SRI LANKA STANDARD 1196 : 1999

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CODE OF PRACTICE FOR TRANSPORT, STORAGE AND HANDLING OF LPG

PART 1 : GENERAL PROVISIONS

SRI LANKA STANDARDS INSTITUTION

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SLS 1196 : 1999

Gr. 6

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SRI LANKA

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This standard does not purport to include all the necessary provisions of a contract.

SRI LANKA STANDARD
CODE OF PRACTICE FOR
TRANSPORT, STORAGE AND HANDLING OF LPG
PART 1 : GENERAL PROVISIONS

FOREWORD

This Code of Practice was approved by the Sectoral Committee on LP Gas Industry and was authorized for adoption and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standards Institution on 1999-12-09.

The object of this part of the Code is to provide an introduction to LPG, illustrating its physical properties, popular applications and common hazards. It is intended as an information guide for the technical and sales staff involved in handling and sale of LPG and its users.

The Sri Lanka Standards Institution gratefully acknowledges the use of the following publication, in the preparation of this standard:

An Introduction to Liquefied Petroleum Gases published by the Liquefied Petroleum Gas Industry Technical Association (UK).

1 SCOPE

This part of the Code deals with the general properties of commercial LPG grades, typical applications of LPG, their characteristics and hazards that those handling and using LPG should generally be aware of.

2 REFERENCES

ASTM D 1657	Test method for density or relative density of light hydrocarbons by pressure thermohydrometre method
ASTM D 1837	Test for volatility of liquefied petroleum gases
ASTM D 2158	Test method for residues in liquefied petroleum gases
ASTM D 2163	Test method for analysis of liquefied petroleum gases and propane concentrates by chromatography
ASTM D 2598	Practice for calculation of certain physical properties of LPG from compositional analysis
ASTM D 2713	Test method for dryness of propane (valve freeze method)
ASTM D 2784	Test method for sulfur in LPG (oxy- hydrogen burner or lamp)
GPA 2140	Liquefied petroleum gas specifications and test methods
CS 102	Presentation of numerical values
SLS 712	Liquefied petroleum gas
SLS 1166	Method for determination of gauge vapour pressure of LP Gases
SLS 1167	Method of sampling for LP Gases

SLS 1168	Method of test for corrosiveness to copper liquefied petroleum gases
SLS 1169	Method of detection of hydrogen sulphide in LPG (lead acetate method)
SLS .....*	Code of practice for transport ,storage and handling of LPG Part 2 Design , installation and maintenance of bulk LPG storage at fixed installations

3 DEFINITIONS

For the purpose of this code,the following definition shall apply :

3.1 LPG : Commercial butane, commercial propane or any mixture thereof

4 PROPERTIES OF COMMERCIAL LPG GRADES

4.1 General

The by-products of crude oil refining fall into three main categories :

a) Methane and ethane having one and two atoms of carbon per molecule respectively. They remain gaseous regardless of pressure unless refrigerated;

b) Propane, butane and isobutane, together with propylene, butylene and isobutylene having three or more carbon atoms per molecule. These have the special property of becoming liquid at atmospheric temperature if moderately compressed and reverting to gases when the pressure is sufficiently reduced; and

c) Other hydrocarbons having five or more carbon atoms per molecule. These are liquids or solids at atmospheric temperature and pressure.

In the case of (b) category of hydrocarbons consisting mainly of propane and butane, advantage is taken of their special property to being able to transport and store in the liquid state, in which they are roughly 250 times as dense as they are when gases. Collectively they are known as LPG.

4.2 Physical properties

Table **1** gives physical properties of commercial propane and commercial butane. The product marketed as LPG is a mixture of commercial propane and commercial butane with varied constituent proportions, depending on the ambient temperature of the country of usage.

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* under preparation

TABLE 1 - Chemical and physical properties of liquefied petroleum gases

Requirements	Product designation				Test methods
	Commercial Propane	Commercial Butane	Commercial PB Mixture	Special duty Propane[A]	
(1)	(2)	(3)	(4)	(5)	(6)
Vapour pressure at 37.8 ^{0}C, max:, kPa	1430	485	[B]	1430	SLS 1166 ASTM D 2598
Volatile residue:					
evaporated temperature,95% max. ^{0}C	-38.3	2.2	2.2	-38.3	ASTM D 1837
or					
butane and heavier, max. Vol %	2.5	---	---	2.5	ASTM D 2163
pentane and heavier, max. Vol %	---	2.0	2.0	---	ASTM D 2163
propylene content, max. Vol %	---	---	---	5.0	ASTM D 2163
Residue on evaporation 100 ml. Max. ml	0.05	0.05	0.05	0.05	ASTM D 2158
Oil stain observation	pass[D]	pass[D]	pass[D]	pass[D]	ASTM D 2158
Relative density at (15.6/15.6 ^{0}C)	[E]	[E]	[E]	[E]	ASTM D 1657 ASTM D 2598
Corrosion, copper, strip, max.	No.1	No.1	No.1	No.1	SLS 1168[G]
Sulphur, ppmw	185	140	200	123	ASTM D 2784
Hydrogen sulphide	pass the test	pass the test	pass the test	pass the test	SLS 1169
Moisture content	pass	---	--	pass	ASTM D 2713
Free water content	none[F]	none[F]	none[F]	---	

