PURPOSE

These guidelines describe safety requirements in the design, construction, operation and maintenance of fuel gas piping and utilisation systems. The requirements are based on applicable legislation and industry standards. It is intended primarily to guide developers, consultants, contractors, owners and operators of piped gas systems in residential, commercial and educational premises, and to educate end-users and the public on pertinent gas safety principles and practices.

These guidelines are not intended to cover in detail all the related safety and technical requirements. For further details on the subject, reference should be made to the applicable regulations and standards mentioned in these guidelines.

CHARACTERISTICS OF PIPED GAS

The two types of fuel gases that are normally piped or reticulated to end-users are liquefied petroleum gas or LPG and natural gas. Their components and characteristics which have implications on safety of the installations are described below.

<table>
<thead>
<tr>
<th>PHYSICAL PROPERTIES OF PROPANE, BUTANE AND METHANE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td>CHEMICAL FORMULA</td>
</tr>
<tr>
<td>SPECIFIC GRAVITY (LIQUID)</td>
</tr>
<tr>
<td>BOILING POINT (ATMOSPHERIC)</td>
</tr>
<tr>
<td>IGNITION TEMPERATURE</td>
</tr>
<tr>
<td>FLAMMABILITY LIMITS (UPPER)</td>
</tr>
<tr>
<td>FLAMMABILITY LIMITS (LOWER)</td>
</tr>
<tr>
<td>IDEAL COMBUSTION RATIO (AIR TO GAS)</td>
</tr>
<tr>
<td>HEAT VALUE PER CU.FT (VAPOR)</td>
</tr>
<tr>
<td>HEAT VALUE PER POUND (LIQUID)</td>
</tr>
</tbody>
</table>

Liquefied petroleum gas (LPG):
- LPG is a mixture of propane (40%) and butane (60%)
- LPG is stored as a liquid under pressure, is colourless and odourless in its natural state
- LPG vapour is heavier than air. Therefore, the vapour may flow along the ground and into drains and be ignited at a considerable distance from the source of leakage.
LPG forms a flammable mixture when mixed with air in the flammability limit to large volumes of vapour/air mixture and thus cause considerable hazard

LPG is odorised before distribution such that any escape of gas may be noticeable by smell.

Natural gas:
- Natural gas is mainly methane
- Natural gas is not stored at the consumer’s premises due to complexity of storage facilities. Natural gas can only be feasibly liquefied under cryogenic conditions
- Natural gas is lighter than air. Hence, escaping vapour rises upwards
- Natural gas forms a flammable mixture flammability limit when mixed with air in the correct proportion
- Natural gas is odorised before distribution.

Basically, safety requirements in the design, construction and maintenance of either LPG or natural gas piping systems at consumer’s premises are the same, except in the following aspects which necessitate different design principles to be used.

- Due to its very low boiling point, natural gas is transported in pressurised vapour state from gas processing plants or terminals via pipelines to end-user appliances. There is no natural gas storage at the consumer’s premises. LPG, due to its relatively higher boiling point, is transported by road tankers in the liquid state from refineries or terminals and stored at consumer’s premises in storage vessels before it is vaporised and piped to end-user appliances.

Hence, in LPG systems there is the risk of liquid leakage or release from the system. Small volume of liquid LPG leakage from the storage system will expand to become an enormous volume of flammable vapour/air mixture which may give rise to BLEVE (boiling liquid expanding vapour explosion). Since there is no natural gas liquid at the consumer’s premises, similar leakage of natural gas will give rise to a much smaller volume of flammable vapour/air mixture.

- Natural gas vapour is lighter than air whereas LPG vapour is heavier than air. Any leakage of natural gas vapour from the piping system will tend to be easily dispersed and diluted upwards whereas LPG vapour leaks from the piping system will tend to accumulate below. Thus, preventive measures need to be incorporated in the design and operation of LPG systems to enhance ventilation and minimise leaking gas accumulation at lower surfaces or depressions at the installation site.

GAS PIPING SYSTEM CONFIGURATION

LPG piping system

The main components of the system are:

- Storage vessel

LPG is stored at consumer’s premises in pressurised vessels (for bulk storage systems) or in cylinders which are manifoldsed together. The design pressure of the vessel or cylinder is usually 1724.0 kiloPascal (kPa) or 250.0 pounds per square
inch (psi). Bulk storage vessels may be installed in any of the following configurations:

- **Aboveground**: tank is fully exposed aboveground
- **Underground**: tank is fully buried underground
- **Mounded**: tank is fully earth-covered above the ground

**Delivery or service pipeline**

This line is used for delivering the LPG vapour from the storage tank to gas appliances. Vaporisers are sometimes installed near the tank to vaporise liquid LPG in the line into vapour before the first stage regulator. This is used only in ‘liquid withdrawal systems’.

Pressure regulators are installed along the line to reduce the vapour pressure progressively from the tank operating pressure (about 80-100 psig) to appliance operating pressure (11 inches water column). This pressure reduction is normally done in two stages (for better reliability and safety) such that the gas line pressure in the building is reduced to not more than 5 psig. A schematic showing a typical configuration of an LPG storage and piping system installed on consumer’s premises is as shown below:

**Natural gas piping system**

Natural gas is delivered from the gas processing plant to consumers by means of a main transmission pipeline. Natural gas from the main transmission pipeline is then reduced in pressure at the city gate station and distributed to a district or city. In each district or city, further pressure reductions are achieved at district stations and service stations or area stations before reaching the consumer gas utilisation facilities.
The main transmission pipeline is designed for 1000 psig maximum operating pressure. However, the normal operating pressure of the line is about 450 psig. The pressure from the main line is reduced at the city gate station to about 260-300 psig and subsequently at district stations to 60 psig. The pressure is further reduced at area stations in residential complexes to about 11 inches water column or at service stations in commercial complexes to 5 psig before the pipe enters the building for further reticulation to gas appliances.

**LEGAL REQUIREMENTS**

The safety and reliability of gas piping or reticulation systems in non-industrial premises are governed by the Gas Supply Act 1993 (Act 501) and the Gas Supply Regulations 1997, under the purview of the Energy Commission (ST).

Act 501 regulates the piping of natural gas downstream of city gate stations or the piping of liquefied petroleum gas (LPG) from the filling point of storage vessels or cylinders up to end-user appliances or equipment.

The design, installation, operation and maintenance of piped gas systems must comply with the safety requirements stipulated in the Gas Supply Regulations 1997 as indicated below.
Competency of technical personnel and contractors who install, construct, maintain, repair or operate piped gas systems are controlled under Act 501 through the registration of competent person and contractor firm respectively.

