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Gases

Standard for the

Installation and Operation of Gas Systems for WELDING AND CUTTING

MAY

1957

*Fifty Cents**

NATIONAL FIRE PROTECTION ASSOCIATION
International

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National Fire Protection Association

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Executive Office, 60 Batterymarch St., Boston 10, Mass.

The National Fire Protection Association was organized in 1896 to promote the science and improve the methods of fire protection and prevention, to obtain and circulate information on these subjects and to secure the cooperation of its members in establishing proper safeguards against loss of life and property by fire. Its membership includes two hundred national and regional societies and associations (list on outside back cover) and seventeen thousand individuals, corporations, and organizations. Anyone interested may become a member; membership information is available on request.

This pamphlet is one of a large number of publications on fire safety issued by the Association including periodicals, books, posters and other publications; a complete list is available without charge on request. All NFPA standards adopted by the Association are published in six volumes of the **National Fire Codes** which are re-issued annually and which are available on an annual subscription basis. The standards, prepared by the technical committees of the National Fire Protection Association and adopted in the annual meetings of the Association, are intended to prescribe reasonable measures for minimizing losses of life and property by fire. All interests concerned have opportunity through the Association to participate in the development of the standards and to secure impartial consideration of matters affecting them.

NFPA standards are purely advisory as far as the Association is concerned, but are widely used by law enforcing authorities in addition to their general use as guides to fire safety.

Definitions

The official NFPA definitions of shall, should and approved are:

SHALL is intended to indicate requirements.

SHOULD is intended to indicate recommendations, or that which is advised but not required.

APPROVED refers to approval by the authority having jurisdiction.

Units of measurements used here are U. S. standard. 1 U. S. gallon = 0.83 Imperial gallons = 3.785 liters.

In Canada, BTC (formerly CRC) cylinders are the same as ICC cylinders in U. S.

Approved Equipment

The National Fire Protection Association does not "approve" individual items of fire protection equipment, materials or services. The standards are prepared, as far as practicable, in terms of required performance, avoiding specifications of materials, devices or methods so phrased as to preclude obtaining the desired results by other means. The suitability of devices and materials for installation under these standards is indicated by the listings of nationally recognized testing laboratories, whose findings are customarily used as a guide to approval by agencies applying these standards. Underwriters' Laboratories, Inc., Underwriters' Laboratories of Canada, Factory Mutual Laboratories and American Gas Association Laboratories test devices and materials for use in accordance with the appropriate standards and publish lists which are available on request.

Welding and Cutting

NFPA No. 51—1957

This edition of the Standard supersedes the 1956 Edition and all previous editions. It incorporates the changes recommended by the Sectional Committee on Industrial Gases and approved by the NFPA Committee on Gases and adopted at the Annual Meeting of the National Fire Protection Association in Los Angeles, Cal., May 22, 1957.

Standards concerning the construction, installation and use of Acetylene Gas Machines and for the Storage of Calcium Carbide date from 1900. Revised editions were published in 1903, 1910, 1919, 1920 and 1924 (NFPA No. 50). In 1925, requirements for acetylene used in cutting and welding operations were placed in separate standards (NFPA No. 51).

The present standards, prepared by the Committee on Gases, were adopted by the NFPA in 1925, and revised in 1927, 1936, 1942, 1944, 1946, 1951, 1953, 1954 and 1956. The current revision was drafted by the Sectional Committee on Industrial Gases.

Previous editions of this standard have been adopted and published by the National Board of Fire Underwriters as their Pamphlet No. 51.

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Changes from 1956 Edition,

Paragraph 8(c). Reference to the venting of lighting enclosures was deleted because of impracticability.

Paragraphs 27, 30 and 32 were revised to more clearly define the limitations for the storage of calcium carbide.

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Standard for the Installation and Operation of Gas Systems for WELDING AND CUTTING

APPLICATION OF RULES

The following standards are intended to apply to the installation and operation of all gas welding and cutting systems, and cover all gases when used with oxygen for welding, cutting, heating and heat treating operations. Where only a portion of a fuel gas system is to be used with oxygen for welding, flame cutting, heating and heat treating operations, only that portion of the system need comply with these standards and that portion shall be separated from the main system by means of a suitable hydraulic back-pressure valve. These standards also provide for the storage of calcium carbide and gases used in these processes.

Where liquefied petroleum gas is not to be used with oxygen, these standards do not apply. See NFPA Standards for the Storage and Handling of Liquefied Petroleum Gases (NFPA No. 58).*

These standards do not apply to systems in or upon cars or other rolling stock or upon vessels, to use in wrecking or for emergency, nor to plants devoted to the manufacture and compression of gases into cylinders.

In the application of these standards only approved equipment such as blowpipes, torches, regulators, acetylene generators, etc., as have been examined and tested and found to be safeguarded as far as practicable, shall be used.