NOTES

A *Equivalent to propane HD-5 of GPA standard 2140 (Gas Processors' Association).*

B *The permissible vapour pressures of products classified as PB mixtures must not exceed 1430 kPa and additionally must not exceed that calculated from the following relationship between the observed vapour pressure and the observed relative density:*
Vapour pressure, max. = 1167 - 1880 (density at 15 ^{0}C).
A specific mixture shall be designated by the vapour pressure at 37.8 ^{0}C in kPa gauge. To comply with the designation, to vapour pressure of mixture shall be within + 0 to -10 of the vapour pressure specified.

C *In case of dispute about the vapour pressure of a product, the value actually determined by Test Method **ASTM D 1267** shall prevail over the value calculated by practice **ASTM D 2598.***

D *An acceptable product shall yield a persistent oil ring when 0.3 ml of solvent residue mixture is added to a filter paper, in 0.1 ml increments and examined in daylight after 2 min as described in **ASTM D 2158.***

[E] *Although not a specific requirement, the relative density must be determined for other purposes and should be reported. Additionally, the relative density of PB mixture is needed to establish the permissible maximum vapour pressure (see Note A).*

[F] *The presence or absence of water shall be determined by visual inspection of the samples on which the relative density is determined.*

[G] *This method may not accurately determine the pressure of reactive materials (for example, H_2S, S^o) in liquefied petroleum gas if the product contains corrosion inhibitors or other chemicals which diminish the reaction with the copper strip.*

5 APPLICATIONS

5.1 Domestic applications

Domestic applications of LPG are mainly for:

a) Cooking;
b) Hot-water supply;
c) Space heating;
d) Air-conditioning;
e) Refrigeration; and
f) Lighting.

Because LPG is available in portable cylinders and disposable cartridges it has applications in recreational leisure activities.

5.2 Industrial applications

Industrial uses of LPG are in the production and manufacture of:

a) Gas and chemicals;
b) Ferrous and non ferrous metals;
c) Engineering equipment and ships;
d) Clay and ceramics;
e) Glass;
f) Food and drink;
g) Electrical goods;
h) Vehicles;
j) Textiles, leather and clothing; and
k) Paper and print.

Table 1 and Note A to Note G were extracted from SLS 712 : 1998

5.2.1 *Gas and chemicals*

Currently the most economical process for the production of lean gas for town gas manufacture, for hydrogen for hydrocracking and other industrial processes, and for synthesis gases for ammonia and methanol production, are those employing continuous catalytic steam reforming of hydrocarbons.

LPG with a low unsaturated hydrocarbon content is a valuable feed stock for the production of petrochemicals. It is also used for enriching lean gas to achieve calorific values suitable for general distribution as town gas.

LPG is employed on a large scale, mainly in the USA chemical industry, for the production of ethylene, butadiene and acetyl chemicals.

5.2.2 *Ferrous and non-ferrous metals*

a) Heat treatment of metals: Premium quality propane is particularly suitable for the heat treatment of metals, in protective controlled atmospheres to reduce or eliminate oxidation or other forms of corrosion, and for hardening of steel parts by gas carburizing.

b) Aluminium production: LPG is used for billet heating prior to rolling, for melting or holding molten aluminium at a steady temperature, and for the baking of carbon anode blocks.

c) Iron making: Butane is used for enriching low calorific value blast furnace gas.

d) Melting in cupolas: LPG can be used to reduce or even eliminate the use of coke for iron melting in cupolas.

5.2.3 *Engineering and shipbuilding*

In shipbuilding, steel plates and sections can be heated by LPG prior to blasting and protective painting. In addition, ovens used for continuous pre-heating before priming, and for the stowing of priming and finishing coats on light steel coil, can be heated by LPG. In gas cutting or profiling of steel plates LPG can be used in place of acetylene.

