UDC 629·114·4 : 621·642·2·036 : 662·767



*Indian Standard*

# SPECIFICATION FOR ROAD TANKERS FOR LIQUEFIED PETROLEUM GAS

[Ref : Doc : EDC : 57 (2967)]
Chemical Engineering Sectional Committee, EDC 57

**1. Scope** — Lays down the requirements for the design, construction and basic safety requirements for road tankers for liquefied petroleum gas (LPG) only and excludes the transport of refrigerated liquefied petroleum gas.

**2. Terminology** — For the purpose of this standard, the following definitions shall apply.

**2.1** *Liquefied Petroleum Gas* — The term liquefied petroleum gas (LPG) refers to certain gaseous hydrocarbon fractions or mixtures of these which are readily liquefied under pressure at ambient temperature.

**2.2** *Filling Density* — Filling density is defined as the ratio of the weight of LPG allowed in a pressure vessel to the weight of water that the vessel will hold at 15°C.

**2.3** *Design Pressure* — Design pressure means the pressure used in the design calculations of a vessel corresponding to the vapour pressure at 55°C for the purpose of determining the minimum wall thickness of the various component parts of the vessel.

**2.4** *Inspector* — Inspector means a person acceptable to the statutory authority for the purpose of inspecting vessels in accordance with the approved design and specifications or code.

**3. Material** — The material used in the manufacture of pressure parts of the tank shall be in accordance with the appropriate specifications listed in Appendix A of IS : 2825-1969 'Code for unfired pressure vessels'.

Other suitable materials may be used for the pressure parts, if agreed by the purchaser, manufacturer and the inspecting authority.

Materials for LPG road tankers should however, be selected for notch ductility and have a minimum impact resistance of 3·5 kgf.m/cm$^2$ at −30°C.

**3.1** Material used for saddles, baffles and other similar non-pressure parts of the tank shall be of weldable quality and suitable in other respects for the desired service.

**3.2** Brittle materials such as cast iron shall not be used for any part of the tank equipment.

**4. Tank Design** — Tanks shall be designed, fabricated and tested in accordance with the requirements of Class I pressure vessels of IS : 2825-1969.

**4.1** The tank should be designed to withstand shocks normally encountered during transport, including those set-up by the movement of the contents of the tank, such as acceleration and deceleration of a minimum of 3 g to be calculated with the tank full. Adequate internal baffles should be provided to minimize shock loads due to surging of the content during transport. Saddle supports and other attachment should also be designed according to IS : 2825-1969.

**4.2** Recognized pressure vessel codes, besides IS : 2825-1969 may be used if acceptable to statutory authorities.

**4.3** The design pressure of the tank, shall not be less than the vapour pressure of the type of LPG, for which it is intended, at the maximum anticipated service environment temperature of 55°C (*see* IS : 4576-1968 Specification for liquefied petroleum gases).

**5. Filling Capacity** — The tank shall not be allowed to become full of liquid due to expansion of contents with rise of temperature to the highest temperature which the contents will reach in service.

Adopted 30 September 1980



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**5.1** The maximum permissible filling ratios are as given under:

| *Product* | *Vessels Less than 0·9 m Diameter* | *Vessels More than 0·9 m Diameter* |
|---|---|---|
| Commercial butane | 0·504 | 0·519 |
| Commercial propane | 0·427 | 0·440 |

**5.2** Knowing the liquid temperature and the filling ratio, the maximum volume of liquid which may be placed in the tank may be determined by the following formula:

$$V_t = \frac{D}{G \times F_t}$$

where

$V_t$ = maximum liquid volume ( in percent of total container capacity ), which shall be placed in a container when the liquid temperature is $t$°C;

$D$ = filling ratio in percent;

$G$ = specific gravity of liquid gas at 15·0°C; and

$F_t$ = liquid volume correction factor from temperature $t$°C to 15·0°C ( *see* Appendix A ).

**5.3** After obtaining $V$ from the above formula, the maximum capacity in litres of LPG which may be placed in the tank is obtained by multiplying the water capacity of the container by $\frac{V}{100}$.

