Guidelines On Domestic Gas Piping System

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Content

PURPOSES

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.

The guidelines are intended primarily to guide developers, consultants, contractors, owners and operators of piped fuel gas installations in residential premises, and to educate end-users and the public on fuel gas safety principles and practices.

SCOPE

These safety guidelines apply to the following piped fuel gas installations in residential premises:

(a) liquefied petroleum gas (LPG) storage tanks or cylinders and piping systems up to end-user appliances.

(b) natural gas area stations and piping systems up to end-user appliances.

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

1. CHARACTERISTICS OF PIPED GAS

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

Physical Properties Of Methane, Ethane, Propane And Butane				
Properties	**Methane**	**Ethane**	**Propane**	**Butane**
Chemical Formula	CH_4	C_2H_6	C_3H_8	C_4H_{10}
Specific Gravity (Liquid)	.3	.4	.509	.582
Boiling Point °C	-164	-89	-42	-0.5
Ignition Temperature °C	620	515	510 – 600	480 - 540
Flammability Limits (Upper) %	16	12.5	9.50	3.50
Flammability Limits (Lower) %	4.0	3.0	2.15	1.55
Ideal Combustion Ratio (Air To Gas)	10 to 1	15 to 1	24 to 1	31 to 1
Heat Value per cu.ft (Vapor) Btu	1,000	1,600	2,516	3,280
Heat Value per Pound (Liquid) Btu	-	-	21,591	21,221

Table 1: Gas properties

1.2 Liquefied Petroleum Gas (LPG)

- LPG is a mixture of propane (30 - 40%) and butane (60 - 70%) 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 within 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 its smell

1.3 Natural Gas

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

1.4 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 daripada sistem storan GPC.

1.4.1 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 remises. 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

1.4.2 Hence, in LPG systems there is a risk of liquid being leaked or released from the system. Small volume of liquid LPG leaks 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

1.4.3 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 to the surface 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

1.5 LPG or natural gas by itself has no toxicity. However, carbon monoxide (CO) is generated as the result of incomplete combustion. CO has extremely high toxicity and, in physical properties, it has essentially the same relative density as air and, since it is also colourless and odourless, people hardly become aware of its presence. Poisoning is caused by inhaling only a very small amount and it could result in death.

2. GAS PIPING SYSTEM CONFIGURATION

2.1 LPG piping system

2.1.1 The main components of the system are:

2.1.1.1 Storage vessel

LPG is stored at consumer's premises in pressurised vessels (for bulk storage systems) or in cylinders, which are manifold together. The design pressure of the vessel or cylinder is usually 1725 kiloPascal (kPa) or 250 pounds per square inch (psig). 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

2.1.1.2 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.

2.1.2 Pressure regulators are installed along the line to reduce the vapour pressure progressively from the tank operating pressure about 414 – 690 kPa (60-100 psig) to appliance operating pressure 300 mm w.c. (water column) or 0.5 psig. This pressure reduction is normally carried out in two stages (for better reliability and safety) such that the gas line pressure in the building is reduced to not more than 35 kPa (5 psig). A schematic showing a typical configuration of LPG storage and piping system installed on consumer's premises is as shown in Fig. 1 and Fig. 2.

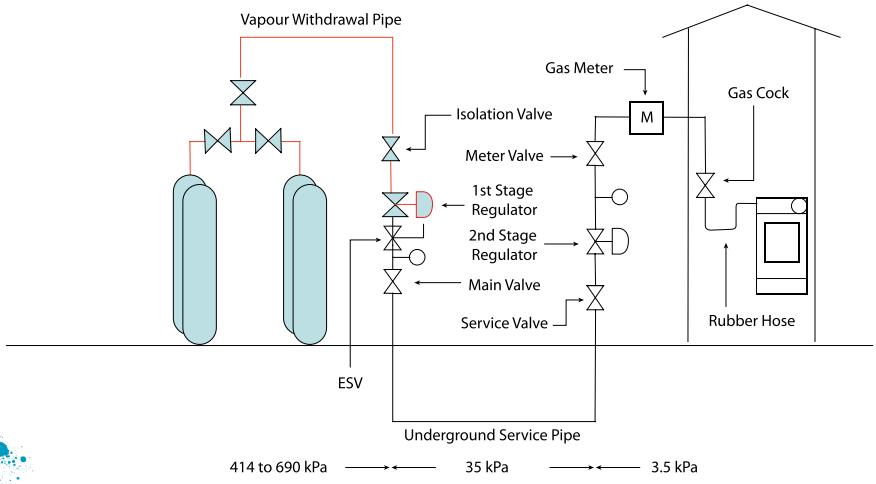


Fig. 1 : LPG manifolded cylinder storage and piping system

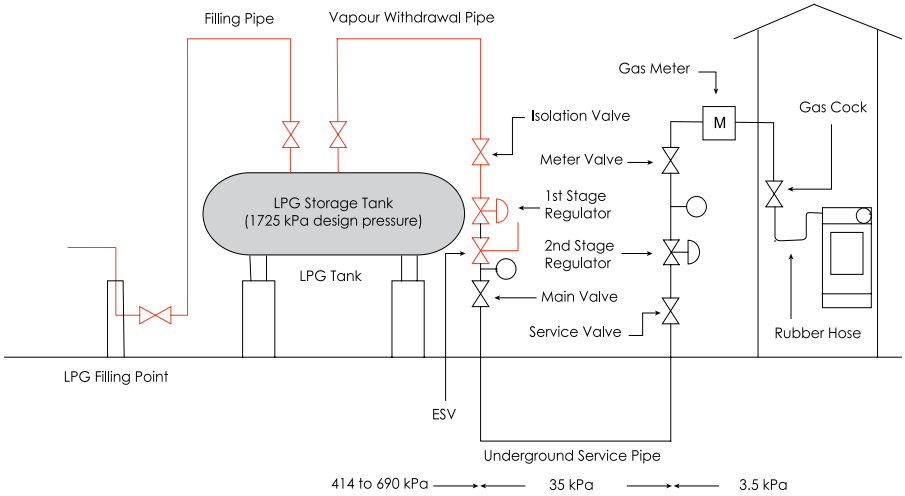


Fig. 2 : LPG bulk storage and piping system

2.2 Natural gas piping system

2.2.1 Natural gas is transported from the gas processing plant to city gate 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.

