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Saudi Authority for Industrial Cities and Technology Zones

Compressed Gas Cylinders & LPG Safety Guidelines

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Part 1. COMPRESSED GAS CYLINDERS

Chapter 1.1. CLASSIFICATION OF COMPRESSED GASES.





Compressed gases are grouped into 3 major categories based on the states of gases:

1. Liquid (carbon dioxide, nitrous oxide, methane, ammonia, chlorine, propane, butane)
2. Non-liquefied gases (oxygen, hydrogen, nitrogen, argon, and helium)
3. Dissolved gases (acetylene) - Dissolved gases like acetylene are chemically unstable by themselves. Acetylene can explode at normal atmospheric pressure. Dissolved gases can be safely stored in cylinders when porous filler material and solvent like acetone are added.

Compressed gases can be classified based on their Hazard:

- **Inert Gases:** Can cause asphyxiation by displacing the air necessary for the support of life. Examples: Helium, Argon, Nitrogen.
- **Cryogen**s can cause freezing burns, frostbite, and destruction of tissue.
- **Oxidizers:** Oxidizers vigorously accelerate combustion; therefore, keep away from all flammable and organic materials. Greasy and oily materials should never be stored around oxygen. Oil or grease should never be applied to fittings or connectors. Examples: Oxygen, Chlorine.
- **Flammable Gases (Fuel Gases):** Flammable gases are easily ignited by heat, sparks, or flames, and may form explosive mixtures with air. Vapors from liquefied gas often are heavier than air and may spread along the ground and travel to a source of ignition and result in a flashback fire. Examples: Methane, Propane, Hydrogen, Acetylene, flammable gas mixtures.
- **Corrosive Gases:** Corrosive gases readily attack the skin, mucous membranes, and eyes. Some corrosive gases are also toxic. Examples: Chlorine, Hydrogen Chloride, Ammonia.

Compressed gases can be classified based on Hazardous Materials Classification (UL):

Label	Class	Examples
	Class 2.1 Flammable Gas	LPG, Hydrogen, Acetylene
	Class 2.2 Non-Flammable Gas	Compressed air, Nitrogen, Argon, Helium, Carbon dioxide
	Class 2.2 Oxidizing Gas	Oxygen, Nitrogen Oxide
	Class 2.3 Toxic Gas	Chlorine, Ammonia, Methyl bromide

Chapter 1.2. STANDARDS/GUIDELINES FOR COMPRESSED GAS CYLINDERS.

Always check with CGA (Compressed Gas Association) and other Standards Developing Organizations for the latest safety guidelines and standards:

- NFPA 55, Compressed gases and Cryogenic Fluids Code.
- OSHA 29 CFR 1910.101, General requirements (Compressed Gases).
- OSHA 29 CFR 1910.102, Acetylene.
- OSHA 29 CFR 1910.103, Hydrogen/Liquid hydrogen.
- OSHA 29 CFR 1910.104, Oxygen/Liquid oxygen.
- OSHA 29 CFR 1910.105, Nitrous oxide.
- OSHA 29 CFR 1910.253, Oxygen-fuel gas welding and cutting.
- OSHA 29 CFR 1926.350, Gas welding and cutting.
- DOT 49 CFR 179-171, Hazardous Materials Regulations
- CGA C6-: Standard for Visual Inspection of Steel Compressed Gas Cylinders.
- CGA C6.1-, Standard for Visual Inspection of High-Pressure Aluminum Alloy Compressed Gas Cylinders.
- CGA C6.2-, Standard for Visual Inspection and Requalification of Fiber Reinforced
- CGA C6.3-, Standard for Visual Inspection of Low-Pressure Aluminum Alloy Compressed Gas Cylinders.
- CGA C6.1-, Standard for Visual Inspection of High-Pressure Aluminum Alloy Compressed Gas Cylinders.
- CGA C6.4-, Methods for External Visual Inspection of Natural Gas Vehicle (NGV) and Hydrogen Gas Vehicle (HGV) Fuel Containers and their Installations.
- CGA C10-, Guideline to prepare Cylinders and Tubes for Gas Service and Changes in Gas Service.
- CGA C13-, Standard for Periodic Visual Inspection and Requalification of Acetylene Cylinders.
- CGA C17-, Methods to Avoid and Detect Internal Corrosion of Gas Cylinders and Tubes.
- CGA C23-, Standard for Inspection of DOT/TC 3 series and ISO 11120 Tube Neck Mounting Surfaces.
- CGA P1-, Standard for Safe Handling of Compressed Gases in Containers.
- CGA P27-, Guideline for the Safe Storage, Handling, and use of small Portable Liquid Oxygen Systems in Health Care Facilities.
- CGA P15-, Standard for the Filling on NON-Flammable Compressed Gas Cylinders.
- CGA P38-, Guideline for De-Valving Cylinders.
- CGA P63-, Disposal of Gases.

Chapter 1.3. IDENTIFICATION OF CONTENTS OF COMPRESSED GAS CYLINDERS.

- Compressed gas cylinders must be legibly marked for the purpose of identifying the gas content with either the chemical or the trade name of the gas. Such marking shall be by means of stenciling, stamping, or labeling, and shall not be readily removable. The marking shall be located on the shoulder of the cylinder.
- Compressed gas cylinders must be properly labeled so that it can be seen from any approach to the cylinder. Labels must be read and confirmed before using a cylinder.
- Labels shall be readable at all times while in service. If any label is damaged, missing, or tarnished in any way, the cylinder shall be taken out of service until the label is replaced.
- Never rely on the color of a label or cylinder for identification due to differences in color coding between suppliers. If the contents cannot be identified, the user must label the cylinder as “contents unknown” and move the cylinder to the empty storage area.
- Labeling should include the name of the material, concentrations, hazard classes, safety precautions and the manufacturer or supplier.
- Ensure cylinders are properly labeled when received.
- Do not accept cylinders that are not labeled and identified.
- Tags should be attached to the gas cylinders on which the names of the users and date of use can be added. Tags also state the name of the gas or mixture and illustrate one of three conditions: Empty, In-use or Full.
- All gas lines leading from a compressed gas supply shall be clearly labeled to identify the gas. Storage areas shall be prominently posted with hazard class, or the name of the gases stored.

Chapter 1.4. VALVES AND REGULATORS.

- The gas cylinder valve shall never be opened without a regulator attached. Regulators reduce high pressure gas on a cylinder or process line to a lower usable level. Regulators come as a single stage for short term applications and two stages for long term applications.
- The application will define the required regulator. If unsure which kind of regulator to use, consult the gas supplier. Regulators are designed to be fitted directly to the cylinder valve. No other fittings, connections, or lubricants shall be used to connect a regulator to a gas cylinder valve.
- The following rules for cylinder valves and regulators shall be always followed:
- Use regulators approved for the specific gas.
- Tampering with safety relief devices in cylinder valves is not permitted.
- Repair or alter of cylinders, valves, or other safety relief devices is strictly prohibited.
- All cylinder valves shall be kept always closed, except when the cylinder is in use.
- Approved pressure regulating devices must be used in all cases when gas pressure in a system is lower than cylinder pressure.
- All cylinder valves shall be opened slowly to prevent ice formation. Appropriate tools shall be used to tighten or loosen tank valves. If the valve will not readily open, return the cylinder to the vendor.
- Before a regulator is removed from a cylinder, the cylinder valve shall be closed, and all pressure released from the regulator and system.
- Be sure the regulator pressure control valve is relieved (or closed) before attaching to the cylinder.
- Remove all pressure from regulators that are not currently used.
- Use pressure relief valves in downstream lines to prevent high pressure buildup in the event that a regulator valve does not seat properly, and a tank valve is left on.
- Pressurize regulators slowly and ensure that valve outlets and regulators are pointed away from all personnel when cylinder valves are opened.
- Fully open valves during cylinder use. A fully open valve improves the internal seal and helps prevent packing leaks.
- Use a cylinder cap hook to loosen tight cylinder caps. Never apply excessive force to pry off caps.
- Regulators, gauges, hoses, and other appliances used with a particular gas or group of gases must not be used on cylinders containing gases having different chemical properties unless approved in writing by the vendor.

Chapter 1.5. BASIC SAFETY REQUIREMENT.

Here are some rules for people dealing with compressed gas cylinders:

- Ensure you have basic knowledge of the properties and potential hazards of compressed Gas Cylinders.
- Follow the manufacturer's instructions for handling, storing, and using the gas.
- Never start any job unless you have been trained to do it with the right procedure.
- Improve your skill in handling safety equipment on site, such as fire extinguishers and fire hose reels/racks, etc.
- Identify the emergency exits, fire fighting equipment, first aid kit, eye wash and emergency shower.
- Smoking is forbidden on site.
- Wear personal protective equipment (PPE) such as eye protection, gloves, safety shoes, and protective clothing.
- Staff deployed to work on tight gas are required to be knowledgeable of storage and handling rules and the related emergency procedures.
- Learn how to close valves quickly in emergency situations.
- If you detect a gas leak, immediately evacuate the area, and call for emergency assistance.
- Inspect gas cylinders regularly for signs of damage or wear.
- Report all deficiencies, faulty equipment, unsafe conditions, all incidents to the supervisory immediately.
- Dispose of gas cylinders according to regulations.
- Never tamper with the pressure relief device on a compressed gas cylinder.
- Store gas cylinders in an upright position, away from heat sources and flames.
- Secure gas cylinders to prevent them from falling over or being knocked over.
- Use a gas cylinder cart or stand to transport cylinders, rather than rolling them on the ground.

Chapter 1.6. TRANSPORTING REQUIREMENT.

- When transporting compressed gas cylinders internal to buildings, the following shall be always followed:
- Valves must be closed with protective caps in place.
- Regulators must be removed.
- Inspect the cylinder for existing damage prior to attempting transport.
- Secure cylinders in a cylinder cart with a chain to move to a new location.
- Do not drag or roll cylinders horizontally or “walk” at an angle.
- Use platforms or cradles that keep cylinders upright and secured when lifting with mechanical equipment. Do not lift cylinders with their valve cap.
- Once the cylinder is placed on a cylinder hand truck, ensure it is secured by a strap rack, heavy gauge chain or clamp to prevent falling.
- Transporting cylinders between floors of a building shall be done by elevator. The elevator car is a small, enclosed space. Should the cylinder leak, gas could quickly fill the car, potentially overcoming passengers with toxic or oxygen-displacing gas. Therefore, no person shall travel in the elevator with the gas cylinder. The cylinder trolley shall be secured to the elevator handrail to prevent it from falling over. Ideally a sign should be used across the entrance of the elevator to prevent others from entering while the cylinder is in transit. A second employee must be on the receiving floor to collect the cylinder. Secure the cylinder immediately once arriving at the usage location.

Chapter 1.7. HANDLING REQUIREMENT.