Approvals are issued by ST to contractors before commencing installation work and after its completion. Engineering drawings and calculations and certificates of completion and test endorsed by the relevant competent persons have to be furnished for the approval purposes.

Gas fittings, appliances or equipments installed in piped gas systems must also be of the type approved by ST or other related government agencies.

In line with the provisions of the Gas Supply Regulations 1997, safety and technical provisions prescribed by the following standards are recognised by ST as a basis for reviewing and approving piped gas installations and equipment.

**Malaysian Standards:**

**MS 830** – Code of practice for the storage, handling and transportation of liquefied petroleum gases.
 *(The code covers the design, construction, location and operation of LPG storage and piping up to the outlet of the first stage regulator)*

**MS 930** – Code of practice for the installation of fuel gas piping systems and appliances.
 *(The code is a safety code which applies to the installation of fuel gas piping systems and appliances from the outlet of the first stage regulator (for LPG) or the customer’s meter set assembly (for natural gas) up to the gas utilisation device)*
American Society of Mechanical Engineers Standards:

ASME B31.8 – Gas Transmission and distribution piping systems
(The code covers the design, fabrication, installation, inspection, testing, and safety aspects of operation and maintenance of gas transmission and distribution systems, including gas mains and service lines up to the outlet of the customer’s meter set assembly.)

PLANNING FOR PIPED GAS SYSTEM

When planning or designing the gas piping or reticulation system, the following aspects must be determined or verified in advance in order to ensure the system meets all safety and technical requirements of the legislation and standards as well as it is able to deliver the required quantity of gas:

- For natural gas supply systems, confirmation on the availability of gas distribution line infrastructure and the required supply pressure must be obtained from the licensed gas supplier.
- Total gas consumption volume of gas appliances (maximum gas volume per hour) must be determined based on existing and anticipated future appliance demands.
- Operation pattern of gas appliances (coincidence factor)
- Supply pressure required for the proper operation of the gas appliance.
- The locations of gas appliances.
- Suitable space or compartment in the housing area, building and users’ premises that is required for the gas piping system installation.
- The land or space in the housing area or building that is required for natural gas regulating station or LPG storage system.
- When the additional piping is to be connected to existing piping, the existing piping must be checked to determine if it has adequate specifications and capacity for the new demand.

GAS DEMAND DETERMINATION

The volume of gas accounted for shall be determined from either the manufacturer’s input rating, gas supplier, equipment manufacturer or a competent personnel. Estimation on equipment’s rating is as shown below (Table 11, MS 930).

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Demand in BTU/hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbecue (residential)</td>
<td>50,000</td>
</tr>
<tr>
<td>Domestic Clothes dryer</td>
<td>35,000</td>
</tr>
<tr>
<td>Domestic Gas Range</td>
<td>65,000</td>
</tr>
<tr>
<td>Domestic Recessed Oven Section</td>
<td>25,000</td>
</tr>
<tr>
<td>Gas Refrigerator</td>
<td>3,000</td>
</tr>
<tr>
<td>Storage Water Heater up to 30 gallon tank</td>
<td>30,000</td>
</tr>
</tbody>
</table>
The total connected hourly load shall be the basis for storage and pipe sizing for all equipment that may be operating at full capacity simultaneously. However, a coincidence factor can be established and may be used with the approval of ST (as per MS 930). Coincidence factor is the ratio of the maximum demand of a group as a whole to the sum of the individual maximum demands of the several components of the group. It is dependent upon the number and kinds of gas appliances installed.

A suggested statistical table for determining the coincidence factor for household units installed with gas cooking ranges and water heaters is as shown below.

<table>
<thead>
<tr>
<th>No. of units</th>
<th>Value of CF</th>
<th>No. of units</th>
<th>Value of CF</th>
<th>No. of units</th>
<th>Value of CF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.0</td>
<td>15</td>
<td>0.225</td>
<td>100</td>
<td>0.152</td>
</tr>
<tr>
<td>2</td>
<td>0.680</td>
<td>20</td>
<td>0.209</td>
<td>150</td>
<td>0.143</td>
</tr>
<tr>
<td>3</td>
<td>0.538</td>
<td>25</td>
<td>0.198</td>
<td>200</td>
<td>0.138</td>
</tr>
<tr>
<td>4</td>
<td>0.453</td>
<td>30</td>
<td>0.190</td>
<td>250</td>
<td>0.134</td>
</tr>
<tr>
<td>5</td>
<td>0.395</td>
<td>40</td>
<td>0.179</td>
<td>300</td>
<td>0.132</td>
</tr>
<tr>
<td>6</td>
<td>0.353</td>
<td>50</td>
<td>0.171</td>
<td>400</td>
<td>0.128</td>
</tr>
<tr>
<td>7</td>
<td>0.320</td>
<td>60</td>
<td>0.165</td>
<td>500</td>
<td>0.126</td>
</tr>
<tr>
<td>8</td>
<td>0.293</td>
<td>70</td>
<td>0.161</td>
<td>600</td>
<td>0.124</td>
</tr>
<tr>
<td>9</td>
<td>0.271</td>
<td>80</td>
<td>0.157</td>
<td>700</td>
<td>0.123</td>
</tr>
<tr>
<td>10</td>
<td>0.252</td>
<td>90</td>
<td>0.154</td>
<td>1000 and above</td>
<td>0.120</td>
</tr>
</tbody>
</table>

**DESIGN PRESSURE**

Piping systems need to have the required structural strength with a reasonable factor of safety to withstand primary stresses arising from internal gas pressures as well as secondary stresses from external forces. Besides this, it must also be leak-proof to prevent inadvertent escape of the flammable and explosive gases to the surroundings.

In order to minimise the risk of gas leaks, in line with the requirements of MS 930 the maximum operating pressure of piping located inside buildings shall not exceed 35 kPa (5 psig) unless approved by ST and one or more of the following conditions are met:
- The piping system is welded.
- The piping is located in a ventilated chase or enclosed for protection against accidental gas accumulation.

The design pressure of LPG bulk storage vessels (aboveground, underground and mounded) and portable LPG cylinders should be 1750 kPa (250 psig). This is in line with MS 830 requirements (The normal operating pressure of LPG storage containers is 80-100 psig).

LPG storage containers have to meet the strength requirements of applicable MS or international standards such as ASME Section 8 and they require approval from DOSH. Piping and components have to comply with ASME B31.8, MS 830 or MS 930, whichever is applicable.

According to ASME B31.8, the piping system should be designed to operate at pipe material hoop stress levels below the yield strength of the pipe material. The safety factor to
Determine the operating stress level takes into account the risk of third party damages which is categorised by the code according to its location class. A location class 1 reflects minimum risk of third party damage whilst location class 4 reflects maximum risk. All distribution pipelines in the country are designed to operate under location class 4 conditions.