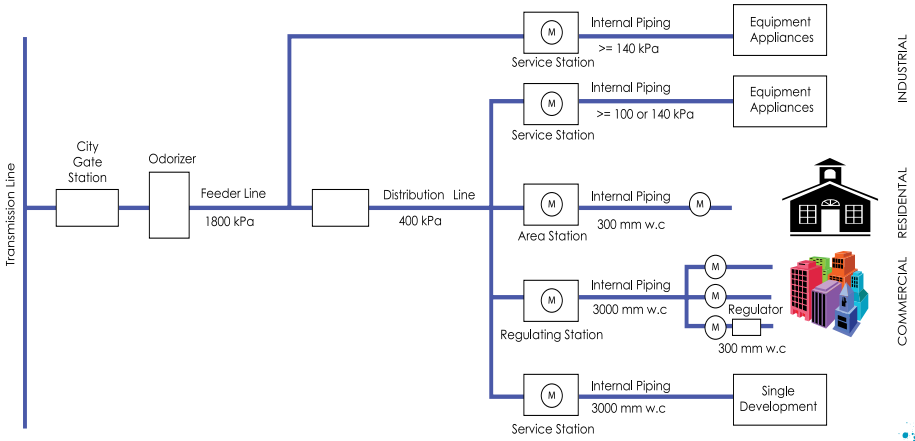


Fig. 3 : Natural gas supply system

2.2.2 The pressure from the main line is reduced at the city gate station to about 1700 - 2070 kPa (250-300 psig) and subsequently at district stations to 400 kPa (60 psig). The pressure is further reduced at area stations in residential complexes to about 300 mm w.c. (0.43 psig) before the pipe enters the building for further reticulation to gas appliances. Refer to Fig. 3.

3. LEGAL REQUIREMENTS

3.1 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 (Suruhanjaya Tenaga). Act 501 regulates the piping of natural gas downstream of the 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.

3.2 Gas is defined as 'methane, ethane, propane, butane, or hydrocarbons which may consist of one or more of the above gases in the form of gas or liquid'. Hence, all natural gas or LPG distribution, reticulation and utilisation systems in the country are covered by the Act..

3.3 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 Fig 4.

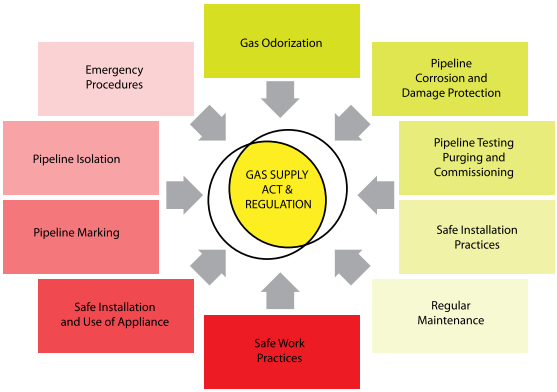


Fig. 4 : Safety requirements in the Gas Supply Regulations 1997

3.4 Competency of technical personnel and contractors who design, install construct, maintain, repair or operate piped gas systems are controlled under Act 501 through the registration of competent person and contractor respectively.

3.5 Approvals (ATI) are issued by Energy Commission to contractors before commencing installation work and after its completion (ATO). Engineering drawings, calculations, 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 Energy Commission or other related government agencies.

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

3.6.1 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)

3.6.2 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.)

3.7 Safety aspects of gas piping installed in premises defined as 'factories' by the Factories And Machinery Act 1967 (Act 139) are outside the scope of Act 501. They fall under the jurisdiction of the Department Of Occupational Safety and Health (DOSH).

4. PLANNING FOR PIPED GAS SYSTEM

4.1 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
- consumption 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, inclusive of parking or loading unloading bay
- when an 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 a new demand
- sizing of piping to carry the maximum gas flow rate

5. GAS DEMAND DETERMINATION

5.1 The volume of gas accounted for should be determined from either the manufacturer's input rating, gas supplier, equipment manufacturer or competent personnel. Estimation on equipment's rating is as shown below in Table 2 (source: from Table 11, MS 930).

Minimum Demand of Typical Gas Appliances in BTUs per hour	
Appliance	**Demand in BTU/hour**
Barbecue (residential)	50,000
Domestic Clothes dryer	35,000
Domestic Gas Range	65,000
Domestic Recessed Oven Section	25,000
Gas Refrigerator	3000
Storage Water Heater up to 30 gallon tank	30,000

Table 2 : Approximate gas input

5.2 The total connected hourly load should be the basis for storage and pipe sizing for all equipment that may be operating at full capacity simultaneously. However, a coincidence factor (CF) can be established and may be used with the approval of Energy Commission (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 types of gas appliances installed.

5.3 A suggested statistical table for determining the coincidence factor for household units installed with gas cooking ranges and water heaters are as shown below in Table 3.

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

Table 3 : Coincidence factor for household

Coincidence Factor (CF) however can also be determined by using Imperial Formula as stated below:

$$CF = \frac{0.95}{n^{0.3}}$$

where **n** is the number of units of specified premises

6. DESIGN PRESSURE

6.1 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.

6.2 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 should not exceed 35 kPa (5 psig) unless approved by Energy Commission 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.

6.3 The design pressure of LPG bulk storage vessels (aboveground, underground and mounded) and portable LPG cylinders should be 1725 kPa (250 psig). This is in line with MS 830 requirements (The normal operating pressure of LPG storage containers is 414-690 kPa (60-100 psig).

6.4 LPG storage containers have to meet the strength requirements of applicable Malaysia Standard or international standards such as ASME Section 8 and they require approval from Department of Occupation, Safety and Health (DOSH). Piping and components specification have to comply with ASME B31.8, MS 830 or MS 930, whichever applicable.

6.5 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 that 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.

6.6 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 (350 psig).
- piping and components used with liquid LPG or with vapour LPG at operating pressure over 860 kPa (125 psig) must be suitable for working pressure of 1725 kPa (250 psig).
- piping and components for use with vapour LPG at pressure not exceeding 1725 kPa (250 psig) should be suitable for working pressure of 1725 kPa (250 psig).

7. PRESSURE REGULATION

7.1 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.