- All cylinders with a water weight capacity of over 13.6 kg shall be equipped with a means of connecting a valve protection cap or with a collar or recess to protect the valve.
- Cylinders shall be kept away from radiators and other sources of heat.
- Empty cylinders shall have their valves closed and shall be marked as empty.
- Cylinder valves shall be closed before moving cylinders and when work is finished.
- Cylinders shall be kept far enough away from the actual welding or cutting operation so that sparks, hot slag, or flame will not reach them, or fire-resistant shields shall be provided.
- Fuel-gas cylinders shall be placed with valve end up whenever they are in use. Liquefied gases shall be stored and shipped with the valve end up.
- Establish and post a maximum use temperature of less than °48.9C. Cylinders should not be positioned within 1 m of heaters or steam pipes.
- Where manifolded, the aggregate water capacity of LPG cylinders shall not exceed 334 Kg per manifold. Where multiple manifolds of such containers are present in the same room, each manifold shall be separated from other manifolds by a distance of not less than 6 meters.
- **Inert/Non-hazardous Gases.**
 - Inert gases should only be used in well-ventilated areas to assure the availability of air suitable for breathing. Care should be taken to ensure connections and tubing are secure. Always check for leaks to ensure the system is operating correctly.
 - All possible precautions should be taken to ensure that an adequate oxygen supply is available.
 - If asphyxiation is possible, workers should be equipped with supplied air respirators.
- **Flammable Gases.**
 - Use only regulators and other equipment designed for the gas being used and always follow the manufacturer’s instructions.
 - All lines and equipment associated with flammable gas systems must be grounded and bonded.
 - In the event of an emergency involving a flammable gas, such as a gas leak, fire, or explosion, personnel must immediately evacuate the area. Do not attempt to extinguish burning gas if the flow of product cannot be shut off immediately without risk.
- **Acetylene.**
 - Never use acetylene at a pressure above 15 psig. Acetylene is highly flammable under pressure and is spontaneously combustible in air at pressures above 15 psig.
 - Never open the cylinder valve more than one turn. Leave the valve key or wrench on the valve whenever the valve is open so that the valve can be closed quickly in case of fire or accident.

- Never use an acetylene cylinder on its side. Keep it upright and chained to a cylinder truck, wall, or other safe, stable object so that it cannot be knocked over or otherwise damaged.
- Avoid storing the cylinder in below-freezing point temperatures.
- Never release or vent acetylene into buildings or confined spaces.
- **Toxic Gases.**
 - Before using a poison gas, all label information and MSDS's associated with the use of the particular toxic gas shall be read. Users shall be familiar with the hazards and health effects of the gas which they are using and procedures to be followed in the event of an emergency.
 - Toxic gases shall only be used in force-ventilated areas, preferably in gas cabinets or hoods with forced ventilation.
 - Toxic gas cylinders shall be of a size that will ensure the complete usage of the cylinder within a reasonable period of time.
- **Corrosive Gases.**
 - An emergency shower and eyewash must be installed within 10 seconds where corrosive gases are used.
 - Cylinders containing corrosive gases shall not be stored for more than six months.
 - Remove regulators after use and flush with dry air or nitrogen.
 - Metals become brittle when used in corrosive gas service. Check equipment and lines frequently for leaks.
 - Use a diaphragm gauge with corrosive gases that would destroy a steel or bronze gauge. Check with the gas supplier for recommended equipment.
- **Oxidizing Gases.**
 - Do not use oil in any apparatus where oxygen will be used.
 - Never oil or grease torches, regulators, hoses, cylinder valves, or anything that may come into contact with oxygen.
 - Do not place oxygen cylinders or equipment in locations where they may encounter oil or grease from machinery.
 - Never allow anyone to dust his or herself with an oxygen line. Clothes can become oxygen saturated and therefore extremely flammable.
 - Never allow a jet of oxygen to contact an oily surface, a greasy cloth or to enter a fuel-oil or other storage tank unless it has been thoroughly cleaned according to approved procedures.
 - Never use oxygen to run air tools. Oxygen and other gases should be used only for their intended purposes.
 - Never use oxygen to blow out pipelines or to provide ventilation. The oxygen may cool the operator, but it also increases the oxygen content of the room. A spark that is inconsequential in air can be extremely hazardous in an oxygen enriched environment.
- **Cryogenic Liquids and Gases.**
 - Use appropriate personal protective equipment, including insulated gloves, lab coat, and eye protection (goggles and face shield) during any transfer of cryogenic liquid.
 - In the event of skin contact with a cryogenic liquid, do not rub skin. Place the affected part of the body in a warm water bath (not to exceed °40C). If a burn is significant, seek medical attention.
 - Use only equipment, valves, and containers designed for the intended product, service pressure, and temperature.
 - Inspect containers for loss of insulating vacuum. If the outside jacket on a container is cold or has frost, some vacuum has been lost. Empty the contents into another cryogenic container and remove the damaged unit from service. Repairs shall be made by the manufacturer or an authorized company.
 - Transfer operations involving open cryogenic containers must be conducted slowly to minimize boiling and splashing of the cryogenic fluid.
 - Ice or other foreign matter shall not be allowed to accumulate beneath the vaporizer or the tank. Excessive ice buildup could result in the discharge of excessively cold gas or structural damage to the cryogenic container or surroundings.
 - All cryogenic systems, including piping, must be equipped with pressure relief devices to prevent excessive pressure build-up. Pressure reliefs must be directed to a safe location. Do not tamper with pressure relief valves or the settings for the valves.
 - Elevators should not be used to transport cryogenic liquids. If transport by elevator is unavoidable, the cryogenic liquid must be transported by itself. Steps should be taken to ensure the elevator does not stop on other floors.

Chapter 1.8 . USAGE REQUIREMENT.

- Know and understand the gases associated with the equipment being used.
- Do not permit cylinders to become part of an electrical circuit.
- Use non-sparking tools (brass) when working with flammable/explosive materials.
- Prevent sparks and flames from contacting cylinders.
- Never strike an arc on a cylinder. Never introduce another product into the cylinder.
- Do not discharge the contents from any gas cylinder directly towards any person.
- Do not force cylinder valve connections that do not fit. If the threads do not match, return the cylinder to the vendor. Teflon tapes can never be used on cylinder or regulator connections.
- Open cylinder valve slowly and carefully after the cylinder has been connected to the process. Use check valves to prevent reverse flow into the cylinder.
- Close the cylinder valve and release all pressure from the downstream equipment. Disconnect the cylinder anytime there an extended non-use period is expected. Cap the cylinder when not in use.
- Never use compressed gas in any confined space.
- Never work alone when using compressed gas.
- Never use compressed gas to dust off clothing. This could cause injury to the eyes or body and create a fire hazard. Clothing can become chemically saturated and burst into flames if touched by an ignition source such as a spark or cigarette.
- If the cylinder's valve does not operate properly, do not attempt to force the valve to turn. The cylinder should be returned to the vendor. Employees must not attempt to repair cylinders or cylinder valves or to force stuck or frozen cylinder valves.
- Regulator and valve fittings shall always be checked for compatibility.
- Eye protection shall be worn when handling compressed gas cylinders.
- Check the Safety Data Sheets for additional personal protective equipment required for the gas contents of the cylinder.
- Tools provided by the supplier shall be used to open valves.
- Pressure relief devices shall be used to protect cylinders from rupture in the event of overpressure.
- Never empty a cylinder below 100 psi to prevent residual contents from becoming contaminated and potentially causing a harmful reaction.

Chapter 1.9. STORAGE REQUIREMENT.

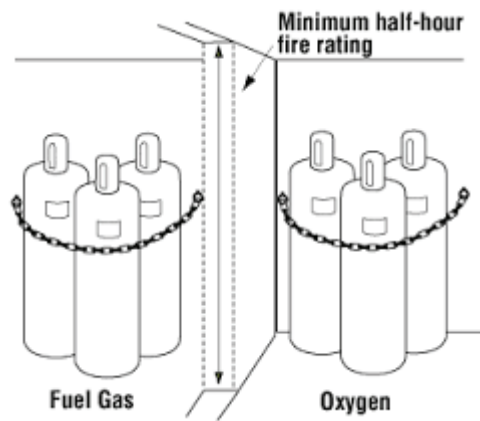
- Storage requirements must be followed when compressed gas cylinders are considered to be "in storage."
- Examples of "in use" include when a single cylinder of oxygen or fuel gas is attached to an approved delivery system (e.g., regulator, manifold, etc.), or when they are secured and are directly supplied to appliances or equipment (these situations are not considered to be "in storage"). These cylinders are considered to be "in-use" or "connected for use" (as opposed to "in storage") and are not regulated by the storage requirements.
- Before using or storing the cylinders, make sure they are properly identified or labelled and that they are in good condition. For cylinders that are not in good condition (e.g., the valve is hard to operate or there is visible damage), place a warning label on it, and report it to the supervisor to have it removed from service.
- Inside buildings: Cylinders shall be stored in a well-protected, well-ventilated (mechanical ventilation may be used, providing at least six air changes per hour), dry location, at least 6.1 m from highly combustible materials such as oil or excelsior such as wood, paper, grease, etc. Cylinders should be stored in assigned places away from elevators, stairs, or gangways. Assigned storage spaces shall be located where cylinders will not be knocked over or damaged by passing or falling objects, or subject to tampering by unauthorized persons. Cylinders shall not be kept in unventilated enclosures such as lockers and cupboards.
- If cylinders are stored within part of a building used for some other purpose, the following conditions should be satisfied:
 - The store should be on the ground floor of the building in a room having at least one wall constituting or contiguous with an external wall with a door or doors leading directly to the open.
 - The store should be separated from the rest of the building by -2hour fire rated walls.

- Outside buildings: Make sure the surrounding area is maintained so that there is no grass, weeds, brush, or other vegetation within the 6.1 m distance.
- When storing outside, make sure the cylinders are stored in the designated storage area. Place the cylinders on a raised concrete pad (or other non-combustible platform) or non-combustible rack inside a secure designated area that is fenced in. The platform should be designed to prevent the cylinders from corroding from contact with ground, water, salt, and high temperatures.
- Oxygen cylinders shall not be stored near highly combustible material, especially oil and grease; or near reserve stocks of carbide and acetylene or other fuel-gas cylinders, or near any other substance likely to cause or accelerate fire; or in an acetylene generator compartment.
- The storage of acetylene should be well ventilated at high and low levels.
- Cylinders should be placed vertically and tightened with chains. It is strictly prohibited to roll or slide them horizontally and should be moved in specially made vehicles.
- Identify empty cylinders with a tag and store them separately from full cylinders.
- Permanent warning notices should be prominently displayed at storage areas, identifying the gases stored and prohibiting smoking and the use of naked lights or motor vehicles (except for loading and unloading of cylinders).
- Fuel-gas cylinder storage: Inside a building, cylinders, except those in actual use or attached ready for use, shall be limited to a total gas capacity of 56 m³ (NTP) or 135.9 kg of liquefied petroleum gas.
- The path to cross to arrive to the cylinders should be free of obstacles so they can be easily closed when any emergency occurs.
- Consider setting up the cylinder storage so that each cylinder can be secured separately to prevent other cylinders from falling when one of them is removed from storage.
- Establish and post a maximum temperature for indoor and outdoor storage of less than °51.7C.
- Do not store cylinders longer than one year without use.
- Areas where cylinders are stored, must be secured against unauthorized personnel.
- Indoor storage: The provision of a leak detection system with remote monitoring should be considered.

Welding Gases Storage Separation.

- The following table lists indoor storage recommendations. Always follow the instructions on the safety data sheet or those provided by the manufacturer.

