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CODE OF PRACTICE FOR TRANSPORT, STORAGE AND HANDLING OF LPG

PART 8 :SAFE HANDLING AND TRANSPORT OF LPG IN BULK BY ROAD

SRI LANKA STANDARDS INSTITUTION

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PART 8 :SAFE HANDLING AND TRANSPORT OF LPG IN BULK BY ROAD

SLS 1196: Part 8 : 2000

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SRI LANKA

Sri Lanka Standards are subject to periodical revision in order to accommodate the progress made by industry. Suggestions for improvement will be recorded and brought to the notice of the Committees to which the revisions are entrusted.

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

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SRI LANKA STANDARD
CODE OF PRACTICE FOR TRANSPORT, STORAGE AND HANDLING OF LPG
PART 8 :SAFE HANDLING AND TRANSPORT OF LPG IN BULK BY ROAD

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 2000-12-27.

The objective of this part of the Code of Practice is to set out the basic Design and Construction requirements and Operational Procedures for the road tankers used for the transport of LPG in bulk by road.

The other parts of the Code of Practices are as follows:

Part 1 : General Provisions
Part 2 : Design installation and maintenance of bulk LPG gas storage at fixed installation
Part 3 : LP Gas piping system - Design and installation
Part 4 : Safe filling of LP gas at depots
Part 5 : Storage of full and empty LPG cylinders and cartridges
Part 6 : Use of LP gas in cylinders at residential premises
Part 7 : Transport of LP gas in cylinders by road, rail or on water

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

a) NFPA 58 - Standard for the Storage and Handling of Liquefied Petroleum Gases; Published by the National Fire Protection Association.

b) Code of Practice number 2 - Safe Handling and Transport of LPG in Bulk by Road, published by the Liquefied Petroleum Gas Industry Technical Association (UK).

1. SCOPE

This part of the Code of Practice covers the basic requirements for the design, construction, inspection, testing and operation of tanks and their ancillary loading and unloading equipment for pressurised LPG road tankers and tank containers.

In addition, safety requirements for vehicle design relevant to the carriage of LPG are included.

NOTE

This code does not preclude the use of alternative designs, materials and methods where these could provide equivalent or better standard of safety as judged by a competent person.

2. REFERENCES

ASME B1.5	ACME screw threads
ASME	Boiler and Pressure Vessel Code. Section VIII - Pressure vessels
BS 476	Fire tests on building materials and structures
BS 2789	Spheroidal graphite or nodular graphite cast-iron
BS 2950	Cartridge fuse links for light electrical apparatus
BS 3799	Steel pipe fittings, screwed and socket-welding for the petroleum industry
BS 3951	Part 2 - Section 2.3, tank containers for gases and liquids
BS 5345	Code of practice for selection, installation and maintenance of electrical equipment for use in potentially explosive atmospheres
BS 5500	Unfired fusion welded pressure vessels
BS 5501	Electrical apparatus for potentially explosive atmospheres
BS 6862	Cables for vehicles
BS 7122	Welded steel tanks for the road transport of liquifiable gases
BS EN 60529	Degree of protection provided by enclosures
SLS 712	Liquefied petroleum gas
SLS 785	Portable fire extinguishers
SLS 1172	Rubber hose and hose assemblies for LPG lines
SLS 1177	Filling ratios and developed pressures for liquifiable and permanent gases
SLS 1197	Inspection, access and entry openings in pressure vessels

3. DEFINITIONS

For the purpose of this Code of Practice the following definitions shall apply :

3.1 carriage by road: Means in the case of a road tanker or a tank container from the commencement of loading LPG in the tank or the tank container until the tank or container has been cleaned or purged so that the contents which remain are not sufficient to create a risk to the health or safety of any person.

3.2 fire safe valve: A valve which can comply with an acceptable fire test.

3.3 LPG: Commercial butane and commercial propane and any mixtures thereof to **SLS 712**.

3.4 road tanker: A goods vehicle which has a tank structurally attached to it or is an integral part of the frame of the vehicle.

3.5 tank: A tank of any size which is suitable for the carriage of LPG in bulk so constructed that it could be securely closed except for the purpose of relieving excessive pressure.

3.6 tank container: A tank having a volumetric capacity of more than 3 m^3 (3000 litres) fitted with a half frame incorporating ISO corner castings and twist lock fastenings etc. which can be lifted onto or off a suitable compatible vehicle.

4. VEHICLE DESIGN

4.1 Engine and related systems

4.1.1 *Engine*

The engine should be of the compression ignition type and should be in front of the rear line of the cab or be otherwise protected so that any spillage or leakage of LPG being conveyed cannot impinge on the heated surface of the engine. An external accessible means should be provided to stop the engine within 5 seconds in an emergency. This engine stop should be positioned behind the cab on or near the rear face of the right-hand front wheel arch and should be indicated by a clearly visible and legible notice.

4.1.2 *Air induction system*

The air induction system should be located and/or protected so as to minimize the possibility of induction of flammable vapour from any spillage of LPG or from any release from a safety relief device on the product carrying tank.

4.1.3 *Exhaust system*

The exhaust system including any turbo charger, should be located in such a position or be so shielded that any spillage or leakage of LPG being carried cannot impinge on the heated surface of the system. Exhaust gases should be directed away from the carrying tank and its associated pipe work.

4.1.4 *Fuel system*

The vehicle fuel tank should be positioned such that any leakage of fuel can drain directly on to the ground without impinging on the engine or its exhaust system.

4.2 Electrical system

4.2.1 The electrical system should be designed, installed and protected to minimise mechanical damage and the risk of electrical fires.

4.2.2 *Circuit voltage*

The nominal circuit voltage of any circuit on the vehicle should not exceed 24 Volts. All control switches should be on the feed side of the circuit.

4.2.3 *Cables*

All cables should have copper conductors, and should be insulated and further covered in accordance with the requirements of **BS 6862**. Except for cables to the starter motor, the current rating of any cable should be chosen such that the conductor temperature should not exceed 70 ^{o}C when it is carrying full load continuously at a maximum ambient temperature of 40 ^{o}C.

All cables should be located and secured on the vehicle so that they are protected against vibration, mechanical damage and heat.

4.2.4 *Batteries*

Batteries should effectively protected against spillage of LPG, and be fitted with an insulated cover as protection against inadvertent contact by objects which could cause a spark.

4.2.5 Behind the rear of the vehicle cab:

a) no screw-in or capless bulbs should be used;
b) junction boxes, connectors and all electrical equipment should be adequately protected and shielded from the ingress of moisture or LPG and the degree of protection should be at least that classified as IP55 in accordance with **BS EN 60529**; and
c) switches should be suitable for use in Zone **2** areas as defined in **BS 5345**.

4.2.6 Either an insulated return circuit should be used or every piece of electrical apparatus on the vehicle should be individually earthed to the chassis.

4.2.7 *Master switch*

A master switch to Zone **2** requirements, as defined in **BS 5345**, to enable all electrical circuits to be isolated should be installed as near as possible to the battery. The switch should have contacts capable of achieving physical separation for isolation purposes to

the requirements of **BS 5501**, Part **1** and Part **7**. The master switch control should be readily accessible to persons outside the vehicle and its location should be indicated by a clearly visible and legible notice. Means must also be provided to enable the driver to operate the switch without leaving his seat. Visual means should be provided to indicate clearly when the master switch is in the 'ON' or 'OFF' position.

4.2.8 *Circuit protection***.**

The following steps should also be taken to ensure protection of the electrical circuits:

a) All circuits, with the exception of the main battery supply and the starter and alternator circuits, should be protected with fuses or circuit breakers in the feed side of each circuit;
b) All circuit protective devices should be mounted forward of the rear of the cab;
c) Fuses or circuit breakers should be fitted within an enclosed unit and fuse holders should be permanently marked with the maximum fuse ratings;
d) The number of circuits connected to any protective device should not exceed four, and the rating of the device should be compatible with the smallest conductor in any of these circuits;
e) Any fuse type circuit protective device should open circuit within 10 seconds when passing a current 200 per cent of its normal rating and for a thermal circuit breaker the trip time at 200 per cent of its normal rating should not exceed 30 seconds; and
f) Grouping of circuits should be so arranged that the failure of a minor circuit does not render a major or obligatory circuit inoperative.

4.2.9 *Other electrical equipment*

Cigarette lighters and power plug points must not be fitted in cabs.

Radios or radio telephones must be permanently wired into a double pole circuit which can be isolated via the master switch.

4.3 Side protection

Adequate side guards designed to provide protection against mechanical damage to LPG tank, pipework or valves in the event of collision or roll-over shall be fitted.