7.2 In LPG systems, a high pressure regulator is installed at the LPG storage container outlet line for reducing the tank pressure of about 550 kPa (80 psig) to 35 kPa (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.

7.3 A low pressure or second stage regulator is installed downstream of the first stage regulator to reduce the 35 kPa (5 psig) gas pressure to about 300 mm w.c. (0.5 psig) outlet pressure, which is the normal operating pressure of LPG appliances.

7.4 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 Over Pressure Shut Off (OPSO) with higher 20% higher setting (with built-in vent limiting devices).

7.5 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 avoid 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.

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

8. MATERIAL SELECTIONS

8.1 Material 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 these gases.

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

8.3 Pipe material should be steel, copper, or polyethylene and should comply respectively with the following or other equivalent specifications approved by Energy Commission:

- 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 should include the ISO method of determination of long-term hydrostatic strength at 20°C derived from 80°C testing.

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

8.5 Medium and high density polyethylene (PE) pipes may be used for buried installations with operating pressures of not exceeding 414 kPa (60 psig).

8.6 Copper pipes (seamless) may be used in vapour phase systems only with operating pressures of not exceeding 140 kPa (20 psig).

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

8.8 Pipe fittings should be steel, copper or polyethylene.

8.9 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, should be of steel, ductile (nodular) iron, malleable iron or brass.

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

8.11 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.

9. LPG STORAGE SIZING

9.1 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 to operate the gas system at the rated gas demand of the appliances. Tank Sweating[1] will occur when the container is undersized.

9.2 In natural vapourization systems, the gas demand must be equal to or less than the vapourization rate of liquid LPG in the storage container at the worst operating condition. The rate of vapourization of a container is dependent upon the temperature of the liquid and the amount of wetted surface[2] 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, resulting in a lower vapourization rate.

9.3 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 minimum of once in 7 days) for the installation. This entails the provision of operating and standby or reserve cylinder banks.

9.4 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.

9.5 To ensure uninterrupted supply of gas, automatic changeover regulators should be used. These regulators change from the supply cylinder (when there is insufficient pressure) to the stand-by unit automatically without having to shutdown the system to refill.

9.6 Storage container evaporative capacity problem may be overcomed 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.

[1] water condensation on external surface of container due to excessive lowering of temperature of LPG liquid in container to meet demand.

[2] liquid in contact that spread over the surface

10. 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:

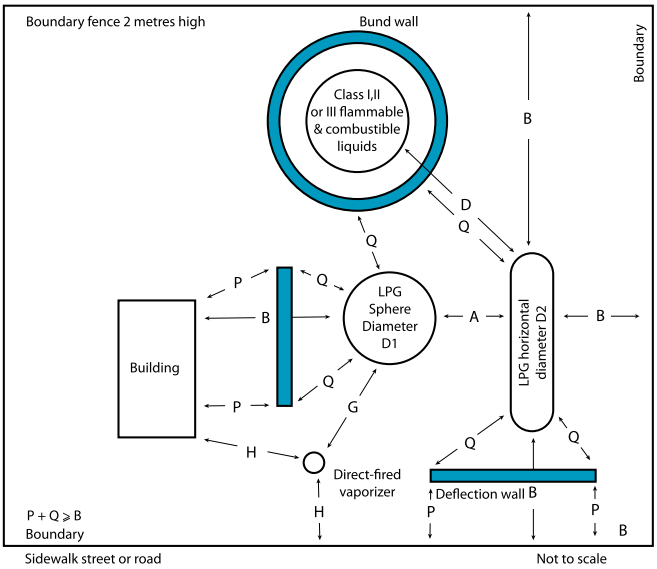
10.1 Safety distance

10.1.1 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.

10.1.2 Safety distances should 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 should be measured in a horizontal line around such walls.

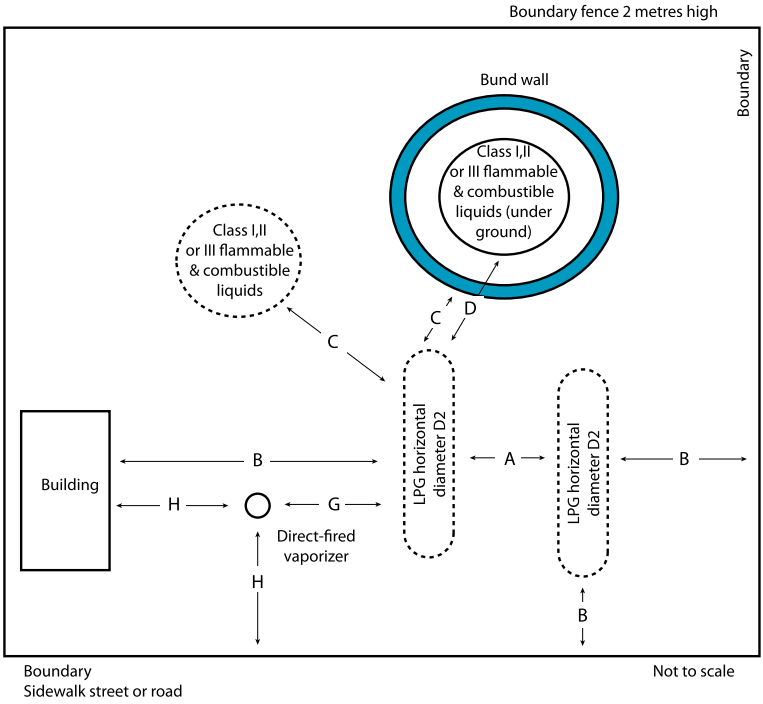
10.1.3 The safety distance requirements for various types of tank installations are spelt out in detail in MS 830. A 4-hour fire-rated deflection wall of 2 meters height may be installed to reduce safety distance between storage vessel and buildings.