Table 1.9. Welding Gases Storage Separation				
Welding Gases	Oxygen	Fuel Gases	Inert Gases	Carbon dioxide
Oxygen	Group oxygen gas cylinders together	Separate at least 6.1 m. OR By a wall at least 1.5 m high with minimum half hour fire resistance	No separation is required	No separation is required
Fuel Gases (e.g. propane, propylene, acetylene, or hydrogen)	Separate at least 6.1 m. OR By a wall at least 1.5 m high with minimum half hour fire resistance	Group fuel gas cylinders together	No separation is required	No separation is required
Inert Gases (e.g. argon, helium, or nitrogen)	No separation is required	No separation is required	Group inert gases together	No separation is required
Carbon dioxide	No separation is required	No separation is required	No separation is required	Group carbon dioxide gases together



- In external storage areas, oxygen cylinders should not be stored in the same cage or within 3m of cylinders of any fuel gas.
- Compressed gas cylinders should not be stored within 3m of any LPG cylinder more than 50kg capacity.

Note that when a single cylinder of oxygen and a single cylinder of fuel gas are attached together or secured to a wall or column at a workstation (“in-use” situation), this situation is not considered storage, and the cylinders do not necessarily need to be separated by distance or a barrier.

Part 2. LIQUEFIED PETROLEUM GASES

The “LP” stands for “liquefied petroleum.” A widely used fuel, LP gas is a mixture of light hydrocarbons, predominantly any of the following or mixtures of them; propane, propylene, butanes and butylene’s, which are gaseous at atmospheric pressure and temperature. Because of its absence of sulfur and its very low production of nitrogen oxides (NOx), this fuel produces low levels of toxic substances and particulates during combustion. NOx emissions are nitric oxides and nitrogen dioxides. LP gas can be easily liquefied by modestly decreasing the temperature or increasing the pressure. This makes it extremely easy to store and transport, even to remote areas.

The materials, equipment including LPG cylinders, tanks, piping, fittings, gauges, valves, etc. shall comply with SBC 801 and NFPA 58.

Chapter 2.1. PERMITS

- An operational permit is required for storage and use of LPG.
- Exception: A permit is not required for individual containers with a 1900 L water capacity or less, or multiple container systems having an aggregate quantity not exceeding 1900 L. serving occupancies in Group R3-.
- Where a single LPG container is more than 7500 liters in water capacity or the aggregate water capacity of LPG containers is more than 15000 liters, the installer shall submit construction documents for such installation.
- When container size exceeds the threshold specified (7500 liters water capacity), applicants must submit plans indicating compliance with requirements before approval can be authorized. Plans should be clear concise, legible, and include the following:
 - Location and legal identification (address and lot or parcel number) of the lot or site.
 - Legal boundaries of the site, including reference to source or survey.
 - Location of significant buildings on the lot or site and adjacent lots or sites.
 - Location of nearest public roadways and site access.
 - Location of all underground and overhead utilities.
 - North arrow.
 - Topographical features.
 - Proposed container location with respect to buildings, building openings, lot lines, public roadways and underground or overhead utilities.
 - Container dimensions and capacity.
 - Container compliance markings (e.g. ASME, DOT, API).
 - Details of container foundation and supports.
 - Section through container showing supports and anchors and, if an underground tank, backfill and corrosion protection.
 - Arrangement of valves and piping.
 - Specifications for containers, valves, piping, tank mounts and pads and other related equipment and appliances.
 - Means for protecting valves from tampering.
 - Name, address and telephone number of property owner.
 - Name, address and telephone number of installer and servicing contractor.

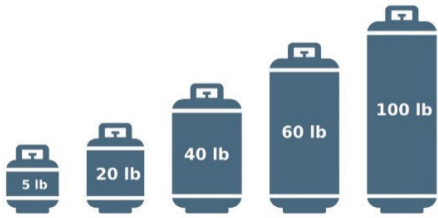
Chapter 2.2. PORTABLE “LPG” CYLINDERS.

Section 2.2.1. GENERAL.

Portable LPG cylinders, as defined in NFPA 58, are Portable LPG containers with a marked water capacity of 1000 lb. (454 Kg) or less that is designed to transport and store LPG.

Propane cylinders will only operate properly when they are vertically upright. While certain types of cylinders are designed for liquid service, most consumer propane bottles are designed for only vapor service, such as with a gas grill.

The most common type of LP Gas container is the propane cylinder, commonly referred to as a “bottle.” Most of us are familiar with the propane bottles used to fuel gas grills. These most used portable propane cylinders are:



- These capacities are for liquid propane weight when full.
- The density of liquid propane at 25oC is around 0.42 g/cm³.
- 100 lbs. (45 Kg) of liquid propane capacity = 240 lbs. (110 Kg) of water capacity.

Specifications

All LP gas cylinders have the same operational and safety mechanisms in place. These include:

- Relief valves.
- Service valves.
- Bleeder valves.
- Stamped markings or nameplates.
- Protective collars / neck rings.
- Foot rings.

The valves on LP gas cylinders must be protected by a protective cap or collar, also called a neck ring. An unprotected valve hit hard enough can break off allowing liquid gas to escape at a dangerously fast rate. The escaping gas can act as propulsion for the cylinder allowing it to become a dangerous projectile.

The bottom of all propane cylinders is required to have a foot ring. The foot ring ensures that the cylinder stands in an upright and level position. Most LP gas cylinders are made of steel and therefore they are subject to rusting. The most common place rust is found is on the bottom of the cylinder and around the foot ring. It is important to keep those areas clean and dry.

Storage and Use

OSHA and NFPA guidelines for storing and using LP gas:

- Minimize exposure to excessive temperature rise, physical damage, or tampering - store cylinders in an open-air storage unit or cage with a protective roof overhead.
- Use and store cylinders in the proper position.
- Store cylinders with the relief valve in direct contact with the vapor space in the container.
- Cylinder valves must be protected - screw-on type caps or collars must be securely in place on all stored cylinders regardless of whether they are full, partially full, or empty, and container outlet valves must be closed.
- Storage locations must be provided with at least one approved portable B:C rated fire extinguisher.
- The required fire extinguisher must be located no more than 15 m from the storage location.

Section 2.2.2. INDOOR INSTALLATION.

LPG Cylinders installation indoors is not allowed generally.

Exception:

- **Construction.**
LPG cylinders are allowed to be used in buildings or areas of buildings undergoing construction.
- **Residential**
In Residential occupancies, domestic residential, apartments, flats and villas, portable LPG cylinders are allowed to have a maximum of 60 kg water capacity cylinders (2 x 30 kg water capacity cylinders) to be installed or stored within the dwelling units for domestic use. Where more than one such container is present in the same room, each container shall be separated from other containers by a distance of not less than 6 meters. (The LPG cylinders shall not be connected together with manifold system).
- **Group F Occupancies.**
In Group F occupancies, portable LPG cylinders are allowed to be used to supply quantities necessary for processing, research, or experimentation. Where manifolded, the aggregate water capacity of such containers shall not exceed 334 Kg per manifold. Where multiple manifolds of such containers are present in the same room, each manifold shall be separated from other manifolds by a distance of not less than 6 meters.

- **Demonstration Uses.**

Portable LPG containers are allowed to be used temporarily for demonstrations and public exhibitions. Such containers shall not exceed a water capacity of 5 Kg. Where more than one such container is present in the same room, each container shall be separated from other containers by a distance of not less than 6 meters.

- **Self-Contained Torch Assemblies.**

Portable LPG containers are allowed to be used to supply approved self-contained torch assemblies or similar appliances. Such containers shall not exceed a water capacity of 1.13 Kg.

- **Commercial food preparation.**

Portable LPG containers are allowed to be used in buildings with commercial food service cooking appliances. These appliances required to be approved and labeled in accordance with one of the ANSI Z83 series standards for commercial gas cooking equipment. The maximum allowable quantity of LPG containers shall be limited to 2 x 80 kg water capacity cylinders. Where more than one such container is present in the same room, each container shall be separated from other containers by a distance of not less than 6 meters. (The LPG cylinders shall not be connected together with manifold system).

Table 2.2.2. Indoor Installation Requirements for Residential, Group E, and Commercial Food Preparation. (LPG Cylinders)

Items	Requirements
Location	<ul style="list-style-type: none"> • LPG cylinder installation shall be properly located so as not to cause any obstruction to the fire escape and any danger to the public. Suitable access to the cylinder for emergency services shall be provided. • The edge of the installation shall be at least 3 m from any boundary or any fire engine access way.
Safety Provisions	<ul style="list-style-type: none"> • An approved gas leak detector system shall be provided in that room, laboratory, and kitchen area, with a local alarm connected to the main fire alarm panel where existed. • The location of the gas leak detector should preferably be not more than 30cm above ground level and not more than 4m away from the edge of the installation and the point of consumption.

Section 2.2.3. SEPARATE COMPARTMENT INSTALLATION

LPG cylinders are allowed to be installed in a separate compartment on the ground floor, provided with the following requirements:

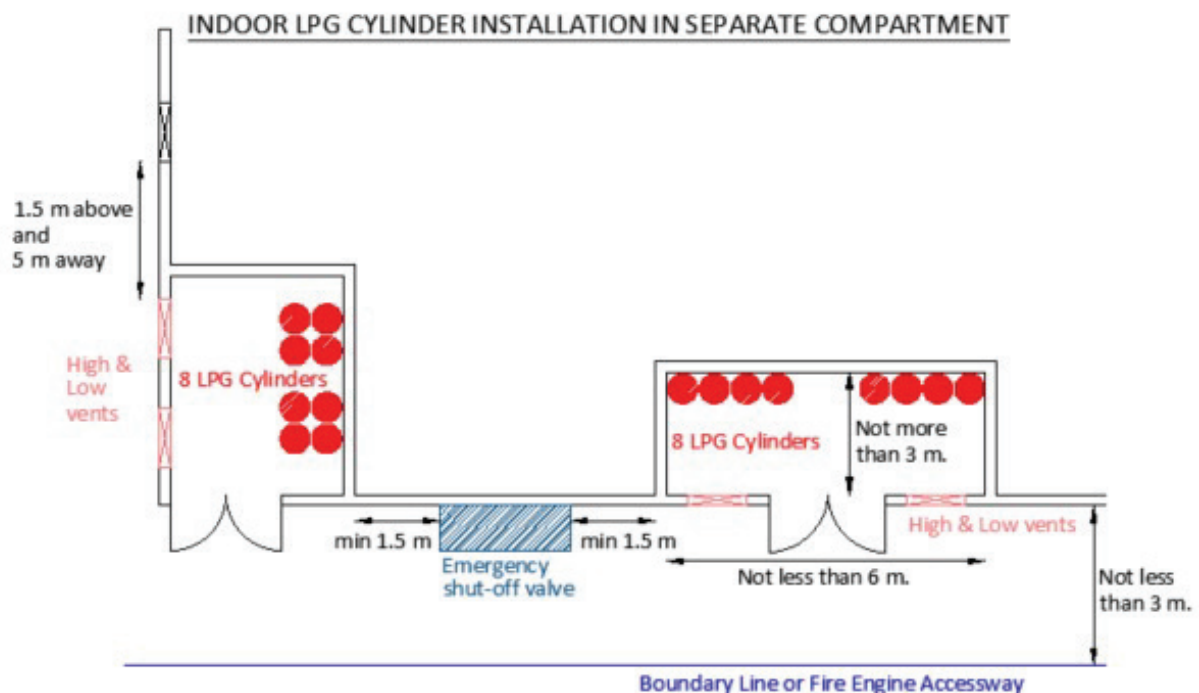


Table 2.2.3. Separate Compartment Installation Requirements. (LPG Cylinders)