4.4 Rear-end protection

The vehicle shall be provided with a rear bumper designed to provide protection for the tank and any rear mounted ancillary equipment in the event of a rear end collision. The width of the bumper should not be less than the width of the tank. The inside face of the bumper should be located at least 100 mm from the rear of the tank shell or any LPG fittings.

4.5 Vehicle stability

The height of the center of gravity of the load should not be greater than 95 per cent of the distance between the outer walls of the supporting tyres measured to the outside of their contact with the ground.

4.6 Driver's cab

4.6.1 The shell of the cab should be constructed of fire resisting materials. The materials used shall have a surface spread of flame characteristic not inferior to that of Class **2** in **BS 476,** Part **7.**

The shell should not collapse or permit the penetration of flame for a period 15 minutes when tested in accordance with **BS 476**, Part **20** and Part **22.**

4.6.2 Where windows are provided at the back of the cab they should be of 6mm thick toughened or safety glass and be retained internally and externally with fire resisting framing or clips. They must not be capable of being opened.

4.6.3 There should be no opening in the cab roof.

4.6.4 There should be a space of not less than 100 mm between the rear of the cab and the foremost point of the product carrying tank or any attachment to the tank other than any connections between the cab and the tank which are necessary for the operation of the vehicle.

4.6.5 *Cab heaters*

Cab heaters, other than those operated by the vehicle engine, should only be installed where the operation of the vehicle requires the driver to remain with the vehicle at times of overnight stops.

A cab heater, other than that operated from the vehicle's engine, when fitted, should be a totally enclosed combustion type complying with the following requirements:-

4.6.5.1 The heater should be operated on gas oil or diesel oil only.

4.6.5.2 The combustion unit should be designed so that it can be readily removed by the vehicle driver if required to do so when entering high risk premises.

4.6.5.3 The combustion unit and its exhaust pipe should be located in such a position or be so shielded that any spillage or leakage of flammable gas cannot impinge on any heated surface of the system and they should be cab-sealed.

4.6.5.4 The heater should be connected to the vehicle's electrical system in such a way that:

a) the heater can only be switched on by the activation of a separate switch in the cab;
b) the heater cannot be used when the engine is running; and
c) the heater is isolated when the master switch is in the 'OFF' position.

4.6.5.5 A durable notice should be fitted adjacent to the switch at (a) above which states that "The heater must not be switched on at a loading or unloading locations or during loading or unloading operations.

4.6.6 *Sleeper cabs*

Full sleeping facilities shall be provided if drivers are required to remain in the cab during overnight stops.

4.7 Draw bar trailers

Draw bar tank trailers shall comply with all relevant parts of this Part of the Code of Practice and shall have not less than four wheels on two axles. The wheel base of the trailer shall not be less than 3/5 th of its overall length.

5 TANK OR TANK CONTAINER DESIGN AND CONSTRUCTION

5.1 New construction

5.1.1 *Capacity*
The maximum carrying capacity of an LPG tank container is determined by the limitations of the maximum safe volume of LPG which may be carried in the tank and/or the overriding statutory limitations of maximum gross laden weight (GLW) and individual axle weights permitted on the public roads. Also see Appendix **A** for maximum filling capacity of LPG tanks and tank containers.

5.1.2 The maximum overall width of any tank and its service equipment shall be such that it does not project beyond the overall width of the rest of the vehicle, or the extremities of the ISO frame in the case of a tank container.

5.1.3 *Tank container*
New tanks or tank containers shall be designed, constructed, heat treated, inspected and tested to **BS 7122 (**category 1 of **BS 5500**) and the requirements of this part of the Code of Practice. Attention is drawn to the inspection and testing required during construction as in **6**.

5.1.4 The design of new tanks shall be based on the following pressures:

Commercial propane not less than 1.68 MPa gauge.
Commercial butane not less than 1.00 MPa gauge.

These pressures assume a finish in accordance with **5.3.3.** An additional allowance shall be made for acceleration forces specified in **5.1.7.**

5.1.5 *Vacuum conditions*

The tank shall be designed for an internal vacuum for example, for an external pressure of one atmosphere, unless vacuum purging is intended.

5.1.6 S*tatic loads*

In allowing for static loads, in addition to self weight, and the weight of LPG to be carried, consideration must be given to initial and possible subsequent hydraulic test when the contents may be water. Where the tank is to be self supporting, tank design must provide for the additional stresses normally carried by the vehicle chassis frame.

5.1.7 The design of tanks and their supports shall take account of acceleration and deceleration forces of normal road transport by multiplying the static loads by the following factors:

in the direction of travel	x2
in the vertical downward direction	x2
in the transverse horizontal direction	x1

5.1.8 *Materials*

Materials used in the construction of tanks shall have impact values complying with Table **1** of **BS 7122** at temperatures down to minus 20 ^{o}C.

5.1.9 *Apertures*

Tank apertures shall be formed from machined or forged connections and provided with studs for flanged fittings, or female taper threads for taper to taper threaded fittings. Relief valves may require protection around the connection against mechanical impact.

5.1.10 Threaded connections should not exceed 80 mm nominal bore. (See also **5.4.2.).**

5.1.11 *Internal pipework*

5.1.11.1 Internal pipework which may be required for liquid fill, spray filling, vapour balance, meter vapour eliminator, pressure gauge, fixed or rotary liquid level gauges shall comply with **5.1.11.2** to **5.1.11.6.**

5.1.11.2 Materials shall comply with Part **3** of this Code of Practice.

5.1.11.3 All internal joints shall be tested to ensure that they are leak tight.

5.1.11.4 Adequate supports shall be provided to resist vibration and acceleration forces associated with road transport and other dynamic forces such as vessel flexing which may otherwise cause fatigue failure.

5.1.11.5 The location of pipework shall not interfere with access for internal inspection through the manway or through internal baffles.

5.1.11.6 The termination of vapour balance and fixed liquid level pipework shall be located so as to avoid liquid carry over during product transfer. Splash caps should be fitted where necessary.

5.1.12 *Tank ends*

Tank dished ends should be formed by hot spinning, or cold forming. Heads where necessary shall be subjected to heat treatment to return the material to not less than the minimum specified properties.

5.1.13 *Data plate*

A corrosion resistant data plate shall be firmly attached to one of the supporting structures or welded to the vessel, in a clearly visible position and shall be stamped with the following information:

a) Manufacturer's name;
b) Date of manufacture (pressure test date);
c) Design code;
d) Hydraulic test pressure;
e) Design pressure range;
f) Design temperature range;
g) Water capacity;
h) Tank serial number; and
j) Retest dates and inspection authority marks.

The characters should not be less than 5 mm high.

5.1.14 *Access and entry opening*

5.1.14.1 Tanks with water capacity of over 7.5 m^3 (7500 litres) shall be fitted with baffle plates set laterally to limit longitudinal surge. They shall be designed to facilitate access through them for purposes of internal inspection of the tank.

5.1.14.2 Tanks with water capacity of over 5 m^3 (5000 litres) shall have a manhole complying with **SLS 1197** Access through baffles shall be by openings not less than
460 mm diameter. Tanks upto and including 5 m^3 capacity should have inspection apertures complying with **SLS 1197**

5.2 Mountings

5.2.1 Mounting structures should be fabricated in steel and be designed to comply with the requirements of the tank and chassis manufacturer. They shall take into account all the additional stresses stipulated in **BS 7122**.

5.2.2 Mountings should be designed as an integral attachment to the shell. Each attachment should be continuously welded to the shell which shall be locally reinforced to alleviate high stress concentrations.

5.2.3 Tanks and fittings shall be electrically continuous with the chassis of the vehicle (maximum resistance 10 Ohms) and shall be fitted with a connection for attachment of an electrical earth/bonding cable for use during loading/unloading. Any metal contact capable of causing electro-chemical corrosion shall be avoided.

5.2.4 In addition to the above, the ISO frame of a tank container shall comply with the requirements of **BS 3951**, Part **2**, Section **2.3**.

5.3 External corrosion protection

5.3.1 Tanks shall have adequate external protection against corrosion arising from atmospheric influences and this shall be properly and adequately maintained.

5.3.2 The external surface of carbon steel tanks and supporting structures should be subjected to a complete shot blast operation and subsequent zinc metal spray treatment or other suitable treatment to a recognized standard prior to painting.

5.3.3 The final painted surface of the tank should be a reflective gloss finish which must be applied before the tank is commissioned. Other finishes may reduce normal reflection of solar radiation. Adequate paint thickness should be provided to acceptable international standards.

5.4 Valves and fittings

5.4.1 All valves, fittings and ancillary equipment shall be of suitable materials for liquid phase LPG at the maximum and minimum pressures and temperatures of service operation, for service in road vehicles and shall be installed or fitted in accordance with the manufacturer's instructions and recommendations.