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



Water capacity of individual container (kl)	Minimum safety distance (m)					
	A	B	C	D	G	H
Up to 0.5	none	no	3	6	10	see 4.3.3.3 (d) in MS 830
Over 0.5 to 2.5	1	4.5	3	6	10	
Over 2.5 to 10	1	7.5	3	6	10	
Over 10 to 135	$\frac{D1 + D2}{4}$	15	3	6	10	

Fig. 5: Safety distance of aboveground bulk stroge container
Source : Figure 2, of MS 830



Water capacity of individual container (kl)	Minimum safety distance (m)					
	A	B	C	D	G	H
Up to 135	1.5	3	3	6	10	See 4.3.3.3(d) in MS 830

Fig. 6 : Safety distance of underground / mounded bulk storage containers at consumers premises (Underground and mounded tank installation offer more protection against surrounding fires)

Source : Figure 4, of MS 830

10.2 Site Topography

To avoid accumulation of liquid or vapour beneath or in the immediate vicinity of a container, the container should 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.

10.3 Security and Damage Protection

10.3.1 The storage facilities installed at site must be adequately protected against tampering by unauthorised persons. This is usually achieved by providing security fencing on the facilities.

10.3.2 The storage and piping system must also be protected against possible damages from encroaching vehicles by installation of barriers or walls whenever required.

10.4 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.

10.5 Ventilation

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

10.5.2 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.

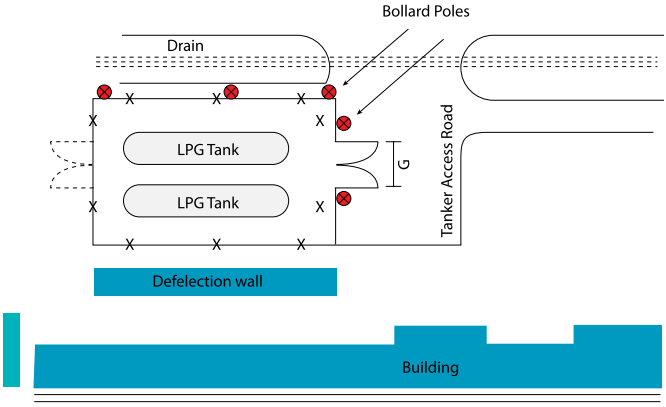


Fig. 7 : A typical layout plan of LPG bulk storage facility

10.6 Corrosion protection

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

10.6.2 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 should be provided with a point at which a test can be made to determine the efficiency of the system.

10.7 Backfilling

Backfilling material immediately adjacent to underground/mounded container should 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 should have a minimum resistivity of 100 Ω when tested after thorough moistening with distilled water. The sand should be well padded into place during the backfilling operation. Mounded containers should have the upper surface covered with earth to a depth of at least 600 mm.

10.8 Electrical and Electrostatic Hazard Precaution

10.8.1 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 (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 should 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.

10.8.2 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/ explosionproof electrical equipment (equipment which contains the explosion within housing, preventing the ignition of the surrounding atmosphere) may be used in Zone 1 or 2.

10.8.3 An effective earthing point and/or bonding connection should 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 should be electrically earthed as a protection against the accumulation of static electricity.

10.8.4 The placing of storage containers within 1.5 m measured horizontally from the vertical plane ofoverhead electric transmission lines should be avoided.

10.9 Manifolded Cylinders Location

10.9.1 Cylinders should be located outside of buildings situated on a firm level ground in a well ventilated location (Cylinders should not be installed in a basement or in locations below ground level – GPC is heavier than air and will "flow" into low points and collect causing a flammable or explosive mixture). The safety distance requirements for cylinders as stipulated by MS 830 are as follows:

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 should not fall within Zone 0, 1 or 2 area
Over 2.5 to 10	7.5	7.5	

Table 4 : Cylinder location and safety distances

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

a) the water capacity of individual cylinder in a manifolded group of cylinders should not exceed 125 ℓ. If more than one manifolded group of cylinders are installed at a consumer site each manifolded group should be separated from the border by at least 7.5 m. A deflection wall of 2 hour fire resistance rating and a minimum height of 2 m may be used to reduce this distance to 3 m provided the vapour path should not be less than 7.5 m. (See also Figure 9 in MS 830)

b) the installations should be fenced and locked to prevent unauthorised access and tampering.

c) any opening into the building that is below the level of the relief valve should be at least 1 m horizontally from the nearest cylinder.

d) 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

e) a cylinder should 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 hour fire resistance rating.

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

g) a specially built compartment within the building boundary but meeting the following requirements should be considered an outdoor installation and should be required to meet the safety requirements and distances for outdoor installations.

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

ii) the floor should be of smooth concrete and at least 100 mm higher than the ground. Rough surface that may cause sparking during cylinder handling should not be allowed.

iii) electrical appliances installed in the compartment should be at least suitable for Zone 2[3] application and preferably located above the cylinder.

iv) ventilation openings of at least 300 cm^2 per 1 m^2 of the floor area should be provided and such opening should be as close to the floor as practicable, so as to prevent leaking gas from accumulating inside the compartment.

v) a door of at least 1.5 m width should be provided with access orientated towards the outside of the building.

10.10 Openings on storage container shell are provided with protective valves (to protect against inadvertent release of LPG) in accordance with MS 830 provisions. Accordingly, all openings on containers, except those for safety relief valves and those connections protected by an opening not larger than No. 54 drill size (0.0550 inch), should 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.

(3) specially selected industrial, non-incendive or restricted breathing equipment

11. PIPE ISOLATION

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 that are compatible with the system operating parameters.

11.1 Isolation shut-off valve

Isolation shut-off valve should be installed 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.

11.2 Emergency shut-off valve (ESV)

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

12. GAS METERING

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

12.2 The location should 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.

12.3 Gas meters should 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.

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

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

12.6 The service pipe termination and internal piping termination should 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.

12.7 Diaphragm gas meter installation should comply to MS1766:2004 (Installation of Diaphragm Gas Meters – Specification)

13. PIPE SIZING

13.1 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.

13.2 Gas piping should 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.

13.3 Two different methods of pipe sizing are presented in Appendix C of the MS 930. These are;

- *NFPA No 54*
- Clifford Method

13.4 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 gas or LPG), type of piping (pipe or tube), pressure, and pressure drop allowed.

13.5 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 should not exceed 35 kPa (5 psi) (as stipulated in MS 930)

13.6 For larger and more complex gas piping systems that are not covered by MS 930, the size of the gas piping system should be determined by standard engineering methods acceptable to Energy Commission. These are:

- Pole's Method
- Cox's Method

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

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

13.9 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.)