**6. Fittings** — The tank shall be provided with the following fittings (typical layout shown in Fig. 1 ) suitable for operation at the design pressure and temperature, and for the type of LPG ( *see* IS : 4576-1968 ) stored:

a) Pressure relief valve,

b) Emergency shut-off valve/excess flow valve,

c) A gauge for determining the liquid level of LPG, and

d) Pressure gauge, and

e) Fixed level gauge.

**6.1** Each vessel shall be equipped with at least 2 pressure relief valves of spring loaded type, each valve having direct communication with the vapour space of the vessel and with the operating mechanism inside the vessel. The pressure relief valves shall be designed to discharge at rates not less than those given in Appendix B before vessel pressure exceeds 120 percent of design pressure.

**6.1.1** The discharge from pressure relief valves shall be vented away from the tank, and upwards, so as to avoid any impingement on the tank. Loose fitting rain caps may also be provided on relief valves.

**6.2** All openings on the tank, other than those for pressure relief valves, temperature gauge, roto gauge, fixed level gauge, slip tube, or those permanently fitted with blank flanges, shall be fitted with automatic or remote operated emergency shut-off valves, designed to prevent excessive escape of LPG in the event of failure or malfunctioning of any hose, equipment and pipe work connected to these openings. When the emergency shut-off valves are of excess flow type they shall have a rated closing flow approximately 50 percent greater than the anticipated normal flow.

**6.3** The tank shall be provided at least with one gauge each for determining the liquid level of LPG and pressure. These gauges shall be so located that at least one gauging device may be read from the ground level.

**6.4** The filling pipe if provided, shall preferably be extended inside the tank to cover major portion of the length, and shall be perforated at the bottom through 120°. Area of perforation shall be at least three times the area of cross section of pipe. It shall also be fitted with a valve.

**6.5** The discharge pipe will be fitted with an excess flow valve.

**6.6** Tank connections shall be designed and attached in accordance with IS: 2825-1969. Liquid and vapour connections shall be flanged.

