**SRI LANKA STANDARD 1303 : 2006**
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**SPECIFICATION FOR**

# TRANSPORTABLE REFILLABLE BRAZED STEEL CYLINDERS FOR LIQUEFIED PETROLEUM GAS (LPG)

**SRI LANKA STANDARDS INSTITUTION**

# SPECIFICATION FOR TRANSPORTABLE REFILLABLE BRAZED STEEL CYLINDERS FOR LIQUEFIED PETROLEUM GAS (LPG)

**SLS 1303 : 2006**
(AMD 438 and AMD 473 Attached)

**Gr. 11**

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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.

# SRI LANKA STANDARD
# SPECIFICATION FOR TRANSPORTABLE REFILLABLE BRAZED STEEL CYLINDERS FOR LIQUEFIED PETROLEUM GAS (LPG)

## FOREWORD

This standard was approved by the Sectoral Committee on Materials, Mechanical Systems and Manufacturing Engineering and was authorized for adoption and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standards Institution on 2006-12-27.

In this standard the requirements for refillable and transportable brazed steel gas cylinders of 0.5 litres up to 15 litres water capacity for liquefied petroleum gas are specified.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or an analysis shall be rounded off in accordance with CS 102. The number of significant places retained in the rounded off value shall be the same as that of the specified value in this standard.

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

**IS 7241** **:1981** Glossary of Terms used in Gas Cylinder Technology

**IS 12586** **:1988** Brazed Low Carbon Steel Gas Cylinders not exceeding 13 Litre Water capacity specification

**BSEN 12807** **: 2001** Transportable refillable brazed steel cylinders for liquefied petroleum gas (LPG) - Design and construction

## 1 SCOPE

This Sri Lanka Standard specifies minimum requirements for material, design, construction and workmanship, procedure and test methods of transportable refillable brazed steel liquefied petroleum gas (LPG) cylinders of water capacity from 0.5 l up to and including 15 l. The limit of 15 l is related to available manufacturing processes.

## 2 REFERENCES

**EN 13133** Brazing – Brazer approval
**EN 13134** Brazing – Procedure approval
**CS 102** Presentation of numerical values
**SLS 1184** Specification for valve fittings for use with liquefied petroleum gas(LPG) cylinders
**SLS 978** Tensile testing of metallic materials Part1– Method of test at ambient temperature

## 3 DEFINITIONS

For the purpose of this standard, the following definitions shall apply.

**3.1 batch :** Batch shall mean, cylinders heat treated in the same manner and constructed from steel of similar analysis and made by the same steel manufacturer.

**3.2 hydrostatic stretch test :** Subjecting the cylinder to a hydrostatic pressure equal to the test pressure of the cylinder.

**3.3 normalizing :** Uniform heating of a cylinder to a temperature within 50 ºC above the upper critical point ($AC_3$) of steel followed by uniform cooling in still air.

**3.4 test pressure :** The pressure at which the cylinder is hydraulically tested.

**3.5 yield strength :** The stress corresponding to a permanent strain of 0.2 per cent of the original gauge length in a tensile test. For practical purposes it may be taken as a stress at which elongation first occurs in the test piece without the increase of load in a tensile test.

## 4 REQUIREMENTS

### 4.1 Materials

**4.1.1** The steel used in the manufacture of cylinder shall conform to any one of the specifications, given in

a) Table **1** and Table **2** or

b) Table **3** and Table **4** or

c) Table **5** and Table **6**.

**TABLE 1 - Chemical composition and permissible variations in the case of product analysis of hot rolled steel plate (upto 6 mm ) , sheet and strip**

| Constituent<br><br>(1) | Grade A Percentage<br><br>(2) | Grade B Percentage<br><br>(3) | Percentage limit of constituents<br><br>(4) | Permissible variation over specified limit, maximum<br>(5) |
|---|---|---|---|---|
| Carbon, maximum | 0.17 | 0.20 | -- | 0.02 |
| Manganese | 0.30 to 0.60 | 0.90, Max | Up to 0.5 | 0.03 |
| | | | Over 0.5 | 0.04 |
| Silicon | 0.10 to 0.35 | 0.10 to 0.35 | -- | 0.03 |
| Sulphur, maximum | 0.045 | 0.045 | -- | 0.005 |
| Phosphorus, maximum | 0.045 | 0.045 | -- | 0.005 |

**NOTES**

1. *When the steel is aluminium-killed, nitrogen content shall not exceed 0.01 per cent. When steel is not fully-killed by aluminium alone, nitrogen content shall not exceed 0.007 per cent. This should be ensured by the manufacturer by occasional check analysis.*

2. *When aluminium or a combination of aluminium and silicon is used for killing the steel, the requirements regarding minimum silicon content do not apply.*

**TABLE 2 - Tensile properties of hot rolled steel plate (up to 6 mm) , sheet and strip**

| PROPERTY<br>(1) | GRADE A*<br>(2) | GRADE B*<br>(3) |
|---|---|---|
| Tensile strength (MPa) | 330 to 410 | 350 to 450 |
| Yield strength, minimum (MPa) | 210 | 240 |
| Elongation percentage, minimum on gauge-length $5.65\sqrt{S_0}$ , where $S_O$ is the original cross-sectional area | 25 | 25 |
| * Both longitudinal and transverse directions. | | |