MS 830 requirements pertaining to the design pressures of sections of LPG piping systems are as follows:

- Piping and components used at pressure higher than storage container pressure, such as on the discharge of liquid transfer pumps must be suitable for a working pressure of at least 2410 kPa.

- Piping and components used with liquid LP Gas or with vapour LP Gas at operating pressure over 860 kPa must be suitable for working pressure of 1750 kPa.

- Piping and components for use with vapour LP Gas at pressure not exceeding 860 kPa shall be suitable for working pressure of 860 kPa.

**PRESSURE REGULATION**

Piping systems have to be installed with the necessary devices to regulate flow and pressure. Pressure regulators are installed for reducing the gas delivery pressure before reaching the appliances.

In LPG systems, a high pressure regulator is installed at the LPG storage container outlet line for reducing the tank pressure of about 80 psig to 5 psig or less before entering the building. When installed as such, the regulator is known as the first stage regulator of the gas reticulation system.

A low pressure or second stage regulator is installed downstream of the first stage regulator to reduce the 5 psig gas pressure to about 11" water column outlet pressure, which is the normal operating pressure of LPG appliances.

Preferably, regulators should be installed outdoors for safety reasons. When this is not possible, regulators installed inside buildings should be vented to the outside air, except venting is not necessary for regulators with built-in vent limiting devices.

A piping system must have at least two acceptable devices (a line pressure regulator plus one other device), each limiting the pressure to a value that does not exceed the maximum working pressure of the downstream system, both of which must fail simultaneously in order to overpressure the downstream system. It is therefore mandatory to have built-in pressure relief devices in the second or final stage regulator to protect the appliances from excessive pressures.

Pressure relieving and pressure limiting devices shall be set so that the pressure shall not exceed a safe level beyond the maximum allowable working pressure for the piping and appliances connected.
MATERIALS SELECTION

Materials used in the construction of gas reticulation systems must be compatible with the properties of the gas. They must have the necessary properties such as good mechanical strength, ductility, resistance against gas attack and environmental degradation. LPG and natural gas will cause natural rubber and some plastics to deteriorate. Hence, installers and users should only use hoses and other equipment specifically designed for gas.

Malaysian Standards MS 830 and MS 930 clearly stipulate the list of materials acceptable for gas reticulation systems as mentioned below.

Pipe shall be steel, copper, or polyethylene and shall comply respectively with the following or other equivalent specifications approved by ST:
- **Steel pipe**: ASTM A106 or API 5L Grade B
- **Copper pipe**: EN 1057.
- **Polyethylene pipe**: ASTM D2513 or ISO 4437. Polyethylene pipes made to other standards shall include the ISO method of determination of long-term hydrostatic strength at 20 °C derived from 80 °C testing.

Carbon steel is the most commonly used piping material with no limitations of piping operating pressures due to its good mechanical properties.

Medium and high density polyethylene (PE) pipes may be used for buried installations with operating pressures of not exceeding 60 psig.

Copper pipes (seamless) may be used in vapour phase systems only with operating pressures of not exceeding 140.0 kPa (20 psig).

Underground carbon steel vessels and pipes need to be protected from corrosion by using protective coatings and cathodic protection system.

Pipe fittings should be steel, copper or polyethylene.

Pressure containing metal parts of valves (except appliance valves), including excess-flow valves, non return valves, safety relief valves, and manual shut off valve used in piping systems, shall be of steel, ductile (nodular) iron, malleable iron or brass.

Steel shall meet the requirements of ASTM A182. Ductile iron shall meet the requirements of ASTM A395 or equivalent. Malleable iron shall meet the requirement of ASTM A47 or equivalent. All materials used, including valve seat discs, packing, seals and diaphragms shall be resistant to the action of LPG under service conditions.

Cast iron is not permitted to be used as piping and fittings material because of its brittle properties. PVC and natural rubber are also not allowed due to their poor long-term resistance to gas attack.
LPG STORAGE SIZING

The capacity of LPG storage tanks or manifolded cylinders must be determined such that enough gas is available to be piped to the appliances at all times. The tanks should be sized such that adequate pressure is maintained in it to operate the gas system at the rated gas demand of the appliances.

“Tank Sweating” (water condensation on external surface of container due to excessive lowering of temperature of LPG liquid in container to meet demand) will occur when the container is undersized.

In natural vaporization systems, the gas demand must be equal to or less than the vaporisation rate of liquid LPG in the storage container at the worst operating condition. The rate of vaporization of a container is dependent upon the temperature of the liquid and the amount of “wetted surface” area of the container. The temperature of the liquid is proportional to the outside air temperature and the wetted surface area is the tank surface area in contact with the liquid. Therefore, when the outside air temperature is lower or the container has less liquid in it, the vaporization rate of the container is a lower value.

It is necessary to manifold LPG cylinders or tanks to a common supply pipeline in order to obtain the required capacity for liquid vaporisation or to minimise cylinder replacement or tank refilling frequency (preferably a maximum of once in 7 days) for the installation. This entails the provision of operating and standby or reserve cylinder banks.

Rules of thumb developed by the industry through experience may be used in sizing LPG storage cylinders. A recommended rule of thumb is that a 50 kg. LPG cylinder has an evaporative capacity of approximately 100,000 Btu per hour.

To ensure uninterrupted operation of manifolded cylinder installations, automatic changeover regulators should be used. These regulators change from the supply cylinder (when the gas is exhausted) to the reserve cylinder automatically without having to shutdown the system to refill.

Storage container evaporative capacity problem may be overcome by reverting to liquid withdrawal using a LPG indirect-fired vaporizer to vaporise the liquid LPG before the first stage regulator. The design and installation of various types of LPG vaporizers are covered by MS 830.

LPG STORAGE SAFETY

A suitable site for the permanent placement of an LPG storage tank or manifolded cylinders must be selected to ensure safety of the installation. The following factors should be considered:

Safety distance

Safety distances are intended to protect the LPG facilities from the radiation effects of fires involving other facilities as well as to minimise the risk of escaping LPG being ignited before being dispersed or diluted.
Safety distances shall be measured horizontally and radially from the container shells to the specified feature (e.g. an adjacent storage container, building, and property boundary) except that where deflection or radiation walls are used, the distance shall be measured in a horizontal line around such walls.

The safety distance requirements for various types of tank installations are spelt out in detail in MS 830. A 4-hour fire-rated deflection walls of 2 meters height may be installed to reduce safety distance between storage vessel and buildings.