**6.7** A manhole of minimum 375 mm diameter shall be provided on the tank.

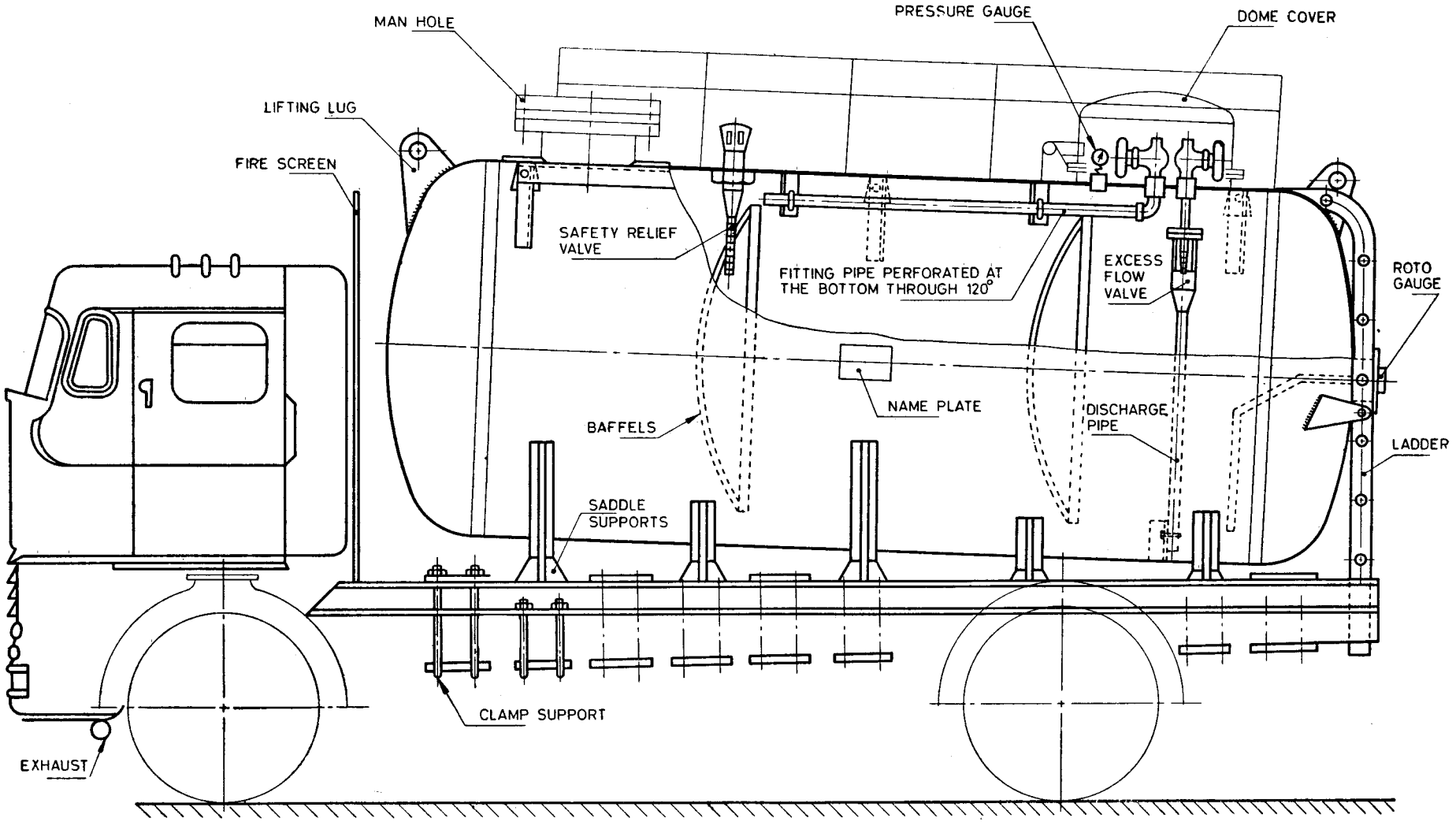


FIG. 1 SCHEMATIC DETAILS OF LPG TANKER

**6.8** All connections shall be designed to withstand the most severe combined stresses on account of tank pressure, pumping pressure and shock loadings likely to occur during transport.

**6.9** Liquid and vapour connections on the tank shall be clearly marked in accordance with relevant Indian Standard.

**7. Protection of Valves and Accessories** — All valves and accessories shall be safeguarded against accidental damage during operation and transport. Suitable covers shall be provided wherever necessary.

**7.1** Valves or accessories if situated at the rear of a road tanker shall be protected by the rear cross member of the chassis against damage. If necessary, some of the fittings may be recessed.

**8. Tank Painting** — The tank shall be painted from the outside to prevent corrosion, and shall be finished to have white reflecting surfaces.

**9. Mounting of Tank** — The tank shall be properly and rigidly secured to the tanker chassis.

**9.1** The centre of gravity of the tank shall be kept as low as possible. The ratio $\frac{H}{W}$ shall be kept less than one, where $H$ is the height of centre of gravity of the tank from ground level, and $W$ is the distance between the middle of the outer tyres of the rear axle.

**9.2** A suitable approach ladder shall be attached to the tank. A platform shall be provided on the top of the tank to facilitate operational and maintenance requirement.

**10. Tank Equipment** — All the LPG piping, fittings, meters, and other equipment mounted on the tanker shall be suitable for use with the tyre of LPG being handled, and shall be capable of withstanding the most severe combined stresses set up by the following:

a) The maximum vapour pressure of product in service, and either;

b) The superimposed pumping pressure; and

c) The shock loadings caused during transport movements.

**10.1** Use of seamless carbon steel piping to IS : 1978-1971 ' Requirements for line pipe ( *first revision* ) ' is recommended and minimum thicknesses of the pipe shall be as follows:

| *Nominal Pipe Size* mm | *Minimum Thickness* mm |
|---|---|
| 15 | 3·7 |
| 20 | 3·9 |
| 25 | 4·5 |
| 40 | 5·08 |
| 50 | 5·5 |
| 65 | 7·0 |

**10.2** Pipe joints over 40 mm nominal size shall be welded or flanged except in case of excess flow valves and Acme adaptors. Joints below this size may be welded, flanged or screwed.

**10.3** All piping and equipment shall be protected against rough usage and mechanical damage during transport.

**10.4** The material and construction of the hoses shall be suitable for the type of LPG handled.

**10.4.1** Hoses carried on the vehicles shall be protected against accidental damage.

**10.4.2** Hose connectors shall conform to IS : 9573 - 1980 ' Specification for LPG hose connectors '.

**11. Safety Requirements of Road Tankers** — The engine and exhaust system together with all electrical generators, motors, batteries and switchgear shall be effectively screened from the tank by a fire screen. There shall be a clear distance of at least 15 cm between the back of the cap and front of the tank.

**11.1** The exhaust system should be fitted with a spark arrestor.

**11.2** In a case where the fuel used for the tanker gives off flammable vapour at a temperature less than 65°C, the fuel tank shall not be located behind the shield unless the following requirements are made.

**11.2.1** The fuel tank is protected from damage by stout steel guards or by the frames of the vehicle.

**11.2.2** The fill pipe of the fuel tank of the vehicle is provided with a cover having locking arrangement.

**11.2.3** The fuel feed apparatus placed in front of the fire resisting shield is used to lift the contents of the fuel tank.

**11.3** The rear end of the tank shall be protected by a strong steel bumper, covering at least the maximum width of the tank, and extending to a minimum of 8 cm to the rear of the rear most portion of the tank.

**11.4** The tank shall be electrically continuous with the chassis.

**11.5** On safety considerations, the electrical systems shall incorporate:

a) an easily accessible battery,

b) a readily accessible cut-off switch, and

c) wiring protected against accidental damage or undue wear.

**12. Marking** — The tank shall have a metal plate permanently fixed to the tank showing the following particulars:

a) Manufacturer's name and identification marks,

b) The standard or code to which the tank is constructed,

c) Official stamp of the inspector,

d) Design pressure,

e) Date of initial hydrostatic test and subsequent tests,

f) Hydrostatic test pressure in $kgf/cm^2$,

g) Water capacity in litres,

h) Extent of radiography,

j) Whether stress relieved, and

k) Product carried.