5.4.2 Joints for pipework up to and including 50 mm nominal bore, or for proprietary items such as pumps, valves and meters up to 80 mm nominal bore, may be threaded. Larger sizes of pipe should be welded or have welded flanges.

Threaded fittings should be forged carbon steel to **BS 3799** and may require the use of heavy-wall pipe. The thread on both the fitting and pipe shall be tapered and of the same form.

5.4.3 Jointing materials, thread sealants and gaskets must be compatible with liquid phase LPG. Thread sealants should be non-setting.

5.4.4 Protection against mechanical damage must be provided by design, location or barriers, against the dangers of collision or roll-over. Mechanical barriers shall not be attached to pipework or valves which they are intended to protect.

5.4.5 *Primary shut-off systems*

5.4.5.1 Primary shut-off systems are valves or a series of valves attached to the tank shell which serve to ensure the integrity of the tank and security of its contents.

5.4.5.2 Primary valve systems shall be of a design intended to leave a closure mechanism intact in the event of external damage.

5.4.5.3 All connections to the tank with a passageway out of the tank in excess of 1.4 mm diameter, other than those for pressure relief valves, or those permanently fitted with blank flanges or plugs, shall incorporate a primary shut-off system.

5.4.5.4 The primary shut-off system required depends upon the size and purpose of the tank connection:

a) (i) For liquid discharge above 40 mm nominal size intended for hoses not exceeding 10 metres including couplings

A normally closed internal shut-off valve with its closure mechanism located within the tank and opened by hydraulic or pneumatic power from the vehicle. It shall be designed for rapid closure on command by one of at least two manual devices located at convenient remote positions on the vehicle and adequately labeled to indicate their use. The system should incorporate a thermally sensitive device which will ensure positive closure in the event of a fire. The closure mechanism should incorporate an excess flow valve facility.

a) (ii) For liquid discharge as (a)(i) but intended for hoses or hose reels longer than 10 metres

As (a) but with the addition of remote manual closure on command from a position adjacent to the receiving vessel by the person controlling the delivery.

b) For other liquid or vapour connections, except those for level gauging or pressure gauges

An excess flow valve or back-check valve, as appropriate, directly mounted into the tank connection in series combination with a manual shut-off valve. Where access to the valve handle would be restricted, consideration should be given to shut-off valves with a remote closure facility as in a (i).All filling connection shall terminate in the vapour phase.

c) For drain connections

Primary drain connections should not exceed 50 mm nominal bore and shall comply with **5.4.5.5** and **5.4.5.6.**

5.4.5.5 Excess flow valves should be set to close at a flow rate below that likely to result from a guillotine failure of associated fittings or pipework system for the lowest practicable system pressure. They should be set high enough to prevent chatter when pumping under normal conditions. A pressure equalizing orifice not greater than 1 .4 mm diameter shall be incorporated. The closing rate of flow should not exceed 150 per cent of the nominal rate of flow.

5.4.5.6 Primary valve systems should not be located at the rear of the tank if they are vulnerable to rear collision damage, unless the risk of such can be shown to be negligible by adequate protection. (See **5.4** and **6.4.4**)

5.4.6 *Secondary shut-off valves and systems*

5.4.6.1 Secondary shut-off valves and systems comprise all valves and fittings not connected directly to the tank.

5.4.6.2 Valves in pipework for liquid transfer or vapour balance connections used for routine operations should be fire safe, located as close as practicable to the end of the rigid pipework, and as close as possible to the final hose inlet.

5.4.6.3 Intermediate valves should be provided to enable individual isolation of the pump or meter. Consideration should be given to automatic closure of these valves by incorporation in the remote closure system of the primary internal valve. **(5.4.5.4).**

5.4.6.4 Any secondary valves and pipework for drain connections shall comply with **5.5.6.**

5.4.7 *Other connections*

All other connections to the tank except pressure relief and liquid-level gauge connections relying on bleed to atmosphere should be provided with:

a) suitable excess flow valves with a pressure equalising orifice not greater than 1.4 mm diameter; or

b) quick closing internal valves designed to remain closed except during delivery or charging,; or

c) back pressure check valves.

5.4.8 *Pressure relief valves*

5.4.8.1 Tanks shall be equipped with one or more pressure relief valves, having direct access to the vapour space of the tank. The start to discharge pressure shall not be greater than the tank designed pressure. (See **5.1.4**)

Their total flow capacity should be sufficient to meet the requirements of **BS 7122**.

5.4.8.2 Pressure relief valves shall be of the internal spring loaded type and as far as practicable should be designed and fitted so as to prevent water accumulating on the discharge side.

5.4.8.3 Pressure relief valves shall be designed and fitted to ensure that, in the case of ignition of discharging product, flame impingement on the tank is avoided.

5.4.8.4 The valve seat of pressure relief valves shall preferably be within the tank. Otherwise they shall be protected against foreseeable impact damage. Shroud protection should be designed to ensure it stands proud of the valve and should be designed so that distortion caused by impact so as practicable will not prevent the relief valve from operating.

5.4.8.5 Each pressure relief valve should be plainly and permanently marked with the following;

a) Manufacturer's mark;
b) Month and year of manufacture;
c) Nominal set pressure;
d) Valve type number; and
e) Discharge capacity quoted in cubic metres per minute of air at standard conditions.

5.4.9 *Marking*

5.4.9.1 All tank connections, e.g. inlets, liquid-level gauge connections etc. but excluding relief valve connections should be labeled to designate their purpose.

5.4.9.2 A flow diagram should be affixed to the vehicle in an easily visible position.

5.5 Ancillary equipment

5.5.1 All valves/equipment/pipe work, their joints with associated jointing materials and thread sealants should be suitable for use with liquid LPG over the full range of operating temperatures and pressures. The maximum design pressure is the vessel design pressure plus the maximum differential pressure generated by the pump. This is normally not less than 2.4 MPa gauge.

The physical location and protection of pipework and ancillary equipment on articulated road tanker trailers should take account of the possibility of collapse of the landing legs.

Installation should comply with manufacturer's instructions.

5.5.2 *External pipework*

5.5.2.1 General advice on pipework can be found in Part **3** of this Code of Practice.

5.5.2.2 Pipework should be kept to the minimum size consistent with the design flow rates.

5.5.2.3 The number of joints and fittings should be kept to a minimum.

5.5.2.4 Where practical joints should be welded flanges although joints up to 50 mm nominal bore and joints on proprietary items up to 80 mm nominal bore may be threaded.

5.5.2.5 Bolts, studs and nuts should comply with **BS 7122**.

5.5.2.6 Welds should comply with Part **3** of this Code of Practice.

5.5.2.7 Pipework should be suitably supported and independently protected against physical damage e.g. due to vehicle vibration or impact.

5.5.3 *Flexible connections*

5.5.3.1 Provision should be made for any relative movement between items of equipment, the chassis and the product carrying tank.

5.5.3.2 Flexible connections between items of equipment or pipework should be designed for the same operating limits as hoses to **SLS 1172** Part **1** or **SLS 1172** Part **3** and have electrical continuity unless electrical continuity is provided through other means.

5.5.3.3 Proprietary flexible connections must be installed strictly to the manufacturer's instructions.

5.5.3.4 Hoses used as flexible connections between items of equipment or pipework should be no longer than is required to avoid over stressing of adjacent pipework or equipment.

5.5.3.5 Hoses above 50 mm nominal bore should be fitted with flanged rather than threaded end connections.

5.5.4 *Hydrostatic relief valves (thermal relief value***)**

(The thermal coefficient of expansion of liquid LPG is ten times that of water)

5.5.4.1 Wherever liquid LPG may be isolated in any section of pipework protection against excessive pressure must be provided. This is usually achieved by the use of hydrostatic relief valves.

5.5.4.2 Hydrostatic relief valves should be installed so that discharge will not cause danger to operators and shall be directed away from the tank shell.

5.5.4.3 Hydrostatic relief valves should be set to discharge above the maximum working pressure but not above the design pressure of the equipment being protected.

5.5.4.4 Subject to **5.5.4.3,** the set pressure for propane hydrostatic relief valves discharging to open air, should not be less than 2.4 MPa gauge.

5.5.5 *Content gauges and Level gauges*

5.5.5.1 Tanks shall be fitted with a suitable contents gauge.

5.5.5.2 The contents of the tanks are to be measured by volume with a rotary dip tube or magnetic gauge. One or more fixed maximum liquid level gauges as a check on these gauges should also be provided.

5.5.5.3 Fixed maximum liquid level gauges should be set to take account of the minimum operating temperature likely to be experienced for each type of LPG to be carried. (See Appendix **A)**.

