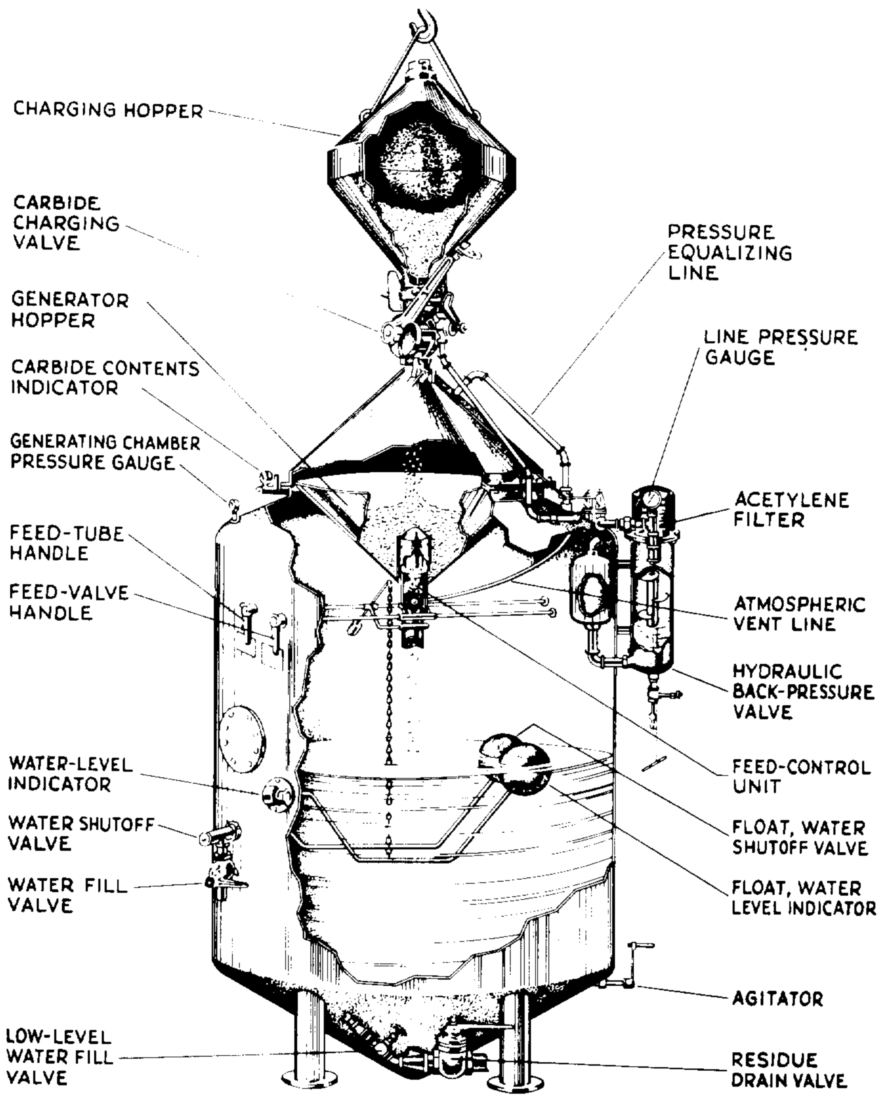


*Fig. 5. Stationary medium-pressure acetylene generator, carbide to water. Charging hopper is attached only during recharging.*

Acetylene generators are of three main types, depending upon the method of bringing the carbide and water into contact:

1. ***Carbide to Water.*** Carbide in small fragments is gradually added to a large quantity of water (Fig. 5).

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2. ***Water Recession.*** Water is brought in contact with carbide by a change of water level, the water being held back by the gas pressure.

3. ***Water to Carbide.*** A limited amount of water is allowed to come in contact with the main mass of carbide.

The carbide-to-water generator is most commonly used and is considered the safest because it dissipates the heat more effectively. Small generators for portable welding equipment are sometimes of the water-recession type.

Because of their small size and the limited amount of carbide charge, which is compressed into cakes with other ingredients to slow down the generating rate, water-recession generators are reasonably safe.

Portable generators may be used both indoors and out of doors (Fig. 6).