**12.1** *ISI Certification Marking* — Details available with the Indian Standards Institution.

# APPENDIX A

*( Clause 5.2 )*

## LIQUID VOLUME CORRECTION FACTORS

| Observed Temp °C | Specific Gravities at 15°C/15°C | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0·500 8 | Propane 0·508 7 | 0·510 8 | 0·520 8 | 0·530 8 | 0·540 8 | 0·550 6 | 0·560 6 | iso-Butane 0·563 7 | 0·570 6 | 0·580 6 | n-Butane 0·585 0 | 0·590 6 |
| | Volume Correction Factors | | | | | | | | | | | | |
| −45·6 | 1·158 | 1·153 | 1·151 | 1·144 | 1·138 | 1·131 | 1·126 | 1·121 | 1·119 | 1·115 | 1·110 | 1·107 | 1·105 |
| −42·8 | 1·151 | 1·146 | 1·144 | 1·138 | 1·132 | 1·126 | 1·121 | 1·116 | 1·114 | 1·110 | 1·105 | 1·102 | 1·100 |
| −40·0 | 1·145 | 1·140 | 1·138 | 1·132 | 1·126 | 1·120 | 1·116 | 1·110 | 1·109 | 1·105 | 1·100 | 1·098 | 1·096 |
| −37·2 | 1·138 | 1·133 | 1·132 | 1·126 | 1·120 | 1·114 | 1·111 | 1·105 | 1·104 | 1·100 | 1·095 | 1·093 | 1·091 |
| −34·4 | 1·132 | 1·127 | 1·126 | 1·120 | 1·114 | 1·109 | 1·105 | 1·100 | 1·099 | 1·095 | 1·091 | 1·089 | 1·087 |
| −31·7 | 1·125 | 1·120 | 1·119 | 1·113 | 1·108 | 1·103 | 1·099 | 1·094 | 1·093 | 1·090 | 1·086 | 1·084 | 1·082 |
| −28·9 | 1·118 | 1·113 | 1·112 | 1·107 | 1·102 | 1·097 | 1·094 | 1·089 | 1·088 | 1·085 | 1·081 | 1·079 | 1·078 |
| −26·1 | 1·110 | 1·107 | 1·105 | 1·100 | 1·095 | 1·091 | 1·088 | 1·083 | 1·082 | 1·079 | 1·076 | 1·074 | 1·073 |
| −23·3 | 1·103 | 1·100 | 1·098 | 1·093 | 1·089 | 1·085 | 1·082 | 1·078 | 1·077 | 1·074 | 1·071 | 1·070 | 1·068 |
| −20·6 | 1·096 | 1·092 | 1·092 | 1·087 | 1·083 | 1·079 | 1·076 | 1·073 | 1·072 | 1·069 | 1·066 | 1·065 | 1·064 |
| −17·8 | 1·090 | 1·086 | 1·086 | 1·082 | 1·078 | 1·074 | 1·072 | 1·068 | 1·067 | 1·065 | 1·062 | 1·061 | 1·060 |
| −16·7 | 1·087 | 1·084 | 1·083 | 1·079 | 1·075 | 1·072 | 1·069 | 1·066 | 1·065 | 1·063 | 1·060 | 1·059 | 1·058 |
| −15·6 | 1·084 | 1·081 | 1·080 | 1·077 | 1·073 | 1·069 | 1·067 | 1·064 | 1·063 | 1·061 | 1·058 | 1·057 | 1·056 |
| −14·4 | 1·082 | 1·078 | 1·078 | 1·074 | 1·070 | 1·069 | 1·064 | 1·061 | 1·060 | 1·058 | 1·056 | 1·054 | 1·053 |
| −13·3 | 1·079 | 1·076 | 1·075 | 1·072 | 1·068 | 1·064 | 1·062 | 1·059 | 1·058 | 1·056 | 1·054 | 1·052 | 1·051 |
| −12·2 | 1·076 | 1·073 | 1·072 | 1·069 | 1·065 | 1·062 | 1·060 | 1·057 | 1·056 | 1·054 | 1·052 | 1·051 | 1·049 |
| −11·1 | 1·073 | 1·070 | 1·069 | 1·066 | 1·062 | 1·059 | 1·058 | 1·055 | 1·054 | 1·052 | 1·050 | 1·048 | 1·047 |