The termination of internal pipes to these gauges shall be located on a vertical line which is as near the volumetric centre of the tank as practicable.

5.5.5.4 Fixed liquid level gauges shall be marked or labeled to show the product for which they have been set.

5.5.5.5 Any gauging device that relies on bleeding to atmosphere, such as rotary dip tube or fixed tube shall be such that;

a) the bleed hole maximum opening is not larger than 1.4 mm diameter. Otherwise it shall be protected by a shut-off valve and a suitable excess flow valve;
b) the operational bleed screw shall remain captive at all times; and
c) the gland is capable of being replaced without withdrawing the tank from service.

5.5.6 *Pumps*

5.5.6.1 The design and materials of construction shall be suitable for use with liquid LPG and the service conditions, including the maximum outlet pressure to which they may be subjected. Cast irons should not be used unless they have adequate ductility and resistance to brittle fracture over the range of pressures and temperatures involve which could be as low as boiling point of LPG being handled. Ductile iron to **BS 2789** with an elongation at fracture of not less than 18 per cent is acceptable.

5.5.6.2 The rotational speed of the drive should have controls to prevent the ratings of the pump being exceeded.

5.5.6.3 In addition to any internal pump over pressure by-pass, the pump or adjacent pipework must be fitted with a separate by-pass valve set at a lower differential pressure to automatically carry any excess liquid back to the carrying tank when the delivery valve is closed. The by-pass valve should be suitably sized to accommodate the pump discharge flow rate.

5.5.6.4 A suitable strainer, should be fitted immediately at the pump inlet. It should be effective of both normal discharge and uplift using the vehicle pump.

5.5.7 *Meters*

5.5.7.1 The design and materials of construction shall be suitable for use with liquid LPG and the service conditions, including the maximum outlet pressure to which they may be subjected. Cast irons should not be used unless they have adequate ductility and resistance to brittle fracture over the range of pressures and temperatures involve which could be as low as boiling point of LPG being handled. Ductile iron to **BS 2789** with an elongation at fracture of not less than 18 per cent is acceptable.

5.5.7.2 Means shall be provided to eliminate vapour from the liquid phase LPG before it passes into the meter measuring chamber.

5.5.7.3 Means of measuring the liquid temperature shall be provided for meters which do not have automatic temperature compensation and should be located in pipework leading to the meter.

5.5.8 *Thermometers (where fitted)*

For temperature measurement of LPG a thermometer pocket shall be used, which shall be a blind tube of suitable length constructed to the design code of the tank or pipework into which it is permanently welded.

5.5.9 *Pressure gauges*

A pressure gauge shall be provided and connected to the vapour space. It shall be protected by a manual shut-off valve and excess flow valve unless the connection through the vessel is 1.4 mm diameter or less.

5.5.10 *Hoses and hose reels*

5.5.10.1 Hoses for liquid transfer and vapour balance shall comply with **SLS 1172** and shall be in one manufactured length without intermediate joints or couplers.

5.5.10.2 Electrical continuity shall exist between the tank and the hose free-end coupling. The electrical resistance shall not exceed that required by **SLS 1172.**

5.5.10.3 Hose end valves should be capable of being latched in the closed position or otherwise protected against inadvertent opening.

5.5.10.4 Hose end valves should have a suitable secure storage location to prevent movement when the vehicle is in motion.

5.5.10.5 Loose transfer hoses shall be fitted with manual shut-off valves at both ends and hoses other than for vapour balance shall be fitted with suitable hydrostatic relief valves.

5.5.10.6 Hose on hose-reels shall not be rewound in the liquid full condition as it could create a pressure rise liable to cause hydrostatic relief valves to discharge.

5.5.10.7 Where hose-reels with hoses exceeding 30 m in length are contemplated consideration should be given to the physical effort required to draw out the hose.

5.5.10.8 Hoses exceeding 10 m in length including end fittings, shall be provided with means for the person controlling the delivery to shut the internal valve in the road tanker by remote control from a position adjacent to the receiving vessel.(See **5.4.5.4).**

5.5.10.9 Hose reels with powered rewind drives should have means of stopping the drive either by a conveniently located switch or by purpose designed drive clutch slip.

5.5.10.10 Hose reel power drives shall be fitted with suitable guards to protect operators.

5.5.11 *Hose end couplings*

5.5.11.1 To maintain an industry standard and to minimise the use of adapters, couplings for hoses intended for tank filling or discharge and for vapour return connections should be one of the types and sizes indicated below. Vehicle half couplings shall be male, and suit delivery hoses with female half couplings at each end.

a) Preferred type

LIQUID
3 1/4" ACME R.H.x6 TPI
2 1/4" ACME R.H.x6 TPI
1 3/4" ACME R.H.x6 TPI

VAPOUR
2 1/4" ACME R.H.x6 TPI
1 3/4" ACME R.H.x6 TPI
1 1/4" ACME R.H.x5 TPI

ACME threads should conform to ASA B1 5 class 2G.

b) Self sealing couplings

This type of coupling will not be compatible with the ACME coupling. Where self sealing couplings are used, the type and size must have compatible mating halves and to avoid the use of adapters the sizes should be restricted to:

LIQUID
3" (80 mm nominal bore)
2" (50 mm nominal bore)
1.5" (40 mm nominal bore)

VAPOUR
2" (50 mm nominal bore)
1" (25 mm nominal bore)

5.5.11.2 Left hand threads shall be used for liquid or vapour couplings for unodorised products and shall not be used for any other purpose.

5.5.11.3 Where it is necessary to use an adapter to enable a loading/unloading operation to be carried out where differing couplings on the tanker and the storage vessel, only one single adapter should be used.

5.5.11.4 Where any storage vessel is to be filled on a regular basis by one supplier the use of adapters should be avoided by ensuring that the couplings on the storage vessel are compatible with those on the tanker hoses.

5.5.12 *Electrostatic earth provision*

5.5.12.1 Vehicle tanks shall be provided with an earth pin and suitable equipment to dissipate any electrostatic potential which may develop due to vehicle movement or between the tanker, the piping and static tank and the ground during loading and unloading operations.

5.5.13 *Drive away prevention*

5.5.13.1 Means should be provided to ensure automatic immobilisation of the vehicle whilst transfer hoses are connected to a road tanker or a receiving vessel, and until they are properly stowed.

5.5.13.2 The system shall be designed so that the automatic actuation of the brakes cannot occur other than when the vehicle is both stationary and the hand brake is applied. This shall not preclude the provision of a manual override system.

6. TESTING AND EXAMINATION OF ROAD TANKERS AND TANK CONTAINERS

A suitable written scheme for the initial examination and the periodic examination of the tank or tank container and its fittings is required to comply with the requirements under this Code and any other regulations in force as framed by the Registrar of Motor Vehicles.

6.1 Initial testing and inspection during construction

6.1.1 During initial tank construction an approved inspection authority will carry out stage inspections in accordance with the tank design code to ensure that the tank complies with the recognised pressure vessel code.

In the case of a tank container, the ISO frame shall be subjected to the inspection, tests and certification, as required by **BS 3951**, Part **2** - Section **2.3**.

6.1.2 The plate material for each tank shall incorporate one production control test plate which must include a longitudinal weld and be of sufficient size to enable destructive tests to be carried out to show that the weld metal is suitable for the intended duty and has tensile properties not less than those specified for the parent metal. Impact tests shall be conducted at minus 20 ^{O}C.

6.1.3 All main seams and butt welds shall be subjected to 100 per cent X Ray examination.

6.1.4 All other welds directly on the shell of the tank internally and externally shall be subjected to crack detection tests i.e. magnetic particle in the case of carbon steels, dye penetration in the case of stainless steels.

6.1.5 Carbon steel tanks shall be stress relieved after the completion of all hot work.

6.1.6 External pipework assemblies shall be constructed to **5.5.2** and Part **3** of this Code of Practice and suitably pressure tested to 3.6 MPa. gauge prior to fitting to the tank.

6.1.7 In addition to the tests indicated in **6.1.1** and **6.1.6** on completion of assembly of the tank, pipework, valves and fittings, the Inspecting Authority shall witness the carrying out of a pneumatic leak test at a pressure of 0.6 MPa. to ensure satisfactory pressure containment of all joints.

6.1.8 On satisfactory completion of the above tests the Inspecting Authority should issue a certificate generally as detailed in Appendix **C**.

6.2 In service periodic examination and testing

6.2.1 The tank and pressure containing pipework shall undergo thorough examination as specified in the written scheme at periodic intervals which should not normally exceed
6 years. The written scheme should include the replacement of all pressure relief valves with equivalent new or reconditioned valves and the scope of examinations in **6.2.2** to **6.2.10,** at the time of the periodic inspection.