The safety distance requirements for aboveground and underground/mounded tank installations at consumer’s premises as stipulated in MS 830 are included as follows:

<table>
<thead>
<tr>
<th>Water capacity of individual container, (kl)</th>
<th>Minimum safety distance, (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 0.5</td>
<td>None</td>
</tr>
<tr>
<td>Over 0.5 to 2.5</td>
<td>1</td>
</tr>
<tr>
<td>Over 2.5 to 10</td>
<td>1</td>
</tr>
<tr>
<td>Over 10 to 135</td>
<td>D1 + D2</td>
</tr>
</tbody>
</table>

**SAFETY DISTANCE OF ABOVEGROUND BULK STORAGE CONTAINER**

**Site topography**

To avoid accumulation of liquid or vapour beneath or in the immediate vicinity of a container, the container shall not be situated in or vertically above a depression on the site, nor should the area under or around the container be filled with aggregate with a high percentage of voids. It should be located far away from underground and deep open drains to prevent leaking LPG vapour from accumulating and flowing to sources of ignitions.

**Security and damage protection**

The storage facilities installed at site must be adequately protected against tampering by unauthorised persons. This is usually achieved by providing security fencing of the facilities.
The storage and piping system must also be protected against possible damages from encroaching vehicles by installation of barriers or walls whenever required.

**Accessibility**

Storage facilities need to be located where there is adequate provision of access and exit routes for gas delivery tankers and also emergency equipment. Escape routes must also be provided for operating personnel during emergencies.

**Ventilation**

Storage facilities must have good natural ventilation to ensure safe dilution of leaking gas.

A typical layout plan of a LPG bulk storage facility with safety distance, security, and damage protection and good accessibility for refilling is as shown below.

**Corrosion protection**

Every buried container and pipeline shall be protected against corrosion by protective coating or wrapping of enamels or plastic materials supplemented by an adequately designed cathodic protection system.

Cathodic protection is an electrical technique for imposing a potential on the protected container or pipeline to counter the tendency for electrochemical ion migration and stop corrosion almost completely. The cathodic protection system may be of the sacrificial anode or impressed current type but in either case shall be provided with a point at which a test can be made to determine the efficacy of the system.

**Backfilling**

Backfilling material immediately adjacent to underground/mounded container shall consist of at least 150 mm of non-corrosive inert material such as water-washed sand free from soil, rocks, gravel or ashes and other deleterious matter. Backfilling sand shall have a minimum resistivity of 100 $\Omega$ when tested after thorough moistening with distilled water. The sand shall be well tamped into place during the backfilling operation. Mounded containers shall have the upper surface covered with earth to a depth of at least 600 mm.

**Electrical and electrostatic hazard precaution**

According to MS 830, an area classified as "hazardous" is an area in which any flammable atmosphere is continuously present (Zone 0), or is likely to occur in normal operating conditions.
conditions (Zone 1) or in abnormal conditions (Zone 2). A storage container and other specified gas equipment and handling facilities such as relief valve discharge, vaporisers and filling points shall be located so that a fixed ignition source does not fall within a hazardous area classified as zone 0, 1 or 2 surrounding the above points.

Only intrinsically safe electrical equipment (equipment that cannot cause ignition when in contact with flammable or explosive atmospheres) can be used in Zone 0, whilst flameproof/explosion-proof electrical equipment (equipment which contains the explosion within a housing, preventing the ignition of the surrounding atmosphere) may be used in Zone 2 or 3.

An effective earthing point and/or bonding connection shall be provided at the storage site for discharging static electricity from bulk tank vehicles prior to commencing the delivery operation. In addition, storage containers greater than 2.5 kl water capacity shall be electrically earthed as a protection against the accumulation of static electricity.

The placing of storage containers within 1.5 m measured horizontally from the vertical plane of overhead transmission lines shall be avoided.

**Manifolded cylinders location**

Cylinders shall be located outside of buildings situated on a firm level ground in a well ventilated location (Cylinders shall not be installed in a basement or in locations below ground level). The safety distance requirements for cylinders as stipulated by MS 830 are as below:

| Aggregate water capacity of cylinders in a manifolded group of cylinders (kl) | Minimum safety distance (m) |
|---|---|---|
| | From building A | From property boundary B | From a fixed ignition source |
| Up to 2.5 | None | None | Fixed ignition source shall not fall within Zone 0, 1 or 2 area |
| Over 2.5 to 10 | 7.5 | 7.5 | |

**Cylinder location and safety distances (Table 10 of MS 830)**

According to MS 830 a cylinder installation outside a building shall comply with the following requirements:

- The water capacity of individual cylinder in a manifolded group of cylinders shall not exceed 125 l. If more than one manifolded group of cylinders are installed at a consumer site each manifolded group shall be separated from the border by at least 7.5 m. A deflection wall of 2 h fire resistance rating and a minimum height of 2 m may be used to reduce this distance to 3 m provided the vapour path shall not be less than 7.5 m. (See also Figure 9)

- The installations shall be fenced and locked to prevent unauthorised access and tampering.
o Any opening into the building which is below the level of the relief valve shall be at least 1 m horizontally from the nearest cylinder.

o One or more cylinders may be installed below a window, provided that there is a minimum distance of 150 mm between the top of any cylinder valve and the bottom of the window opening.

o A cylinder shall be located at a distance of at least 5 m from flammable or combustible liquid storage and other forms of combustible materials. This distance may be reduced to 3 m by using a deflection wall of 2 h fire resistance rating.

o Any exterior source of ignition, openings into direct-vent (sealed combustion system) appliances or mechanical ventilation air intakes shall be at least 1.5 m in any direction away from the nearest cylinder or opening to the compartment whichever is nearer.

o A specially built compartment within the building boundary but meeting the following requirements shall be considered an outdoor installation and shall be required to meet the safety requirements and distances for outdoor installations.

o The compartment shall be separated from the rest of the building by surrounding walls having 4 h fire resistance rating. The separation shall be absolute in such manner that it will have no openings of access towards the inside of the building proper.

o The floor shall be of smooth concrete and at least 100 mm higher than the ground. Rough surface which may cause sparking during cylinder handling shall not be used.

o Electrical appliances installed in the compartment shall be at least suitable for Zone 2 application and preferably located above the cylinder.

o Ventilation openings of at least 300 cm² per 1 m² of the floor area shall be provided and such opening shall be as closed to the floor as practicable, so as to prevent leaking gas from accumulating inside the compartment.

o A door of at least 1.5 m width shall be provided with access orientated towards the outside of the building.

**PIPE ISOLATION**

Openings in storage container shell are provided with protective valves (to protect against inadvertent release of LPG) in accordance with MS 830 provisions. Accordingly, all openings in containers, except those for safety relief valves and those connections protected by an opening not larger than No. 54 drill size (0.0550 inch), shall be equipped with excess flow valves or other suitable automatic valves or devices which will automatically prevent loss of the tank contents in the event of a connection or line failure.