Inlet Node	Outlet Node	Flow Rate scmh	Length m	CF	Diameter mm	Inlet Pressure kPa	Outlet Pressure kPa	Pressure Drop kPa	Pressure Drop %	Velocity m/s

Table 5 : Format for gas reticulation network pipe sizing calculations

14. PIPE INSTALLATION

14.1 General Requirements

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

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

b) gas pipes should be located such that the locations 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.

c) gas pipes should, as far as practicable, be run outside the building, especially when the operating line pressure exceeds 35 kPa (5.0 psi). However for maintenance purposes, it is recommended that pipe riser to be installed at accessible and reachable location near corridors or dedicated shafts.

d) gas pipes should preferably enter the building aboveground and remain aboveground and in ventilated location.

e) gas pipes should be properly painted and labelled for identification purposes. The colour for gas pipes should be yellow.

f) the pipe route selection should avoid any positions where the pipe could be liable to damage, either during the building construction or when the property is finally occupied.

g) the fire resistance of the building must not be impaired.

h) the route should, as far as possible, avoid the need to cut into load-bearing walls or joist.

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

j) pipe riser ducts must have 2 hour fire rated doors and have one side as an external wall with fixed louvers or ventilated pre-cast block venting naturally to atmosphere.

k) there should be a space of at least 50 mm between a gas pipe and any other services. Where electrical services are being use in the same duct, the gas riser should be separated from the electrical services by a gas-tight partition with respect to the electrical services.

l) pipes passing through a cavity must take the shortest route and be sleeved.

m) pipes are normally run above ceiling, dropping down to appliances on the floor below it, when no other route is available.

n) pipes must not be laid under or through foundations.

o) pipes should never run diagonally across walls or floor. They should normally follow the line of the walls and be kept close to them.

p) the piping system must not be exposed to the excessive external stress, vibration or corrosion.

q) the piping system must be installed at a location where maintenance and checking work can be done easily.

r) 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
- at area or location owned or exclusively used by third party (e.g. local authority)
- in case of riser not provided with ventilation, it is best to install gas detector to detect leakage immediately

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

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

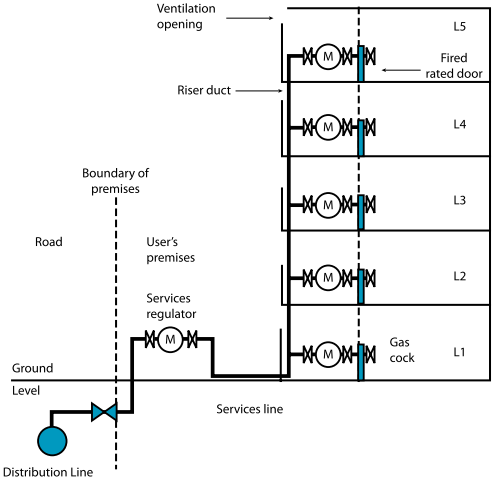


Fig. 8 : A typical natural gas piping layout on domestic consumer's premises

14.2 Pipe Shaft or Duct

14.2.1 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 access for maintenance.

14.2.2 Where a gas riser is to be 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.

14.2.3 Where shafts are continuous, ventilation can normally be achieved by the provision of openings at the top and bottom to the outdoors The opening should have a minimum free area (in inches square 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.

14.2.4 When a pipe shaft takes the form of an enclosure at each storey level, riser pipes should 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 should be fire stopped at the point of entry.

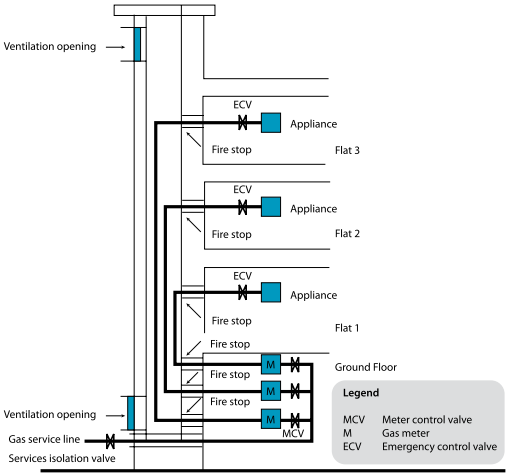


Fig. 9 : Typical layout of ventilated gas pipe shaft/duct

14.3 Piping buried in concrete or soil

14.3.1 Pipe chase in wall

Provided the wall thickness is adequate, pipe work 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.

14.3.2 Piping buried in a ground

Underground pipes also need to be protected against above ground loading by using protective sleeves and concrete slabs. When dissimilar metal are joined underground, an insulating coupling or fitting should be used. Piping should not be laid in contact with cinders. Please refer to fourth schedule of Gas Supply Regulations 1997.

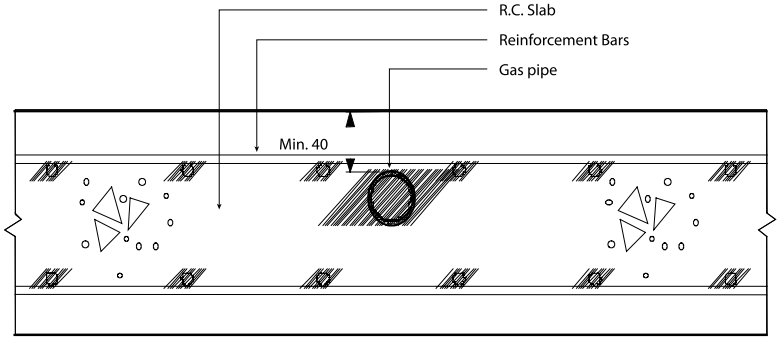


Fig. 10 : Piping embedded in concrete floor

14.3.3 Pipe in floor channel

The channels should be constructed such that the structural strength of the floor is not reduced and the pipes are wholly encased within the floor structure.

Uncoated threaded or socket welded joints should 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, should be protected against corrosion in an approved manner.