The words "torch" and "blowpipe" are synonymous. They are used interchangeably in this pamphlet.

CONSTRUCTION AND MARKINGS ON CYLINDERS AND OTHER CONTAINERS. All cylinders used for the shipment of compressed gases shall be constructed in accordance with Interstate Commerce Commission specifications effective at the date of their manufacture, and charged with gas and maintained in accordance with Interstate Commerce Commission requirements.†

For the primary identification of cylinder or manifold gas supply unit content, each cylinder or unit shall be legibly

*See Appendix A for availability.

†In Canada the specifications and regulations of the Board of Transport Commissioners for Canada apply.

marked with the name of the gas contained in accordance with American Standard Method of Marking Portable Compressed Gas Containers to Identify the Material Contained. (ASA Z48.1 - 1954.)*

For the identification of cylinder or manifolded gas supply unit content, each cylinder or unit shall be stenciled, stamped or labeled with the chemical or trade name of the gas contained therein, such as, "This cylinder or unit contains ....." These markings shall not be cut into the metal of the cylinder.

Containers other than I.C.C. cylinders for the storage of liquefied petroleum gases shall be constructed, installed and charged with gas in accordance with NFPA Standards for Storage and Handling Liquefied Petroleum Gases (NFPA No. 58).

ACETYLENE GENERATORS, GENERAL

1. Approved and Marked Generators to Be Used.

Generators shall be of approved construction and shall be plainly marked with the rate in cubic feet of acetylene per hour for which they are designed, the amount or weight and size of carbide necessary for a single charge, the manufacturer's name and address, and the name or number of the type of generator.

Acetylene generators shall be used only for the generation of acetylene from calcium carbide unless specifically approved for other use.

2. Rating of Generators.

The total hourly output of a generator shall not exceed the rate for which it is approved and marked. Unless specifically approved for higher ratings, carbide-feed generators should be rated at one cubic foot per hour per pound of carbide required for a single complete charge.

NOTE:—Single automatic generators used as the sole acetylene supply should be of sufficient capacity to furnish a continuous supply of gas for at least one working period. Where more than one automatic generator or duplex machine is installed, permitting alternate use and recharging without affecting the continuity of the gas supply, the capacity of the generator or generators in service should be sufficient to supply within the marked hourly ratings, the total demand for gas.

*See Appendix A for availability.

AUTOMATIC STATIONARY ACETYLENE GENERATORS.

3. Location of Generators.

While generators, especially in closely built-up districts, should preferably be placed outside of buildings in generator houses constructed and located in compliance with Section 4, the installation of approved generators within buildings in accordance with these rules is permitted. Attention is drawn, however, to the prohibition of acetylene generators within buildings in certain districts by local authorities having jurisdiction.

4. Outside Generator Houses.

(a) No opening in any outside generator house shall be located within 5 feet of any opening in another building.

(b) Walls and roof of generator house shall be of noncombustible material.

(c) Where a part of the house is to be used for the storage or manifolding of oxygen cylinders, the space to be so occupied shall be separated from the generator or carbide storage section by partition walls continuous from floor to roof or ceiling, of one of the types of construction listed in 5(b).

Such separation walls shall be without openings and be joined to the floor, other walls and ceiling or roof in a manner to effect a permanent, gas-tight joint.

(d) Exit doors shall be located so as to be readily accessible in case of emergency.

(e) A portion of the exterior walls equal to not less than 10 per cent of the combined areas of the enclosing walls shall be of light noncombustible material, preferably single thickness, single strength glass. Single strength window glass skylights or lightly fastened roof hatch covers, swinging doors fixed to open outward, sheet metal siding or lightly fastened roofs may be accepted in part in lieu of the glass area, provided the required percentage of explosion venting area is thus obtained.

5. Inside Generator Rooms or Compartments.*

(a) The installation of acetylene generators within buildings shall be restricted to buildings not exceeding one story

*Where the word "buildings" is used in this Section it means a building having occupancy other than that directly associated with the production of acetylene, the storage of calcium carbide or the storage and manifolding of gases used in welding and cutting.

in height; provided, however, that this shall not be construed as prohibiting such installations on the roof or top floor of a building exceeding such height.

(b) Where generators are installed inside buildings, they shall be enclosed in a separate room or compartment of ample size. The walls or partitions, floor and ceiling of such room or compartment shall be one of the types of construction listed below or other construction equivalent in strength and fire resistance. Walls or partitions shall be continuous from floor to ceiling and shall be securely anchored. At least one wall of an inside generator room shall be an exterior wall.

Gypsum or cement plaster at least ¾ of an inch thick on metal lath on each side of a stud partition.

Expanded metal lath encased in solid cement plaster not less than 2½ inches thick.

Reinforced concrete.

Brick.

Tile, gypsum or concrete block (cement plaster on each side to a thickness of ¼ inch).