Generators may be either non-automatic or automatic. In non-automatic equipment, gas is generated continuously at a rapid rate for a short time in sufficient quantities to last for a day or more and is stored in a gasholder or gasometer. In automatic generators, the production of acetylene is governed by its rate of consumption.

One make of generator (Fig. 7) has two identical carbide-charging hoppers on the generator tank. When one hopper is exhausted, the other automatically goes into service, permitting uninterrupted production of gas.

Control equipment available for another make of acetylene generator equalizes the delivery rate from two or more generators, keeping the acetylene supply at a constant pressure. The generators may be arranged to operate on a predetermined schedule so that they will run out of carbide one at a time or in alternate groups.

Low-pressure generators deliver acetylene at pressures from 6 to 20 in. of water (15 to 50 mb) (1.5 to 5 kPa), while medium-pressure generators produce at pressures up to 15 psi (1.0 b) (103 kPa). Because of the extreme hazard of acetylene above 15 psi (1.0 b) (103 kPa), generators operating above this pressure are usually prohibited by state or local laws or ordinances and should not be used.

### 3.4 Hazards

Explosions in acetylene-production equipment can occur from excess pressure, excess temperature, off-ratio flow, ignition of acetylene-air or acetylene-oxygen mixtures, or decomposition of acetylene. Leakage from equipment and piping can result in gas-air room explosions. Ignition sources may be glowing carbide, flashbacks, mechanical sparks, electrical sparks, or open flames.

The hydrocarbon-reforming processes have the hazard of large quantities of flammable gases and ignitable liquids in addition to the specific hazards of acetylene. Acetylene-decomposition explosions are unlikely in hydrocarbon-reforming reactors because of low acetylene concentration. However, where concentration becomes high in purification equipment, decomposition is a possibility. Excessive oxygen in the partial oxidation process or air within reactors or processing equipment can result in combustion explosions. Overpressure and overtemperature can result in mechanical failure of pressure vessels. Malfunction in the quenching stage can create serious upset conditions in downstream equipment.

In generators, glowing carbide can result from the presence of excessive fines in the carbide charge, forming floating clumps on the water in the generator chamber. It can also result if carbide fines are allowed to accumulate in the hopper or on the feeding mechanism where they may react with water vapor in the upper part of the chamber. Introduction of carbide into a damp generator that the operator has failed to refill with water after draining may also produce glowing particles.

Flashbacks to the generator can occur if the proper water level is not maintained in the hydraulic arrester at the generator.

During charging and recharging of the generator with water and carbide, mixtures of air and acetylene within the generator should be prevented by purging in accordance with the manufacturer’s operating instructions.

Excessive acetylene generation can result from failure of the feed mechanism to shut off the flow of carbide, or from the water level in the generator rising to enter the carbide hopper. Normally, the relief valves on generators are sized to prevent excessive pressures should the entire carbide charge be dumped into the generator, but overpressure can result if the relief valve line is obstructed or the relief valve sticks.