14.4 Pipe penetrating through solid wall or floor

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

14.4.2 Anti corrosion tape should be wrapped at least 100 mm travel from finish wall.

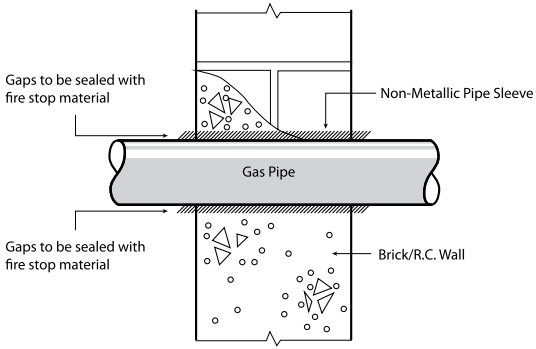


Fig. 11 : Pipe penetrating through solid wall or floor

14.5 Underground pipe damage protection

14.5.1 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.

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

14.5.3 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.

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

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

14.5.6 Warning marker (concrete 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.

14.5.7 Warning slab / warning tape 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 as required by the regulations.

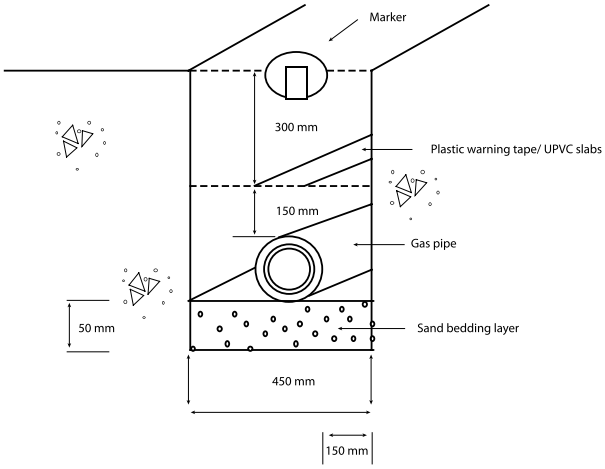


Fig. 12 : Piping buried in ground floor or under concrete external of building

14.6 Pipe Support

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

14.6.2 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.

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

14.6.4 Spacing of supports in gas piping installations should not be greater than as shown below (source: Table 2 of MS 930):

Steel Pipe Nominal Size of Pipe mm (Inches)	Spacing of Supports m (Feet)	Nominal Size of Tubing mm (Inch OD)	Spacing of Supports m (Feet)
15 (1/2)	1.8 (6)	15 (1/2)	1.2 (4)
20 (3/4) or 25 (1)	2.4 (8)	16 (5/8) or 20 (3/4)	1.8 (6)
32 (1 1/4) or larger (horizontal)	3 (10)	22 (7/8) or 25 (1)	2.4 (8)
32 (1 1/4) or larger (vertical)	Every floor level	-	-

Table 6 : Support of Piping

14.7 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 every 50 m intervals, where the discontinuity can be detected easily.

An insulated copper wire of at least 4 mm or AWG 14 should be used as tracer wire.

14.8 Clearance from Other Buried Facilities

14.8.1 When a gas pipe runs close to some other services, contact between them should 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:

14.8.2 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

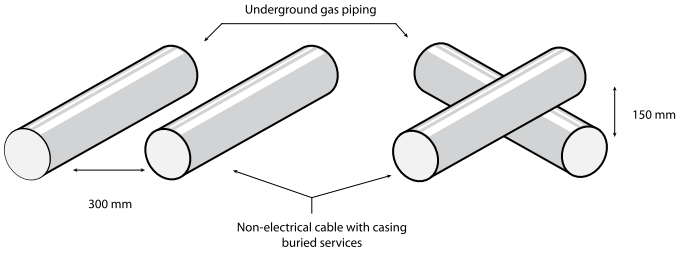


Fig. 13 : Underground gas piping

14.8.3 Clearance from electrical cable without casing and lightning arrestor should be as per table below:

Buried Facility	Clearance (mm)
Low voltage cable	> 100
High voltage cable	> 1000
Lightning arrestor	> 1500

Table 7 : Clearance from buried electrical facilities

14.9 Drain Crossing

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

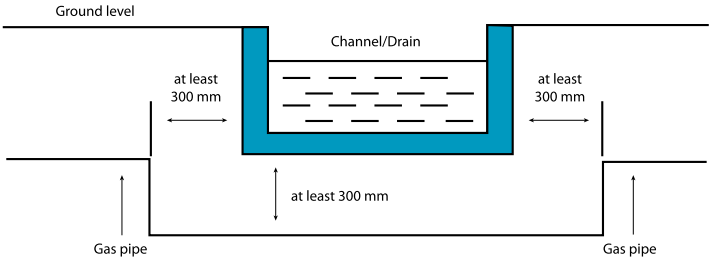


Fig. 14 : Typical drain crossing

14.10 Connection of Plastic Piping (Polyethylene Piping)

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

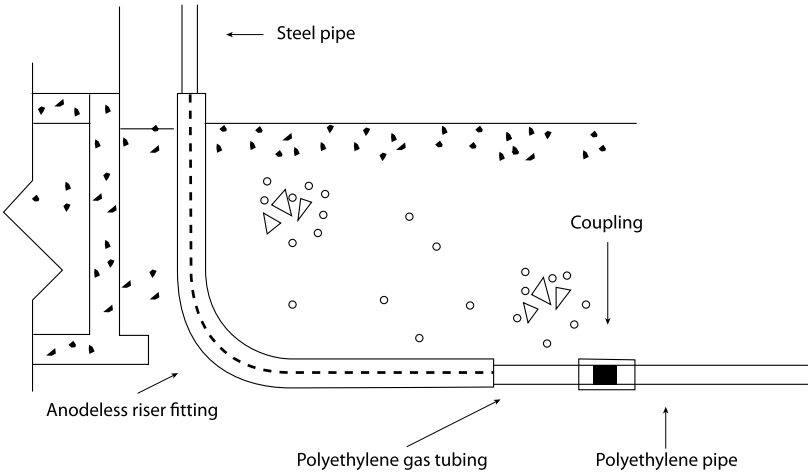


Fig. 15 : Typical installation of anodeless riser fitting

14.11 Isolation Joint Installation

Isolation joint should 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, in case cathodi protection is installed, underground piping is protected with cathodic protection.

15. PIPE JOINTING

15.1 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.

15.2 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/underground pipe installations as stated in MS 930.