Items	Requirements
Maximum Allowable Quantity.	<ul style="list-style-type: none"> • A maximum of 800 kg water capacity of LPG is allowed to be installed using a single manifold system inside a compartment. The quantity of cylinder is restricted to 8, regardless of the capacity of each cylinder. • The compartment in which the LPG cylinders are installed shall be sprinkler protected. If the compartment is not sprinkler protected, the quantity of LPG shall be halved (i.e. 400 kg). • For commercial premises, the maximum number of LPG manifold system shall not exceed two per building.
Compartment.	<ul style="list-style-type: none"> • The compartment shall have at least one external wall and there shall be no access from the compartment into the building. • Walls common to the compartment and the internal spaces of the building shall be -2hour fire rated and shall be of masonry construction. • Each compartment shall contain only one number LPG manifold system. • The edge of the installation shall be at least 3 m from any boundary or any fire engine access way.
Ventilation.	<ul style="list-style-type: none"> • Doors shall have high- and low-level louvers and shall be opened outwards. • Natural ventilation is allowed if the total length of the compartment external wall is not less than 6m and the distance between the external wall and its opposite wall is not more than 3m. Otherwise, mechanical ventilation shall be provided. • High and low vents shall be provided on the external wall at just below ceiling level and above floor level. The total free area of the vents provided shall be at least 300 cm²/m² of floor area. • The vent openings shall be kept free from obstruction and shall not discharge directly onto a public place, e.g. a pavement or path. It shall not be less than 5 m from any air intake openings and shall be at least 1.5 m horizontally away from any building opening which is below the vent opening level. • Where mechanical ventilation is used, air circulation shall be at least 5.1 l/sec per 1 m² of floor area. Discharge outlets shall be at least 1.5 m horizontally away from any building opening which is located below the discharge level.
Safety Provisions.	<ul style="list-style-type: none"> • An approved gas leak detector system shall be provided in that compartment, with a local alarm connected to a main fire alarm panel. The leak detector should link to the exhaust fan control panel and the emergency shut-off valve where applicable. • The location of the gas leak detector should preferably be not more than 30cm above ground level and not more than 4 m away from the edge of the installation and the point of consumption. • Remote Emergency shut-off valve shall not be installed inside the compartment and be at least 1.5 m away from the edge of the installation. It shall be clearly marked and at a suitable height to access during emergencies. • Automatic fire suppression system, if installed, shall be linked to the LPG cylinder installation in such a way that activation of the system shall automatically shut off the supply of LPG to the inside of the building.

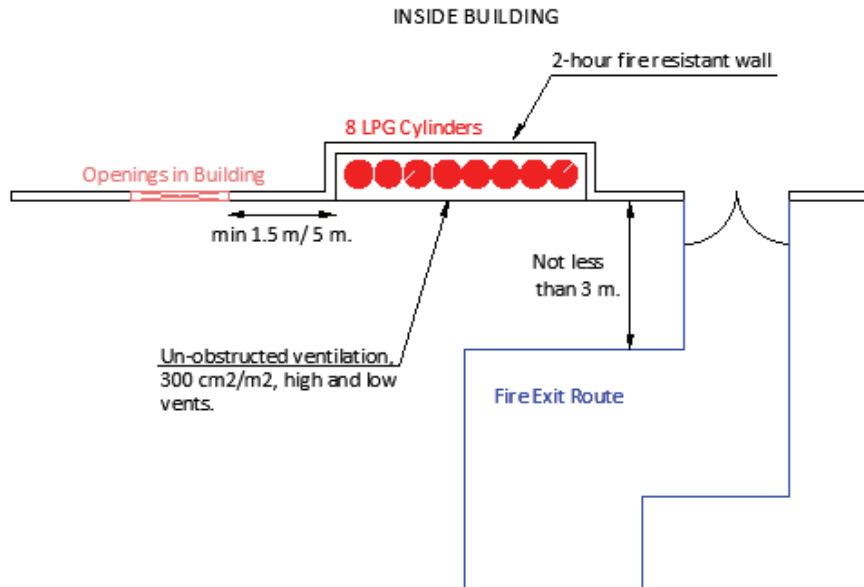
Section 2.2.4. RECESSED AREA INSTALLATION

LPG cylinders are allowed to be installed in a recessed area compartment on the ground floor, provided with the following requirements (See the figure below):

Table 2.2.4. Recessed Area Installation Requirements. (LPG Cylinders)

Items	Requirements
Maximum Allowable Quantity.	<ul style="list-style-type: none"> A maximum of 800 kg water capacity of LPG is allowed to be installed using a single manifold system inside the recessed area. The quantity of cylinder is restricted to 8, regardless of the capacity of each cylinder. For commercial premises, the maximum number of LPG manifold system shall not exceed two per building.
Location.	<ul style="list-style-type: none"> The maximum depth of the recess shall be not more than 1 m deep. The floor, ceiling and the dividing walls between the recess and the internal spaces of the building shall be brick or concrete, noncombustible and shall have a fire-resistant rating of not less than 2 hours. Access to the recess shall only be from the external of the building. The recess shall be at ground-floor level and shall be for the exclusive use of housing LPG cylinders. The recess shall not be located within 3 m of any fire exit route from a building that has only one designated means of exit. If the 3 m distance cannot be complied with, a -2hour fire rated masonry wall shall be provided between the fire exit and the installation to achieve the 3m horizontal distance. The recess shall be located at least 1.5 m from any horizontal openings (windows, doors, air vents, balanced-flue outlets, etc.) of the building having more than one designated means of escape, measured horizontally from the nearest LPG cylinder. If the 1.5 m distance cannot be complied with, a -2hour fire rated masonry wall shall be provided between the openings and the installation to achieve the 1.5 m horizontal distance. The recess shall be located at least 3m from ignition source. A minimum distance of 3m horizontal distance must be maintained between the nearest edge of a vehicle parking lot to the recessed area. Recessed area located below windows or openings shall maintain is a minimum distance of 150mm between the top of the recessed area or any part of the manifold system (piping, vaporizer, etc., whichever is higher) and the bottom of the windows or openings. LPG cylinders shall be located at least 5 m horizontally from any mechanical air intake which is below any part of the manifold system and 1.5 m from any mechanical intake which is above any part of the manifold system.
Ventilation.	<ul style="list-style-type: none"> Permanent unobstructed high and low ventilation openings, not less than 300cm²/m² of recess floor area, shall be provided for venting the recess space to the external of the building.
Safety Provisions.	<ul style="list-style-type: none"> Any pipe penetration on the walls of the recess area shall be suitably fire stopped to maintain the -2hour fire resistance of the walls. An approved gas leak detector system shall be provided in the compartment where the LPG pipes pass through, with a local alarm connected to a main fire alarm panel. The gas leak detector shall be linked to the exhaust fan control panel and the emergency shut-off valve where applicable.

RECESSED AREA LPG CYLINDER INSTALLATIONS



Section 2.2.5. OUTDOOR INSTALLATION



Table 2.2.5. Outdoor Installation Requirements. (LPG Cylinders)

Items	Requirements
Maximum Allowable Quantity.	<ul style="list-style-type: none"> • For Domestic Residential Uses. A maximum of 2 cylinders each of 50 kg water capacity of LPG is allowed to be installed in one group in the enclosure. 1 cylinder shall be main, and 1 cylinder shall be reserve in a common manifold with isolation valves. • For Commercial uses. A maximum of 4 cylinders each of 100 kg water capacity of LPG is allowed to be installed in one group in the enclosure. 1 cylinder shall be main, and 1 cylinder shall be reserve in a common manifold with isolation valves. • For industrial uses. An aggregate maximum of 2000 Kg water capacity pf LPG is allowed to be attached to a common manifold, provided: <ul style="list-style-type: none"> - Maximum two numbers of steel cabinets are allowed, and each cabinet is allowed to house a maximum of 10 x 100 kg water capacity of LPG cylinders; and - A -2hour fire rated wall or a spacing of 3 m shall be provided to separate these two steel cabinets.
Location.	<ul style="list-style-type: none"> • LPG cylinders shall be placed on a firm, clean, dry, and level base. They shall be sited at ground level and in a well-ventilated area where any gas leakage can safely and rapidly disperse. They shall not be placed close to any passageways or exits and shall not cause any obstruction or danger to the occupants during gas leakage or fire. • LPG cylinders shall not be located within 3m of any fire exit route of a building having only one exit. If the 3m distance cannot be complied with, a -2hour fire rated masonry wall shall be provided between the fire exit and the LPG installation to achieve the equivalent 3m horizontal distance. The masonry wall shall be at least 1.8 m high. • LPG cylinders shall be located at least 1.5 m horizontally away from any openings (windows, doors, air vents, balanced-flue outlets, etc.) of the building having more than one exit. If the 1.5 m distance cannot be complied, a -2hour fire rated masonry wall must be provided between the openings and the installation to maintain a 1.5 m horizontal distance. The masonry wall should be at least 1.8 m high. • A minimum distance of 3 m must be maintained between the edge of a vehicle parking lot. • LPG cylinders shall be located at least 5 m horizontally from any mechanical air intake which is below any part of the manifold system and 1.5 m from any mechanical intake which is above any part of the manifold system. • LPG cylinders may be installed below windows or openings if there is a minimum distance of 150 mm between the top of any cylinder or the manifold system and the bottom of the windows or openings. • LPG cylinders of total capacity up to 600 kg shall be located at least 1.5 m from any uncovered opening that is below the level of the cylinders, such as drains, pits, openings to basements, etc. For LPG cylinders having a total capacity above 600kg, the distance from any uncovered opening shall be at least 3 m. • LPG cylinders shall be located at least 3 m away from any boundary and any fire engine accessway. • LPG cylinders shall be located at least 10 m away from any fire hydrant.
Protection.	<ul style="list-style-type: none"> • Permanent unobstructed high and low ventilation openings, not less than 300cm²/m² of recess floor area, shall be provided for venting the recess space to the external of the building. • Cylinders shall be installed in louvered steel enclosures and locked against tampering and accidental damage. • Cylinders located near parking lots, vehicle ramps and roads, shall be provided with steel barricades along with enclosures to safeguard cylinders from vehicular collisions.