Isolation valves should be installed at strategic locations in the gas piping system to facilitate isolation of sections or components of the piping system for servicing and maintenance and during emergency situations. Isolation valves must have manufacturer’s design and operating specifications which are compatible with the system operating parameters.
Isolation shut-off valve
This is usually installed at various locations along the line e.g. at branch lines, before regulators and meters, at each riser point, at appliance points, to enable isolation of each section of the pipe for maintenance as well as during emergency. Isolation valves should be of quick-action type such as manually operated ball valves.

Emergency shut-off valve
This valve can be either manually automatically triggered shut from a remote location away from the valve unit. This kind of valve, preferably of fire-proofed type, should be installed at strategic locations such as before entering a building, to enable remote shut-off during emergency. They may sometimes be controlled from the building control room.

GAS METERING

A meter location agreed upon by the gas utility company shall be provided as close as possible to the point where the gas service piping enters the building.

The location shall be such that the meter, meter connections, gas service piping tee and gas service shut off valve are exposed and accessible for inspection, installation, replacement, removal, locking, unlocking and reading.

Gas meters shall not be located where meters will be subject to damage, such as in public passageways, over doors or in locations subject to dripping water or unusual moisture conditions or extreme high temperatures or where the meter will be inaccessible.

Gas meters shall be located at least 1 m from sources of ignition. Meters shall be securely supported and shall be protected against overpressure, backpressure and vacuum.

All riser/meter compartments shall be naturally ventilated by fixed louvers or precast concrete ventilation blocks at the top and bottom of the compartment to atmosphere. The door of the duct opening to the lobby area shall be fire-rated to the relevant authority’s requirement.

The service pipe termination and internal piping termination shall be in line and parallel to the face of the door of the riser shaft or duct to enable the gas meter and control valve to be installed easily without the need for further pipe adjustments.

PIPE SIZING

Proper sizing of supply pipelines is important so that each gas appliance receives enough gas to perform properly. Inadequate sizing of supply pipelines not only will cause inefficient appliance operation but also supply interruptions which can adversely affect the safety of the system.

Gas piping shall be sized to provide the maximum demand, and such that the supply pressure at the gas utilization equipment is appropriate and greater than the minimum pressure required.

Two different methods of pipe sizing are presented in Appendix C of the MS 930. These are;
The sizing tables in MS 930 contain gas-carrying capacities for different sizes and lengths of rigid pipe and semi-rigid tubing. The tables are in order by type of gas (natural or LPG), type of piping (pipe or tube), pressure, and pressure drop allowed.

The design parameters must adhere to certain pressure limitations as stipulated in the applicable standards. For instance, under normal conditions, the maximum design operating pressure for piping located inside buildings shall not exceed 35 kPa (5 psi) (as stipulated in MS930).

For larger and more complex gas piping systems that are not covered by MS 930, the size of the gas piping system shall be determined by standard engineering methods acceptable to ST. These are:
- Poles Method
- Cox’s Method

The maximum allowable pressure drop recommended for the design of internal gas piping should be less than 15 percent.

The maximum gas velocity in the gas pipe should be less than 20 m/s such that the gas velocity shall not have negative effects, for example, by eroding the pipe wall or creating nuisance to the public from excessive noise emissions.

A recommended format for presenting gas reticulation network pipe sizing calculations is as shown below. (Pipe sizing softwares are readily available from Universiti Teknologi Malaysia.)

<table>
<thead>
<tr>
<th>Inlet Node</th>
<th>Outlet Node</th>
<th>Flow Rate scmh</th>
<th>Length m</th>
<th>CF</th>
<th>Diameter mm</th>
<th>Inlet Pressure kPa</th>
<th>Outlet Pressure kPa</th>
<th>Pressure Drop KPa</th>
<th>Pressure Drop %</th>
<th>Velocity m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PIPE INSTALLATION**

**General requirements**

The general principles which must be borne in mind when planning a gas pipe installation on residential premises are as follows:

- The piping system must be designed so that the gas meter provided by gas supplier can be properly located for the building of the owner or each customer.

- Gas pipes should be located such that the location of isolation valves are easily accessible to the users to facilitate line isolation during emergency. Each floor or
section of a building should be provided with an isolation point, in case of fire or leakage at any of the sections.

- Gas pipes should, as far as practicable, be run outside the building, especially when the operating line pressure exceeds 35 kPa (5.0 psi).

- Gas pipes should preferably enter the building aboveground and remain in an aboveground and ventilated location.

- Gas pipes should be properly painted and labelled for identification purposes. The currently adopted colour for gas pipes is yellow.

- The route should avoid any positions where the pipe could be liable to damage, either during the building operations or when the property is finally occupied.

- The fire resistance of the building must not be impaired.

- The route should, as far as possible, avoid the need to cut into load-bearing walls or joists.

- Pipes may be concealed, but provision should be made for access. Exposed gas pipes would facilitate leak detection and maintenance.

- Pipe riser ducts must have fire rated doors and have one side as an external wall with fixed louvers or ventilated p.c. block venting naturally to atmosphere.

- There should be a space of at least 50 mm between a gas pipe and any other service. Where electrical services use the same duct, the gas riser shall be separated from the electrical services by a gas-tight partition with respect to the electrical services.

- Pipes passing through a cavity must take the shortest route and be sleeved.

- Pipes are normally only run above ceiling, dropping down to appliances on the floor below it, when no other route is available.

- Pipes must not be laid under or through foundations.

- Pipes should never run diagonally across walls or floor, they should normally follow the line of the walls and be kept close to them.

- The piping system must not be exposed to the excessive external strength, vibration or corrosion.

- The piping system must be installed at a location where maintenance and checking work can be done easily.

- To prevent the distribution of gas leakage throughout the building, piping inside any building must not be installed at the following locations:
  - Lift shaft.
  - Flues, chimneys and gas vents.
  - Circulating air duct and ventilating duct.
  - Clothes chute.
- Enclosed staircase
- In rooms provided with high voltage power facilities
- Air handling room
- Unventilated void space
- Fire protected/smoke free/enclosed lift lobby areas.
- Within protected corridors or passageways which are routes of escape/exit
- Under load bearing foundations and walls

- All piping outlets shall be installed to provide sufficient clearance from ceilings, walls and floors to permit use of a pipe wrench of suitable size without straining or bending the pipe. The outlet fitting or piping shall not be placed behind doors.

- Each outlet, including pipe terminating with a valve, shall be securely closed gas-tight with an approved threaded plug or threaded cap immediately after installation and shall be left closed until an appliance is connected.