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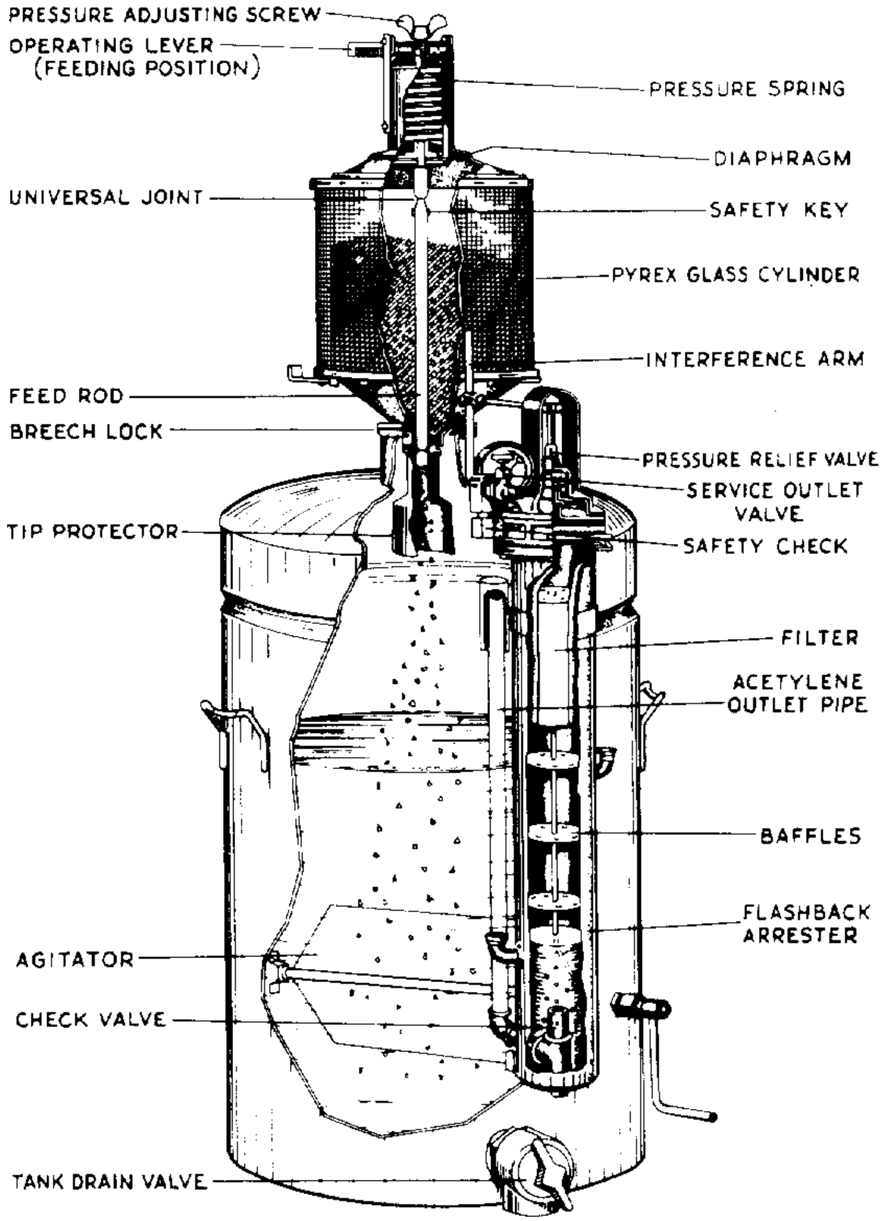


*Fig. 6. Portable medium-pressure acetylene generator. Withdrawal of acetylene decreases the pressure under a flexible diaphragm which causes the feed rod to drop and permit carbide to fall into the water.*

Most generators are equipped with 1) safety relief valves to prevent building up excessive internal pressures that would render the acetylene unstable, 2) hydraulic flash arresters to prevent a flashback or reverse flow into the generator, 3) interference mechanisms to prevent improper manipulation of valves or improper sequence of operations when recharging, 4) feed-control mechanisms sufficiently sensitive to permit only a slight pressure rise when the maximum acetylene flow is suddenly shut off, and 5) controls to prevent too high or too low water levels during generator operation.