Table 2.2.5. Continued

Table 2.2.5. Continued

Items	Requirements
<p>Safety Provisions.</p>	<ul style="list-style-type: none"> • Any pipe penetration on the walls of the recess area shall be suitably fire stopped to maintain the -2hour fire resistance of the walls. • An approved gas leak detector system shall be provided in the compartment where the LPG pipes pass through, with a local alarm connected to a main fire alarm panel. The gas leak detector shall be linked to the exhaust fan control panel and the emergency shut-off valve where applicable. • Remote Emergency shut-off valve shall be located at least 3 m away from the edge of the installation. It shall be clearly marked and placed at a suitable height for easy access during emergencies. • For Commercial kitchens provided with fixed fire suppression system, activation of the Suppression system shall automatically shut off the supply of LPG to the kitchen. <ul style="list-style-type: none"> • There shall be no ignition source within 3 m from the cylinder installation. • All fixed electrical equipment within 1.5 m of the LPG installation shall be spark-proof and intrinsically safe in accordance with the relevant clause in NFPA 70. • Vaporizers shall not be installed inside the steel cabinet or within the same housing of the LPG cylinders. Wall-mounted vaporizers shall be located at least 1.2 m above the ground and 600 mm away from any LPG cylinders. • The cylinder enclosure shall only be used for LPG cylinder installation. No other usage or storage is allowed. • A warning sign or notice of minimum size of 800 mm x 600 mm shall be permanently and legibly displayed at the front of the installation. In Arabic and English conveying, "LPG / HIGHLY FLAMMABLE / NO SMOKING / NO NAKED LIGHTS" • The LPG installation shall be provided with at least one approved portable B:C rating dry chemical fire extinguisher having a minimum capacity of 9 kg.

Chapter 2.3. LPG TANKS

Section 2.3.1. DESIGN STAGE REQUIREMENTS.

- When manufacturing LPG tanks, the architectural design shall consider the earthquake hazards. Thus, designs that are resistant to high levels of earthquakes shall be adopted because of the dangerousness of the tanks' materials during such accidents.
- The design of the LPG tanks shall be consistent to engineering design specifications and regulations that comply with the health and safety conditions adopted in the Kingdom of Saudi Arabia.
- The requirements for constructing LPG tanks shall be applied according to the types of tanks, whether aboveground or underground, as per NFPA 30.
- The standards of NFPA 30 shall be applied while identifying the locations of the aboveground tanks to be built within the lands, considering the adopted chart.
- When constructing tanks, all the aboveground LPG tanks shall comply with the terms of venting systems that consider the public safety conditions. The type of LPG tanks shall be determined according to the required separating distances and the easy access for operating, maintenance, and firefighting.
- Traffic congestion around the tanks should be examined to provide a high level of service without any obstruction, considering the public safety at the location. Therefore, the number of fire extinguishers shall be increased, and an emergency plan shall be provided.
- Most countries should have their own regulations that reflect the climatic and natural environment interacting with the different types of gas and tanks. Companies shall abide by the separating distances mentioned in the local code of each type of fluid. If the charts that define the specifications of the fluid are not available, the global requirements of the NFPA shall be followed. In case a difference in the rates is noticed, the higher rates shall be approved for the sake of public safety.
- Geo-technical studies shall be carried out to determine the type of soil and the extent of its suitability for containing the LPG tank.
- The topographical nature of the land shall be studied to a better location investment considering the economic requirements for the project.
- The environmental impact on the residential area shall be considered by clarifying the

impact of the tank on the area and the impact of the surrounding movements on the tank in return.

- A technical justification shall be provided for constructing the aboveground or underground LPG tank and for the size required to build it.
- In selecting the appropriate locations for the tanks to meet the requirements for public safety, the tanks shall meet the following requirements for the aboveground or underground types, on a flat or sloped land, on a dusty or rocky land:
 - Aboveground tanks shall be used for aboveground storage only.
 - Underground tanks shall be used for underground storage only.
 - The aboveground or underground tanks shall be built in accordance with recognized engineering standards for each type of tank.
- The requirements for the location and the permissible pressure level of the underground tanks noted in NFPA30 and NFPA 58 shall be considered.

Section 2.3.2. MULTIPLE LPG TANKS INSTALLATION.

Multiple LPG tanks installation with a total water storage capacity of more than 681,300 liters, shall be subdivided into groups containing not more than 681,300 liters in each group. Such groups shall be separated by a distance of not less than 15 meters, unless the tanks are protected in accordance with one of the following:

- Mounded in an approved manner.
- Protected with approved insulation on areas that are subject to impingement of ignited gas from pipelines or other leakage.
- Protected by fire walls of approved construction.
- Protected by an approved system for application of water as specified in Table 6.4.2. of NFPA 58.
- Protected by other approved means.

Where one of these forms of protection is provided, the separation shall be not less than 7.5 meters between LPG tank groups.

Section 2.3.3. ABOVEGROUND LPG TANKS INSTALLATION.

- Aboveground and underground tanks shall be built on a balanced solid ground. Such ground shall withstand loaded Tank weights, wind loads and seismic loads.
- Where saddles are used to support the container, they shall allow for expansion and contraction and prevent an excessive concentration of stress.
- Containers shall be installed on a level surface with bottom of the Tank not more than 300 mm above concrete foundation surface.
- The container shall be secured to the building structure.
- Saddles or foundations or masonry and supports shall be coated or protected to minimize corrosion.
- LPG Tanks shall not be stacked one over the other in any arrangements.
- The solid materials used for the construction of tanks shall be noncombustible or have a fire resistance rating of not less than 2 hours. In addition, the required insulation and the appropriate durability shall be provided in the construction of aboveground and underground tanks.
- The requirements for aboveground tank sites and the approved pressure mentioned in NFPA 30 and NFPA 58 shall be adopted.
- **LPG containers used in stationary installations shall not be located on the roofs of buildings.**



2.3.3.1. SEPARATION DISTANCES FOR ABOVEGROUND LPG TANKS

- Above ground LPG Tanks shall be separated from Flammable liquids containers as per **Table 2.3.3.1.A**
- Above ground LPG Tanks shall be separated from Liquid Oxygen containers as per **Table 2.3.3.1.B.**
- Above ground LPG Tank separation shall be as per **Table 2.3.3.1.C**
- 6 m distance shall be maintained from tank surface to any Air intake units, Window type and Split Type AC units, Air vents, etc.
- 10 m distance shall be maintained from tanks to Fire Hydrant, firefighting equipment, firefighting valves, and fire command centers where available.
- An aboveground LPG tank and any of its parts shall not be located within 1.8 m of a vertical plane beneath overhead electric power lines that are over 600 volts.
- There shall be no vegetation, dry grass, and combustible material within 3 m around the surface where aboveground tank is located.

Table 2.3.3.1.A. Separation Distances between LPG and Flammable Liquids Tanks.

Flash Points of Flammable Liquids	Minimum Separation from LPG Tanks of Capacity up to 113,500 liters water capacity. (m)	Minimum Separation from LPG Tanks of Capacity more than 113,500 liters water capacity. (m)
Less than 32oC	6 m to bund wall	15 m to bund wall
32oC to 65oC Less than 3000 liters tanks.	3 m to bund wall	6 m to bund wall
32oC to 65oC More than 3000 liters tanks.	3 m to bund wall and 6 m to tank.	15 m to bund wall

Table 2.3.3.1.B. Separation Distances between LPG and Liquid Oxygen Tanks.

LPG Tank Capacity (Water Liters)	Minimum Separation Distance from Liquid Oxygen Tanks of Capacity up to 125,000 liters. (m)	Minimum Separation Distance from Liquid Oxygen Tanks of Capacity more than 125,000 liters. (m)
Up to 1,900	6	30
1,901 to 3,800	7.6	45
3,801 to 7,570	7.6	Risk Assessment is required
7,571 to 113,550	15	Risk Assessment is required
113,551 to 264,950	23	Risk Assessment is required
More than 264,950	Risk Assessment is required	Risk Assessment is required

Table 2.3.3.1.C Aboveground LPG Tanks Separation Distances.

LPG Tank Capacity (Water Liters)	Minimum Separation between LPG Tanks and Buildings, Public Ways Or Lot Lines of Adjoining Property that can be Built Upon. (a) (m)	Minimum Separation between LPG Tanks (a) (m)
Less than 475 (b)	1.5 (c)	None
475 to 950	3	None
951 to 1,900	3	0.9
1,901 to 7,570	7.5 (c), (d)	0.9
7,571 to 113,550	15	1.5
113,551 to 264,950	23	4/1 x "Sum of Diameters of Adjacent LPG Tanks"
264,951 to 340,650	30	
340,651 to 454,200	37.5	

Notes:

- (a): For other than installations in which the overhanging structure is 15 m or more above the relief-valve discharge outlet. In applying the distance between buildings and ASME LPG tanks with a water capacity of 475 liters or more, not less than 50 percent of this horizontal distance shall also apply to all portions of the building that project more than 1,500 mm from the building wall and that are higher than the relief valve discharge outlet. This horizontal distance shall be measured from a point determined by projecting the outside edge of such overhanging structure vertically downward to grade or other level upon which LPG tank is installed. Distances to the building wall shall be not less than those prescribed in this table.
- (b): At a consumer site, if the aggregate water capacity of a multi-tank installation, comprised of individual LPG tanks having a water capacity of less than 475 liters, is 1900 liters or more, the minimum distance shall comply with the appropriate portion of Table 4.3.3.1. applying the aggregate capacity rather than the capacity per LPG tank. If more than one such installation is made, each installation shall be separated from other installations by not less than 7500 mm. Minimum distances between LPG tanks need not be applied.
- (c): The following shall apply to aboveground tanks installed alongside buildings: LPG tanks of less than a 475 liters water capacity are allowed next to the building they serve where in compliance with the following:
 - DOT LPG tanks shall be located and installed so that the discharge from the tank pressure relief device is not less than 900 mm horizontally from building openings below the level of such discharge and shall not be beneath buildings unless the space is well ventilated to the outside and is not enclosed for more than 50 percent of its perimeter. The discharge from LPG tank pressure relief devices shall be located not less than 1500 mm from exterior sources of ignition, openings into direct-vent (sealed combustion system) appliances or mechanical ventilation air intakes.
 - ASME LPG tanks of less than a 475 liters water capacity shall be located and installed such the discharge from pressure relief devices shall not terminate in or beneath buildings and shall be located not less than 1500 mm horizontally from building openings below the level of such discharge and not less than 1500 mm from exterior sources of ignition, openings into direct vent (sealed combustion system) appliances, or mechanical ventilation air intakes.
 - The filling connection and the vent from liquid-level gauges on either DOT or ASME LPG tanks filled at the point of installation shall be not less than 3000 mm from exterior sources of ignition, openings into direct vent (sealed combustion system) appliances or mechanical ventilation air intakes.
- (d): This distance is allowed to be reduced to not less than 3000 mm for a single LPG tank of 4,540 liters water capacity or less, provided such tank is not less than 7500 mm from other LPG tanks of more than 475 liters water capacity.

2.3.3.2. ABOVEGROUND LPG TANKS FIRE PROTECTION.

- Fire protection shall be provided for installations having LPG storage tanks with a water capacity of more than 15,140 liters.
- Above ground LPG tank shall be provided with fixed water spray system. The fire pump and water tank shall be from the building that the LPG tank is serving.
- Where fire pump and fire water tank are not available in the building that the LPG tank is serving, Dry type water spray ring with open nozzles, connected to Civil Defense breaching inlet, shall be provided.
- At least one ABC dry chemical extinguisher with a 12 kg capacity is installed between 5 m and 15 m from each fuel tank opening.

Section 2.3.4. UNDERGROUND AND MOUNDED LPG TANKS INSTALLATION.