**Pipe shaft or duct**

Where practicable, gas pipes within the building, including gas risers, should be run exposed. The areas through which the riser passes should be well ventilated. This will ensure early detection of gas leaks, prevent accumulation of gasses to dangerous levels and allow for access for maintenance.

Where a gas riser is to located in a pipe shaft (or duct), permanent ventilation to the outside of the building should be provided to ensure that minor gas leakage does not cause the atmosphere within the duct to become unsafe.

Where shafts are continuous, ventilation can normally be achieved by the provision of openings at the top and bottom to the outdoors. The opening shall have a minimum free area (in square inches) equal to the product of one-half of the maximum pressure in the piping (in psi) times the largest nominal diameter of that piping (in inches), or the cross-sectional area of the duct, whichever is smaller.

When a pipe shaft takes the form of an enclosure at each storey level, riser pipes shall be fire stopped as the pass from one floor to another unless in their own protected shaft which is ventilated top and bottom to outside atmosphere. When riser pipes from a shaft or duct enter a flat or apartment unit they shall be fire stopped at the point of entry.
Piping buried in concrete or soil

Provided the wall thickness is adequate, pipework may be placed in a chase. A chase is a recess which is made after the wall has been constructed. A chase must be made vertically or horizontally, never diagonally.

Underground pipes also need to be protected against aboveground loading by using protective sleeves and slabs. When dissimilar metal are joined underground, an insulating coupling or fitting shall be used. Piping shall not be laid in contact with cinders.

Uncoated threaded or socket welded joints shall not be installed in contact with soil where internal or external crevice corrosion may occur. Piping which is in contact with soil or other materials which may corrode the piping shall be protected against corrosion in an approved manner.

Pipe penetrating through solid wall or floor

Gas pipes passing through solid walls or floors must take the shortest practicable route and be enclosed in a gas tight sleeve.
Underground pipe damage protection

Proper protective measures should be taken to protect underground gas piping against damage caused by the third party work. In addition, when underground gas piping is installed in soft soil, proper measures should be taken against differential settlements.

Underground gas piping installation before the boundary line of private land should have a depth of cover not less than 900 mm.

Underground gas piping installation beyond the boundary line of private land should have a depth of cover not less than 450 mm or deeper whichever is required by authority. The cover should be permitted to be reduced to a minimum of 300 mm if external damage to the pipe is not likely to result.

Pipe casing or protection slab should be used where the depth of cover of underground gas piping is not sufficient to protect the pipe from damage.

For steel underground gas piping installation, a cathodic protection will be used in conjunction with the coating to protect the gas pipe against corrosion.

Warning marker should be installed at suitable intervals along the straight and curved runs, and whenever there is abrupt change in direction of the underground gas piping as required by the regulations.

Warning slab should be located above the entire length of the underground gas piping. The purpose of warning marker and slab is to show that underground gas piping has been installed.
Pipe support

The piping system must be supported to avoid the external strength such as vibration, thermal shrinkage and must be installed at a location where maintenance work can be done easily. Gas piping shall be supported with the proper size pipe hooks, metal pipe straps, bands or hangers.

The supports must be of adequate strength and quality, and located at proper intervals, so that the piping cannot be moved accidentally from the installed position.

The building structure shall not be weakened by the installation of any gas piping. Gas piping shall not be supported by other piping.

Spacing of supports in gas piping installations shall not be greater than as shown below (taken from table 2 of MS 930):

<table>
<thead>
<tr>
<th>Steel Pipe Nominal Size of Pipe (Inches)</th>
<th>Spacing of Supports (Feet)</th>
<th>Nominal Size of Tubing (Inch OD)</th>
<th>Spacing of Supports (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>6</td>
<td>1/2</td>
<td>4</td>
</tr>
<tr>
<td>3/4 or 1</td>
<td>8</td>
<td>5/8 or 3/4</td>
<td>6</td>
</tr>
<tr>
<td>1 1/4 or larger (horizontal)</td>
<td>10</td>
<td>7/8 or 1</td>
<td>8</td>
</tr>
<tr>
<td>1 1/4 or larger (vertical)</td>
<td>Every floor level</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pipe Tracer Wire

For polyethylene (PE) underground gas piping installation, a tracer wire is installed along the entire length of gas pipe for the purpose of locating the gas pipe from aboveground using a pipe locator. The tracer wire should be installed around the pipe surface and the wire ends should be led to aboveground, at appropriate intervals, where the discontinuity can be detected easily.

An insulated copper wire of at least 4 mm should be used as tracer wire.

Clearance from Other Buried Facilities

When a gas pipe runs close to some other services, contact between them shall be prevented by segregation or other means. Requirements for clearance (parallel and cross layout distances) from other buried facilities is as shown in the figure below:

For polyethylene pipe installation, ample clearance must be provided to separate such pipe from any heat source in order to assure that the surface temperature of the pipe does not exceed 35°C.
Underground gas piping

300 mm Other buried facilities

Parallel layout distance  Cross layout distance

Clearance from electrical cable and lightning arrestor should be as per table below:

<table>
<thead>
<tr>
<th>Buried Facility</th>
<th>Clearance (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low voltage cable</td>
<td>&gt; 100</td>
</tr>
<tr>
<td>High voltage cable</td>
<td>&gt; 1000</td>
</tr>
<tr>
<td>Lightning arrestor</td>
<td>&gt; 1500</td>
</tr>
</tbody>
</table>

Drain Crossing

Drain crossing gas pipe should be installed under the drain as shown in the following figure:

Connection of plastic piping (polyethylene piping)

When plastic piping (polyethylene pipe) is used as underground piping, connection between metallic pipe (steel) and polyethylene pipe shall be made only outside, underground and with approved transition fittings.

Isolation Joint Installation

Isolation joint shall be installed in the following location:

- Location where pipes or fittings made of different materials are joined in buried portion.
- Transition portion between underground and aboveground piping.
PIPE JOINTING

Jointing methods must also be suitable for the particular gas reticulation design. Gas piping joints must have good strength and leak tightness properties. The joint must be able to sustain the maximum end force due to the internal pressure and any additional forces due to temperature expansion or contraction, fatigue or to the weight of the pipe and its contents.

Welded joints are normally used for their excellent strength and sealing properties under all operating conditions. However, sometimes threaded joints may be use for very small diameter pipes operating at low pressures. Threaded joints are very leak-prone, hence, they should not be used in concealed pipe installations.

Although welding is preferred, threaded joints and fittings are permitted for pipe sizes up to and including 4" operating at 1 PSIG or less. Pressure piping larger than 4" and all pressure piping above 5 PSIG regardless of size must be welded or flanged.

Joints in steel pipe may be welded in accordance with API 1104 or ASME IX. Metallic pipe and fitting threads shall be taper pipe threads and shall comply with ANSI B2.1.