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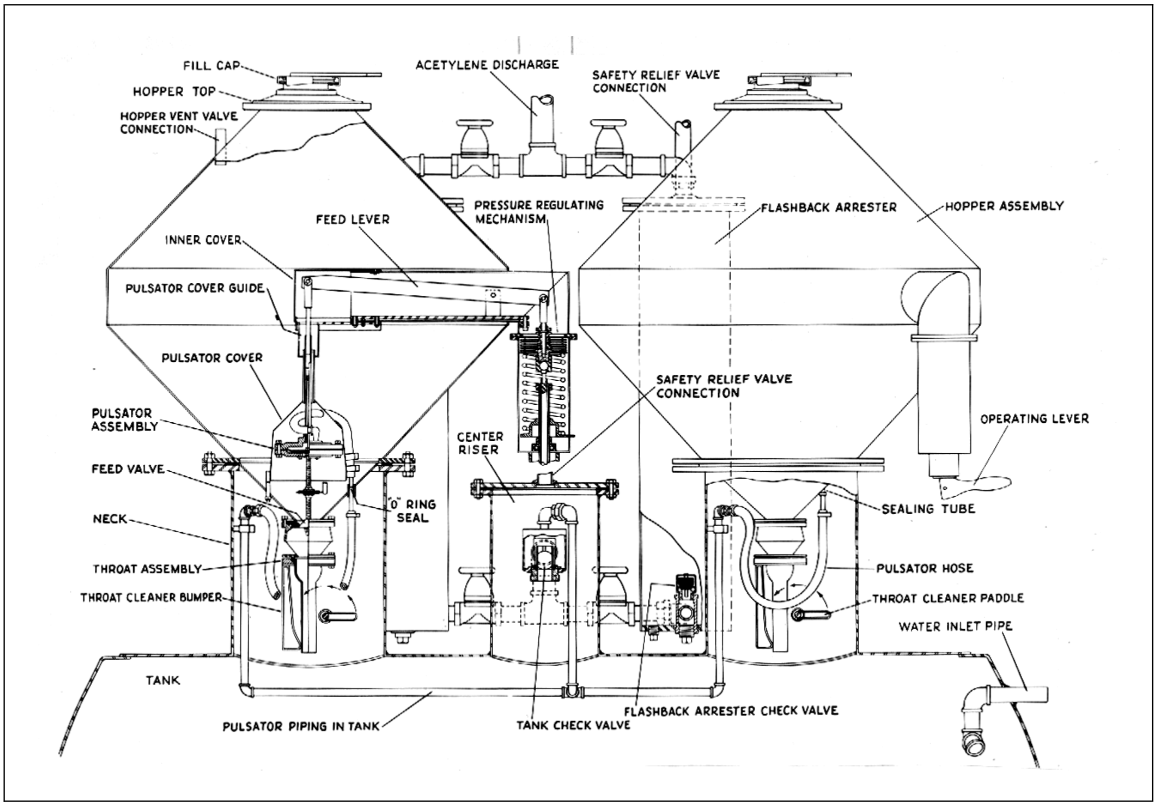


*Fig. 7. Stationary acetylene generator equipped with twin charging hoppers, permitting uninterrupted flow of gas.*

### 3.5 NFPA

Related NFPA standards are: No. 51, *Oxygen-Fuel Gas Systems, for Cutting and Welding*, and No. 51A, *Acetylene Cylinder Charging Plants*. There are no known conflicts with these standards.

## 4.0 REFERENCES

### 4.1 FM

Data Sheet 7-14, *Fire Protection for Chemical Plants.*

Data Sheet 7-29, *Ignitable Liquid Storage in Portable Containers*.

Data Sheet 7-32, *Ignitable Liquid Operations*.

Data Sheet 7-45, *Instrumentation and Control in Safety Applications*.

Data Sheet 7-46/17-11, *Chemical Reactors and Reactions*.

Data Sheet 7-50, *Compressed Gases in Portable Cylinders and Bulk Storage*.

Data Sheet 7-95, *Compressors*.

### 4.2 NFPA Standards

NFPA 51, *Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting and Allied Processes*, 1997.

NFPA 51A, *Acetylene Cylinder Charging Plants,* 1996.

### 4.3 Others

*National Electrical Code,* Article 501.

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## APPENDIX A GLOSSARY OF TERMS

*FM Approved:* References to ″FM Approved″ in this data sheet mean a product or service has satisfied the criteria for FM Approval. Refer to the Approval Guide, an online resource of FM Approvals, for a complete listing of products and services that are FM Approved.

*Ignitable Liquid:* Any liquid or liquid mixture that is capable of fueling a fire, including flammable liquids, combustible liquids, inflammable liquids, or any other reference to a liquid that will burn. An ignitable liquid must have a fire point.

## APPENDIX B DOCUMENT REVISION HISTORY

January 2012. Terminology related to ignitable liquids has been revised to provide increased clarity and consistency with regard to FM Global's loss prevention recommendations for ignitable liquid hazards.

May 2000. This revision of the document has been reorganized to provide a consistent format.

September 1998. Reformatted.

February 1975. Technical Revision.

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