- It is necessary to comply with the conditions set for underground tanks construction when a building covers a part of them or in the case of adjacent buildings according to the type of use allocated to it.
- Means of maintenance shall be provided after calculating the space needed to facilitate the maintenance process. Noting that coordination between the owner and the body should take place to adopt the appropriate design.
- Abiding by operation conditions is a must. This aims to provide public safety through different means such as using pipes that meet the technical specifications, closing tight from the top, filling and emptying the liquid only from the top, etc.
- Underground tanks shall comply with the appropriate requirements and their openings shall be provided with a cover from the top, based on the design conditions. The opening shall also be clearly visible and easy to use by workers. Moreover, the scope of protection of these tanks should be emphasized.
- Cathodic protection shall be provided for the underground and mounded LPG tanks to prevent corrosion.
- Tanks shall be coated fully without any pinholes in the coating to protect underground or mounded tanks from corrosion.
- Gas detector explosion proof type shall be installed in close proximity to every underground or mounded tank.
- At least one ABC dry chemical extinguisher with a 12 kg capacity is installed between 5 m and 15 m from each fuel tank opening.

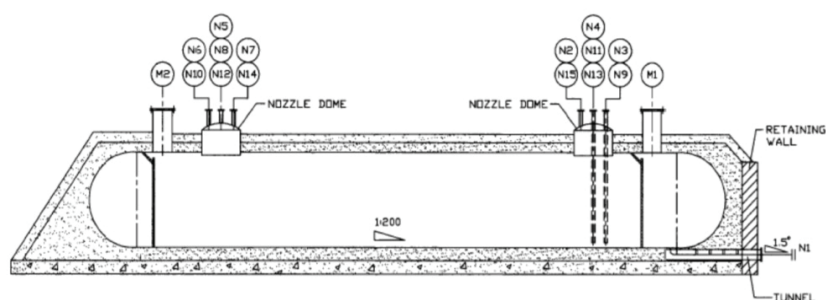
2.3.4.1. UNDERGROUND LPG TANKS.



- A concrete bed shall be provided as foundation in all cases and designed to overcome buoyant forces in case of water flooding. The underground tanks must be fixed/ strapped to this foundation.
- All underground tanks must be strapped or fixed to a solid foundation designed to prevent floatation in case of submergence of the tank due to water flooding for any reason.

- An underground LPG tank shall not be acceptable as underground installation without backfilling the pit.
- The backfill shall be free of rocks and abrasives so that coating is not compromised.
- The discharge of the regulator vent shall be above the highest probable water level to protect the tank relief valve from blockages.
- Before backfilling, any damage to LPG tanks shall be inspected and repaired.
- Containers shall be set level and shall be surrounded by earth or sand firmly tamped in place.

2.3.4.2. MOUNDED LPG TANKS.



- A Mounded tank is an approved and listed container designed for underground service installed above the minimum depth required for underground service and covered with earth, sand, or other material, or an ASME container designed for aboveground service installed above grade and covered with earth, sand, or other material.
- Mounded LPG tanks shall be installed above grade and covered with earth, sand, vermiculite, or perlite with wall around or any other method to hold these filling materials.
- Such filling materials shall cover the Tank with thickness of at least 30 cm.
- A protective cover shall be provided on top of mounding materials to safeguard against corrosion.
- Mounded LPG tank bottom valves and appurtenances shall be accessible for operation or repair, without disturbing mounding material by providing an opening or tunnel of width 1.2 m in diameter.
- Alternatively, to access the mounded tank valves and appurtenances, these bottom connections shall be extended beyond the mound to exterior as per ASME code and design.

2.3.4.3. SEPARATION DISTANCES FOR UNDERGROUND AND MOUNDED LPG TANKS.

- • Underground LPG Tank separation shall be as per Table 2.3.4.3.
- • LPG Tanks shall not be located within 3 m of dike wall of other flammable and combustible liquids.
- • Underground or Mounded LPG tanks installed in areas with no vehicle traffic shall be installed at least 15 cm below grade.
- • Underground or Mounded LPG tanks installed in areas with vehicle traffic within 3 m shall be installed at least 46 cm below grade or shall be provided with barricades around the entire tank and connections to prevent vehicular damages and accidents.
- • 6 m distance shall be maintained from tank pressure relief valve to any Air intake units, Window type and Split Type AC units, Air vents, Balanced type flue outlets.
- • 10 m distance shall be maintained from tank pressure relief valve to Fire Hydrant, firefighting equipment, firefighting valves, fire command centers.
- • Underground or mounded LPG tank pressure relief valve and any of its parts shall not be located within 1.8 m of a vertical plane beneath overhead electric power lines that are over 600 volts.
- • There shall be no dry grass and combustible material within 3 m around the surface where underground or mounded tank is located. However, landscaping with greenery is acceptable when appropriate coating to tanks and method is ensured to restrict irrigation water from seeping onto tank surfaces, causing corrosion.

Table 2.3.4.3. Underground and Mounded LPG Tanks Separation Distances.

LPG Tank Capacity (Water Liters)	Minimum Separation between LPG Tanks and Buildings, Public Ways Or Lot Lines of Adjoining Property that can be Built Upon. (a) (m)	Minimum Separation between LPG Tanks (b), (c) (m)
Less than 475 (c), (d)	3	None
475 to 950	3	None
951 to 1,900	3	0.9
1,901 to 7,570	3	0.9
7,571 to 113,550	15	1.5
113,551 to 264,950	15	4/1 x "Sum of Diameters of Adjacent LPG Tanks"
264,951 to 340,650	15	
340,651 to 454,200	15	

Notes:

- (a): Minimum distance for underground LPG tanks shall be measured from the relief device and the filling or liquid-level gauge vent connection at the tank, except that all parts of an underground LPG tank shall be not less than 3000 mm from a building or lot line of adjoining property that can be built upon.
- (b): For other than installations in which the overhanging structure is 15 m or more above the relief-valve discharge outlet. In applying the distance between buildings and ASME LPG tanks with a water capacity of 475 liters or more, not less than 50 percent of this horizontal distance shall also apply to all portions of the building that project more than 1,500 mm from the building wall and that are higher than the relief valve discharge outlet. This horizontal distance shall be measured from a point determined by projecting the outside edge of such overhanging structure vertically downward to grade or other level upon which LPG tank is installed. Distances to the building wall shall be not less than those prescribed in this table.
- (c): Where underground multi-tank installations are composed of individual LPG tanks having a water capacity of 475 liters or more, such tanks shall be installed so as to provide access at their ends or sides to facilitate working with cranes or hoists.
- (d): At a consumer site, if the aggregate water capacity of a multi-tank installation, comprised of individual LPG tanks having a water capacity of less than 475 liters, is 1900 liters or more, the minimum distance shall comply with the appropriate portion of Table 4.3.3.1. applying the aggregate capacity rather than the capacity per LPG tank. If more than one such installation is made, each installation shall be separated from other installations by not less than 7500 mm. Minimum distances between LPG tanks need not be applied.

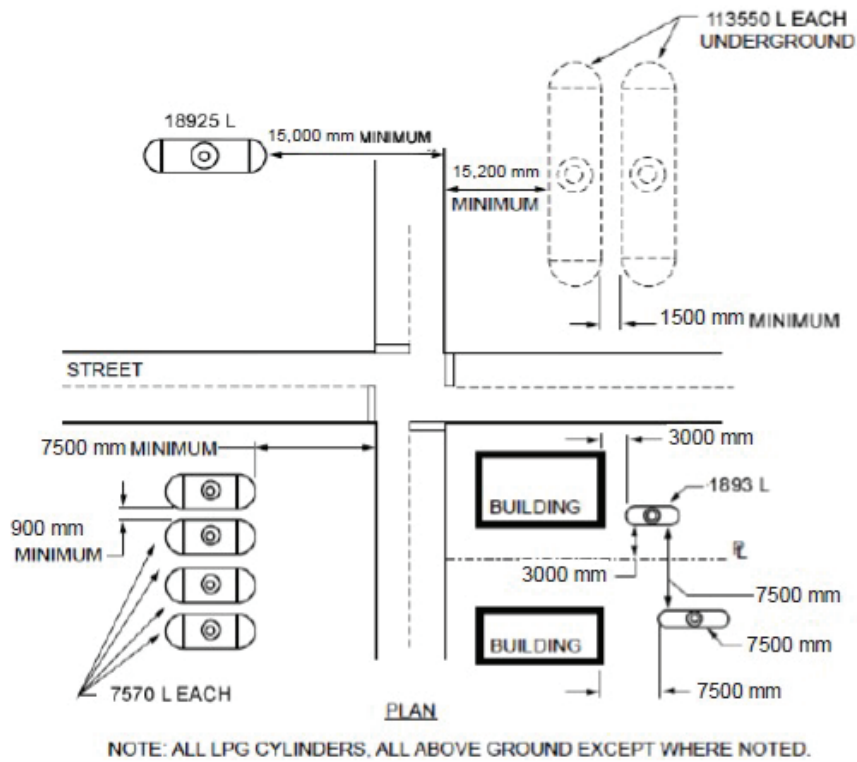


FIGURE 6104.3(1)
LOCATION OF LPG CYLINDER/CONTAINER PER TABLE 6104.3

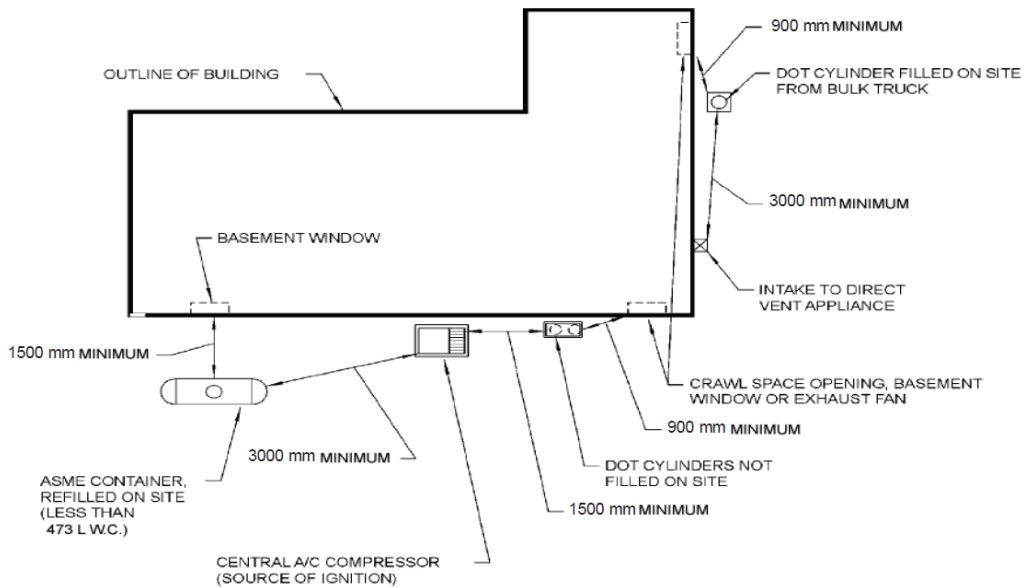


FIGURE 6104.3(2)
LOCATION OF DOT AND ASME CONTAINERS

Section 2.3.6. FENCING

- Industrial type, chain-link fencing of 1.8 m height shall be provided around the LPG tank installations. Such fencing shall have a minimum of 2 exit gates of 1.2 m width available where LPG tanks are filled within the fenced enclosure.
- Above ground tanks located near parking lots, vehicle ramps and roads, shall be provided with steel barricades along with fences to safeguard tanks from vehicular accidental collisions.