**TABLE 3 - Chemical composition and permissible variations for product analysis of hot rolled micro-alloyed steel plate, sheet and strip**

| Constituents<br>(1) | Grade A Percentage<br>(2) | Over specified permissible variation limit, percent maximum (*For product analysis only*)<br>(3) |
|---|---|---|
| Carbon, maximum | 0.15 | 0.02 |
| Manganese, maximum | 0.90 | 0.04 |
| Sulphur, maximum | 0.035 | 0.005 |
| Phosphorus, maximum | 0.035 | 0.005 |
| Micro-alloying elements, maximum | 0.15 | 0.02 |

**NOTES**

1 *Micro-alloying elements like Nb, V and Ti may be used individually or in combination.*

2 When the steel is silicon killed, the product analysis shall show a minimum of 0.10 per cent silicon. When the steel is aluminium killed or killed with a combination of aluminium and silicon , the requirement of minimum silicon content shall not apply, but the aluminium content shall be 0.02 per cent minimum.

**TABLE 4 - Tensile properties of hot rolled micro-alloyed steel plate, sheet and strip**

| Property<br>(1) | Grade A<br>(2) |
|---|---|
| Tensile strength, minimum (MPa) | 350 |
| Yield strength, minimum (MPa) | 270 |
| Elongation percentage, minimum on gauge length $5.65\sqrt{So}$ , where $S_O$ is the original cross-sectional area | 27 |

**TABLE 5 - Chemical composition and physical properties, permissible variations for product analysis of hot rolled carbon steel sheet**

| Constituent<br>(1) | Type Deep Drawing (DD) percentage<br>(2) | Type Extra Deep Drawing (EDD) percentage<br>(3) | Percentage limit of constituent<br>(4) | Variations over, specified limit, percentage<br>(5) |
|---|---|---|---|---|
| Carbon | 0.10 | 0.08 | Up to 0.23 | 0.02 |
| Manganese | 0.40 | 0.40 | Up to 0.50 | 0.03 |
| | | | Above 0.50 | 0.04 |
| Sulphur | 0.035 | 0.030 | -- | 0.005 |
| Phosphorus | 0.035 | 0.030 | -- | 0.005 |
| Tensile Strength (MPa) | 260 - 390 | 260 – 380 | | |
| Yield Strength, minimum (MPa) | -- | -- | | |
| Elongation percentage, minimum on gauge length $5.65\sqrt{So}$ , where $S_O$ is the original cross-sectional area | 28 | 32 | | |

**NOTE :** Product analysis shall not be applicable to rimming steel

**TABLE 6 - Chemical composition , and permissible variations for product analysis of cold rolled carbon steel sheets**

| Constituent<br><br>(1) | Type, Deep Drawing (DD)<br><br>(2) | Type, Extra Deep Drawing (EDD)<br>(3) | Variation over the specified maximum limit, percentage, maximum<br>(4) |
|---|---|---|---|
| Carbon percentage, maximum | 0.10 | 0.10 | 0.02 |
| Manganese percentage, maximum | 0.50 | 0.45 | 0.03 |
| Sulphur percentage, maximum | 0.04 | 0.035 | 0.005 |
| Phosphorus percentage, maximum | 0.04 | 0.035 | 0.005 |

**NOTE :** *Tensile test shall be carried out only if specified by the purchaser. When tensile properties are not specified for design purposes, the tensile strength may be taken as 275 N/mm$^2$.*

The minimum yield strength, which is (Re) to be guaranteed after heat treatment of the finished cylinder by the cylinder manufacturer shall not be more than the yield strength guaranteed by the steel manufacturer and shall not be less than 186.32 MPa. The yield strength (Re) guaranteed by the cylinder manufacturer shall be used for the purpose of calculation of minimum wall thickness.

**4.1.2** A certificate shall be supplied by the steel maker giving analysis of the finished steel supplied for the manufacture of the cylinders, for each heat number. The inspecting authority shall be given the opportunity of making an independent check analysis if necessary.

The manufacturer of gas cylinder shall establish means to identify the cylinders from the casts of steel from which they are made. These provisions shall be applicable to steel mentioned in **4.1.1**.

**4.1.3** *Valve pad or bung*

The material used for the manufacture of valve pad or bung shall conform to any one of the specifications, given in

a) Table **7** and Table **8**, Table **10** or

b) Table **9** and Table **8**, Table **10.**

**TABLE 7 - Specifications for mild steel plate, sections and bars etc-chemical composition and permissible variations for product analysis.**

| Constituent<br><br>(1) | Percentage, maximum<br><br>(2) | Variation, over specified maximum limit percentage, maximum<br>(3) |
|---|---|---|
| Carbon (for thickness/diameter 20 mm and below) | 0.23 | 0.02 |
| Carbon (for thickness/diameter over 20 mm) | 0.25 | 0.03 |
| Sulphur | 0.055 | 0.005 |
| Phosphorus | 0.055 | 0.005 |