5.2.4 *Ceramics, clay and other building materials*

a) Clay Industry: In the heavy clay industry the replacement of solid and liquid fuels by LPG is not only enabling manufacturers to meet clean air provisions but is also giving other benefits. For example, conversion of a beehive down draught kiln to butane reduced firing times by almost 50 per cent.

Brick, tile and pipe manufacturers find that the improved control and flexibility of LPG reduce waste and rejects and may also increase production and efficiency of firing. Kiln exhaust gases from LPG burners could also be used for drying purposes, while the use of direct fired LPG burners in dryers increases production.

b) Ceramics Industry: The special advantage of LPG in the ceramics industry lie in its purity, flexibility and temperature profile control that it permits.

5.2.5 *Glass manufacture*

LPG is used to heat glass-melting pots and for annealing. Second stage and finishing processes in the production of tableware, bottles, electric bulbs, fluorescent tubes, etc. are effected using LPG, especially those necessitating sharp-pointed flames.

5.2.6 *Food and drink processing*

The superiority of LPG in food processing stems not only from ease of control but also from its purity which permits direct heating. Because of this it is used in the spray drying of food such as potato granules and milk, and in baking - for example, biscuits.

5.2.7 *Manufacturing industry*

LPG is widely used as a fuel for the direct fired drying of paints and enamels in metal finishing in vehicle production and in light engineering industry. It can also be used in processes such as direct contact drying of tyre-reinforcing cord after treatment with latex where low sulphur content fuel is essential.

5.2.8 *Agriculture*

Various types of LPG fired space heaters are used in the poultry breeding industry and warming green houses in cold climates.

LPG fired air heaters are used extensively for the direct contact drying of grain, curing and drying of tobacco.

5.2.9 *Automotive uses*

The main automotive use of LPG is as a fuel for spark ignition internal combustion engines. A typical fuel system comprises an LPG tank, filter, vaporiser, two stage pressure governor and LPG -air mixing device on the carburetor inlet, together with automatic safety controls.

Because of the cleaner exhaust, LPG vehicles make a marginal contribution to reducing atmospheric pollution.

6 STORAGE AND HANDLING

6.1 General

The use of LPG is dependent on the development and application of economical transport and storage techniques. LPG containers must be strong enough to resist the gas pressure exerted, unless they are refrigerated - a technique economically employed only on a very large scale.

An important characteristic of LPG is its high coefficient of thermal expansion in the liquid phase. The pressure that would arise from an increase in the temperature of a completely liquid filled vessel is far greater than that which would arise purely from the increase in vapour pressure over the same temperature increase. A free space (ullage) must therefore be allowed above the liquid level of a charged LPG container, whatever its size, to allow for thermal expansion. A smaller ullage allowance is required for butane as it has a lower coefficient of thermal expansion than propane.

Fixed bulk storage tanks are fitted with safety relief valves having extended vent pipes. These valves are designed to safely relieve any excess pressure caused by very hot weather, fires etc. before the safe pressure limit of the tank is reached. Large tanks may have several such valves, any one of which may be removed for maintenance without the tank being taken out of service.

The siting of storage tanks in relation to each other and to buildings, and precautions to be taken against fire hazard are covered by the Part 2 of this Code. A particular reason for care in their storage and handling is the fact that LPG is heavier than air and may therefore accumulate in spaces below the level at which any leakage occurs from a container or its connecting pipework system.

6.2 Bulk transport

Road tankers are used for transporting bulk loads between 1 and 20 tonnes. Suitably constructed rail tankers too could be used for this purpose.

6.3 Cylinders and cartridges

Refillable cylinders are used mainly for domestic and light industrial applications and range in content weight from 2 kg to 45 kg. Disposable cartridges are also used, largely in the leisure field, in content weights upto approximately 1 kg.

6.4 LPG odorization

LPG shall be odorized prior to delivery to a bulk plant by the addition of a warning agent of such character that they are detectable, by a distinct odor, down to a concentration in air of not over one-fifth, the lower limit of flammability.

NOTE

Odorization, however is not required if harmful in the use of further processing of the LPG or if such odorization will serve no useful purpose as a warning agent in such further use or processing.

6.5 Precautions to be observed

All the cylinders and bulk vessels referred to above must be physically adequate for the stresses involved. They must be gas tight, provided with safety relief valves where necessary and marked for ready identification. Their design characteristics, testing, inspection, retesting, handling and siting when stationary are covered by appropriate part of this code of practice, standards or regulations, some of which are mandatory.

Before embarking on any project involving the installation of LPG facilities, it is important that statutory requirements in respect of such installations will be complied with.