Transfer hoses and end fittings shall be subjected to regular inspections and retests.

6.2.2 Before the commencement of the examinations, the tank, valves and fittings, and external pipework shall be purged and made safe for entry.

6.2.3 The Inspecting Authority shall carry out an initial visual internal and external inspection of the tank for obvious defects, i.e. dents, corrosion etc. Any defects should be recorded and if necessary rectified with agreement of the operator prior to conducting tests detailed in **6.2.3.1** (a) or (b).

6.2.3.1 The tank shall then be subjected to one of the following tests:

a) A hydraulic test at the pressure specified on the previous test certificate followed by a visual internal and external inspection to determine whether detrimental conditions have arisen. Non-destructive testing methods may be applied where the visual inspection indicates areas of doubt, or

b) Non destructive tests of all attachment welds on the tank wall internally or externally, e.g. magnetic particle or dye penetrant crack detection tests on nozzle welds and structure attachment fillet welds.

6.2.3.2 Any repairs considered necessary should be approved by the inspecting Authority and the operator.

6.2.4 All other welds on tank mountings should also be subjected to thorough visual inspection for cracks and/or corrosion.

6.2.5 Any defects listed in **6.2.3** and **6.2.4** should be rectified as required by **6.2.7** before the tank is returned to service.

6.2.6 "Hot-work" shall only be conducted under a "work permit" system, all rectification being in accordance with the relevant design code.

6.2.7 Weld repairs to the tank shall be subjected to one or other of the tests called for in **6.2.3.1.**

6.2.8 On satisfactory completion of the test in **6.2.3.1** (a) or (b) and reassembly of new or refurbished valves, fittings and pipework, the Inspecting Authority shall witness a pneumatic leak test at the pressure specified on the previous test certificate to ensure pressure containment of the valve and pipework joints. All replacement relief valves shall be provided with current test certificates.

6.2.9 On satisfactory completion of the above tests the Inspecting Authority should stamp the tank data plate accordingly and issue a certificate as detailed in Appendix **D**.

6.2.10 The frame of an ISO type tank container shall be inspected as required by **BS 3951**, Part **2** - Section **2.3**.

6.3 Gas charging for commissioning

Care should be taken to limit flash vaporisation when carrying out the initial fill of new tankers or those being returned to service after being purged or gas freed.

6.4 Accident damage

6.4.1 A tank or its associated pipework or equipment which has been subjected to accident damage in such a way that it may affect its safety, must not be returned to service until it has satisfactorily passed the relevant section of the periodic inspection procedure outlined above and if necessary rectified accordingly.

6.4.2 The mounting structure and frame of tank containers which have been subjected to accident damage should be examined, tested and repaired to satisfy the requirements of **BS 3951**, Part **2** - Section **2.3**.

7 WORKSHOP MAINTENANCE AND REPAIRS

7.1 Work on vehicles containing LPG should only be carried out in a controlled environment. This environment should be directly assessed by a trained competent person of at least supervisory level and the work carried out as directed by him.

7.2 The competent person should assess the time to be taken for such work and if not completed in one shift should ensure the transfer of responsibility and any relevant information to the workshop supervisor in charge of successive shifts.

7.3 Hot-work shall only be conducted under a "work permit" system. Welding on the tank shell or elsewhere on the pressure containing system shall be by suitably qualified welders to written procedures approved by the Inspecting Authority and the operator. Stress relief may be required after welding on the tank shell or ends.

7.4 Weld repairs to the vessel and pressure containing system shall only be conducted after the vessel and pressure system has been satisfactorily purged and cleaned to eliminate any sources of LPG and a gas free certificate has been issued.

7.5 Regular and systematic maintenance should be carried out on the vehicle to ensure that it complies with the requirements of the Motor Traffic Regulations

7.6 Regular checks should be carried out during vehicle service periods to ensure the electrical continuity is retained between the shell of the tank and:

a) the free hose end coupling.
b) the end of the earthing cable.
c) the earth tread plate (where applicable).

7.7 Regular checks should be carried out on the vehicle fire extinguishers to ensure that they are within test/service date and in satisfactory operating condition.

7.8 Regular checks should be carried out to ensure the continued effectiveness of drive away protection devices, and other safety systems.

7.9 Flexible metallic hoses and flexible rubber hoses shall be regularly inspected and tested for integrity and deterioration.

7.10 Regular visual inspection of loading and unloading couplings should be made to detect wear beyond acceptable limits and the replacement of seals as necessary.

8. HAZARD WARNING PANELS AND LABELS

8.1 Road tankers

A road tanker transporting LPG must display three (3) hazard warning panels applicable to the load being conveyed, i.e. commercial LPG.

One panel must be positioned at the rear of the vehicle and one on each side of the vehicle as close as is reasonably practicable to the front of the tank and all in a substantially vertical plane, and at least one metre from the ground.

8.2 Tank containers

A tank container larger than 6 m^3 transporting LPG must display four (4) identical hazard warning panels applicable to the load being conveyed, i.e. commercial LPG. The panels must be positioned one on each side and one on each end of the container.

For tanks of 6 m^3 and less, two such panels one on each side are adequate.

8.3 Display of panels

8.3.1 Hazard warning panels may be permanently attached to the vehicle or tank where it is in dedicated service, otherwise panels shall be removable.

8.3.2 Panels must not be affixed over previous panels which may cause confusion in an emergency.

8.3.3 Removable hazard warning panels must have the warning on one side only.

8.3.4 Hazard warning panels shall be removed or covered only after the tank has been purged and cleaned so that it no longer creates a risk.

9. OPERATIONAL REQUIREMENTS

9.1 Information Relating to LPG

9.1.1 A consignor of LPG is required to ensure that the operator has such information as will enable him to comply with his duties under this code and to enable him to be aware of the hazards of LPG. This information shall enable the operator to display the appropriate hazard warning panels described in **8** and also to provide the information in writing to be carried during carriage.

9.1.2 *Information in writing to be carried during carriage*

Following information in writing is required to be carried in the cab and be readily available whilst LPG is being carried. This information shall include a material data sheet with the following minimum information (See Appendix **G**) :

a) the substance being carried; i.e. LPG.
b) the quantity being carried; and
c) the nature of the hazards and action to be taken in an emergency.

9.2 Precautions against fire and explosion

9.2.1 *Smoking*

A driver or any other person shall not smoke at any time whilst involved in the loading, unloading or carriage of LPG. No matches, lighters or other means of ignition shall be carried on the vehicle.

9.2.2 *Fire extinguishers*

One fire extinguisher shall be provided in the cab of the vehicle having a minimum test fire rating of 21B **(BS 5423**) such as 2 kg dry powder to be used as a first defense against a fire in the engine compartment.

Two fire extinguishers having a minimum test fire rating of 144B (**BS 5423)** such as 9 kg dry powder, should be provided on the vehicle or trailer, adjacent to the carrying tank and suitably protected against weather.

9.3 Loading and unloading operations

9.3.1 *General requirements*

9.3.1.1 Loading and unloading of LPG involves both road tankers and static storage installations. Hence guidance on operational procedures is also contained in Part **2** of this Code of Practice.

9.3.1.2 Written loading and unloading procedures including emergency action should be available and understood by all persons involved in each operation and their responsibilities clearly defined. For tanker to tanker product transfer, (See also Appendix **B**).

9.3.1.3 Precautions against fire and explosion (See **9.2**) are particularly applicable during loading and unloading.

9.3.1.4 Loading and unloading should be under the constant supervision of a competent person over 18 years of age.

9.3.1.5 Protective gloves and eye protection should be worn when carrying out the loading and unloading operations and particularly when making and breaking LPG connections.

9.3.1.6 When loading or unloading a vehicle, drive-away protection devices which require driver actuation should be engaged.

9.3.2 *Loading*

To ensure that road tankers are in an acceptable condition for 'safe loading,' it is recommended that the operators of supply terminals identify each vehicle following an initial examination of major safety aspects. A record of the examination should be kept at the terminal and by the vehicle operator for subsequent entry. Periodic spot checks are recommended.

9.3.2.1 The vehicle should be positioned on an essentially level surface within easy reach of the transfer connections and precautions taken to prevent inadvertent movement of the vehicle. The hand brakes should be firmly applied, and the gears disengaged and the engine stopped (except where it is necessary for driving a vehicle mounted pump). All vehicle electrical equipment not required for the loading should be switched off and cab heaters removed if required under **4.6.5.2.**

9.3.2.2 The exit from the loading bay should be kept clear of obstructions at all times.

9.3.2.3 Precautions should be taken to ensure that the grade of LPG to be loaded is correctly identified, the tanker is suitable for the intended load and it is correctly labeled.