Section 2.3.7. CONSTRUCTION STAGE REQUIREMENTS

- Tanks of various shapes and sizes can be built as needed, considering the international standards of the construction of LPG tanks.
- When starting the construction of LPG tanks, the type of liquid to be stored and its suitability with the materials used in the construction of the tank shall be studied. Therefore, an environmental certificate showing the environmental impact of liquid storage on the surrounding area shall be provided.
- Flammable liquids shall be stored in underground tanks, allowing their usage in pre-approved areas by the Saudi Industrial Property Authority. The construction of aboveground tanks shall be allowed only for the storage of Class I, II and III flammable liquids if the public health and safety conditions are respected.
- It is necessary to comply with the isolation conditions when constructing tanks, to protect them from natural factors and mitigate the risks of accidents.
- All connections shall be placed underground and covered by a slab of reinforced concrete to protect them from soil movement factors or any other damage.
- The design shall consider the degree of inclination of the land to determine the possibility of a tank construction at the site, and to adopt the most suitable type, as long as the design and construction are in line with the requirements for public safety.
- Building above the tanks in the land shall be forbidden. In case of violation, the Authority shall withdraw the construction or operation license. The land shall preferably be used as an open space.
- Separating walls shall be built to protect tanks from fire and other hazards and to prevent the leak of liquids.
- It is necessary to provide all the safety means that help prevent the public from entering the site. These means can take the shape of a fence or hazard warning signs or by isolating the location geographically, noting that the safety and isolation procedures are related to the size and capacity of the tank.

Section 2.3.8. OPERATION STAGE REQUIREMENTS

- While distributing spaces, a space shall be allocated to civil defense to provide the required space for civil defense vehicles when needed. Fire extinguisher's locations shall be well-studied at the workplace to ensure quick intervention in cases of emergency.
- Filling and emptying processes shall be carried out in accordance with the Global Operation Conditions.
- The materials allocated to the tank shall not be replaced with other materials. If the owner wants to do so, prior approval shall be obtained from the Industrial Property Authority, conforming to the technical conditions assigned to each type of liquid gas stored in the tank.
- Tankers shall be trained to accomplish their work in a way that maintains the health and safety of individuals and the company, avoiding all kinds of hazards that may occur during operation stages.
- An operational plan for liquid gas tanks that shows how to deal with the risks shall be provided.
- The tank shall be labeled with the materials used, the hazards and the ways to deal with these hazards. Tankers shall not be allowed to work unless they are fully knowledgeable about the instructions.
- The instructions set by the tank manufacturer shall be followed during installation and operation processes. In case any error has occurred during installation or operation, the factory shall be informed directly to know whether the work shall be stopped or not for the sake of public safety.

Chapter 2.4. PIPING DISTRIBUTION SYSTEM.

Section 2.4.1. PIPE MATERIALS

- Pipes used shall be:
 - Steel and wrought-iron pipe not less than schedule 40, complying with one of the following standards: ASME B10 36.10m, ASTM A53/A53M, or ASTM A106.
 - Copper and copper alloy pipe. Shall not be used if the gas contains more than an average of 0.7 mg of hydrogen sulfide per 100 liters of gas.
 - Corrugated Stainless Steel Tubing (CSST). Shall be listed in accordance with ANSI LC 1/CSA 6.26.
 - Plastic pipe. Shall be identified and conform to the 2018 edition of ASTM D2513. Such pipe shall be marked "Gas" and ASTM D2513". (HDPE100- and MDPE80-)

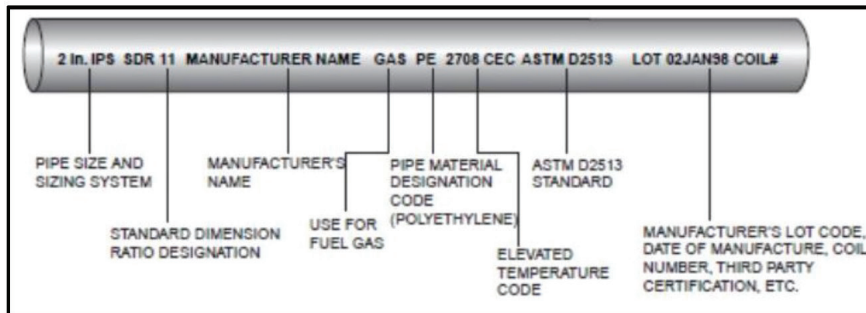


Figure 4-26: Approved polyethylene gas piping with markings in accordance with the CODE and ASTM D2513

- Cast Iron pipes and fittings shall not be used in the system.
- Underground pipes shall be seamless steel to ASTM A53, A 106 with Denso /Bitumen Tape wrapping or HDPE(PE100-)/MDPE(PE80-) SDR11.
- Each length of pipe and tubing and each pipe fitting, utilized in a fuel gas system, shall bear the identification of the manufacturer. (Field-cut nipples might not be)
- For other than steel pipe, exposed piping shall be identified by a yellow label marked "Gas" in black letters. The marking shall be spaced at intervals not exceeding 1524 mm. Marking shall not be required on pipe located in the same room as the appliance served.
- When connecting additional gas utilization equipment to a gas piping system, the existing piping shall be checked to determine if it has adequate capacity. If inadequate, the existing system shall be enlarged as required, or separate gas equipment of adequate capacity shall be provided.

Section 2.4.2. PIPING

- No liquid phase LPG is allowed to be piped into the building.
- In infrastructure LPG distribution, liquid phase shall be permitted up to compound walls of the building.
- Two Stage pressure regulators are essential for all LPG installations. First regulator to reduce system pressure to 5 psi (0.350 bar) for large commercial customers or to 75 mbar for residential customers, and second stage regulator (Known as Medium Pressure "MP" regulator or Pounds to inches regulator) to reduce it further to 0.5 psi (0.035 bar). However, in large infrastructure LPG networks, the pressure reduction shall be in accordance with length of the network and drop calculations.

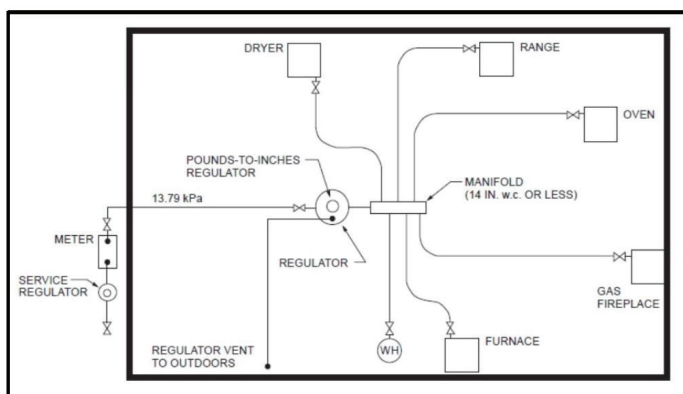
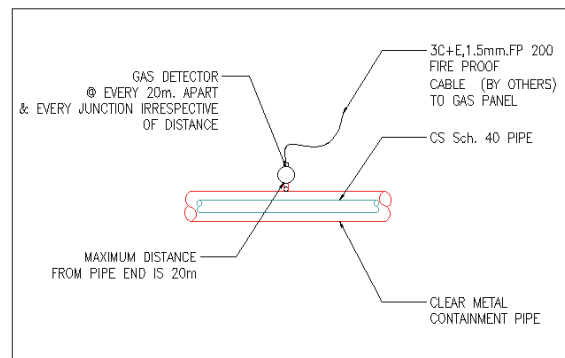


Fig. 2.4.2.a. Two-stage pressure regulators distribution system

- LPG pipe installation shall not be permitted in the following areas:
 - In the ground under concrete flooring within building, except where the piping is encased in an approved conduit material designed to withstand the superimposed loads.
 - Under building foundations.
 - Within lift shafts and cavity walls.
 - In compartments or ducts dedicated for electrical switchgears, transformers, or generators.
 - In refrigeration chambers, cold rooms, air handling rooms and ventilation or air-conditioning ducts.
 - Adjacent to pipes and vessels containing flammable, oxidizing, corrosive and other hazardous materials.
 - In fire-fighting lobby, fire command centers, smoke stop lobbies, fire pump rooms, fire-fighting water tank rooms, sprinkler control valve rooms, firefighting riser ducts, areas of refuge, protected corridors, protected staircases, bedrooms, and other occupied area etc.
- Proper metal pipe sleeves shall be installed for the gas pipes running in enclosed, unventilated areas or basement floor, and areas exposed directly to the exterior open safe space. These sleeves are used to facilitate gas leak detection.



- The gas pipe running vertically shall be enclosed within a protected riser shaft and be fully fire-rated separated from other MEP risers. Ventilation opening shall be provided for such gas riser.
- Underground piping system shall be installed at a minimum depth of 305 mm below grade, except for individual outside appliances, where the minimum is 203 mm.
- Metallic piping and metallic tubing that conveys fuel gas from an LPG storage tank shall be provided with an approved dielectric fitting to electrically isolate the underground portion of the pipe or tube from the above-ground portion that enters a building. Such, dielectric fitting shall be installed above ground outdoors.

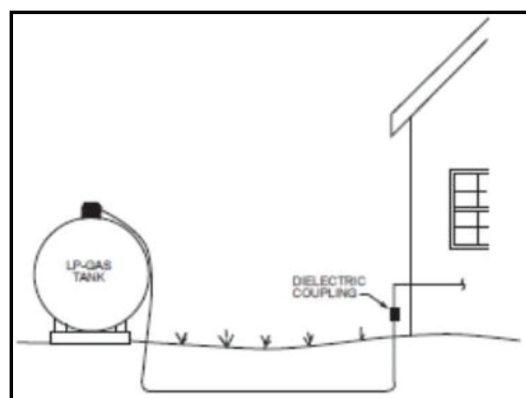


Fig. 2.4.2.b. LPG piping isolation

Section 2.4.3. FILLING LINES

- Filling connections shall be electrically classified areas without any ignition sources within 7.6 m.
- LPG filling connection shall be at 1 m from finished ground level.
- LPG fill line and connection arrangement shall be fully exposed outside the building. Where the need arises to cover it aesthetically, fully ventilated, or fully perforated enclosure is acceptable.
- Fill connections shall be as close to the LPG Tank as possible.
- Filling connections shall be located within the LPG Tank fenced area. and when this is not possible, the fill connections shall be secured and guarded with lockable ventilated box against tampering and vandalism.
- If LPG tanks have top filling arrangements, safe access and platform with standard steps, handrail and guards shall be provided.
- Filling connections should necessarily have a Vapor equalizing line to take care of any unexpected pressure rise during filling operations and shall be clearly labeled “LIQUID” or “VAPOR” as appropriate.
- LPG filling point shall be fully protected from vehicle impact by suitable crash barriers and unauthorized access.