**NOTE:** *Product analysis shall not apply to rimming quality steel.*

**TABLE 8 - Mechanical properties of structural steel**

| Class of steel product<br><br>(1) | Nominal thickness /diameter<br><br>mm | Tensile strength<br><br>MPa<br>(3) | *Yield stress, Minimum MPa<br>(4) | Percentage elongation, Minimum,gauge length $5.65\sqrt{So}$<br>(5) |
|---|---|---|---|---|
| Plates, sections (for Example, angles, tees, Beams, channels, etc) and flats | Below 6 | *Bend test only | | |
| | 6 up to and including 20 | 410 to 530 | 250 | 23 |
| | Over 20 up to and Including 40 | 410 to 530 | 240 | 23 |
| | Over 40 | 410 to 530 | 230 | 23 |
| Bars (round, square and Hexagonal) | Below 10 | * Bend test only | | |
| | 10 up to and including 20 | 410 to 530 | 259 | 23 |
| | Over 20 | 410 to 530 | 240 | 23 |

**NOTES**

1. *1 N/ mm² = 1 MN/ m² = 1 MPa*

2. *Provided that the yield stress and elongation requirements are complied with, the upper limit for tensile strength may be raised by 30 MPa*

**In case of plates, sections, and flats below 6 mm, the yield stress shall be assumed to be at least the same as that for thickness between 6 mm and 20 mm.*

**In case of bars below 10 mm diameter, the yield stress shall be assumed to be at least the same as for bars of diameter between 10 mm and 20 mm.*

**TABLE 9 - Specification for carbon steel billets , blooms, slabs and bars for forgings – chemical composition and permissible deviations from specified composition limits**

| Constituent | Percentage | Permissible variation, percentage, maximum | |
|---|---|---|---|
| | | For sections 250 $mm^2$ or less | For sections 250 $mm^2$ to 500 $mm^2$ |
| (1) | (2) | (3) | (4) |
| Carbon | 0.10 – 0.18 | ± 0.02 | ± 0.04 |
| Silicon | 0.15 - 0.35 | ± 0.02 | ± 0.04 |
| Manganese | 0.40 – 0.70 | ± 0.04 | ± 0.07 |
| Sulphur | 0.04 (Max) | +0.005 | + 0.010 |
| Phosphorus | 0.04 (Max) | +0.005 | + 0.010 |

**NOTES**

1. *The following elements wherever not specified in Table **9** shall not be added to the steel, except where agreed to, other than for the purpose of finishing the heat and shall not exceed the following limits*:

| **Constituent** | **Percentage** |
|---|---|
| Nickel | 0.30 |
| Chromium | 0.30 |
| Copper | 0.25 |
| Molybdenum | 0.05 |
| Vanadium | 0.05 |
| Boron | 0.0003 |
| Tin | 0.055 |

2. *Trace elements (Cr + Ni + Mo) when added together shall not exceed 0.50 per cent.*

3. *Per cent copper + 10 x (Per cent tin) shall not exceed 0.50 per cent.*

**TABLE 10 Specification for hot-rolled bars for the production of bright bars and machined parts for engineering application**

| Dimensions mm | | Depth of defects, mm | | |
|---|---|---|---|---|
| Over | Up to and Including | Grade 1 | Grade 2 | Crack tested (Round, Square Hexagon and Flat) |
| (1) | (2) | (3) | (4) | (5) |
| 6 | 8 | 0.13 | 0.26 | By agreement between the purchaser and the manufacturer |
| 8 | 12 | 0.15 | 0.30 | |
| 12 | 14 | 0.18 | 0.36 | |
| 14 | 20 | 0.25 | 0.50 | |
| 20 | 25 | 0.28 | 0.56 | |
| 25 | 32 | 0.30 | 0.60 | |
| 32 | 42 | 0.35 | 0.70 | |
| 42 | 53 | 0.40 | 0.80 | |
| 53 | 63 | 0.60 | 1.20 | |
| 63 | 80 | 0.80 | 1.60 | |
| 80 | 100 | 1.00 | 2.00 | |
| Above 100 mm | | By agreement | | |

**NOTES**

*Grade 1 is recommended for drawing, turning and grinding.*

*Grade 2 is recommended for the production of machined parts for general engineering purposes.*

**4.2 Design**

**4.2.1** The cylinder shall be of brazed construction having a cold or hot drawn cylindrical portion with ellipsoidal or torispherical ends braced to it, or two halves cold or hot drawn and circumferentially brazed together.

**4.2.2** There shall be no longitudinal seam joint. Non-pressure retaining attachments shall either be brazed or welded. Electric resistance spot welding shall be permitted for locating the attachments in position prior to brazing. The lap joint for pressure retaining attachments shall not be less than three times the thickness of the material to be joined. The joint when tensile tested shall break in parent material. Joggle butt joints shall be uniform press fit with substantial metal to metal contact between members. Such joints shall not be loose to be removed by normal hand pulling.

**4.2.3** The calculation of the thickness of the pressure parts of the gas cylinders is related to the minimum value of yield strength guaranteed by the cylinder manufacturer for the finished cylinder and the test pressure.

**4.3** Nomenclature for the design of shell

t calculated minimum wall thickness of cylindrical shell in mm excluding any additional thickness to resist influences other than those of internal pressure and of external forces due to normal handling (See **4.4.1**)

$P_h$ test pressure, in MPa ($N/mm^2$) above atmosphere

$D_i$ inner diameter, in mm

$D_o$ outer diameter, in mm

$R_e$ yield strength (minimum value specified in **4.1,** in MPa).