9.3.2.4 The electrostatic bonding connection should be made between the tanker and the fixed installation before the LPG lines (liquid and vapour) are connected and not removed until after the LPG lines have been disconnected.

9.3.2.5 Checks should be made to ensure that the transfer couplings are properly connected without use of undue force before loading and again for any signs of leakage as transfer commences.

9.3.2.6 Level gauging of the receiving tanker should be carried out during the loading operation, with whatever devices provided, to ensure that the filling requirements of **5.1.1** are met. Periodic level checks and observation of tank pressure during loading will assist in identifying if the vapour balance excess flow valve has inadvertently closed. Should this occur, the operation should be stopped and the condition rectified.

9.3.2.7 The filling rate should be reduced as the maximum fill in the receiving tanker is approached to avoid overfilling.

9.3.2.8 Means should be available to stop loading immediately the maximum level in the receiving tanker is reached.

9.3.2.9 If a tanker is accidentally overfilled the excess LPG should be removed in a safe manner as soon as possible and departure of the vehicle.

9.3.2.10 Vehicles filled to a level gauge may need to be weighed after loading to ensure that they are not overloaded.

9.3.2.11 After disconnection of loading lines, earthing connections, a final check should be made that all tanker outlets are properly closed and secured and that the vehicle is in a fit condition to be driven away.

9.3.3 *Unloading*

The unloading of LPG from a tanker into static storage vessels follows the general principles applicable to loading.

9.3.3.1 The competent person to supervise unloading will normally be the driver, but in addition, particularly at large industrial installations, supervision by a plant operator is desirable.

9.3.3.2 Unloading shall not be undertaken during the hours of darkness without adequate lighting.

9.3.3.3 The vehicle should be positioned within easy reach of the transfer connection so that the hose is not under tension and at least one turn remains on hose reel. Vehicle electrical equipment not required should be isolated (switched off).

9.3.3.4 The driver should have unrestricted access between the vehicle and the static tank. The vehicle should be at a designated place and should stand where a clear line of sight exists for the driver or other person in control of the product transfer to see both the receiving vessel and the vehicle. If the location of receiving tank is remote or underground special attention is drawn to **9.3.3.12**.

9.3.3.5 The road tanker should preferably stand off the highway whilst unloading, and the vehicle exit should be clear at all times.

9.3.3.6 Precautions should be taken to ensure that the grade of LPG is correctly identified and the receiving vessel is suitable and it has sufficient ullage for the intended delivery.

9.3.3.7 A visual check should be made of the surroundings, the tank and its connections for any unusual or dangerous situation.

9.3.3.8 The vehicle fire extinguishers shall be readily available in case of emergency.

9.3.3.9 The tank of the delivery vehicle should be earthed and/or electrostatic bonding connection should be made between the tanker and the receiving vessel before the LPG transfer hoses are connected and not removed until after the LPG transfer hoses have been disconnected.

9.3.3.10 Delivery hoses should be visually examined for kinks, wear or any damage. Couplings and seals should be similarly examined to ensure compatibility and for any dirt etc. before connection.

9.3.3.11 Checks should be made to ensure that the transfer couplings are properly connected without use of undue force before unloading and again for any signs of leakage as transfer commences.

9.3.3.12 Level gauging of the receiving tank should be carried out during the unloading operation, with whatever devices provided, to ensure that over filling does not occur.

9.3.3.13 The pumping rate should be reduced as the maximum fill in the receiving tank is approached to avoid overfilling.

9.3.3.14 The delivery shall be stopped immediately the maximum level in the receiving tank is reached and isolating valves closed.

9.3.3.15 If a tank is accidentally overfilled the excess LPG should be removed in a safe manner as soon as possible. The tank must not be left in an unsafe condition.

9.3.3.16 At the completion of delivery **9.3.3.17** to **9.3.3.20** shall apply.

9.3.3.17 All isolating valves on the tanker shall be closed.

9.3.3.18 All relevant static vessel fill line/vapour line valves shall be closed.

9.3.3.19 Delivery hoses shall be disconnected and stowed or reeled in, and protective caps re-attached.

9.3.3.20 The earth lead/bonding cable shall be disconnected from the static vessel after the hoses have been disconnected.

9.4 Parking and supervision of vehicles

9.4.1 *Parking*

9.4.1.1 For overnight stops or periods exceeding 1 hour, the driver of any LPG tanker, whether full or nominally empty should :

a) choose a lorry park approved by the local authority, or
b) some other safe place in the open air but with no access to members of the public, e.g. a transport depot.

9.4.1.2 In case where parking according to **9.4.1.1** not possible, the vehicle should only be parked at a place which is:

a) not a road;
b) not within 15 metres of occupied premises; and
c) not a place where the public usually pass or gather.

9.4.1.3 When parked in accordance with **9.4.1.1** or **9.4.1.2** the motive unit should not be detached from a semitrailer except where it is necessary for operational reasons. This will enable the vehicle to be moved easily and quickly in an emergency.

9.4.2 *Supervision*

9.4.2.1 When a driver needs to park his vehicle for a short period, e.g. to partake of food, go to the toilet or whilst seeking access to a delivery point, he may not be able to park in accordance with **9.4.1.** In such circumstances he should park such that he may remain in sight of the vehicle as far as is reasonably practicable.

9.4.2.2 Where the driver cannot park as in **9.4.2.1** he should seek the help of some other person over 18 years of age who can remain in sight of the vehicle in his absence.

9.4.3 *Breakdown*

In the event of a breakdown of any LPG tanker or of a leakage or some other incident involving the LPG being carried, it may be necessary to call a breakdown service or the emergency services. In such circumstances the driver should stay with the vehicle, where it is safe for him to do so, and warn other persons to keep clear and be on hand when the breakdown or the emergency services arrive.

9.4.4 *Security of vehicle during parking*

Except where the tanker is parked in a secure location or compound, the driver should render the load secure as is reasonably practicable against theft and interference, before leaving the vehicle. Inlet and outlet valves should be secured with tamper proof devices unless secured in a lockable cage.

9.4.5 *Sleeper cabs*

Only vehicle cabs provided with proper sleeping facilities may be used for such purposes by drivers during overnight stops. In such circumstances and before retiring, the driver should render the load as secure as is reasonably practicable against interference.

9.5 Instruction and training of drivers

In addition to requirements for drivers under the 'Regulations for the carriage of dangerous or hazardous goods on road' all drivers of vehicles carrying LPG should have adequate instructions and training to understand the nature of dangers of LPG and his duties. Appendix **H** sets out a minimum training syllabus for the training of drivers to satisfy these requirements.

APPENDIX A

MAXIMUM FILLING CAPACITY OF LPG TANKS AND TANK CONTAINERS

A.1 General

A.1.1 The overriding factor is the maximum gross laden weight/permitted axle load for the road vehicle. A weigh bridge check should be carried out after filling a new road tanker for the first time to the fixed liquid level gauge, to ensure that the permitted load specified by the manufacturer is not exceeded.

The maximum volume of LPG in any tank must be limited because in its liquid phase, it has an extremely high coefficient of thermal expansion, about 10 times that of water. For this reason the maximum volume of LPG which is permissible to fill into any container must be such that the hydraulically full condition will not be reached for the foreseeable range of product temperatures to be encountered in normal service.

A.1.2 To ensure this condition there must always be sufficient ullage and the vessel must not be more than 97 per cent full at the 'filling reference temperature', and in addition must not be liquid full at 5 ^{o}C above this temperature.

A.1.3 The filling reference temperature to be used in Sri Lanka is specified in **SLS 1177**. For tanks above 1 m^3 upto and including 5 m^3 the reference temperature is 47.5 ^{o}C. For tanks over 5 m^3 the reference temperature is 45 ^{o}C.

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A.1.4 For LPG to **SLS 712**, if the volume does not exceed 97 percent full at the reference temperature, the hydraulically full condition will not be reached at 5 ^{o}C above the reference temperature.

A.2 Filling by volume

A.2.1 The maximum permissible volume of liquid in LPG storage vessels can be calculated as follows:-

$$U_{max} = 0.97 \, V \, g_i/g_t$$

where ,
gt = relative density of liquid at the filling temperature,
gi = relative density of liquid at the filling reference temperature,
V = internal volume of the tank (l),
Umax = maximum permitted LPG liquid volume (l)

A.2.2 When filling by volume without correction for filling temperature and product density the liquid level determined by the fixed liquid level gauge shall not be exceeded.