(c) Openings from generator room or compartment to other parts of the building shall be protected by a fire door classified and labeled as suitable for use in Class B situations as defined in NFPA Standards for the Protection of Openings in Walls and Partitions Against Fire (NFPA No. 80).* The door shall be of the swinging type and close into a rabbet, or otherwise be made tight to prevent passage of flame around edges; it shall be self-closing. Exit doors shall be located so as to be readily accessible in case of emergency. Windows, if provided in partitions, shall be wired glass in approved metal frames with fixed sash.

(d) A portion of the exterior walls equal to not less than 10 per cent of the combined areas of the enclosing walls shall be of light noncombustible material, preferably single thickness, single strength glass. Single thickness, single strength window glass skylights, or lightly fastened roof hatch covers, swinging doors in exterior wall opening outward, sheet metal siding or lightly fastened roofs, may be accepted in part or entirely in lieu of the glass area or its equivalent, provided the required percentage of explosion venting area is thus obtained.

*See Appendix A for availability.

6. **Installation.**

The foundation shall be so arranged that the generator will be level and so that no excessive strain will be placed on the generator or its connections.

7. **Space About Generator.**

The space around the generator shall be ample for free and unobstructed operation and maintenance and permit ready adjustment and charging.

8. **Ventilation, Lighting and Heating of Generator Houses or Rooms and the Use of Electrical Equipment Therein.**

(a) Generator houses or rooms shall be well ventilated, employing vents at floor and ceiling level.

(b) The heating shall be by steam, hot water, or other indirect heating system; the furnace or other heat producing means shall be so located that no flame, fire or electrically heated element is in the generator house, room, or any enclosure communicating with it.

(c) Generator houses or rooms shall have natural light during daylight hours. Where artificial lighting inside the room is necessary, it shall be restricted to electric lamps installed in a fixed position. Unless specifically approved for use in atmosphere containing acetylene, such lamps shall be provided with enclosures of glass or other approved noncombustible material, so designed and constructed as to prevent gas vapors from reaching the lamp or socket and to resist breakage. The wiring method used shall be rigid conduit with threaded connections and conduit shall be internally sealed off in an approved manner wherever it enters the generator room.

NOTE:—Lamps installed outside of wired glass panels set in gas-tight frames in the walls or ceilings of the generator house or room, are acceptable.

Electrical switches, telephones, motors, and all other electrical apparatus, unless specifically approved for use in atmospheres containing acetylene, shall be located outside of generator houses or rooms, or in a room separated from the generator room by a gas-tight partition and provided with adequate ventilation, except that where the generator system is designed so that no carbide fill opening or other part of the generator is open to the generator house or room during the operation of the generator, and so that residue is carried in closed piping

from the residue discharge valve to a point outside the generator house or room, electrical equipment in the generator house or room shall conform to the provisions of the National Electrical Code, Article 500, for Class I, Division 2 locations.

9. Protection Against Freezing.

Generators shall be placed where water will not freeze. No common salt (sodium chloride) or other corrosive chemical is permissible as a protection against freezing.

10. Water Supply Connection.

Water shall not be supplied through a continuous connection to the generator except when generators are provided with an adequate overflow or automatic water shut-off to effectively prevent overfilling of generator. The supply pipe shall terminate not less than 2 inches above the regularly provided opening for filling so that the water can be observed as it enters the generator.

11. Drain Connection.

Unless otherwise specifically approved, generators shall not be fitted with continuous drain connections leading to sewers, but shall discharge through an open connection into a suitably vented outdoor residue settling pit which may have clear water connection to sewer.

NOTE:—An open connection for the sludge draw-off at the generator is desirable to enable operator to observe leakage of generating water from the sludge cock or drain valve.

12. Generator Escape or Relief Pipes.

(a) Each generator shall be provided with an escape or relief pipe of standard full-weight galvanized iron or steel except that outside of buildings vent pipes larger than 4 in. in diameter may be of galvanized tubing or sheet steel not less than 14 gauge.

(b) The escape or relief pipe shall be substantially installed without traps and so that any condensation will drain back to the generator.

(c) The escape or relief pipe shall be carried full size to a suitable point outside the building and shall terminate in an approved hood or bend located at least twelve feet above the ground, and as far as practicable from windows or other openings into buildings, and as far as practicable from sources of

ignition such as flues or chimneys, and tracks used by locomotives. Generating chamber relief pipes shall not be interconnected but shall be led separately to the outside air. The hood or bend shall be so constructed that it will not be obstructed by rain, snow, ice, insects or birds; outlet shall be at least 3 feet from combustible construction.

13. **Maintenance and Operation.**

(a) Generator rooms shall not be open to unauthorized persons.

(b) When recharging generators the order of operations specified in the instructions supplied by the manufacturer shall be strictly followed. The instructions shall be mounted in a conspicuous place near generator or otherwise kept convenient for ready reference.

