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JAPANESE INDUSTRIAL STANDARD

**Refillable Welded Steel
Gas Cylinders for
Liquefied Petroleum Gas**

JIS B 8233—1986

Translated and Published

by

Japanese Standards Association

Printed in Japan



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Refillable Welded Steel Gas Cylinders
for Liquefied Petroleum Gas

B 8233-1986

1. Scope

This Japanese Industrial Standard specifies the refillable welded steel gas cylinders for liquefied petroleum gas, hereinafter referred to as the "cylinder", of permissible maximum filling quantity not less than 2 kg up to and including 50 kg. However, the cylinders submitted to those for fuel of automobile are excluded.

Remark: In this standard, units and numerical values given in { } are in accordance with the conventional units, and are the standardized values.

2. Definitions

For the purposes of this standard, the following definitions apply.

- (1) liquefied petroleum gas A substance of which principal component is a mixture of 3-carbon or 4-carbon hydrocarbons, and of which pressure at the temperature of 48°C is not more than 1.82 MPa {18.6 kgf/cm²}.
- (2) proof test pressure The pressure to be used in the proof pressure test of completed cylinders, which is 5/3 times the maximum filling pressure. In this standard, this is defined as 3.04 MPa {31 kg/cm²}.
- (3) maximum filling pressure The maximum value of pressure under which the liquefied petroleum gas is capable of being filled in a cylinder. In this standard, this is defined as 1.82 MPa {18.6 kgf/cm²}.
- (4) calculated wall thickness The wall thickness calculated from the formula of 4.1, according to the permissible stresses of material used.
- (5) minimum wall thickness A wall thickness of not less than the calculated wall thickness, which is guaranteed by a manufacturer of cylinders, after forming process.

Applicable Standards and Corresponding International Standard: See page 31.

3. Classes

The classes of the cylinders shall be in accordance with Table 1 according to the permissible maximum filling quantity of the liquefied petroleum gas to be filled.

Table 1. Classes of Cylinders

Class	Permissible maximum filling quantity kg	Class	Permissible maximum filling quantity kg
LP- 2	2	LP-15	15
LP- 2 S	2	LP-20	20
LP- 5	5	LP-30	30
LP- 8	8	LP-50	50
LP-10	10	LP-50 S	50

Remarks 1. LP-2 S shall be the cylinder with portable gas range.

2. LP-50 S shall be the cylinder for vaporizer.

4. Design of Wall Thickness

4.1 Calculated Wall Thickness of Pressure Receiving Parts The wall thickness of the shell parts and end parts shall be not less than the values calculated by using the following formulae.

(1) Shell part

$$t = \frac{Pd}{2S\eta - 1.2P} \left\{ t = \frac{Pd}{200S\eta - 1.2P} \right\}$$

(2) Dished end part

$$t = \frac{Pdw}{2S - 0.2P} \left\{ t = \frac{Pdw}{200S - 0.2P} \right\}$$

(3) Semiellipsoidal end part

$$t = \frac{PdV}{2S - 0.2P} \left\{ t = \frac{PdV}{200S - 0.2P} \right\}$$

where t : calculated wall thickness mm

P : maximum filling pressure = 1.82 MPa {18.6 kgf/cm²}

d : inside diameter of shell part. For the dished end part, the radius of inner face of centre curved part, and for the semiellipsoidal end part, the length of major axis of inner face of semiellipsoid mm

w : the shape factor of dished end part, which has been obtained from the following formula:

$$\frac{3 + \sqrt{n}}{4}$$

In this formula, n expresses the ratio of the inside diameter of the centre curved part of end part to the inside diameter of end curved part.

V : The shape factor of semiellipsoidal end part, which has been obtained from the following formula:

$$\frac{2+m^2}{6}$$

In this formula, m expresses the ratio of the length of the major axis to that of the minor axis of the inner face of the semiellipsoid.