A.2.3 A fixed liquid level gauge incorporates an internal dip tube which gives a visible indication as the liquid surface rises when it reaches the maximum fill by volume. The controlled vapour release from the device changes from an invisible vapour to a clearly visible white mist. At this point filling must cease immediately.

A.2.4 The length of the dip tube fitted to the fixed liquid level gauge should take into account the lowest liquid temperature during filling of the road tanker or tank container.

A.2.5 Because the fixed liquid level gauge has to allow for the extremes of LPG density and the filling temperature it will indicate a conservative fill. Filling by weight and/or by the use of actual densities and temperatures may therefore exceed the level of the fixed liquid level gauge.

A.3 Use of rotary gauges (dip tubes)

A.3.1 These are useful for checking the progress of filling but they should not be used for determining the maximum safe fill volume.

A.4 Filling by weight

A.4.1 Filling by weight requires the use of:

a) an on-site weigh bridge;
b) vehicle installed load cells;; and
c) mass flow meter (integrator).

To prevent a possible overfill it is essential to determine how much product, if any, remains in the tank from the previous load before the commencement of filling.

A.4.2 To enable the requirements of **A.1** to be satisfied, each individual tractor, trailer or rigid chassis vehicle must be weighed prior to its first introduction into operation. It shall be weighed in its normally empty and gas charged condition and the following weights recorded:

(a) Tractor or rigid vehicle
  i. Kerb weight;
  ii. Front axle weight;
  iii. Rear axle weight; and
  iv. Calculated maximum weight of LPG the tanker can accept (See **A.4.3**).

All the above weights shall be determined with a full fuel tank, oil, water, discharge equipment including hoses and an allowance added for the driver.

(b) Semi-trailer or draw-bar trailer
  i. Kerb weight;
  ii. Trailer axle weights; and
  iii. Calculated maximum weight of LPG the tank can accept (See **A.4.3**)

A.4.3 The calculated maximum weight of LPG the tank can accept may be limited by the vehicle gross laden weight, but it shall not in any case exceed the volume requirements specified in **A.1.2** and **A.1.3.** This may be determined from the filling ratio tables in **SLS 1177** if the product density is known at a particular temperature.

A.4.4 When presented for filling by weight the recorded weights determined by **A.4.2** apply to the particular vehicle. This information together with the allowable gross vehicle weight must be used by the person responsible for loading.

A.4.5 Where doubt arises concerning the accuracy of the data or calculations it is recommended that loading by weight shall not be used.

APPENDIX B

TANKER TO TANKER PRODUCT TRANSFER

B.1 Other than in emergency situations such as road accidents where a tanker is damaged and cannot be safely moved, no transfer of LPG from one tanker to another shall take place on, or adjacent to a public highway or other public place.

B.2 In addition to the general requirements specified in **9.3.1** the following precautionary measures shall apply;

a) A minimum of 2 competent persons over the age of 18 years shall be present throughout the operation.

b) The transfer should take place essentially on level ground and in the open air;

c) Other than allowed in **B.1** both vehicles should be at least 15 metres from any public road or place, source of ignition or occupied premises; and

d) Transfer should not be undertaken during the hours of darkness without adequate and safe lighting.

B.3 When transferring LPG from one tanker to another the general principles applicable to unloading (See **9.3.3**) should be observed with the receiving tanker being regarded as the static vessel. Additional requirements are:

Both vehicles should be suitably positioned for ease of transfer hose connection and shall be prevented from inadvertent movement.

APPENDIX C

REPORT OF INITIAL EXAMINATION AND TEST

Typical report of initial examination and test certificate of suitability of a carrying tank/tank container and its fittings used for the carriage of LPG by road.

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1. **Name of Operator:**

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2. **Address of Operator :**

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3. **Description and distinctive number of the tank:**

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4. **Date and type of examination and test:**

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5. **Date of construction :**

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6. **Date and result of hydraulic test and pressure applied :**

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7. **Result of external examination of tank :**

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8. **Result of internal examination :**

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9. **Result of examination of fittings and attachments including the ISO frame of tank containers :**

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10. **Results of leak tests on tank and fittings :**

State tests carried out, pressure applied and results

11**. Maximum permissible working pressure :**

Maximum permissible working pressure calculated from dimensions and the data obtained from the examinations, due allowance being made for severe or exceptional conditions of working.

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12. **Conditions :**

Any limitations laid down regarding the purposes for which the tank is intended to be used arising from examinations and tests

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13. **Further examinations :**

Interval before further examinations (and tests) of the tank and its fittings are to be carried out as specified in the written scheme. State if this interval is to be shortened.

State date before which further examinations (and tests) are to be carried out.

I state that on --------- (date) the tank and its fittings ---------- (identification numbers) were examined and tested in accordance with the written scheme for the initial examination and testing of the tank and its fittings in accordance with the Code of Practice for Transport, Storage and Handling of LPG, Part 8. (If there are any road traffic regulations covering the transport of LPG in road tankers such regulation could be quoted here.) I certify that the tank and its fittings are suitable for the carriage of LPG by road.

Signed ..... Date .....

Certifying Officer or Company .....

Address .....

APPENDIX D

REPORT ON PERIODIC EXAMINATION AND RE-TEST

Typical report of periodic examination (and test) of a carrying tank/tank container and its fittings used for the carriage of LPG by road.

1.**Name of Operator :**

2.**Address of Operator :**

3.**Description and distinctive number of the tank :**

4.**Maximum permissible working pressure of the tank :**

5.**Interval between periodic examinations (and tests) :**

As specified in written scheme or such shorter period as was considered necessary by the competent person at the last examination and test.

6.**Date of last examination and test :**

7.**Results of examination :**

a) Brief description and results of examination (include the ISO frame of tank containers).

b) Details of replacement of relief valves (including hydrostatic relief valves).

---

8. Results of pressure and leak tests (if applicable):

Brief description and results of tests carried out. Date of test and pressure to be stamped on tank data plate.

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9. Repairs and modifications :

State:-

a) Any repairs or modifications which should be carried out as a result of the examinations and tests.

b) Whether the tank and its fittings can continue to be used with safety for the intended purposes.

---

10. Amended use of tank :

If the tank is not suitable for the purposes specified in the current certificate of initial examination and tests, state the limitations to be observed.

---

11. Further examinations and tests :

(a) If the interval between further examination (and tests) is to be shortened, state new intervals between examinations.

(b) State dates before which further examinations/tests are to be carried out.

I state that on ---------- (date) the tank and its fittings --------- (identification numbers) were examined and tested in accordance with the written scheme for the periodic examination and test of the tank and its fittings in accordance with the requirements under the Code of Practice for Transport, Storage and Handling of LPG, Part 8. (If there are any road traffic regulations covering the transport of LPG in road tankers such regulation could be quoted here.)

I certify that the tank and its fittings are suitable for the purposes and under the conditions specified in the current certificate of initial examination and tests dated .....but subject to the amendments specified in paragraph 10 above.

Signed ..... Date .....

Certifying Officer or Company .....

Address .....

APPENDIX E

TYPICAL PROPERTIES OF COMMERCIAL LPG

(1)	**Commercial Butane (2)**	**Commercial Propane (3)**
Relative density of liquid at 15.6^{o}C	0.57 to 0.58	0.50 to 0.51
litre/tonne at 15.6 ^{o}C	1760 to 1723	2019 to 1965
Relative density of gas compared with air at 15.6 ^{o}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 ^{o}C and 101.59 kPa pressure	406 to 431	537 to 543
Boiling point at atmospheric pressure in ^{o}C approx.	-2	-45
Vapour pressure (gauge) maximum specified for products at selected key temperatures Temp ^{o}C -40 -18 0 15.6 38 45	 kPa - - 90 193 483 586	 kPa 50 230 450 690 1450 1760
Latent heat of vaporisation (kJ/kg) at 15.6 ^{o}C	372.2	358.2
Specific heat of liquid (kJ/kg) at 15.6 ^{o}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 ^{o}C	410 to 550	460 to 580
Air required for combustion (m^{3} to burn 1 m^{3} of gas)	30	24

APPENDIX F

DISCHARGE RATES FOR RELIEF VALVES

F.1 Setting

The pressure at which the relief devices shall be capable of discharging the volume of gas required shall not exceed the test pressure.

The pressure at which the relief devices start to discharge shall be either not less than 80% of the test pressure or at a lower pressure if operational or other requirements so dictate. In no case shall the pressure at which the relief devices start to discharge be lower than the pressure P_d developed by the contents at the reference temperature.