| −10·0 | 1·070 | 1·068 | 1·067 | 1·064 | 1·060 | 1·057 | 1·055 | 1·052 | 1·052 | 1·050 | 1·048 | 1·046 | 1·045 |
| − 8·9 | 1·068 | 1·065 | 1·064 | 1·061 | 1·058 | 1·054 | 1·053 | 1·050 | 1·049 | 1·047 | 1·045 | 1·044 | 1·043 |
| − 7·8 | 1·065 | 1·063 | 1·062 | 1·059 | 1·055 | 1·052 | 1·050 | 1·048 | 1·047 | 1·045 | 1·043 | 1·042 | 1·041 |
| − 6·7 | 1·062 | 1·060 | 1·059 | 1·056 | 1·052 | 1·049 | 1·048 | 1·045 | 1·045 | 1·043 | 1·041 | 1·040 | 1·039 |
| − 5·6 | 1·059 | 1·057 | 1·056 | 1·053 | 1·050 | 1·047 | 1·045 | 1·043 | 1·043 | 1·041 | 1·039 | 1·038 | 1·037 |
| − 4·4 | 1·056 | 1·054 | 1·053 | 1·050 | 1·047 | 1·044 | 1·043 | 1·041 | 1·041 | 1·047 | 1·037 | 1·036 | 1·035 |
| − 3·3 | 1·053 | 1·051 | 1·050 | 1·047 | 1·045 | 1·042 | 1·041 | 1·038 | 1·038 | 1·036 | 1·035 | 1·035 | 1·033 |
| − 2·2 | 1·050 | 1·048 | 1·047 | 1·045 | 1·042 | 1·039 | 1·038 | 1·036 | 1·036 | 1·034 | 1·033 | 1·033 | 1·031 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| −1·1 | 1·047 | 1·045 | 1·044 | 1·042 | 1·039 | 1·037 | 1·036 | 1·034 | 1·034 | 1·032 | 1·031 | 1·031 | 1·029 |
| 0·0 | 1·044 | 1·042 | 1·041 | 1·039 | 1·036 | 1·034 | 1·034 | 1·032 | 1·032 | 1·030 | 1·029 | 1·029 | 1·027 |
| 1·1 | 1·041 | 1·039 | 1·038 | 1·036 | 1·034 | 1·032 | 1·031 | 1·030 | 1·029 | 1·028 | 1·027 | 1·027 | 1·025 |
| 2·2 | 1·037 | 1·036 | 1·035 | 1·033 | 1·032 | 1·030 | 1·029 | 1·027 | 1·027 | 1·026 | 1·024 | 1·024 | 1·023 |
| 3·3 | 1·034 | 1·033 | 1·032 | 1·030 | 1·030 | 1·028 | 1·026 | 1·025 | 1·024 | 1·024 | 1·022 | 1·022 | 1·021 |
| 4·4 | 1·031 | 1·030 | 1·029 | 1·027 | 1·027 | 1·025 | 1·024 | 1·023 | 1·022 | 1·022 | 1·020 | 1·020 | 1·019 |
| 5·6 | 1·028 | 1·027 | 1·026 | 1·026 | 1·024 | 1·023 | 1·022 | 1·021 | 1·020 | 1·020 | 1·018 | 1·018 | 1·017 |
| 6·7 | 1·025 | 1·024 | 1·023 | 1·022 | 1·021 | 1·020 | 1·019 | 1·018 | 1·018 | 1·017 | 1·016 | 1·016 | 1·015 |
| 7·8 | 1·021 | 1·020 | 1·020 | 1·020 | 1·019 | 1·017 | 1·017 | 1·016 | 1·015 | 1·015 | 1·014 | 1·014 | 1·013 |
| 8·9 | 1·018 | 1·017 | 1·017 | 1·017 | 1·016 | 1·015 | 1·014 | 1·013 | 1·013 | 1·012 | 1·012 | 1·012 | 1·011 |
| 10·0 | 1·015 | 1·014 | 1·014 | 1·014 | 1·013 | 1·012 | 1·012 | 1·011 | 1·011 | 1·010 | 1·010 | 1·010 | 1·009 |
| 11·1 | 1·012 | 1·011 | 1·010 | 1·011 | 1·010 | 1·009 | 1·009 | 1·008 | 1·008 | 1·008 | 1·008 | 1·008 | 1·007 |
| 12·2 | 1·008 | 1·008 | 1·007 | 1·008 | 1·007 | 1·007 | 1·006 | 1·006 | 1·006 | 1·006 | 1·005 | 1·005 | 1·005 |