7 REQUIREMENTS FOR PERSONNEL CONCERNED WITH STORAGE AND HANDLING OF LPG

7.1 Awareness

All persons concerned with the storage and handling of LPG should be familiar with the following characteristics and hazards of LPG

7.1.1 LPG is stored, normally as a liquid under pressure, is colourless and its weight as a liquid is approximately half that of an equivalent volume of water.

7.1.2 LPG vapour is denser than air, commercial butane being about twice as heavy as air and commercial propane about one and a half times as heavy as air. Therefore the vapour may flow along the ground and into drains, sinking to the lowest levels of the surroundings and be ignited at a considerable distance from the source of leakage. In still air any vapour will disperse slowly.

7.1.3 When mixed with air, LPG can form a flammable mixture; the flammable range at ambient temperature and pressure extends between approximately 2 per cent of the vapour in air at its lower limit and approximately 10 per cent of the vapour in air at its upper limit. Within this range there is a risk of explosion. Outside this range any mixture is either too weak or too rich to propagate flame, but over-rich mixtures can become hazardous when diluted with air.

7.1.4 Small quantities of the liquefied gas can give rise to large volumes of vapour/air mixture and thus cause considerable hazzard. A suitable, properly calibrated explosimeter may be used for testing the concentration of LPG in air. **ON NO ACCOUNT SHOULD A NAKED FLAME BE USED TO DETECT A LEAK.**

7.1.5 LPG vapour is slightly anesthetic and may also cause suffocation if present in sufficiently high concentrations.

7.1.6 LPG is normally odorised before distribution by the addition of odorant such as ethyl mercapton or dimethyl sulphide, enabling detection by smell of the gas at concentrations down to one fifth of the lower limit of flammability (i.e. approximately 0.4 per cent of the gas in air).

7.1.7 Escape of LPG may be noticeable otherwise than by smell. When the liquid evaporates, the cooling effect on the surrounding air causes condensation and even freezing of water vapour in the air. This effect may show itself as frost at the point of escape and thus make it easier to detect an escape LPG. Because of the different refractive index of LPG to air leaks can sometimes be seen as a 'shimmering'.

7.1.8 Owing to its rapid vaporisation and consequent lowering of temperature, LPG, particularly liquid, can cause severe frost burns if brought into contact with the skin. Protective clothing such as gloves and goggles should be worn if exposure to this hazard is likely to occur.

7.1.9 A container which has held LPG and is normally 'empty' may still contain LPG in vapour form and is thus potentially dangerous. In this state the internal pressure is approximately atmospheric and if a valve is leaking or is left open, air can diffuse in to the container forming a flammable mixture and creating a risk of explosion; alternatively, LPG can diffuse to the atmosphere.

7.2 Qualification of personnel

In the interest of safety, all persons employed in and bulk handling LPG shall be trained in proper handling and operating procedures, which the employer shall document. All employees shall carry written certification of their job qualification issued by the training agent or a written document issued by the authority having jurisdiction identifying the functions each person is authorised to perform.

APPENDIX A

TABLE 2 - Typical Physical properties of commercial butane and commercial propane

(1)	Commercial Butane (2)	Commercial Propane (3)
Relative density of liquid at 15.6 °C	0.57 to 0.58	0.50 to 0.51
Imperial gallons/ton at 15.6 °C	385 to 393	439 to 448
litre/tonne at 15.6 °C	1723 to 1760	1965 to 2019
Relative density of gas compared with air at 15.6 °C and at 101.59 kPa pressure.	1.90 to 2.10	1.40 to 1.55
Volume of gas (litres) per kg of liquid at 15.6 °C and 101.59 kPa pressure	406 to 431	537 to 543
Boiling point at atmospheric pressure in °C approx.	-2	-45
Vapour pressure (gauge) maximum in kPa specified for products at selected key temperatures Temp °C -40 -18 0 15.6 38 45	 - - 90 193 483 586	 50 230 450 690 1450 1760
Latent heat of vaporisation (kJ/kg) at 15.6 °C	372.2	358.2
Specific heat of liquid (kJ/kg) 15.6 °C	2.386	2.512
Sulphur content percent weight	Negligible to 0.02	Negligible to 0.02
Limits of flammability (percentage by volume of gas in a gas air mixture to form a combustible mixture)	Upper 9.0 Lower 1.8	Upper 10.0 Lower 2.2
Calorific Value; Gross (MJ/m^3) dry (MJ/kg) Net (MJ/m^3) dry (MJ/kg)	 121.8 49.3 112.9 45.8	 93.1 50.0 86.1 46.3
GJ/tonne	49.3	50.0
Approximate ignition temperatures in air °C	410 to 550	460 to 580
Air required for combustion (m^3 to burn 1 m^3 of gas)	30	24

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SRI LANKA STANDARDS INSTITUTION

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