F.2 Discharge capacity

The total flow of pressure relief devices shall be calculated as follows:

$$Q = 45320 \sqrt{\frac{A^{0.82} F}{V} \Big/ \frac{ZT}{LC}}$$

Where

Q is the required air discharge capacity (m^3/h) at atmospheric pressure and 15^oC;

A is the total external surface area of tank (m^2);

F is a coefficient with the value =1,
for uninsulated tanks and = 8U(649 - t)/391800, for insulated tanks.

Where

U is the overall thermal conduction of the insulation determined at 37.8^oC (in kJ/m^2 per hour per degree Celsius);

t is the temperature of tank contents. If unknown a value of $t=15^oC$ shall be used.

The value of F shall in no case be taken as less than 0.25;

Z is the gas compressibility factor at the accumulating condition. If unknown a value of Z=1.0 shall be used;

T is the absolute temperature above the pressure relief valve at the accumulating condition;

L is the latent heat of evaporation (kJ/kg) at the accumulating condition;

M is the relative molecular mass of the gas;

C is a constant based on the ratio of specific heat capacities of the gas, K= C_p/C_v (see Table **1** below). A value of 0.606 corresponding to a ratio of 1.0 shall be used in the absence of definite data.

TABLE 1 - Constant C for gas or vapour related to the ratio of specific heat capacities K = C_p/C_v at standard conditions

K	**C**	**K**	**C**	**K**	**C**
1.00	0.606	1.32	0.671	1.64	0.722
1.02	0.611	1.34	0.674	1.66	0.725
1.04	0.615	1.36	0.677	1.68	0.728
1.06	0.620	1.38	0.681	1.70	0.731
1.08	0.624	1.40	0.685	1.72	0.734
1.10	0.628	1.42	0.688	1.74	0.736
1.12	0.633	1.44	0.691	1.76	0.739
1.14	0.637	1.46	0.695	1.78	0.742
1.16	0.641	1.48	0.698	1.80	0.745
1.18	0.645	1.50	0.701	1.84	0.750
1.20	0.649	1.52	0.704	1.88	0.755
1.22	0.652	1.54	0.707	1.92	0.760
1.24	0.656	1.56	0.710	1.96	0.765
1.26	0.660	1.58	0.713	2.00	0.770
1.28	0.664	1.60	0.716	2.04	0.774
1.30	0.667	1.62	0.719		

APPENDIX G

TRANSPORT EMERGENCY CARD (ROAD)

Cargo `Butane or Propane, Commercial to **SLS 712 .** Colourless normally odorised liquefied petroleum gas under pressure.

Nature of Hazard Highly flammable. Spilled liquid is very cold and vapourizes very rapidly except in extreme cold weather and may create a visible white cloud
The gas is invisible, heavier than air and spreads along the ground.
Even small amount can form a flammable mixture with air.
Heat will cause pressure to rise in the tank or container and may cause the relief valve to open and ignition of ttje discharge. In extreme cases there is a risk of bursting and explosion.

Protective Devices Complete eye protection e.g. goggles or visor.
Plastic gauntlets

EMERGENCY ACTION - NOTIFY EMERGENCY SERVICES IMMEDIATELY

Road Accident Or Spillage If possible move vehicle to the open ground
Stop vehicle engine.
No naked lights. No smoking. No unsafe electrical equipment. e.g. radios.
Turn electrical master switch OFF if without risk.
Shut off leaks if without risk.
Keep public away from possible danger area.
Contain leaking liquid with sand or earth.
Prevent liquid entering drains, basements and workpits.
Vapour may create a flammable atmosphere.
If substances has entered a water course or drain or has contaminated soil or vegetation, inform police,
Keep upwind.

Fire If exposed to fire, keep vehicle tank cool by water spray**.**
Do not extinguish a leaking gas flame unless absolutely necessary.
Consult an expert for advice whether to extinguish using dry chemical or form.
Do not use water jet.

First aid Remove contaminated clothing as soon as possible.
Seek medical treatment when anyone has symptoms apparently due to inhalation or contact with skin or eyes.

APPENDIX H

SYLLABUS OF TRAINING FOR DRIVERS IN THE LPG INDUSTRY

H1	Product Knowledge
H2	Tanker Knowledge
H3	Operating Procedures
H4	Fire Prevention, Control and Safety
H5	Emergency Procedures
H6	First Aid in Emergency

This syllabus is regarded as a minimum for LPG road tanker drivers and should meet the statutory requirements. It may require further training for the issuance of the relevant driving license.

H.1 - PRODUCT KNOWLEDGE

At the completion of this unit the driver should have an understanding of the products distributed by his company and an awareness of the hazards involved in their transportation.

Product knowledge should include:

1 Nature and manufacture of company products.

2. Characteristics and hazards in the handling of different products.

a) Flammable Hazards

Definitions: ignition, temperature, flammable limits, vapour pressure and any others relevant to the products.

b) Other Hazards

Inhalation, aspiration, ingestion or direct contact with the products.

c) Effects on environment

Toxicity of products.

d) Other properties including liquid and vapour density and any others relevant to the products.

H.2 - TANKER KNOWLEDGE

At the completion of this unit the driver should have an understanding of the vehicles used by his company and the equipment associated with them. He should also be aware of the vehicle handling characteristics when carrying LPG.

The tanker knowledge should include:

i. Basic design and construction of company tankers and where appropriate,specific information on the vehicle most likely to be used by the driver.

ii. The operation of the vehicle and its associated equipment and an understanding of the potential hazards in their use.

a) Valves, hoses, contents and fixed liquid gauges and other relevant items.

b) Pumps, compressors, power take-off equipment and other ancillaries.

ii. Emergency and fire equipment provided with the tanker.

iv. The effects of surge of bulk liquids of the handling of a tanker during cornering, braking and acceleration.

H.3 - OPERATING PROCEDURES

At the completion of this unit the driver should have an understanding of the company procedures for operating his tanker and the potential hazards involved in those operations. There also may be local regulations affecting his particular terminal in which he should receive specific instruction.

Operating procedures should include:

A. Loading and unloading:

a) Standard procedures, potential hazards including overfilling and anti tow-aways.
b) Action to be taken in the event of an accident, spillage or fire.
c) Ensuring that the tanker is safe before loading and unloading, the permissible load is not exceeded and the vehicle tank is not overfilled.

B. Checks before commencing any journey

C. The driver should ensure that:

a) Information is provided in writing about the load to becarried and any action to be taken in the event of an emergency or accident.

b) Appropriate fire and safety equipment are in good order.

c) Documentation provided, agrees with instructions and warning panels provided.

d) There are no leaks and all relevant valves are properly closed.

D. Static electricity

Causes and potential hazards, minimizing hazards, earthing.

H.4 - FIRE PREVENTION, CONTROL AND SAFETY

At the completion of this unit the driver should have an understanding of how fires are caused, their prevention and control and be able to use the fire extinguishers provided with his vehicle.

Fire prevention, control and safety should include:

a). Nature of fire
Theory of combustion. Classification of fires. Identification of potential hazards and ignition sources. Types of fire fighting media.

b). Extinguishers
Use of dry powder extinguishers.

c). Practical use of extinguishers

Briefing for a practical fire fighting exercise. Individual practice in dealing with simple fires.

Companies may provide other safety equipment or protective clothing and the driver should receive instruction in their use.

H5 - EMERGENCY PROCEDURES

At the completion of this unit the driver should understand his responsibilities in an emergency and what actions he must take.

Emergency procedures should include:

i. Emergencies, incidents and accidents
Alerting the Emergency Services.
Actions to contain the emergency. Specific action in the event of spillage and/or fire. First aid in the event of injury.

ii Emergency Services
Responsibilities of the Emergency Services. Liaison with Emergency Services.
Notification of accidents.

H6 - FIRST AID IN EMERGENCY

At the completion of this unit the driver should be able to provide a prompt response to situations where people may be injured, in immediate danger or involved with an emergency concerning his tanker use, where appropriate, the first aid requirements specified.

1. Initial action before arrival of Emergency Services
Removal from danger.
Breathing and Resuscitation.
Leading, basic first aid.
Care of the unconscious casualty, Recovery position.

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The Sri Lanka Standards Institution is the owner of the registered certification mark shown below. Beneath the mark, the number of the Sri Lanka Standard relevant to the product is indicated. This mark may be used only by those who have obtained permits under the SLS certification marks scheme. The presence of this mark on or in relation to a product conveys the assurance that they have been produced to comply with the requirements of the relevant Sri Lanka Standard under a well designed system of quality control inspection and testing operated by the manufacturer and supervised by the SLSI *which includes surveillance inspection of the factory, testing of both factory and market samples.*

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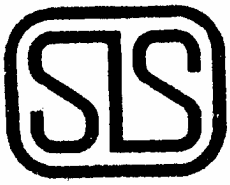

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SRI LANKA STANDARDS INSTITUTION

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