| 13·3 | 1·006 | 1·005 | 1·004 | 1·005 | 1·004 | 1·005 | 1·004 | 1·004 | 1·004 | 1·004 | 1·003 | 1·003 | 1·003 |
| 14·4 | 1·001 | 1·001 | 1·001 | 1·002 | 1·002 | 1·002 | 1·002 | 1·001 | 1·001 | 1·001 | 1·001 | 1·001 | 1·001 |
| 15·0 | 1·000 | 1·000 | 1·000 | 1·000 | 1·000 | 1·000 | 1·000 | 1·000 | 1·000 | 1·000 | 1·000 | 1·000 | 1·000 |
| 16·7 | 0·996 | 0·995 | 0·995 | 0·996 | 0·996 | 0·996 | 0·996 | 0·997 | 0·997 | 0·997 | 0·997 | 0·997 | 0·997 |
| 17·8 | 0·992 | 0·991 | 0·992 | 0·993 | 0·993 | 0·993 | 0·994 | 0·994 | 0·994 | 0·994 | 0·995 | 0·995 | 0·995 |
| 18·9 | 0·989 | 0·988 | 0·988 | 0·989 | 0·990 | 0·991 | 0·991 | 0·992 | 0·992 | 0·992 | 0·992 | 0·992 | 0·992 |
| 20·0 | 0·985 | 0·984 | 0·985 | 0·986 | 0·987 | 0·988 | 0·989 | 0·989 | 0·989 | 0·989 | 0·990 | 0·990 | 0·990 |
| 21·1 | 0·982 | 0·981 | 0·982 | 0·983 | 0·984 | 0·985 | 0·986 | 0·987 | 0·987 | 0·987 | 0·988 | 0·988 | 0·988 |
| 22·2 | 0·978 | 0·978 | 0·979 | 0·980 | 0·981 | 0·982 | 0·983 | 0·984 | 0·985 | 0·985 | 0·986 | 0·986 | 0·986 |
| 23·3 | 0·975 | 0·974 | 0·975 | 0·977 | 0·979 | 0·979 | 0·981 | 0·982 | 0·982 | 0·983 | 0·984 | 0·984 | 0·984 |
| 24·4 | 0·971 | 0·971 | 0·972 | 0·974 | 0·976 | 0·977 | 0·978 | 0·979 | 0·980 | 0·980 | 0·981 | 0·981 | 0·982 |
| 25·6 | 0·968 | 0·968 | 0·968 | 0·971 | 0·973 | 0·974 | 0·976 | 0·977 | 0·977 | 0·978 | 0·979 | 0·979 | 0·980 |
| 26·7 | 0·964 | 0·966 | 0·966 | 0·968 | 0·970 | 0·971 | 0·973 | 0·974 | 0·975 | 0·976 | 0·977 | 0·977 | 0·978 |
| 27·8 | 0·960 | 0·962 | 0·962 | 0·965 | 0·967 | 0·968 | 0·970 | 0·971 | 0·972 | 0·973 | 0·975 | 0·975 | 0·976 |
| 28·9 | 0·956 | 0·958 | 0·959 | 0·961 | 0·964 | 0·965 | 0·967 | 0·969 | 0·970 | 0·971 | 0·973 | 0·973 | 0·974 |
| 30·0 | 0·953 | 0·955 | 0·955 | 0·958 | 0·960 | 0·963 | 0·965 | 0·966 | 0·967 | 0·968 | 0·970 | 0·970 | 0·971 |
| 31·1 | 0·949 | 0·951 | 0·952 | 0·954 | 0·957 | 0·960 | 0·962 | 0·964 | 0·965 | 0·966 | 0·968 | 0·968 | 0·969 |
| 32·2 | 0·945 | 0·948 | 0·948 | 0·951 | 0·954 | 0·957 | 0·959 | 0·961 | 0·962 | 0·963 | 0·966 | 0·966 | 0·967 |
| 33·3 | 0·941 | 0·944 | 0·945 | 0·948 | 0·951 | 0·954 | 0·956 | 0·958 | 0·959 | 0·961 | 0·963 | 0·964 | 0·965 |
| 34·4 | 0·937 | 0·940 | 0·941 | 0·945 | 0·948 | 0·951 | 0·953 | 0·956 | 0·957 | 0·958 | 0·961 | 0·961 | 0·963 |
| 35·6 | 0·934 | 0·937 | 0·938 | 0·941 | 0·943 | 0·948 | 0·951 | 0·953 | 0·954 | 0·956 | 0·958 | 0·959 | 0·960 |
| 36·7 | 0·930 | 0·933 | 0·934 | 0·938 | 0·942 | 0·945 | 0·948 | 0·951 | 0·952 | 0·953 | 0·956 | 0·956 | 0·958 |

*(Continued)*

| Observed Temp °C | Specific Gravities at 15°C/15°C | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0·500 8 | Propane 0·508 7 | 0·510 8 | 0·520 8 | 0·530 8 | 0·540 8 | 0·550 6 | 0·560 6 | iso-Butane 0·563 7 | 0·570 6 | 0·580 6 | n-Butane 0·585 0 | 0·590 6 |
| | Volume Correction Factors | | | | | | | | | | | | |
| 37·8 | 0·926 | 0·929 | 0·931 | 0·935 | 0·939 | 0·942 | 0·945 | 0·948 | 0·949 | 0·951 | 0·953 | 0·954 | 0·956 |
| 40·6 | 0·916 | 0·919 | 0·922 | 0·926 | 0·930 | 0·934 | 0·938 | 0·942 | 0·942 | 0·945 | 0·948 | 0·948 | 0·950 |
| 43·3 | 0·906 | 0·910 | 0·912 | 0·917 | 0·922 | 0·926 | 0·931 | 0·935 | 0·936 | 0·938 | 0·942 | 0·943 | 0·945 |
| 46·1 | 0·896 | 0·901 | 0·903 | 0·908 | 0·914 | 0·919 | 0·924 | 0·929 | 0·929 | 0·932 | 0·936 | 0·937 | 0·939 |
| 48·9 | 0·886 | 0·891 | 0·893 | 0·899 | 0·906 | 0·911 | 0·917 | 0·922 | 0·923 | 0·926 | 0·930 | 0·931 | 0·933 |
| 51·7 | 0·875 | 0·880 | 0·883 | 0·889 | 0·897 | 0·902 | 0·908 | 0·915 | 0·915 | 0·919 | 0·924 | 0·926 | 0·927 |
| 54·4 | 0·864 | 0·870 | 0·872 | 0·879 | 0·887 | 0·894 | 0·900 | 0·907 | 0·908 | 0·912 | 0·917 | 0·920 | 0·922 |
| 57·2 | 0·853 | 0·860 | 0·862 | 0·870 | 0·878 | 0·886 | 0·893 | 0·900 | 0·901 | 0·906 | 0·911 | 0·913 | 0·915 |
| 60·0 | 0·841 | 0·849 | 0·851 | 0·860 | 0·869 | 0·878 | 0·885 | 0·892 | 0·894 | 0·899 | 0·904 | 0·906 | 0·909 |

# APPENDIX B

(*Clause* 6.1)

## MINIMUM RATE OF DISCHARGE FOR SAFETY RELIEF VALVES

### A-1. RATE OF DISCHARGE

**A-1.1** Flow rate is the required flow capacity in cubic meter per hour of air at standard conditions of temperature ( 15·6°C ) and atmospheric pressure ( 103 kPa ).

**A-1.2** The minimum rates of discharge for safety relief valves are given in Table 1.

**A-1.2.1** The rate of discharge may be interpolated for intermediate valve of surface area.

**A-1.2.2** For containers with total outside suface area greater than 186 $m^2$, the required flow rate may be calculated using formula:

$$\text{Flow rate, } m^3/h = 639{\cdot}981 \times A^{0{\cdot}82}\ m^3/h$$

where $A$ = total outside surface area in $m^2$.

**TABLE 1 MINIMUM RATE OF DISCHARGE**

| Outside Surface Area | Flow Rate | Outside Surface Area | Flow Rate |
|---|---|---|---|
| (1) $m^2$ | (2) $m^3/h$ | (1) $m^2$ | (2) $m^3/h$ |
| 1 | 639·981 | 30 | 10 412·494 |
| 2 | 1 129·567 | 35 | 11 814·053 |
| 3 | 1 574·994 | 40 | 13 177·213 |
| 4 | 1 994·821 | 45 | 14 514·774 |
| 5 | 2 395·450 | 50 | 15 826·735 |
| 6 | 2 781·358 | 60 | 18 380·260 |
| 7 | 3 156·387 | 70 | 21 208·977 |
| 8 | 3 520·537 | 80 | 23 263·317 |
| 9 | 3 877·646 | 90 | 25 618·447 |
| 10 | 4 228·356 | 100 | 27 935·179 |
| 12 | 4 909·936 | 120 | 32 440·647 |
| 14 | 5 571·676 | 140 | 36 805·319 |
| 16 | 6 216·777 | 160 | 41 073·993 |
| 18 | 6 847·799 | 180 | 45 233·871 |
| 20 | 7 462·181 | 186 | 46 469·035 |
| 25 | 8 966·137 | | |



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