Charging at other than daylight hours is allowable where generator room is lighted as specified in rule 8(c).

(c) When generators are not in use, the water chamber shall be kept full to proper level if any carbide remains in the hopper.

(d) Whenever repairs are to be made or the generator is to be charged or carbide is to be removed, the water chamber shall be full during such operations to avoid the danger of explosive mixtures of air and gas within the water space and also to prevent dropping fresh carbide into insufficient water.

Hot repairs shall not be made in a room where other generators are installed. They should preferably be made out of doors. Portable lights shall not be used.

Previous to making repairs involving welding, soldering or any hot work or operation liable to produce a spark, the carbide charge, and feed mechanism, to avoid wetting, shall be completely removed, and all acetylene expelled by completely flooding the generator shell with water, and the generator disconnected from the piping system. Keep the generator filled with water, as far as work permits, positioning it so as to hold as much water as possible.

(e) Relief valves shall be regularly operated to insure proper functioning. Relief valves for generating chambers shall be set to open at a pressure not in excess of 15 pounds per square inch. Relief valves for hydraulic back-pressure valves shall be set to open at a pressure not in excess of 20 pounds per square inch.

(f) The water-carbide residue mixture drained from generators shall never be discharged into sewer pipes, or deposited or stored in areas near open flames or combustible material. Clear water from residue settling pits may be discharged into sewer pipes.

(g) The carbide added each time the generator is recharged should be sufficient to refill the space provided for carbide without ramming the charge.

No steel or other ferrous tool shall be used in distributing the charge.

NON-AUTOMATIC STATIONARY ACETYLENE GENERATORS.

In addition to the foregoing rules which apply, non-automatic generators shall comply with the following requirements:

14. Non-automatic generators shall not be used for generating acetylene at pressures exceeding one pound per square inch, and all water overflows shall be visible.

15. Gas Holder.

(a) The gas holder shall be constructed in a standard manner on the gasometer principle, the bell being suitably guided. The gas bell shall move freely without tendency to bind and shall have a clearance of at least two inches from the shell.

(b) The gas holder may be located in the generator room or in a connecting room complying with the rules for generator rooms. In order to prevent collapse of the gas bell due to vacuum caused by compressor or booster pump, a compressor or booster cut-off shall be provided at a point 12 inches or more above landing point of bell.

(c) When not located within a heated building, gas holder seals shall be protected against freezing.

(d) The arrangement shall be such that generator feeding mechanism will be stopped before gas holder reaches the upper limit of its travel, which would permit escape of gas from the gas holder.

(e) When connected to only one generator, the gas capacity of the gas holder shall be not less than one-third of the hourly rating of the generator.

(f) Where acetylene is used in the shop directly from the gas holder, without increase in pressure at some points, and with increase in pressure by a compressor or booster pump for other points, separate hydraulic back-pressure valves shall be used in the supply lines. The main low pressure hydraulic back-pressure valve shall be between the gas holder and the shop line and the medium pressure hydraulic back-pressure valve shall be between the compressor or booster pump and the shop line.

16. Compressor or Booster Equipment.

(a) Compressor or booster equipment shall be of an approved type.

(b) Electric motor for driving compressor or booster pump shall be located outside the room in which the compressor or booster is located, and the drive shaft shall pass through a gas-tight stuffing box, or equivalent. Belt drive shall not be used inside compressor room.

(c) The compressor or booster pump shall be provided with a suitable device which will relieve pressure exceeding 15 pounds per square inch to the open air or by returning the gas to the inlet side or to the gas supply source.

(d) The booster pump discharge outlet shall be protected by an hydraulic back-pressure valve.

PORTABLE ACETYLENE GENERATORS.

17. General.

(a) The apparatus shall be of a type specifically approved for portable use.

(b) Generators shall not be used within 10 feet of combustible material other than the floor.

(c) Generators shall not be used in rooms of total volume less than 35 times the total gas generating capacity per charge* of all generators in the room. Generators shall not be used in rooms having a ceiling height less than ten feet.

(d) Generators shall be protected against freezing of water in generator and in its appurtenances. No common salt (sodium chloride) or other corrosive chemical is permissible as a protection against freezing.

18. Operation and Maintenance.

(a) Generators shall be removed to outside the building for cleaning, charging and purging. Special exceptions may be granted by the authority having jurisdiction, in large-area, well-ventilated one-story buildings.

(b) Generators shall not when charged be moved by crane or derrick.

(c) When not in use generators shall not be stored in any room in which open lights or fires are used unless free of carbide and thoroughly purged of gas. Storage rooms shall be thoroughly ventilated.

(d) When portable acetylene generators are to be transported and operated on vehicles, they shall be securely anchored in place.

*To obtain the gas generating capacity in cubic feet per charge, multiply the pounds of carbide per charge by 4.5.

SERVICE PIPING SYSTEMS FOR ALL GASES.

19. Materials.

(a) **Oxygen Piping.** Steel, wrought iron, brass, or copper shall be used. For pressures of 150* lbs. per square inch or less, standard weight pipe and fittings or approved, seamless nonferrous gas tubing with approved fittings may be used. For pressures in excess of 150 lbs. per square inch, piping shall have wall thickness and fittings in accordance with the requirements of Section 2 (Gas and Air Piping) of the American Standard Code for Pressure Piping (ASA B31.1—1955),† except that such pipe and fittings shall be extra heavy as a minimum. For pressures in excess of 700 lbs. per square inch, nonferrous pipe and fittings are recommended.

All fittings and lengths of pipe for service lines shall be examined internally before assembly and, if necessary, hammered to free them from scale or dirt. They shall be washed out with a suitable nonflammable solution which will effectively remove grease and dirt. Hot water solutions of caustic soda and tri-sodium phosphate have been found effective cleaning agents for this purpose.

(b) **Acetylene Piping.** For acetylene, steel or wrought iron pipe only shall be used.

(c) **General.** Except as provided in 19(a) and 19(b) piping shall be of wrought iron, steel, brass or copper pipe, or approved seamless copper, brass or other approved non-ferrous gas tubing.

All piping and fittings for conveying gas or liquid at pressures up to 150 lbs. per square inch, shall be suitable for a safe working pressure of not less than 150 lbs. per square inch. For pressures in excess of 150 lbs. per square inch piping shall have wall thicknesses and fittings in accordance with the requirements of Section 2 (Gas and Air Piping) of the American

*Owing to the urgent need of conserving critical materials, the National Board of Fire Underwriters recommended that during the period of World War II, the requirements of paragraph (a) of Section 19 be modified to permit the use of standard weight pipe for oxygen pressures not exceeding 350 pounds per square inch. Such standard weight pipe may be continued in service but should be inspected frequently.

†See Appendix A for availability.

Standard Code for Pressure Piping (ASA B31.1—1955)* except that such pipe and fittings shall be extra heavy as a minimum.

20. Jointing.

Joints in steel or wrought iron pipe shall be welded or made up with threaded or flanged fittings. Rolled, forged or cast steel, or malleable iron fittings may be employed. Cast iron fittings shall be prohibited.

Joints in brass or copper pipe may be welded, or made up with threaded or flanged fittings; or, if of the socket type, they may be made with silver solder or similar high melting point material.

Joints in approved seamless copper, brass or other approved non-ferrous gas tubing shall be made by means of approved gas tubing fittings or, if of the socket type, with silver solder or other high melting point material.

Threaded connections in oxygen piping shall be tinned or made up with litharge and glycerine (litharge and water for service pressures over 300 lbs. per square inch), or other joint compound approved for oxygen service and applied to the male threads only.

21. Installation.

Piping located inside or outside of buildings may be placed above or below ground. All piping shall be run as directly as practicable, carefully protected against injury, proper allowance being made for expansion and contraction, jarring and vibration. Pipe laid underground in earth shall be located below the frost line. After assembly they shall be thoroughly blown out with oil-free air or oil-free nitrogen to remove foreign materials. For oxygen piping, only oil-free air or oil-free nitrogen shall be used.

Oxygen piping may be placed in the same tunnel, trench or duct with fuel gas pipe lines provided there is good natural or forced ventilation, but under no circumstances shall an oxygen pipe line be placed in a tunnel, trench or duct where it may be exposed to contact with oil.

*See Appendix A for availability.

Where of necessity low points occur in any piping carrying a moist gas, they shall be drained into drip pots constructed so as to permit pumping or draining out the condensate at necessary intervals, and provided with drain valves having outlets normally closed with screw caps or plugs. No open end valves or petcocks shall be used, except that in drips located out of doors underground and not readily accessible, valves may be used at outlet if they are equipped with means to secure them in the closed position. Pipes leading to the surface of the ground shall be cased or jacketed where necessary to prevent loosening or breaking.

Gas cocks or valves shall be provided for all buildings at points where they will be readily accessible for shutting off gas supply to buildings in any emergency. There shall also be provided a shut-off valve in the discharge from the generator, gas holder, manifold or other source of supply.

22. Testing.

All piping shall be tested and proved gas tight at one and one-half times its maximum working pressure, and shall be thoroughly purged of air before being placed in service. Any medium used for testing oxygen lines must be oil free.

23. Painting and Signs.

(a) All buried pipe and tubing and outdoor ferrous pipe and tubing shall be covered or painted with a suitable corrosion resisting material.

(b) All oxygen pipe lines shall be painted one color, preferably green, and all fuel gas pipes a different color. Where more than one fuel gas is employed, the pipe line supplying the different fuel gases shall be painted distinctive colors.

(c) A color chart indicating the colors employed for this purpose shall be prominently displayed.