Section 2.4.4. VALVES

- Shutoff valves shall be of an approved type and be constructed of materials compatible with the piping and shall comply with the standard that is applicable for the pressure and the application.
- Shutoff valves shall be prohibited in concealed locations and furnace plenums.
- Shutoff valves shall be located in places so as to provide access for operation and shall be installed so as to be protected from damage.
- Every meter shall be equipped with a shutoff valve located on the supply side of the meter.
- In multiple tenant buildings where a common piping system is installed, shutoff valves shall be provided for each tenant. Each tenant shall have access to the shutoff valve serving that tenant’s space.
- A listed shutoff valve shall be installed immediately ahead of each Medium-Pressure regulator.
- Each appliance shall be provided with a shutoff valve.
- Shutoff valve for laboratories. Where provided with two or more fuel gas outlets including table-bench and hood-mounted outlets, each laboratory space in educational research commercial and industrial occupancies, shall be provided with a single dedicated shutoff valve through which all such gas outlets shall be supplied. The dedicated shutoff valve shall be readily accessible located within the laboratory space served located adjacent to the egress door from the space, and shall be identified by approved signage stating, “Gas Shutoff”.
- The internal shutoff valves shall remain closed except during periods of operations.
- An exterior shutoff valve to permit turning off the gas supply to each building in an emergency shall be provided and plainly marked.

Section 2.4.5. ELECTRICAL

- Electrical circuits shall not utilize gas piping or components as conductors.
- All electrical connections between wiring and electrically operated control devices in a piping system shall conform to the requirements of NFPA 70.
- Any essential safety control (in the vaporizer) depending on electrical current as the operating medium shall be of a type that will shut off (fail safe) the flow of gas in the event of current failure.

Section 2.4.6. LPG PIPING CONNECTIONS, AND LEAK DETECTION CONTROL.

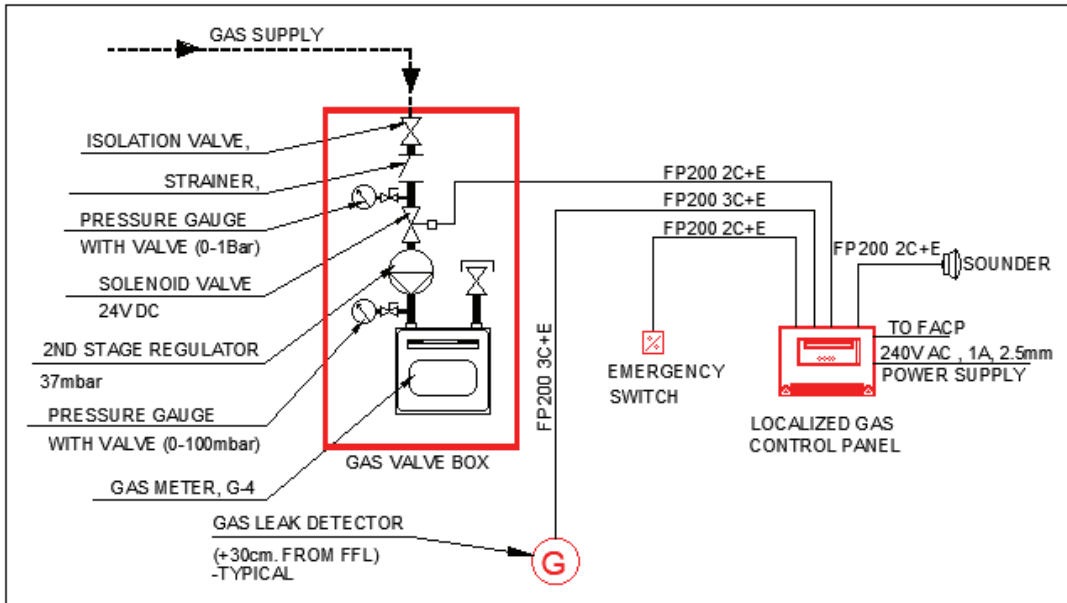


Fig. 2.4.6.a. Typical Connection for Kitchen Appliances.

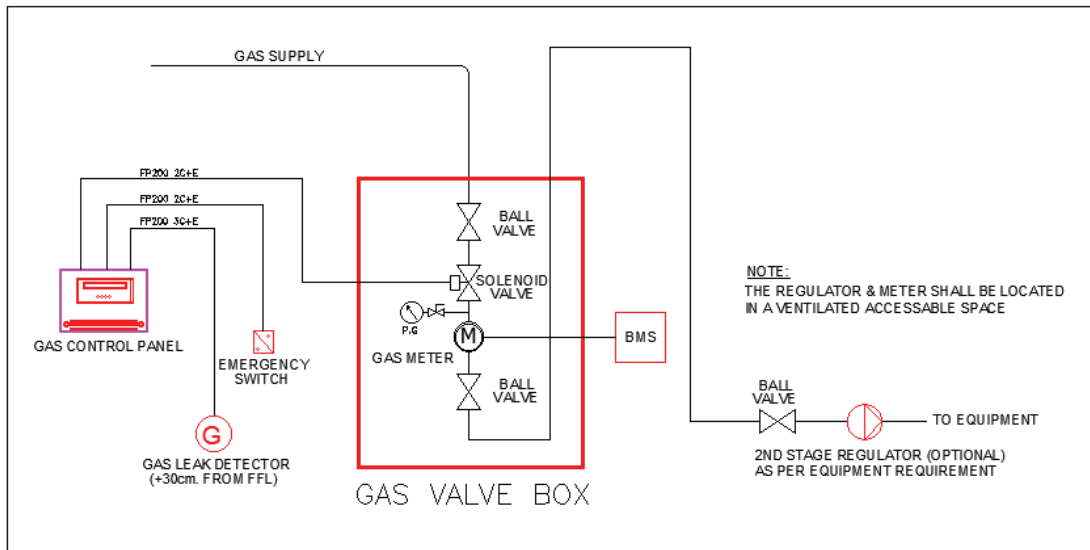


Fig. 2.4.6.b. Typical Connection for Industrial Equipment.

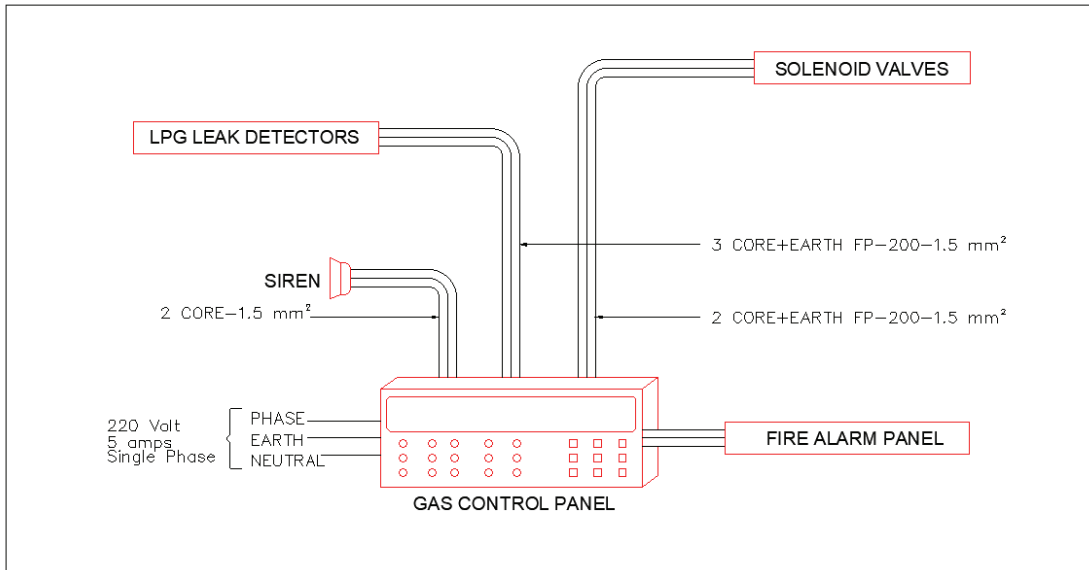


Fig. 2.4.6.c. Control Panel Wiring Detail for Central Gas System.

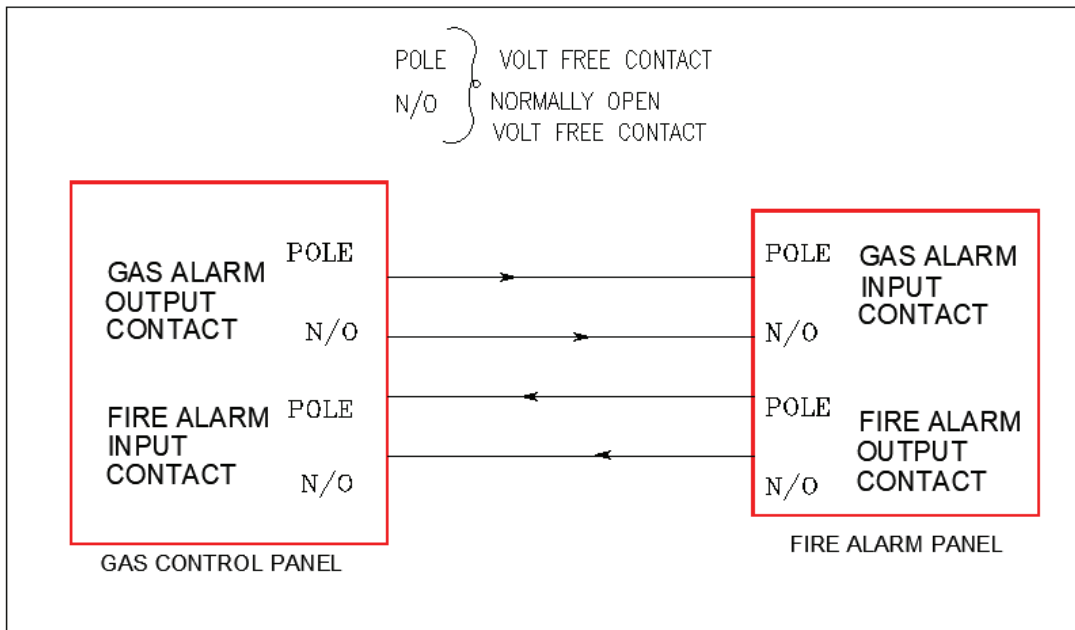


Fig. 2.4.6.d. FACP - GCP (Gas Control Panel) Interface Detail.

Applicability of the guide

1. This guide is governed by all the legal and statutory general provisions and obligations applied in the KSA and is governed by all agreements binding the KSA
2. The references of the Saudi building code and international codes accredited by the Saudi Arabian Standards Organisation (SASO) and their provisions and standard specifications are considered an integral part of this guide
3. The most recent publications of health regulations and requirements issued by the Ministry of Health, the Saudi Food and Drug Authority, the Presidency of Meteorology and Environment and the relevant stakeholders are considered an integral part of this guide. Their provisions are to be applied when no relevant text is available in this guide
4. If there is a conflict between one of the guide conditions, the manual conditions, and the NFPA (Codes), and it was irreconcilable; then the higher requirements should be applied.
5. If any of the design documents or communications between the work parties mentions the guide or part of it as a reference, this shall have the same compulsory effect as the guide, to the extent stipulated by the mention



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