S : permissible stress. A numerical value of the proof yield point (or 0.2 % proof stress) of the manufacturer of cylinder multiplied by the numerical value obtained from the following formula $\text{N/mm}^2 \{ \text{kgf/mm}^2 \}$:

$$\frac{1.7-\gamma}{2}$$

In this formula, γ expresses the ratio (when less than 0.7, 0.7) of the proof yield point of the manufacturer of cylinder to the proof tensile strength.

Remark: The proof yield point and proof tensile strength shall be the minimum yield point and minimum tensile strength guaranteed by the manufacturer of cylinder in accordance with JISs of the equivalent material respectively, as appropriate.

η : welding efficiency of longitudinal joint of shell part
= 0.85

4.2 Safety Factors The safety factors for the destruction of the shell part and end part of the cylinder, when calculated by using the following formulae, shall be not less than 3.5 in all cases.

(1) Safety factor of shell part

$$S_1 = \frac{2ft_1}{Pd + 1.2Pt_1} \left\{ S_1 = \frac{200ft_1}{Pd + 1.2Pt_1} \right\}$$

(2) Safety factor of end part

$$S_2 = \frac{2ft_2}{PdX + 0.2Pt_2} \left\{ S_2 = \frac{200ft_2}{PdX + 0.2Pt_2} \right\}$$

where S_1 : safety factor of shell part

S_2 : safety factor of end part

f : proof tensile strength of cylinder manufacturer
 $\text{N/mm}^2 \{ \text{kgf/mm}^2 \}$

P : maximum filling pressure = 1.82 MPa {18.6 kgf/cm²}

t_1 : minimum wall thickness of shell part mm

t_2 : minimum wall thickness of end part mm

d : inside diameter of shell part. For the dished end part, the radius of inner face of its centre curved part, and for the semiellipsoidal end part, the length of the major axis part of the semiellipsoid mm

X : for the dished end part, the value of w in accordance with 4.1, and for the semiellipsoidal end part, the value of V in accordance with 4.1

5. Performances

5.1 Mechanical Properties of Parent Metal Parts

5.1.1 The yield point, tensile strength and elongation of the parent metal parts, when subjected to the tensile test specified in 11.3 (1), shall conform to the requirements of Table 2.

Table 2. Yield Point, Tensile Strength and Elongation of Parent Metal Parts and Welds

Division of materials	Yield point N/mm ² {kgf/mm ² }	Tensile strength N/mm ² {kgf/mm ² }	Elongation %
Those of which tensile strength is less than 441 N/mm ² {45 kgf/mm ² }	Not less than proof yield point	Not less than proof tensile strength	30 min.
Those of which tensile strength is not less than 441 N/mm ² {45 kgf/mm ² } to 539 N/mm ² {55 kgf/mm ² } excl.			22 min.
Those of which tensile strength is not less than 539 N/mm ² {55 kgf/mm ² }			18 min.

Remarks 1. The division of the material shall be in accordance with the minimum tensile strength guaranteed by the cylinder manufacturer in accordance with the Japanese Industrial Standard of the material concerned, as appropriate (hereinafter, the same as in Tables 3, 8 and 9).

2. The minimum value of elongation, in the case of the wall thickness of test piece is less than 8 mm, shall be a numerical value obtained by subtracting 1.5 on each reduction of 1 mm or a fraction thereof from 8 mm in its wall thickness.

5.1.2 The cylinder, when subjected to the crushing test specified in 11.3 (2), shall not cause any crack on the crushed part. However, a cylinder which is not suited to be subjected to the crushing test, when subjected to the bend test specified in 11.3 (3), shall not cause any crack on the bent part.

5.2 Performances of Welds

5.2.1 The yield point and tensile strength of the welds, when subjected to the tensile test specified in 11.4 (1), shall comply with the requirements of Table 2.

5.2.2 The weld, when subjected to the surface bend test specified in 11.4 (2), the outer surface of which shall satisfy the following conditions.