(d) All outlet stations should be provided with signs warning against other than intended usage.

(e) Signs clearly establishing the location and identity of section shut-off valves should be provided.

MANIFOLDING OF CYLINDERS.

24. General.

(a) Cylinders are manifolded for the purpose of centralizing the gas supply, to provide a continuous supply of gas and to provide gas at a rate in excess of that which may be obtained from a single cylinder. Such manifolds must be of substantial construction and of a design and materials suitable for the particular gas and service for which they are to be used. The wide range of pressures involved in the gases used, which range from the relatively low pressures of some of the fuel gases to the high pressures needed for oxygen, makes it necessary that care be employed in the construction, installation and maintenance of manifolds. It is advisable to obtain manifolds from, and have them installed under the supervision of those familiar with the proper practices with reference to their construction and use.

(b) All component parts used in the methods of manifolding described in Section 25 and the manifold described in Section 26, shall be approved as to materials, design and construction either separately or as an assembled unit. All manifolds and parts used in methods of manifolding shall be used only for the gas or gases for which they are approved.

25. Manifolding Cylinders for Direct Supply to Consuming Devices.

NOTE:—The units described in 25(a) and (b) are generally called "Portable Manifolds."

(a) In one type of manifolding the gas passes from the cylinders through individual cylinder leads to a single, common coupler block and from there through a single, common pressure reducing regulator to the consuming device.

(b) In a second type of manifolding, the cylinders of gas are connected together in sequence. The individual cylinders are provided with coupler tees attached to the cylinder valve. The gas contents of each cylinder pass through the coupler tee and join the main gas stream flowing through a common line composed of leads joining coupler tee to successive coupler tee. A properly supported regulator serves the entire group of connected cylinders.

(c) The aggregate capacity of fuel gas cylinders connected as a unit inside a building as described in Sections 25(a) and (b) shall not exceed 3,000 cubic feet of gas, or 300 pounds in the case of liquefied petroleum gas.

26. Manifolding of Cylinders for Shop Pipe Line Supply Systems.

(a) This type of manifold consists of a substantially supported stationary pipe type header to which a number of cylinders are connected by means of leads. One or more permanently mounted regulators serve to reduce and regulate the pressure of the gas flowing from the cylinders to the point or points of consumption. Such stationary manifolds shall comply with Section 27.

27. Fuel Gas Manifolds—(Acetylene, Liquefied Fuel Gases, and Non-Liquefied Fuel Gases Other Than Acetylene).

(a) Only cylinders containing gas at approximately equal pressure should be manifolded.

(b) Except as provided in Paragraph (c) of this section, fuel gas cylinders connected to one manifold inside a building shall be limited to a total gas capacity not exceeding 3,000 cubic feet. More than one such manifold may be located in the same room if separated at least 50 feet.

(c) Where it is necessary to manifold fuel gas cylinders having an aggregate gas capacity in excess of 3,000 cubic feet, they shall be located outside, or in a special building or in a separate room constructed in accordance with the provisions of Section 5, paragraphs (b) and (c).

(d) Special buildings or rooms, if provided, shall have no other occupancy except that they may be used for the storage of drums of calcium carbide and cylinders containing fuel gases as provided for in Section 30. Such buildings or rooms shall have no open flames for heating or lighting and shall be well ventilated.

27A. Oxygen Manifolds.

(1) Oxygen manifolds shall not be located in an acetylene generator room, or in close proximity to cylinders of combustible gases. Unless well separated, there should be a fire-resistive partition of one of the types of construction specified in Sec. 5(b), between the oxygen manifold and the combustible gas cylinders. Oxygen manifolds shall be located away from highly flammable material, especially oil, grease or any substance likely to cause or accelerate fire.

(2) Oxygen manifolds to which cylinders having an aggregate capacity of more than 6,000 cubic feet of oxygen are connected should preferably be located outside or in a special

building. If located inside a building* having other occupancy, such manifolds shall be located in a separate room of fire-resistive construction or in an area of fire-resistive construction with no combustible material within 20 feet of the manifold.

27B. Liquid Oxygen.

Where liquid oxygen in a quantity exceeding 100 gallons is to be used for welding and cutting, the container or containers shall be located outside or in a special building having no other occupancy except that related to the handling and gasification of the oxygen.

28. Portable Outlet Headers.

The term "portable outlet header" is used to mean any assembly of valves and connections used for service outlet purposes which is connected to the permanent service piping system by means of hose or other non-rigid conductors. Devices of this nature are commonly used at piers and drydocks in shipyards where the service piping cannot be located close enough to the work to provide a direct supply.

(a) Use of portable outlet headers shall be restricted to locations out-of-doors, and to temporary service where the conditions preclude a direct supply from outlets located on the service piping system.

(b) Each outlet on the service piping from which oxygen or fuel gas is withdrawn to supply a portable outlet header, shall be equipped with a shutoff valve located in a readily accessible position. Where the local conditions permit, the installation of a hydraulic back-pressure valve on the supply outlet of the fuel gas service piping is sometimes desirable.

(c) Hose used for connecting the portable outlet header to the service piping outlet shall comply with the standards for torch hose as specified in Section 36(a), (b), (c), (d), and (g).

(d) Connection fittings for the supply hose shall comply with Section 36(e) and (f). Connections for oxygen hose shall be of sufficiently different dimension or pattern from that for fuel gas to prevent intermixing in making connection.

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*NOTE:—Where the word "building" is used in this sentence it means a building having occupancy other than that directly associated with the production of acetylene, the storage of calcium carbide or the storage and manifolding of gases used in welding and cutting.

(e) Master shut-off valves for both oxygen and fuel gas shall be provided at the entry end of the portable outlet header.

(f) Outlet headers for fuel gas service shall be provided with an approved hydraulic back-pressure valve installed at the inlet end preceding the service outlets, unless an approved pressure reducing regulator, approved back flow check valve or an approved hydraulic back-pressure valve is employed at each outlet.

Outlets provided on headers for oxygen service may be fitted for the use of pressure reducing regulators or for direct hose connection.

(g) Each service outlet on the portable header unit shall be provided with a valve assembly that includes a detachable outlet seal cap, chained or otherwise attached to the body of the valve.

(h) Materials and fabrication procedures employed in the construction of portable outlet headers shall comply with the requirements stated in Section 19(a), (b) and (c); Section 20; Section 22 and Section 23(b) and (c).

(i) The portable outlet header shall be provided with a frame which will support the equipment securely in its correct operating position, and protect it from injury during handling and operation.

STORAGE OF CYLINDERS.

29. General.

(a) Cylinders stored in the open should have valves and safety devices protected against accumulations of ice and snow.

(b) Cylinders permitted inside of buildings shall be stored away from highly combustible materials and in locations where they are not liable to excessive rise in temperature, mechanical injury or tampering by unauthorized persons. Empty cylinders shall have their valves closed in storage and when shipped.

30. Fuel Gases.

Cylinders, stored inside a building, except those in actual use or attached ready for use, shall be limited to a total capacity of 2,000 cubic feet of gas (250 pounds of liquefied petroleum gas). For storage in excess of 2,000 cubic feet total gas capacity of cylinders, (250 pounds of liquefied petroleum gas) a sepa-

rate room or compartment as provided for by Section 5(b) and (c) shall be provided, or cylinders shall be kept outside or in a special building. Special buildings, rooms or compartments shall have no open flame for heating or lighting and shall be well ventilated. Cylinders of dissolved acetylene shall be stored with the valve end up. Calcium carbide in quantities not to exceed 600 lbs., when contained in metal packages complying with Section 32(a), may be stored in the same room with fuel gas cylinders.

31. Oxygen.

Inside of buildings, cylinders of oxygen shall not be stored in an acetylene generator room or in close proximity to cylinders of combustible gases. Unless well separated there should be a fire-resistive partition between the oxygen cylinders and combustible gas cylinders. Cylinders of oxygen, except those in actual use, shall be stored away from highly flammable material, especially oil, grease, or any substance likely to cause or accelerate fire.

STORAGE OF CALCIUM CARBIDE.

32. (a) Calcium carbide shall be contained in metal packages of sufficient strength to insure handling without rupture and shall be provided with a screw top or its equivalent. They shall be constructed water and air-tight without the use of solder, except at such points as it may be necessary to use this in order to close small crevices which cannot be otherwise sealed. Solder shall not be used on joints in such a manner that fire would disrupt the package.

(b) Packages containing calcium carbide shall be conspicuously marked "Calcium Carbide—Dangerous if Not Kept Dry."

INDOOR STORAGE.

(c) Calcium carbide in quantities not to exceed 600 pounds may be stored inside of buildings when contained in metal packages complying with Section 32(a), provided that the place of storage is dry, waterproof and well ventilated, and also provided that all but one of the packages of each size of carbide shall be sealed. The seals shall not be broken so long as there is carbide in excess of one (1) pound in any other unsealed package of that size of carbide in the building.

(d) When intended for other than merchandising purposes, it is recommended that the quantities of carbide permitted under paragraph (c) be stored in the generator room and not elsewhere, unless a more suitable place can be provided.

(e) Calcium carbide in excess of 600 pounds but not in excess of 5,000 pounds may be stored in a separate room or compartment inside a one-story building containing other occupancy, provided such room or compartment is constructed in accordance with the provisions of Section 5(b) and (c) and without cellar or basement underneath such carbide storage section. This room or compartment shall not be used for any other purpose. Adequate ventilation shall be provided.

Not to exceed 5,000 pounds of calcium carbide may also be stored within an inside generator room or compartment of construction as prescribed by Section 5(b) and (c) when such generator room or compartment is located in a one-story building without cellar or basement underneath the generator section.

(f) Calcium carbide in excess of 5,000 pounds shall be stored above ground in one-story buildings having no cellar or basement and used for no other purpose. Calcium carbide in excess of 5,000 pounds may be stored in outside generator houses.

Location of such storage buildings shall be outside congested mercantile or manufacturing districts.

Construction used shall be such as to insure a dry, waterproof building. Adequate ventilation shall be provided.

If storage building is of non-combustible construction, it may adjoin other one-story buildings if separated therefrom by unpierced fire walls. If detached less than 10 feet from such building or buildings, there shall be no opening in any of the mutually exposing sides of such buildings within said distance.

If the storage building is of combustible construction it shall not be within twenty (20) feet of any other one or two-story building, nor within thirty (30) feet of any other building exceeding two stories.

OUTDOOR STORAGE.

(g) Calcium carbide in full unopened metal containers complying with the requirements of Section 32(a) may be stored out of doors in industrial areas provided reasonable pre-

cautions are observed. Each container to be so stored should be carefully examined to make sure that it is in good condition. Frequent periodic re-examinations should be made for excessive rusting or other damage to a container that might affect its water and air tightness. Containers preferably should be stored horizontally in single or double rows. Ample space should be provided between rows or pairs of rows to facilitate periodic re-examinations and the removal of containers found defective. The bottom tier of each row should be placed on wooden planking or an equivalent so that the containers will not come in contact with the ground or ground water. The contents of drums longest in storage should be used first. Such storage shall be located at least 10 feet from line of adjoining property that may be built upon.

EQUIPMENT.

33. Storage.

Welding equipment such as regulators, torches, hose, etc., when not attached to cylinders ready for use, shall be stored in clean locations away from grease and oil. Hose should be stored in cool locations, special care being taken that it is not laid on greasy floors or shelves where it is likely to absorb such materials.

34. Hydraulic Back-Pressure Valves.

The terms "hydraulic back-pressure valves," "hydraulic seals" and "hydraulic valves" are used interchangeably.

The provisions of this section shall not apply to "Portable Outlet Headers," the construction requirements for which are given in Section 28.

(a) In low pressure fuel gas systems, including acetylene, liquefied petroleum gas, city gas, natural gas, etc., where the gas is piped at a pressure not in excess of one pound per square inch, an approved hydraulic back-pressure valve shall be employed at every point where gas is withdrawn from the piping system to supply a blowpipe* or machine. A shut-off valve shall be installed at the inlet of each hydraulic valve.

*NOTE:—As many as four blowpipes may be supplied from one hydraulic back-pressure valve through rigid piping connected to the hydraulic outlet, provided each outlet from such piping is equipped with a shut-off valve, and provided the fuel gas capacity of any one blowpipe does not exceed fifteen cubic feet per hour.

(b) In fuel gas systems when the fuel is piped at a pressure in excess of one pound per square inch, an approved pressure reducing regulator, an approved back flow check valve or an approved hydraulic seal shall be employed to prevent back flow at every point where gas is withdrawn from the piping system to supply a blowpipe* or machine. A shut-off valve shall be installed at the inlet of each hydraulic seal, regulator or check valve.

Where regulators or check valves are used at station outlets, the distribution system should be conveniently sectionalized and each section protected by an approved branch-line hydraulic back-pressure valve.

The term "machine" is here used to mean a device in which one or more torches using oxygen are incorporated.

(c) The escape or relief pipe from hydraulic seals should be at least as large as the vent connection on the hydraulic seal. The escape or relief pipe should be substantially installed without low points where moisture may collect. If shop conditions make low points unavoidable, these points should be provided with drip pots normally closed with screw caps or plugs. No petcocks shall be used.

(d) The maintenance of correct liquid levels in hydraulic back-pressure valves is important. Such liquid levels shall be checked at intervals frequent enough to insure the correctness of same. Suitable anti-freeze may be used in hydraulic back-pressure valves for manifold branch lines and station outlet service, but not hydraulic back-pressure valves on acetylene generators.

35. Pressure Reducing Regulators.

(a) Regulators or automatic reducing valves shall only be used for the gas for which they are intended.

(b) When repairs to regulators or parts of regulators, such as gauges, are necessary, such repairs shall only be performed by skilled mechanics properly instructed in the work. Working or low pressure gauges attached to regulators should be periodically tested to insure their accuracy. Do not test oxygen gauges with oil. In general, it is best to return regulators to the supplier for repairs, calibrations or adjustments.

*NOTE:—As many as four blowpipes may be supplied from one hydraulic back-pressure valve through rigid piping connected to the hydraulic outlet, provided each outlet from such piping is equipped with a shut-off valve, and provided the fuel gas capacity of any one blowpipe does not exceed fifteen cubic feet per hour