Joints in copper pipe shall be brazed in accordance with ANSI/AWS B2.2-91. Copper fittings shall conform to EN 1254.

Joints in polyethylene pipe shall be made by heat fusion in accordance with manufacturers’ instruction. Polyethylene fittings shall conform to ASTM D2683 or ASTM D3261. Plastic pipe or tubing shall not be threaded.

Welders of metallic gas piping or jointers of non-metallic piping must have a valid certificate of qualification from the relevant authority such as DOSH or Construction Industry Development Board (CIDB). For this, welders have to pass performance qualification tests according to the API 1104 or equivalent code requirements before they can be allowed to do the welding job.

GAS APPLIANCE SELECTION

The gas appliance operating pressure range and required gas consumption rate must be able to be met by the actual pressure and flow rate in the piping system.

All appliances used must be type-approved by ST. Appliances designed for LPG must only be used with LPG and similarly, appliances designed for natural gas must be used only with natural gas.

In order to convert existing LPG appliances to operate on natural gas, the gas burner nozzles size must be changed or increased to the meet natural gas characteristics. Appliance conversions must only be performed by competent persons registered with ST.
**GAS APPLIANCE INSTALLATION**

The gas appliance must be of the approved type and is suitable for the type of gas supply (natural gas or LPG) to which it will be connected. The installer shall provide the user with all the relevant manufacturer’s instructions.

A gas appliance should not be installed in a premises without testing the connection for gas tightness, ascertaining that all the gas safety controls are in proper working order, ensuring that there is proper ventilation and the operating pressure is as recommended by the manufacturer.

To enable appliances to be moved to a limited extent for convenience of use or to facilitate cleaning, a flexible hose connection approved by ST should be used. The length of connecting hose or tube from the gas cock to the appliance shall not exceed 1.5 m. The material of the hose or tube shall be rubber or copper approved by ST.

Adequate ventilation for combustion should be provided by ensuring air change, natural or otherwise in the kitchen as a whole. Separate flues or venting to the outside air are normally not required for domestic cooking appliances unless the kitchen area is fully air-conditioned. In such cases, flues should be designed and installed according to MS 930 requirements. Appliance manufacturers generally offer detailed information on proper venting of gas appliances. These instructions must be closely followed as specified in the appliance installation manual and operating instructions.

Gas cocks shall not be located in a position where either the flame of the gas table range could touch the gas cock or where heat from flame could have any significant effect on it or the gas hose.
INSPECTION, TESTING AND COMMISSIONING

Prior to acceptance and initial operation, all piping installations shall be inspected and tested by a competent person to ensure that the materials, design, fabrication and installation comply with the technical and safety requirements of the Gas Supply Regulations and applicable standards.

Inspection shall consist of visual examination during or after fabrication, assembly or test as appropriate.

Corrosion protective coating shall be subjected to holiday testing (test of the continuity of protective coating) and coating defects or damage that may impair effective corrosion control shall be repaired prior to installation in the ditch as specified by the relevant codes such as MS 830 or National Association of Corrosion Engineers (NACE) Recommended Practice.

The pressure or leak test medium shall be air or an inert gas (e.g. nitrogen, carbon dioxide). Gas may be used as the test medium at the maximum pressure available in the system at the time of the test.

Pipe joints including welds shall be left exposed for examination during the test. Expansion joints shall be provided with temporary restraints, if required for the additional thrust load under test.

Soapy water solution test may be used to locate leaks if all joints are accessible during the test. The test pressures and duration for various sections of natural gas and LPG piping systems are summarised in the table below:

<table>
<thead>
<tr>
<th>Scope</th>
<th>Maximum Operating Pressure kPa (psi)</th>
<th>Type of Test</th>
<th>Test Pressure kPa (psi)</th>
<th>Test Duration (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>From tank/ manifold up to 1st Stage Regulator</td>
<td>Up to 1725 (250)</td>
<td>Pneumatic/ leak</td>
<td>Nitrogen</td>
<td>1900 (275)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Air</td>
<td></td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leak (during commissioning)</td>
<td>LPG</td>
<td>Operating Pressure</td>
</tr>
<tr>
<td>From 1st Stage Regulator up to 2nd Stage Regulator</td>
<td>Up to 140 (20)</td>
<td>Pneumatic/ leak</td>
<td>Nitrogen</td>
<td>345 (50)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Air</td>
<td></td>
<td>1440</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leak (during commissioning)</td>
<td>LPG</td>
<td>Operating Pressure</td>
</tr>
<tr>
<td>After 2nd Stage Regulator</td>
<td>Up to 7 (1)</td>
<td>Pneumatic / leak (appliances disconnect)</td>
<td>Nitrogen</td>
<td>40 (20)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Air</td>
<td></td>
<td>1440</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leak (during commissioning)</td>
<td>LPG</td>
<td>Operating Pressure</td>
</tr>
</tbody>
</table>
### NATURAL GAS PIPING SYSTEM PRESSURE / LEAK TEST REQUIREMENTS

<table>
<thead>
<tr>
<th>Scope</th>
<th>Maximum Operating Pressure kPa( psi)</th>
<th>Type of Test</th>
<th>Test Pressure kPa (psi)</th>
<th>Test Duration (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Test</td>
<td>Medium</td>
<td>Above ground</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydrostatic</td>
<td>Water</td>
<td>345 (50) or 1.5 MOP whichever is higher</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pneumatic/ leak</td>
<td>Nitrogen</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leak (during commissioning)</td>
<td>Natural gas</td>
<td>Operation Pressure</td>
</tr>
<tr>
<td>From service / area station up to final stage regulator / meter</td>
<td>Above 140 (20)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydrostatic</td>
<td>Water</td>
<td>345 (50)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pneumatic/ leak</td>
<td>Nitrogen</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leak (during commissioning)</td>
<td>Natural gas</td>
<td>Operating Pressure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>从服务/区域站到最终阶段调节器/表</td>
<td></td>
<td></td>
</tr>
<tr>
<td>From service / area station up to final stage regulator / meter</td>
<td>Up to 140 (20)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydrostatic</td>
<td>Water</td>
<td>345 (50)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pneumatic/ leak</td>
<td>Nitrogen</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leak (during commissioning)</td>
<td>Natural gas</td>
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</tr>
<tr>
<td></td>
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<td>从服务/区域站到最终阶段调节器/表</td>
<td></td>
<td></td>
</tr>
<tr>
<td>After final stage regulator / meter</td>
<td>Up to 7 (1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pneumatic/ leak (appliances disconnected)</td>
<td>Nitrogen</td>
<td>140 (20)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leak (during commissioning)</td>
<td>Natural gas</td>
<td>Operating Pressure</td>
</tr>
</tbody>
</table>

Note:
- * Pressure chart recorders shall be used when underground piping systems are involved.
- ** Soapy water solution shall be used when a Gas detector is not available.