- (1) There shall be no crack (except that generates on the rim corner.) exceeding 3 mm in length.
- (2) The total length of the cracks of not more than 3 mm in length shall be not more than 7 mm.
- (3) The total of cracks and blow holes shall be not more than 10 pieces.

5.2.3 The joints, when subjected to the radiographic test in 11.4 (3), the defects of which shall be not less than Grade 2 of the grade classification specified in JIS Z 3104.

5.3 Pressure Resistance The cylinder, when subjected to the pressure test specified in 11.5, shall be free from leakage or abnormal expansion, as well as the permanent increasing rate in the expansion measuring test shall be not more than 10 %.

5.4 Air Tightness The cylinder, when subjected to the air tightness test specified in 11.6, shall be free from leakage.

5.5 Burst Resistance The cylinder, as agreed between the parties concerning acceptance, of which performances specified in accordance with 5.1 and 5.2 may be replaced by the burst resistance. In this case, the cylinder shall be subjected to the burst test specified in 11.7, and the results shall comply with the following requirements.

- (1) The maximum pressure until the burst takes place shall not be less than 6.38 MPa {65.1 kgf/cm²}.
- (2) The volumetric expansion rate shall, when the burst has taken place, be in accordance with Table 3.

Table 3. Volumetric Expansion Rate at the Moment of Burst

Division of tensile strength of material Division of shapes of cylinders	That of less than 353 N/mm ² {36 kgf/mm ² }	That of not less than 353 N/mm ² {36 kgf/mm ² }
Where the length of the part subject to pressure of a cylinder is larger than the outer diameter	20 % min.	15 % min.
Where the length of the part subject to pressure of a cylinder is not more than the outer diameter	14 % min.	10 % min.

- (3) The starting point of the burst shall comply with the following requirements:
- (a) It shall not be the end part (however, in the case where the length of the part subject to pressure is not more than 2 times the outside diameter is excluded.).
 - (b) It shall not be a longitudinal weld.
 - (c) It shall not be the circumferential joint weld other than that at right angles to the joint.
- (4) After bursting, the visual inspection on the inside and outside faces of the cylinder shall be carried out, and any abnormality on welds and material, which are impedimental in safety for the cylinder shall not be found.

6. Shape and Dimensions

6.1 Shapes The shapes of the cylinders shall be in accordance with the followings other than given in Fig. 1.

- (1) The shape of the shell of the cylinder shall be of the cylindrical shape, and the longitudinal joint shall be not more than one place.
- (2) The shape of the end plate of the cylinder shall be of the dish shape or 2:1 semiellipsoidal shape and of without joint. Furthermore, the circumferential joint shall be not more than 2 places.
- (3) The cylinders of LP-50 and LP-50 S shall be limited, irrespective of the requirements of (1) and (2), to those having constitution of one longitudinal joint and two circumferential joints.

Fig. 1. Shapes of Cylinders

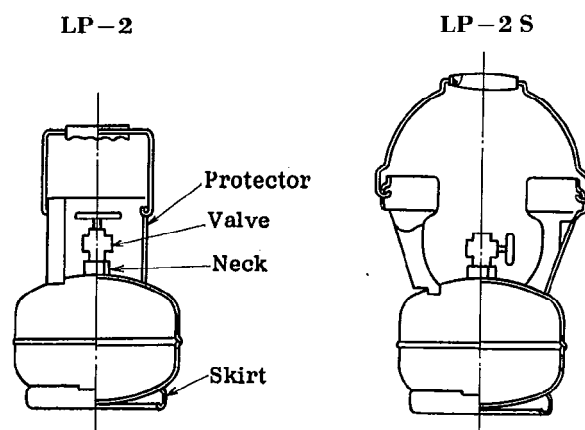
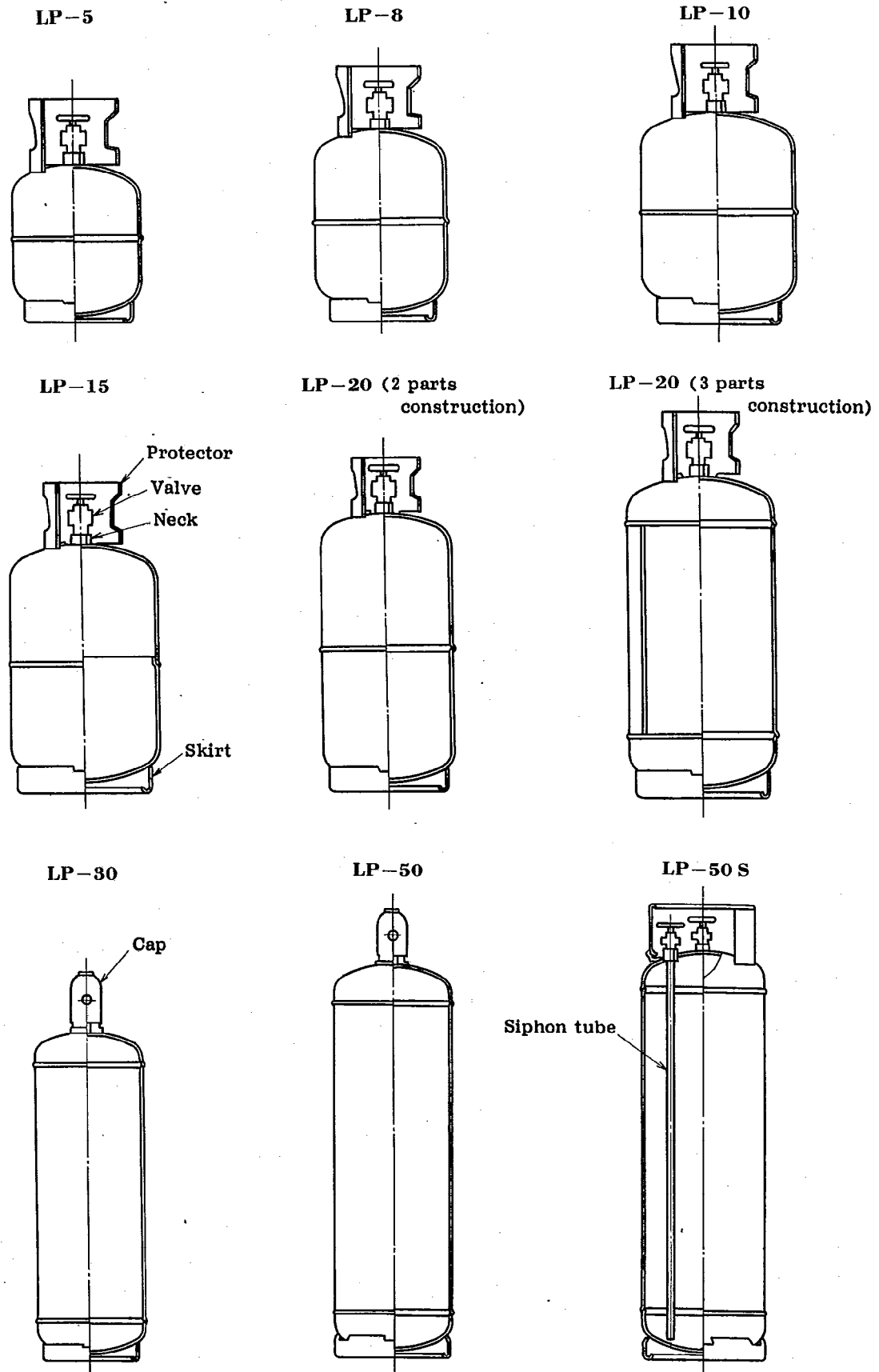


Fig. 1 (Continued)

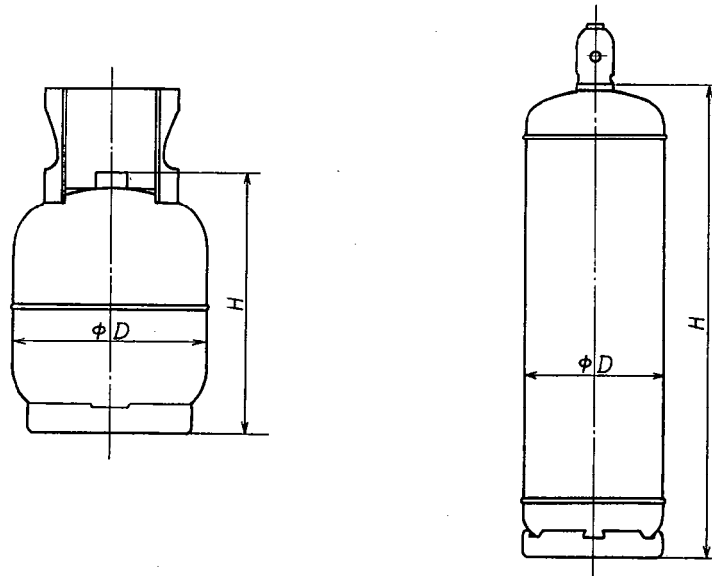


Remark: Figure gives an example of the shape of the cylinder, and it does not control the shape.

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6.2 Dimensions The dimensions of the parts of cylinder subject to pressure shall be in accordance with Table 4.

Table 4. Dimensions of Parts of Cylinder Subject to Pressure



Type of cylinder	Cylinder						Wall thickness
	Inside volume		D		H ⁽¹⁾		
	Standard inside volume l	Permissible quantity l	Standard outside diameter mm	Tolerance %	Standard height mm	Tolerance %	
LP-2	4.7	+0.2 0	210 to 220	± 1	200 to 220	± 1	Not less than the wall thickness specified in 4.
LP-2 S	4.7	+0.2 0	210 to 220		200 to 220		
LP-5	12	+0.4 -0.2	250 to 255		320 to 340		
LP-8	19	+0.4 -0.2	275 to 285		410 to 430		
LP-10	24	+0.4 -0.5	300 to 310		425 to 455		
LP-15	36	+0.4 -0.5	320		560 to 580		
LP-20	47	+0.4 0	310 to 320		705 to 760		
	48	+0.4 -0.5					
LP-30	71	+0.4 -0.5	320		1 000 to 1 050		
LP-50	118	+0.4 -0.5	365 to 370		1 230 to 1 280		
LP-50 S	118	+0.4 -0.5	365 to 370	1 230 to 1 280			

Note ⁽¹⁾ H indicates the dimension from the face of the skirt seat to the upper face of the neck.

7. Appearance and Painting

7.1 Appearance The appearance of the cylinder shall be as given in the following:

- (1) The surface of the cylinder shall be free from flaws, cracks, streaks, wrinkles and others which are impedimental to use.
- (2) The weld shall be sufficient in penetration, as well as be free from harmful cracks, undercut, overlap, crater and the like.
- (3) The inside of the cylinder shall be cleansed with water or other method, and be free from oils and fats, welding slag, isolated scale and others, as well as be dried sufficiently.

7.2 Painting The overall exterior surface of the cylinder shall be processed with painting; and its colouring method and the like shall be in accordance with the followings:

- (1) Pretreatments Prior to the painting, the cylinder shall be treated with the treatments given in the following or equal or superior to these in effect, as required.
 - (a) Degreasing
 - (b) Coating-formation treatment
 - (c) Pickling
 - (d) Shot blasting (surface preparation Class 1)
 - (e) Etching primer
- (2) Execution of Painting
 - (a) Rust preventing painting shall, after the treatment of (1) has been processed, be carried out rapidly in accordance with Table 5.
 - (b) The painted colour of the top coat shall be dark gray which is an achromatic medium gray colour (N 6 or N 7 specified according to three attributes) in accordance with JIS Z 8721, and this shall be carried out in accordance with Table 5.
 - (c) The type of paint and the method of coating shall be those having rust preventing effect equal or superior to Table 5.