H depth of dishing, in mm;

K the ratio $D_0/H$;

R dishing radius, in mm ( $R \leq D_o$ ) ;

r knuckle radius, in mm ( $r \geq 0.1\ D_o$ ) and

$\mathcal{J}$ brazed joint factor

The joint factor to be used in the design of cylinder shall be 1.0 for joints in which examination assures that the brazing filler metal has penetrated through the entire joint and appears on both the sides of the joint. However, in cases where visual examination will not provide the proof that the Brazing filler metal has penetrated the entire joint, the joint factor shall be 0.5.

**4.4** The agreed finished thickness shall not be lower than that calculated from the following formulae :

a) For the cylindrical portion, the greater value of the following shall be used

$$t = \frac{P_h D_o}{200 \times 0.8 \mathcal{J} R_e + P_h} \qquad \text{or} \qquad t = \frac{P_h D_i}{200 \times 0.8 \mathcal{J} R_e - P_h}$$

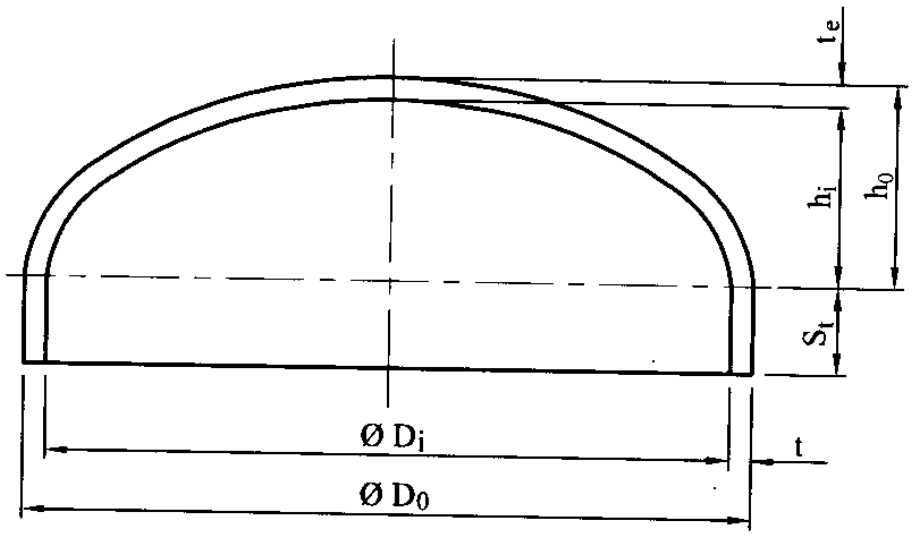
b) For semi – ellipsoidal part or end (See Figure **1a**)

$$t = \frac{P_h D_o}{200 \times 0.8 \mathcal{J} R_e + P_h} \times \frac{K(0.65 + 0.1K)}{4}$$

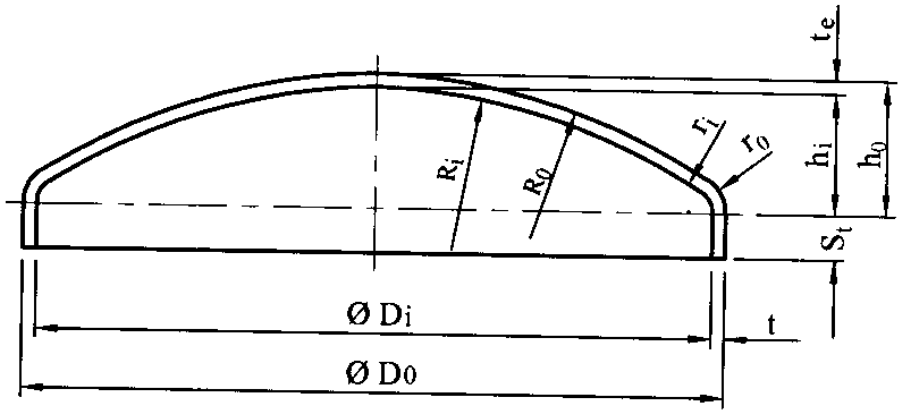
For torispherical part or end (See Figure **1b**)

$$t = \frac{P_h D_o}{200 \times 0.8 f R_e + P_h} \times \frac{KZ}{5}, \qquad \text{where } Z = \frac{\frac{20_{ri}}{R_i} + 3}{\frac{20_{ri}}{R_i} + 1}$$

**4.4.1** The thickness of the shell shall not be less than 1 mm for cylinders up to and including 75 mm outside diameter and 1.4 mm for cylinders over 75 mm diameter up to 15 litre water capacity.




1a Semi-ellipsoidal




1b Torispherical

FIGURE 1 - Domed ends

### 4.5 Brazer qualification

**4.5.1** The manufacturer shall have the technical capability and have at his disposal all appropriate means and properly qualified personnel necessary to satisfactorily carry out the manufacture of cylinders.

**4.5.2** Each manufacturer, with the agreement of the inspection body, shall, before proceeding with the production of a given design of cylinder, approve the brazing procedures to **EN 13134** for all-brazing associated with the pressure envelope including non-pressure-containing parts.

Records of such qualification shall be kept on file by the manufacturer.

**4.5.3** Brazing procedure approval tests shall be made in such a manner that the joints shall be representative of those made in production.

**4.5.4** Brazers shall have passed the approval tests for the specific type of work and procedure concerned (see **EN 13133**).

### 4.6 Fabrication

**4.6.1** *Brazing*

The cylinder halves may be brazed by copper or copper alloys. These shall be lap jointed according to Appendix **A**. The brazing procedure including brazing methods shall be according to Appendix **B**.

**4.6.1.1** Before brazing, the parts to be joined shall be free from scale, grease, oil, and dirt. In case of rolled-in scale, the same shall be removed by chemical or mechanical process before brazing.

**4.6.1.2** The non-pressure attachments like foot ring, valve protection cap, hanging lugs, can be located in position by electric resistance, spot welding/ protection welding if brazed. The brazing shall be throughout the length of the joint which is to be in contact with the body.

**4.6.1.3** The brazing material generally shall be as specified in Appendix **C**.

**4.6.2** *Manufacture*

The end of deep drawn parts shall be of semi-ellipsoidal or torispherical ends. The end shall have a cylindrical skirt or parallel portion of minimum length 10 mm or 3 times the shell thickness, whichever is greater.

**4.6.2.1** Agreed, finished thickness

The agreed finished thickness shall not be less than the minimum calculated wall thickness obtained by the application of formula given in **4.4.a)** or by **4.4.b)** all any transverse section of the cylindrical portion. Additional thickness shall also be provided to cover corrosion allowance, manufacturing tolerances and stress due to horizontal acceleration and retardation

during transportation. The amount of this allowance shall be as agreed between the manufacturer and purchaser.

**4.6.3** *Examination of the cylinders before closing-in operation*

Each cylinder shall be examined for wall thickness before the closing-in operation. The manufacturer shall check for circularity of the cylindrical shell and the skirt portion of ends, external and internal surface defects, the profile regularity of the ends and off set at the joints. The manufacturer shall assure himself that the wall thickness is not less than the agreed thickness at any point. For this, the standard laid down by manufacturers and the inspecting authority shall form the guidelines.

**4.6.3.1** Circularity

The out of roundness of the cylindrical shell be limited to such a value that the difference between the maximum and minimum outside diameter in the same cross section is not more than one per cent of the mean of these diameters when assembled.

**4.6.3.2** Surface defects

The internal and external surfaces of the cylinder shall be free from defects which would adversely affect the safe working of the cylinder.

**4.6.3.3** Profile regularity

The inner surface of the end shall not deviate from the prescribed shape by more than 1.25 per cent of the nominal diameter of the head skirt . Such deviations shall not be abrupt.

**4.6.3.4** Straightness

Unless otherwise shown on the drawing, the maximum deviation of the shell from a straight line shall not exceed 0.3 per cent of the cylindrical length.

**4.6.4** *Water capacity*

Water capacity of the cylinder shall have a tolerance of $_{0}^{+5}$ per cent on calculated or declared capacity.

**4.6.5** *Valves*

The valve connections shall consist of a brazed pad, boss or nipple, and shall be threaded to suit the type of valve used.

**4.6.5.1** The valve shall conform to **SLS 1184:1998**.

**4.6.5.2** The valve shall be protected by a stout metal collar welded to the upper end of the container concentric with the neck. The height and the diameter of the collar shall ensure adequate protection to the valve. The thickness of the collar shall not be less than that of the cylinder wall thickness.

**4.6.6** *Fittings other than valves*

Handle or other suitable attachments for lifting the cylinder may be provided. It shall be capable of withstanding static loading in any direction equal to twice the weight of the cylinder when filled with water.

**4.6.7** *Foot ring*

The foot ring, where fitted as a separate fixture to the bottom end of the cylinder, shall be at least 20 mm away from the circumferential joint. In case the first ring is made out of sheet, the thickness of the sheet from which the foot ring is made shall not be less than the calculated wall thickness of the cylinder body. Alternatively, steel rods of adequate strength may also be used. The foot ring may be intermittently brazed. It shall be provided with holes for ventilation, as well as draining holes to avoid corrosion. The maximum permissible deviation from the vertical shall not exceed one degree ($1^{o}$). Foot ring shall be sufficiently strong, made of steel compatible with that of the cylinder. The bottom of foot ring shall not be less than 5 mm below the outside bottom of the cylinder shell.

**4.6.8** *Test requirements*

**4.6.8.1** In normal batch production, for test purposes, a batch shall consist of containers constructed from steel of similar analysis and by the same steel manufacturer and heat treated in the same manner as well.

**4.6.8.2** One container selected at random out of each batch of 202 or less of heat treated cylinders, shall be used to take test pieces which shall be subjected to the mechanical tests as described in **6.1** and shall satisfy the requirements of **6.1**

**4.6.8.3** One container selected at random of each batch of 403 or less shall be subjected to bursting test, in accordance with **6.1.8.1** and then comply with **6.1.8.2** and **6.1.8.3** when hydraulically tested to destruction.

## 5 HEAT TREATMENT

**5.1** All cylinders passing through the brazing furnace shall be considered as heat treated provided they meet physical properties as specified in **4.1.1** when tested as per **6**.

**5.1.1** The manufacturer shall have the option to normalize or stress relieve the cylinder subsequent to brazing operation.

## 6 METHODS OF TEST

### 6.1 Mechanical tests

**6.1.1** *General*

The mechanical tests shall be carried out on the plate material and the brazed joints.

The following tests shall be made on test pieces taken at random out of each batch of heat – treated cylinders.

**a)** Tensile test, for one test piece in a longitudinal direction on plate material and

**NOTE** *: Test specimens that are not sufficiently flat shall be pressed by cold pressing to make them flat.*

**b)** Minimum thickness test, for one test piece.

**6.1.2** *Tests on plate material*

**6.1.2.1** Tensile test on plate material

The tensile test shall be carried out in accordance with **SLS 978 : Part 1:1992** on two proportional test pieces or of gauge length $5.65 \sqrt{S_0}$ cut from the cylinder where $S_0$ is the original cross-sectional area of the test specimen in square millimeters. The tensile strength and percentage of elongation thus determined shall not be less than the minimum value specified for the parent material. The value of yield strength thus determined shall not be less than the value of yield strength (Re) guaranteed by the cylinder manufacturer for the finished cylinder and used for the design thickness calculation in **4.4**.

**6.1.3** *Bend test on plate material*

The width of the test piece shall be 25 mm or 4 times the agreed finished thickness of the cylinder as specified on the drawing (including corrosion allowance) whichever is greater. The face and back of the test piece shall not be machined except that the edges may be rounded off. The test piece shall not crack when bent round a mandral of diameter equal to twice the plate thickness for actual tensile strength. (of parent metal) up to and including 422 MPa and a mandral of diameter equal to thrice the plate thickness for actual tensile strength more than 422 MPa.

**6.1.4** *Brazed joint test*

**6.1.4.1** Tensile test of brazed joint

The test specimen shall be cut from the cylinder used for the tensile test. The specimen which is taken from across the braze shall not break from the brazes.

**6.1.4.2** Peel test

The braze joint shall be peel tested according to Appendix **D**. Before taking the sample for this test it shall be checked for penetration of brazing material in the joints.

**6.1.4.3** One section test shall be carried out to check penetration.

**6.1.5** *Minimum thickness test*

A ring shall be cut from the thinnest portion of the cylinder used for the tensile test and

examined for wall thickness. The thickness at any point shall not be less than the calculated thickness.

**6.1.6** *Proof test*

**6.1.6.1** Proof test shall be carried out hydrostatically at the maximum testing pressure which shall be one and a half (1 1/2) times of the design pressure.

The pressure shall be raised to the test pressure under proper control and shall be maintained at the test pressure for not less than 30 s. The cylinder shall not be struck during testing. Any cylinder which leaks or develops a visible bulge shall be rejected and destroyed.

**6.1.7** *Leakage test*

Subsequently to the proof test if done hydrostatically, every cylinder shall be dried and tested for leakage by subjecting to air pressure of not less than 686 kPa while immersed in water, and shall show no leakage.

**6.1.8** *Bursting test*

**6.1.8.1** One cylinder taken at random from each batch shall be subjected to an internal hydrostatic pressure till it bursts.

The pressure is increased gradually till the required test pressure is reached, after which the pressure is retained for 30 seconds. The cylinder is then examined for any reduction in pressure, leakage, visible bulge or deformation.

The cylinder taken for bursting shall be first subjected to hydrostatic stretch test. The permanent stretch suffered by the cylinder due to the application of test pressure shall not exceed 10 per cent of the total stretch suffered during the test.

The nominal hoop stress corresponding to the pressure at which destruction occurs shall be calculated as given in the following formula :

$$f_b = \frac{P_h \times D_i}{2t'}$$

where,

$f_b$ = nominal hoop stress, in MPa ($N/mm^2$), at which destruction occurs ;

$P_h$ = internal hydrostatic pressure, in MPa ($N/mm^2$), at which cylinder bursts;

$D_i$ = nominal original internal diameter, in mm, of the cylinder ; and

$t'$ = minimum agreed finished thickness, in mm, as specified on the drawing (including corrosion allowance ) (*See* **4.5.2.1**)

**6.1.8.2** The value of $f_b$ shall not be less than 0.95 of the minimum specified tensile strength of the material of the cylinder.

**6.1.8.3** The cylinder shall burst without fragmentation and fracture shall not occur in the direction parallel to circumferential joint within 10 mm from the edge of circumferential joint.

**6.1.9** *Retest*

If the sample fails in any of the mechanical tests specified in **6.1.1** and **6.1.2** and the inspecting authority considers that the failure was due to an error in carrying out the test, a fresh test shall be made on a test piece taken from the same cylinder. The defective test shall be ignored but otherwise at the cylinder maker's discretion one of the following procedures shall be adopted:

a) The mechanical test in which the failure occurred shall be repeated on the same cylinder and in addition, the tests specified in **6.1.1** and **6.1.2** shall be carried out on another cylinder from the same batch. If both cylinders comply with the test requirements of **6.1.1** and **6.1.2** the batch may be accepted.

b) The batch may be reheat treated in accordance with **5** and the tests specified in **6.1.1** and **6.1.2** shall be carried out on two cylinders which have not previously been tested. If both cylinders then comply with the requirements of **6.1.1** and **6.1.2** the batch may be accepted.

**6.1.10** If the sample fails in any of the mechanical tests specified in **6.1.1.a) ,** the batch may be reheat treated and rested in accordance with **6.1.1.b)**.

**6.1.10.1** If any of the tests specified in **6.1.1.b)** fails, the batch shall be rendered unserviceable for holding gas under pressure.

**6.1.11** The cylinders which have been rejected before or after heat treatment due to pin holes in the brazing or due to leak at the braze in proof pneumatic leakage test may be repaired and re-offered for inspection provided following conditions are satisfied:

a) The cylinder has been reheat-treated if procedure calls for;
b) The cylinder has been subjected to prescribed proof and pneumatic leakage tests ;
c) Proper records of such repairs have been maintained, and
d) Not more than two attempts for repair have been made.

**6.1.11.1** Cylinders showing leaks in the hydrostatic or pneumatic leakage test at any place other than the brazed area shall be rejected and rendered unserviceable.

**6.1.12** *Failure in bursting test*

If a cylinder fails due to non-compliance of the requirement of **6.1.8.2** or **6.1.8.3** then the following procedure shall be adopted.

a) All cylinders belonging to the control unit in which the cylinder failed shall be rejected. From the rest of the batch, one cylinder from each control unit shall be selected at random and cylinders shall be passed or failed control unit wise, depending upon the results of the burst tests.

b) If failure can be attributed to a cause which is discernible even before the test, all cylinders with such defects shall be segregated and reprocessed after repair. From the balance of the cylinders two more cylinders shall be selected at random and tested if one or both fail, the procedure laid down for testing control unit wise above shall be adopted.

## 7 MARKING

**7.1** Each cylinder shall be permanently stamped with the following :

a) Month and year of manufacture of cylinder, such as 08/06 for August 2006
b) Serial number of the cylinder;
c) Identification symbol of the manufacturer,
d) Tare mass and gross mass of cylinder, in kg;
e) Identification symbol of owner, if required;
f) Maximum working pressure, in MPa ($N/mm^2$)
g) Test pressure, in MPa ($N/mm^2$)
h) Water capacity, in litres; and
i) Inspector's official mark.

**7.1.1** All the markings shall be either at the foot ring or on any non-pressure part of the cylinder. In case it is not possible to mark on the foot ring or non- pressure part of the cylinder the details may be marked on a plate of the same composition as the body of the cylinder and it may be brazed soundly on shoulder of the cylinder.

**7.1.2** The stamp used for marking shall have small radii at changes of section to avoid formation of sharp edges in the stamped marking.

## 8. PREPARATION FOR DESPATCH

Before being fitted with valves, all cylinders shall be thoroughly cleaned and dried internally. The outside shall be given a suitable protective coating before painting and dispatch as agreed between the buyer and the manufacturer.

## APPENDIX A

## JOINT DESIGN

**A.1** The easiest joints to braze and which give the best results are those where the component parts of the assembly are self-locating and need no external jigs to hold them on their correct relationship to one another. Sometimes the design of the joint needs to be varied in accordance with the manner in which the filler metal is to be fed to it.

**A.2 EXAMPLES OF BASIC DESIGNS FOR BRAZING ARE SHOWN IN FIG. 2**

**A.3** As a general rule the overlaps should be three times the thickness of the parent metal. This may be varied according to the circumstances and the type of joint required. Excessive overlap may not improve the strength of the joint and may cause undesirable features such as porosity, gas and flux inclusions.

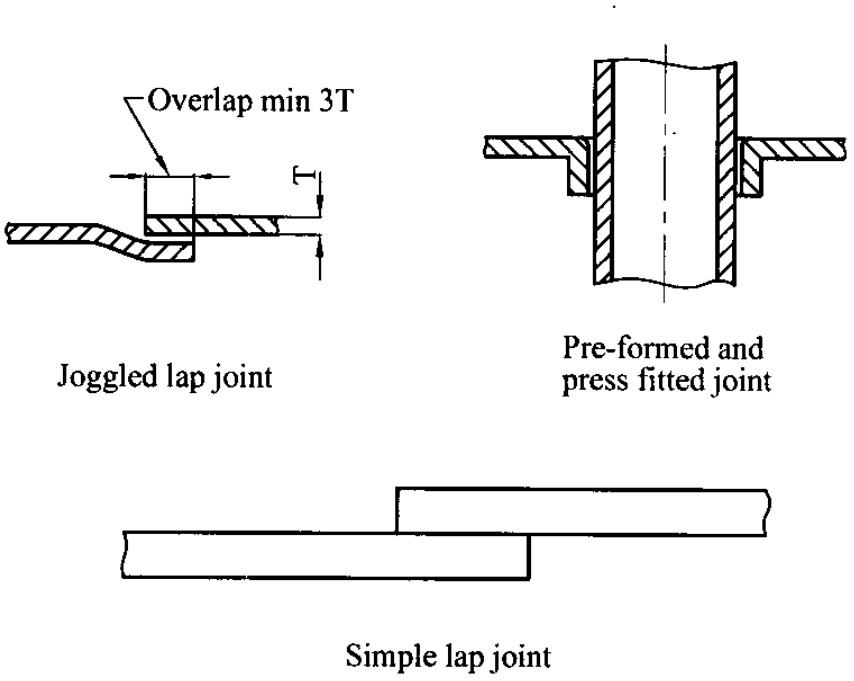



FIGURE 2 - Basic designs for brazing

## APPENDIX B

## BRAZING PROCEDURE

**B1** The manufacturer shall establish the brazing procedure and shall demonstrate that the procedure meets with the test required for the acceptance tests for cylinders and the minimum requirement of the test as specified for the cylinders in various clauses.

**B.2** The main variables for the brazing procedure are listed below:

a) Base metal
b) Joint design
c) Braze material
d) Brazing process as
   i) Furnace brazing; or
   ii) Torch brazing
e) Brazing temperature
f) Brazing atmosphere in the furnace; and
g) The position of flow

**B.2.1** Specifications, in Table **3** and Table **4** should be considered as for one class of material and Table **1**, Table **2**, Table **5** and Table **6** shall be considered as another class of material.

**B.2.2.** The manufacturer shall specify the required details for No.(a) to (g) of **B.2** and shall qualify the brazing procedure. The test pieces shall be cut and tested in accordance with **6.1.4 , 6.1.4.1, 6.1.4.2** and **6.1.4.3** and shall meet the minimum requirement. In case any of the above variables are altered, fresh procedure shall be qualified.

The manufacturer shall then prove the procedure by conducting again the tests specified for the braze joint according to **6.1.4.**

## APPENDIX C

## BRAZING MATERIAL

### C.1 COPPER FILLER METALS

The following three are the standard copper brazing filler metals:

a) Filler metal having a minimum of 99.90 per cent copper and a maximum of 0.10 per cent of other elements . It is available in strip, rod and wire on spools.

b) Filler metal having a minimum 99.0 per cent copper and a maximum of 0.30 per cent of other metallic elements. It is available as a powder in two standard sieve analyses, medium-1 and medium –2. It is applied as a powder in some applications, but is frequently mixed with liquid vehicle and applied as a paste. In most applications, (a) and (b) are interchangeable.

c) Filler metal available in the form of a paste having a minimum of 86.5 per cent copper and a maximum of 0.50 per cent other metallics and 1.3 per cent non-metallic contaminants including chlorides, sulphates and matter insoluble in nitric acid or soluble in acetone. The remainder is oxide. The paste is a suspension of particles of copper and cuprous oxide in a volatile vehicle.

## C.2 COPPER FILLER METALS COMMONLY USED IN FURNACE BRAZING

| Classification | Minimum Copper (Percent) | Brazing Temperature |
|---|---|---|
| a) | 99.90 | 1 080 °C to 1 150 °C |
| b) | 99.0 | 1 080 °C to 1 150 °C |
| c) | 86.5 | 1 080 °C to 1 150 °C |

# APPENDIX D
# PEEL TEST – ACCEPTANCE CRITERIA

The specimen shall be separated or peeled by suitable means and the separated faying surfaces of joints shall meet the following criteria (*See* Figure **3**) :

a) The total area of defects (unbrazed area flux inclusion, etc.) shall not exceed 30 per cent of the total design area of any individual faying surfaces.

b) The sum of the lengths of defects measured on any one line in direction of the lap, shall not exceed 25 per cent of the lap.

c) No defect shall extend continuously from one edge of the joint to the other edge irrespective of the direction of the defects.

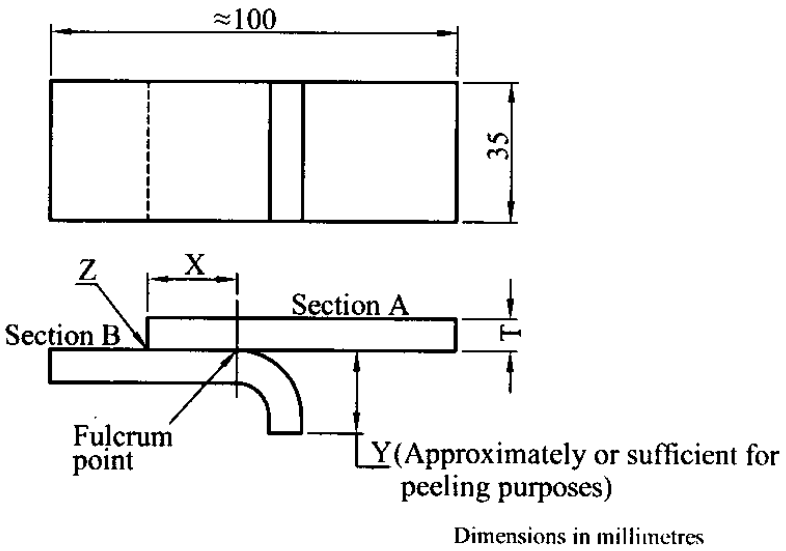



FIGURE 3 - Lap joint peel specimen

**Amendment No. 01 Approved on. 2012-01-27 to SLS 1303:2006**

# SRI LANKA STANDARD SPECIFICATION FOR TRANSPORTABLE REFILLABLE BRAZED STEEL CYLINDERS FOR LIQUEFIED PETROLEUM GAS (LPG)

**Clause 4.6.5.1** Replace the term(standard) **SLS 1184:1998** by **SLS ISO 14245:2011**

Amendment No. 02 approved on 2015-04-09.
to SLS 1303: 2006

**SRI LANKA STANDARD SPECIFICATION FOR TRANSPORTABLE REFILLABLE BRACED STEEL CYLINDERS FOR LIQUEFIED PETROLEUM GAS (LPG)**

Clause **4.6.5.2**

Add the following paragraph after the existing paragraph

'When the valve protection is integral with the cylinder, this shall be demonstrated by drop testing in accordance with clause **6.7** of **SLS ISO 11117:2008.'**

……..……

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