15.3 Although welding is preferred, threaded joints and fittings are permitted for pipe sizes up to and including 4" operating at 35 kPa (5 psig) or less. Pressure piping larger than 4" and all pressure piping above 35 kPa (5 psig) regardless of size must be welded or flanged.

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

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

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

15.7 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 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.

16. GAS APPLIANCE SELECTION

16.1 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.

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

16.3 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 Energy Commission.

17. GAS APPLIANCE INSTALLATION

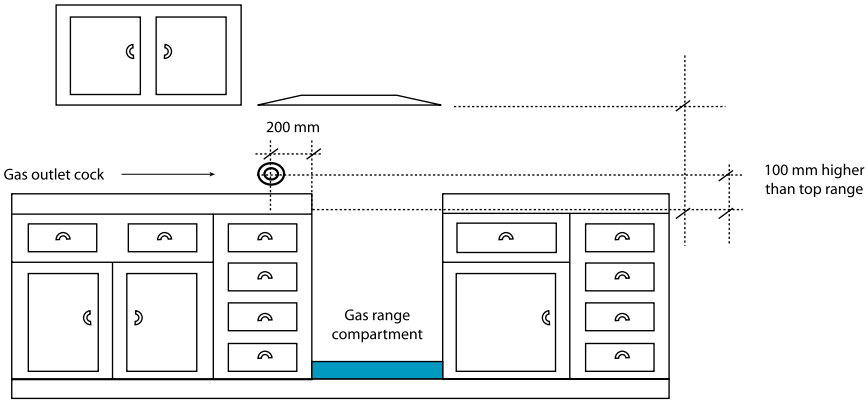
17.1 The gas appliance must be of the approved type and is suitable for the type of gas supply (natural gas or LPG) to which it will be connected. The installer should provide the user with all the relevant manufacturer's instructions.

17.2 Gas appliances should not be installed in premises without the connection being tested 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.

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

17.4 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.

17.5 Gas cocks should 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.



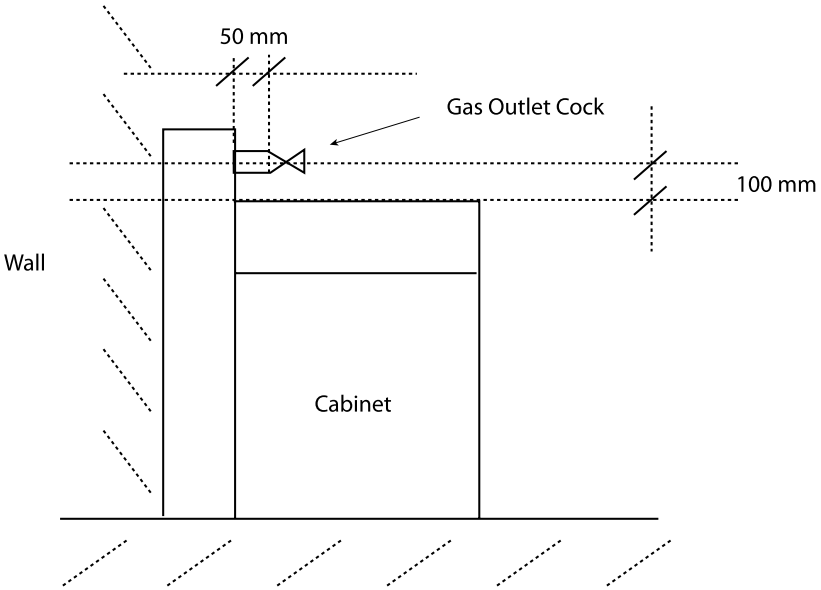


Fig. 16 : Typical location of gas cock at cabinet type top range

17.6 Gas leak detector installation

It is recommended that gas leak detection system be installed in the kitchen or gas meter compartment or area of gas piping system to ensure that leakages are detected immediately.

18. INSPECTION, TESTING AND COMMISSIONING

18.1 Prior to acceptance and initial operation, all piping installations should 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 1997 and recognized standards.

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

18.3 Corrosion protective coating should be subjected to holiday testing (test of the continuity of protective coating). Coating defects or damage that may impair effective corrosion control should 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.

18.4 The pressure or leak test medium should be air, water 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.

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

18.6 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:

Scope	Maximum Operating Pressure kPa(psi)	Type of Test		Test Pressure kPa (psi)	Test Duration (minutes)		Equipment			
		Test	Medium		Above ground	Buried	Pressure gauge	Pressure Chart Recorder*	Soap solution	Gas detector**
From tank/ manifold up to 1st Stage Regulator	Up to 1725 (250)	Pneumatic/ leak	nitrogen	1900 (275)	60		√	√	√	
		Leak (during commisioning)	LPG	Operating Pressure					√	√
From 1st Stage Regulator up to 2nd Stage Regulator	Above 140 (20)	Pneumatic/ leak	nitrogen	345 (50)	60	1440	√	√	√	
			air							
		Leak (during commisioning)	LPG	Operating Pressure			√		√	√
After 2nd Stage Regulator	Up to 7 (1)	Pneumatik/ leak (appliances disconnect)	nitrogen	140 (20)	30	1440	√	√	√	
			air							
		Leak (during commisioning)	LPG	Operating Pressure			√		√	√

Table 8 : LPG piping system pressure / leak test requirements

Scope	Maximum Operating Pressure kPa(psi)	Type of Test		Test Pressure kPa (psi)	Test Duration (minutes)		Equipment			
		Test	Medium		Above ground	Buried	Pressure gauge	Pressure Chart Recorder*	Soap water solution	Gas detector**
From service station up to 2nd stage regulator / meter	Above 140 (20)	Hydrostatic	Water	345 (50)	60	1440	√	(√)	√	
From service / area station up to 2ndstage regulator / meter	Up to 140 (20)	Hydrostatic	Water	345 (50)	120	1440	√	√	√	
		Pneumatic/ leak	Nitrogen							
			Air							
		Leak (during commisioning)	Natural gas	Operating Pressure			√		√	(√)
After 2nd stage regulator / meter	Up to 7 (1)	Pneumatik/ leak (appliances disconnect)	Nitrogen	140 (20)	30	1440	√	(√)	√	
			Air							
		Leak (during commisioning)	Natural gas	Operating Pressure			√		√	(√)

Note :
* Pressure chart recorders should be used when underground piping system are involved
** Soapy water solution should be used when a Gas detector is not availble.