After the gas installation is satisfactorily tested for gas tightness as above, purging should be carried out by using an inert gas throughout the entire gas installation in order to remove all air or other gas mixture. If the gas installation is not to be used at once it shall be sealed off at every outlet with the appropriate fitting.

Any loose connection in the gas installation used in the purging procedure and seal after the purging procedure shall be retightened and shall be retested for gas tightness.

Upon the commissioning of the gas installation, the gas to be supplied through the installation shall be conveyed into the entire gas installation to remove all the inert gas present in the gas pipeline.

**OPERATION & MAINTENANCE**

Gas piping systems in service are subjected to various degrading or abnormal operating conditions such as third party activities, corrosive environment, ground erosion, excessive pressure fluctuations, malfunctioning or breakdown of components, material wear and tear, and tampering.
The regulations provide for a 'responsible person' who may be the licensee or consumer, or an occupier of the premises, or where there is no consumer or occupier, the owner of the premises or any person authorised by the consumer or occupier to be in charge of the gas pipeline or gas installation in the premises.

His role is essentially to be in charge of the gas pipeline or gas installation in the premises to ensure that certain basic safety and administrative requirements are being followed in the operation and use of the system. He has to shoulder the following responsibilities as provided for under the regulations:

- ensuring that the gas pipeline can be continuously identified,
- immediately taking all reasonable steps to cause the supply of gas to be shut off in the event of him knowing or suspecting gas escaping into the premises,
- informing the Director General or Gas Utility Licensee if gas continues to escape after supply has been shut off,
- taking all reasonable steps to ensure that gas can be re-supplied without causing any danger after supply is shut off for safety reasons,
- ensuring that the gas installation is maintained in a good and efficient working order,
- ensuring that safety is observed at all times so as to prevent danger from arising at the gas installation,
- attending and assisting any inspection on the gas installation performed by the Director General or his Authorised Officers,
- keeping of a maintenance record book in which any maintenance and repair work carried out on a gas installation is recorded,
- being informed of any alteration or repair to be carried out on the supply system by the competent person,
- being notified of any necessary emergency repairs done by the competent person, and
- taking adequate precautions to prevent a gas installation or equipment from being accidentally or inadvertently made unsafe during maintenance work.

Proper maintenance programmes and procedures including procedures for regular leakage surveillance of the system has to be prepared and followed by the responsible person. In addition to that, emergency procedures have to be prepared and rehearsed for actual implementation during emergencies involving gas leakage or fire.

The piping system must be subjected to a thorough inspection and testing by competent persons registered with ST at least once every 3 years. Pressure vessels must be inspected by DOSH Inspector regularly every fifteen months. Maintenance and repair works on the system must similarly be performed by competent persons.
**RECOMMENDED PREVENTIVE MAINTENANCE PROGRAMME FOR GAS PIPING SYSTEMS**

**Natural gas and LPG piping**

<table>
<thead>
<tr>
<th>MAINTENANCE ITEMS</th>
<th>FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Detailed visual survey for pipe, connections, valves and equipments by using gas detector or soap liquid. Every Two Years</td>
</tr>
<tr>
<td>2.</td>
<td>Detailed visual inspection for pipe support and surrounding conditions around piping and gas appliances Annually</td>
</tr>
<tr>
<td>3.</td>
<td>Inspection for PE/Steel transition joints. Annually</td>
</tr>
<tr>
<td>4.</td>
<td>Inspection and functional test of valves and regulators. Annually</td>
</tr>
<tr>
<td>5.</td>
<td>Air-tightness test for leak check testing. Every Three Years</td>
</tr>
<tr>
<td>6.</td>
<td>Painting &amp; labeling. Every Five Years</td>
</tr>
</tbody>
</table>

**Natural gas metering stations and LPG storage facilities.**

<table>
<thead>
<tr>
<th>MAINTENANCE ITEMS</th>
<th>FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Inspection of abnormalities on metering facilities. Monthly</td>
</tr>
<tr>
<td>2.</td>
<td>Leak check on pipe connections, fittings, valves and equipment using gas detector or soapy liquid. Six Month</td>
</tr>
<tr>
<td>3.</td>
<td>Functional test of valves, vaporizers, regulators, pressure gauges, earthing/grounding and emergency shut-off valves. Six Month</td>
</tr>
<tr>
<td>4.</td>
<td>Clean oil separator and strainers to bleed of heavy ends. Six Month</td>
</tr>
<tr>
<td>5.</td>
<td>Housekeeping and washing of station facilities Six Month</td>
</tr>
<tr>
<td>6.</td>
<td>Piping corrosion prevention. Annually</td>
</tr>
<tr>
<td>7.</td>
<td>Painting and labelling Every Fifteen Months</td>
</tr>
<tr>
<td>8.</td>
<td>Overhaul and soft part change-out Every Three Years</td>
</tr>
</tbody>
</table>
RELATED STANDARDS AND CODES OF PRACTICE FOR GAS PIPING SYSTEM

Malaysian Standards (MS):

MS 830:2003 - Code of Practice for the storage, handling and transportation of liquefied petroleum gases.


MS 1766:2004 - Code of Practice for the Installation of Gas Meters


    Part 2: 2002 - Domestic gas cooking appliances for use with LPG: General construction
    Part 3: 2002 - Domestic gas cooking appliances for use with LPG: Test method
    Part 4: 2002 - Domestic gas cooking appliances for use with LPG: Glossary

MS 158: 2001 - Specification for LPG (Second revision)

MS 875: 2001- Method of test for vapour pressure of LPG (LPG method)

MS 573:2000: - Method of test for vapor pressure of LPG,

MS 564:2000 - Method of sampling LPG

MS 537:2001 - Method of test for volatility of LPG

MS 641:1982 - Specification for LPG cylinders up to 1000 pounds water capacity without electric- arc welded longitudinal seam.

MS 642: 1982 - Specification for LPG cylinders up to 1000 pounds water capacity with electric- arc welded longitudinal seam.

MS 1165: 1989 - Specification for pressure regulators and automatic changeover devices for LPG


MS 773:1999 - Specification for flexible rubber tubing and hose for use in LPG vapour phase and LPG/air installations

American Society of Mechanical Engineers (ASME)

ASME B31.8:1999 - Code for Gas Transmission and Distribution Piping Systems

American Petroleum Institute
API 5L - Specification for Line Pipe
API 1104 - Standard for Welding Pipelines and Related Facilities.

National Association of Corrosion Engineers (NACE)

NACE Standard RP-02-74 - Recommended Practice for High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation