

Compressed natural gas vehicles - Tube fittings and tubing - Performance requirements

1 Scope

This standard specifies tube fittings and tubings that are used in fuel supply lines for compressed natural gas vehicles with maximum filling pressures of 20.0 MPa and 24.8 MPa. Carbon steel pipes used in high-pressure tubings and tubings specified in **JASO M111** are excluded.

Note

Pressure values used in this standard refer to gauge pressures.

2 Normative reference

The following standards contain which, thorough reference in this Standard, constitute provisions of this Standard. If the indication of the year of coming into effect is given to these referred standards, only the edition of indicated year constitutes the provision of this Standard but the revision and amendment made thereafter are not applied. If not, the most recent editions of the standard indicated below shall be applied.

JASO Z202	Automotive parts - Pipe fittings - Glossary of terms
JIS D 1601	Vibration testing methods for automobile parts
JIS K 6257	Rubber, vulcanized or thermoplastic - Determination of heat ageing properties
JIS Z 2329	Methods for bubble leak testing
JIS Z 2371	Methods of salt spray testing
ASTM B117-95	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM F1387	Specification for Performance of Piping and Tubing Mechanically Attached Fittings

3 Definitions

Definitions of main terms used in this standard shall be based on **JASO Z202** and as follows.

3.1 High-pressure tube fittings and tubings

Tube fittings and tubings used in fuel supply lines in natural gas vehicles with a maximum operating pressure of 1.0 MPa or greater and less than 24.8 MPa.

3.2 Low-pressure tube fittings and tubings

Tube fittings and tubings used in fuel supply lines in natural gas vehicles with a maximum operating pressure less than 1.0 MPa.

3.3 Screw-in fitting

A fitting, for attachment to a part (exclusive of tubings), that is sealed using a male or female screw.

3.4 Rotation controlled fitting

A fitting for which the tightening of the nut is controlled with respect to a rotation count. Commonly, the term refers to 2-compression ring fittings comprise a body, a front ferrule, a back ferrule, and a nut.

3.5 Torque controlled fitting

A fitting in which the tightening of the nut is controlled with respect to a specified torque. Commonly, the term refers to flare-type tube fittings and o-ring face sealing fittings.

4 Types

Table 1 shows types of test items, fittings that are subject to testing, and a list of applicable fittings. **Table 2** shows a list of test fittings locations that are subject to the strength tests described in **6.3** to **6.8**.

Table 1 List of applicable items

Test item	Fitting		Tubing	
	High pressure	Low pressure	High pressure	Low pressure
6.1 Air tightness	○ ^{a)}	○	○	○
6.2 Pressure resistance	○	○	○	○
6.3 Excessive torque strength	○	○	× ^{a)}	×
6.4 Bending moment strength	○	○	○	○ ^{* b)}
6.5 Detachability	○	○	○	○
6.6 Excess tightening strength	○	○	○	○
6.7 Bending strength	×	×	○	○
6.8 Tensile strength	○	○	×	×
6.9 Operating durability	○	○	○	○
6.10 Corrosion resistance	○	○	○	○ [*]
6.11 Ageing resistance	○ [*]	○ [*]	×	○ [*]
6.12 Gas resistance	○ [*]	○ [*]	×	○ [*]
6.13 Oil resistance	○ [*]	○ [*]	×	○ [*]
6.14 Vibration resistance	○	○	○	○
6.15 Season cracking strength	○ [*]	○ [*]	○ [*]	○ [*]
Note ^{a)} ○: Applicable, ×: Not applicable Note ^{b)} For items with an asterisk (○*), exclusions are provided on target parts.				

Table 2 List of target locations on strength tests

Test item	Target location		
	Parts and fittings	Tubings and fittings	Tubings only
6.3 Excess torque strength	○ ^{a)}	× ^{a)}	×
6.4 Bending moment strength	○	○	×
6.5 Detachability	×	○	×
6.6 Excess tightening strength	×	○	×
6.7 Bending strength	×	×	○
6.8 Tensile strength	○	○	×
Note ^{a)} ○: Applicable, ×: Not applicable			

5 Performance requirements

The performance of fittings and tubings shall meet the criteria listed in **Table 3**.

Table 3 Performance requirements

Item	Performance	Test item
Airtightness	When a prescribed test is performed on a fitting or tubing, either there is no bubble formation, or the amount of leak from one joint must be no greater than 6 cm ³ /h (A.N.R.) ^{a)} .	6.1
Pressure resistance strength	After a prescribed test is performed on a fitting or tubing, there must not be any damage, such as an abnormal swelling or fracture.	6.2
Excess torque strength	When subjected to a prescribed test, the screw-in fitting must not break. After the test, it must satisfy the air tightness criterion.	6.3
Bending moment strength	When subjected to a prescribed test, the fitting must not produce bubbles during the test and must not break.	6.4
Detachability	When subjected to a prescribed test, the detachable fitting must not break. After the test, it must satisfy the air tightness criterion.	6.5
Excess tightening strength	When subjected to a prescribed test, the detachable fitting must not break. After the test, it must satisfy the air tightness criterion.	6.6
Bending strength	When subjected to a prescribed test, the tubing must not produce surface fractures or other abnormalities. After the test, it must satisfy the air tightness criterion.	6.7
Tensile strength	When subjected to a prescribed test, the fittings and tubings must not break or become loose.	6.8
Operating durability	When subjected to a prescribed test, the fittings and tubings must satisfy the air tightness criterion.	6.9
Corrosion resistance	When subjected to a prescribed test, the fittings and tubings must satisfy the air tightness criterion.	6.10
Ageing resistance	When subjected to a prescribed test, the non-metallic material in the fittings and tubings must satisfy the air tightness criterion.	6.11
Gas resistance	When subjected to a prescribed test, the non-metallic material used in fittings and tubings must not produce a condition where the test piece is crushed or disintegrates. Further, they must not produce a condition where the test piece undergoes a volume expansion greater than 25 %, a volume contraction greater than 1 %, or a mass change greater than 10 %.	6.12
Oil resistance	When subjected to a prescribed test, the non-metallic material used in fittings and tubings must not produce a condition where the test piece undergoes a volume expansion greater than 25 %, a volume contraction greater than 1 %, or a mass change greater than 10 %.	6.13
Vibration resistance	When subjected to a prescribed test, the screw-in fitting must not produce abnormal conditions, such as harmful deformations or flaws. After the test, they must satisfy the air tightness criterion.	6.14
Season cracking resistance	When a prescribed test is performed on a fitting or tubing, no cracking must be observed at 25× magnification.	6.15
Note ^{a)} A.N.R. is a code that represents a standard state (the state of gas with a 20 °C temperature, a 101.3 kPa absolute pressure, and a 65 % relative humidity).		

6 Test Methods

Test methods are described in **6.1** to **6.15**.

The size (outer diameter and thickness), hardness, external appearance, and finish of the tubing to be tested shall be determined by mutual consultation between the parties involved. Fittings shall be assembled according to the conditions recommended by fitting manufacturers.

6.1 Airtightness

Tests are conducted with the part, the fitting, or the tubing assembled, in sequence **a)** to **c)** described below, and an evaluation is performed.

- a)** Let the fitting and the tubing stand in a constant temperature bath at temperatures specified in **Table 4** for 2 h. If a foaming liquid specified in **JIS Z 2329** is used, similarly let the specimens stand in a constant temperature bath at a specified temperature for 2 h.
- b)** Using the appropriate coupling parts, connect both ends of the fitting and tubing to a pressure source, such as dry air or dry nitrogen.
- c)** Apply the pressure specified in **Table 4**. Determine the presence or absence of any bubble formation for two min, either by dipping the specimen in a liquid at a specified temperature or by applying a foaming liquid. If bubbles are noted, measure the amount of leakage for 1 min or more under each condition, and convert the results to the amount of leakage per hour.

Table 4 Airtightness test conditions

Test temperature °C	Test pressure on a fitting or tubing
-20±2	Max. operating pressure × 75 %
20±2	Max. operating pressure × 150 %
85±2	Max. operating pressure ×150 %

6.2 Pressure resistance strength

Using liquid, apply a pressure 4 times the maximum operating pressure to the fitting and the tubing at (20±5) °C; keep that pressure for a minimum of 3 min, and evaluate the results with respect to presence or absence of unusual swellings or fractures.

6.3 Excess torque strength

Perform tests in the following sequence **a)** to **c)** and evaluate the connection between the fitting and a part.

- a)** Attach the screw-in fitting to a jig having sufficient strength, then apply a tightening torque 1.5 times the tightening torque recommended by manufacturers of screw-in fittings.
- b)** After letting it stand for 15 min, remove the screw-in fitting from the jig, and examine it for the presence or absence of any deformation or damage to the fitting screw part.
- c)** As a further step, re-attach the same screw-in fitting to the jig, and perform test **6.1**.

6.4 Bending moment strength

Perform tests in the following sequence, **a)** to **d)**, and evaluate the connection between a part and the fitting and the tubing.

For the test, use a hard tubing made of metal and other materials that are immune from plastic deformation when subjected to a test load.

- a)** Attach one end of the fitting to a jig having sufficient strength.
- b)** Attach a tubing greater than 300 mm to the other end of the fitting, apply a 5.0 kPa pressure, apply a foaming liquid at $(20 \pm 5) ^\circ\text{C}$, and examine the joint for the presence or absence of bubbles.
- c)** After that, with the 5.0 kPa pressure still applied, apply the load indicated in **Table 5** at a position 300 mm from the joint for 15 min as shown in **Figure 1**. With the load still applied, at $(20 \pm 5) ^\circ\text{C}$, examine it for the presence or absence of bubbles.
- d)** In the next step, on the remaining three directions as well, perform operations to verify the presence or absence of bubbles with a load similarly applied. Also, remove the fitting from the jig, and examine it for any damage.

Table 5 Bending moment test

Tubing outer diameter mm	Load N
$D \leq 6.5$	3.4
$6.5 < D < 12$	9.0
$12 \leq D$	17.0

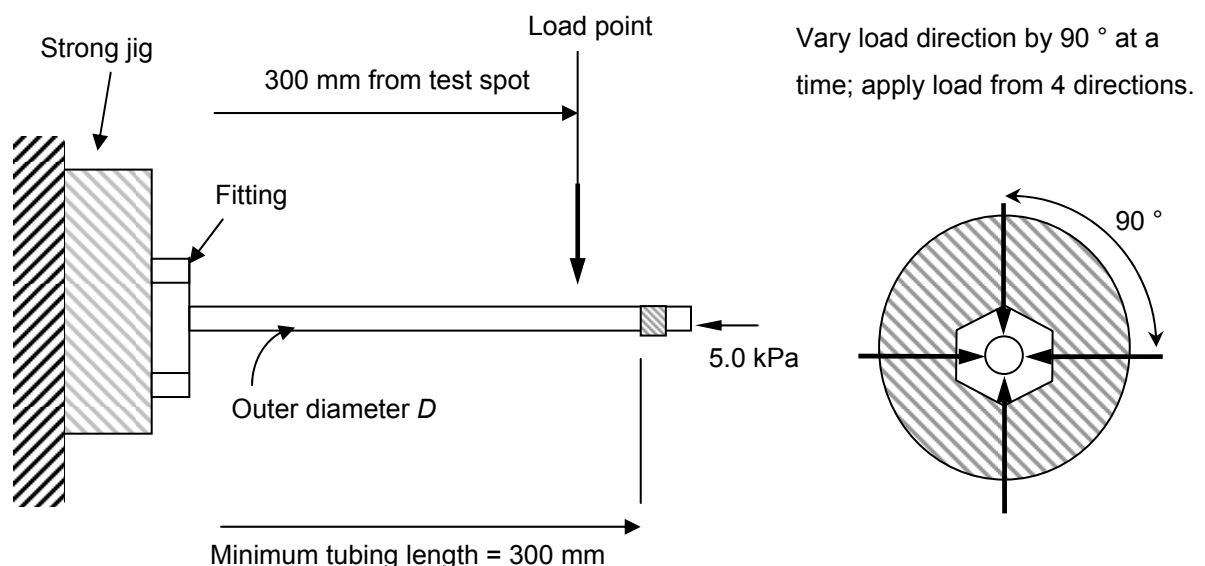


Figure 1 Bending moment test

6.5 Detachability

Perform tests in the following sequence, **a)** to **c)**; evaluate the joint between the tubing and the fitting.

- a)** Fix the main part of an unused detachable fitting ¹⁾ to a jig having sufficient strength.