Table 9 : Natural gas piping system pressure / leak test requirements

18.7 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 should be sealed off at every outlet with the appropriate fitting.

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

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

19. OPERATION & MAINTENANCE

19.1 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. It is the duty of the owner or occupier of the premises to safely operate and maintain the system in accordance with manufacturer's specifications.

19.2 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.

19.3 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 adhered to in the operation and use of the system. He is responsibilities as provided for under the regulations are as follows:

- 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 Energy Commission 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 Energy Commission 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.

19.4 Proper maintenance programmes and procedures including procedures for regular leakage surveillance of the system have 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.

19.5 The piping system must be subjected to a thorough inspection and tested by registered competent persons at least once every three years. Pressure vessels must comply with DOSH requirements. Maintenance and repair works on the system must similarly be performed by competent persons.

19.6 It is unlawful to remove or disconnect any gas equipment without first plugging or capping with a screwed joint fitting the outlet from which the gas equipment was removed. All outlets to which gas equipment are not connected should be left capped gas tight on any piping system being installed, altered, extended or repaired.

RECOMMENDED PREVENTIVE MAINTENANCE PROGRAMME FOR GAS PIPING SYSTEMS

	Maintenance Items	Frequency
1	Detailed visual survey for pipe, connections, valves and equipments by using gas detector or soap liquid.	Every Two Years
2	Detailed visual inspection for pipe support and surrounding conditions around piping and gas appliances	Annually
3	Inspection for PE/Steel transition joints.	Annually
4	Inspection and functional test of valves and regulators.	Annually
5	Air-tightness test for leak check testing.	Every Three Years
6	Painting & labelling.	Every Two Years

Table 10 : Natural gas and LPG piping

	Maintenance Items	Frequency
1	Inspection of abnormalities on metering facilities.	Monthly
2	Leak check on pipe connections, fittings, valves and equipment using gas detector or soapy liquid.	Six Month
3	Functional test of valves, vaporizers, regulators, pressure gauges, earthing / grounding and emergency shut-off valves.	Six Month
4	Clean oil separator and strainers to bleed of heavy ends.	Six Month
5	Housekeeping and washing of station facilities	Six Month
6	Piping corrosion prevention.	Annually
7	Painting and labelling	Every Two Years
8	Overhaul and soft part change-out	Every Three Years

Table 11 : Natural gas matering stations and LPG storage facilities

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 930:1986	*Code of Practice for The Installation of Fuel Gas Piping Systems and Appliances.*
MS 1766:2004	*Code of Practice for the Installation of Gas Meters*
MS 1870: 2005	*Gas meters (Diaphragm meters)*
MS 1086:1987	*Specification for Buried Polyethylene (PE) Pipes for the supply of gaseous fuels.*
MS 1535 Part 1: 2002	*Domestic gas cooking appliances for use with LPG: Specification.*
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: 1998	*Specification for LPG (Second revision)*
MS 875: 2001	*Method of test for sulphur in LPG (Oxy-hydrogen burner or lamp)*
MS 573:2000	*Method of test for vapour pressure of LPG (LPG method)*
MS 564:2000	*Method of sampling LPG (First revision)*
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.*
S 1165: 1989	*Specification for pressure regulators and automatic changeover devices for LPG*
MS 831:1986	*Specification for valves for use with domestic LPG cylinder*

MS 773:1999	*Specification for flexible rubber tubing and hose for use in LPG vapour phase and LPG/air installations*
MS 217:1974	*Method for the hydrostatic strength testing of liquefiable and other compressed gas cylinders*

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*

CONVERSION TABLE

Conversion Table							
Pressure	Pounds per square inch (psi)	Kilopascals (kPa)	Millimetre of water column (mm w.c.)	Energy	British Thermal Unit (Btu)	Kilojoules (kJ)	Kilowatt hour (kWh)
Pounds per square inch (psi)	1	6.895	703.773	British Thermal Unit (Btu)	1	1.05507	0.00029
Kilopascals (kPa)	0.145038	1	102.0735	Kilojoules (kJ)	0.9478	1	0.00027
Millimetre of water column (mm w.c.)	0.0014183	0.00097794	1	Kilowatt hour (kWh)	3411.8070	3599.7120	1
Volume	Cubic meters (m^3)	Cubic Feet (ft^3)	Litre	Temperature	Celsius (°C)	Fahrenheit (°F)	Kelvin (K)
Cubic meters (m^3)	1	35.315	1000	Celsius (°C)	1	(°C x 9/5) + 32	°C + 273.15
Cubic Feet (ft^3)	0.0283	1	28.3168	Fahrenheit (°F)	(°F - 32) x 5/9	1	[(°F-32) x 5/9] + 237.15
Litre	0.001	0.03531	1	Kelvin (K)	K - 273.15	[9/5 x (K - 273.15)] + 32	1

SURUHANJAYA TENAGA HEADQUARTERS AND REGIONAL OFFICES :

HEADQUARTERS
No. 12, Jalan Tun Hussein
Precinct 2
62100 Putrajaya
Toll Free Number : 1-800-2222-78
Tel : 03-8870 8500
Fax : 03-8888 8637

Regional Offices
Pejabat Kawasan Suruhanjaya Tenaga
Tingkat 10, Bangunan KWSP
13700 Seberang Jaya
Butterworth
PULAU PINANG
Tel : 04-3984 957 / 398 8255 / 398 1357
Fax : 04-390 0255

Pejabat Kawasan Suruhanjaya Tenaga
Tingkat 10, Menara PKNS
No 17, Jalan Yong Shook Lin
46050 Petaling Jaya
SELANGOR
Tel : 03-7955 8930
Fax : 03-7955 8939

Pejabat Kawasan Suruhanjaya Tenaga
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JOHOR
Tel : 07-224 8861
Fax : 07-224 9410

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Tingkat 7, Kompleks Teruntum
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25000 Kuantan
PAHANG
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Jalan Padang Garong
15000 Kota Bharu
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Jalan Persekutuan MITC
75450 Ayer Keroh
MELAKA
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Fax : 06-231 9620

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Tingkat 7, Bangunan BSN
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Pejabat Kawasan Suruhanjaya Tenaga
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