Submitted by the expert from Japan

Informal document **GRSG-108-11**
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Proposal for amendments to UN Regulation No. 110

In fiscal year 2013, we established a 'Study group for CNG cylinders/LNG tanks' under the Japan Gas Association, a private association of Japanese gas utilities consisting of experts in high pressure gas cylinders/LNG tanks including university professors, members from the High Pressure Gas Safety Institute of Japan (KHK: Kouatsu-Gas Hoan Kyoukai), cylinder/tank manufacturers, cylinder/tank accessory manufacturers and so on, to investigate the safety of UN Regulation No. 110. The text written below was prepared by the experts from Japan to propose amendments to UN Regulation No.110.

A. PROPOSAL

UN Regulation No.110

Paragraph 2., amend to read (deleting two references):

"2. References

…….

EN Standards[4]

~~EN 13322-2 2003 Transportable gas cylinders – Refillable welded steel gas cylinders – Design and construction – Part 2: Stainless steel~~

~~EN ISO 5817 2003 Arc-welded joints in steel; guidance on quality levels for imperfections~~

EN 1251-2 2000 Cryogenic vessels. Vacuum insulated vessels of not more than 1,000 litres volume

……"

Paragraph 6.3., amend to read:

"6.3. Every container shall also bear a marking plate with the following data clearly legible and indelible:

(a) A serial number;

(b) The capacity in litres;

(c) The marking "CNG";

(d) Operating pressure/test pressure**/working pressure** [MPa];

(e) Mass [kg];

(f) Year and month of approval (e.g. 96/01);

(g) Approval mark according to paragraph 7.4. "

Insert new paragraph 6.4., to read:

"**6.4. Every automatic valve and every pressure relief device fitted to the container shall also bear a marking with the following data clearly legible and indelible:**

(a) The marking "CNG";

(b) Working pressure [MPa]."

Paragraph 6.4. (former), renumber as paragraph 6.5.

Insert new paragraph 6.6., to read:

"**6.6.** **Every one of the following components shall also bear a clearly legible and indelible marking of the data listed below (a) and (b): pressure relief valve (primary); pressure relief valve (secondary); manual fuel shut off valve; manual vapour shut off valve; LNG check valve; and LNG valves (manual or automatic) fitted to the tank.**

(a) **The marking "LNG";**

(b) **Working pressure [MPa].**"

Paragraph 18.1.8.4., amend to read:

"18.1.8.4. A label shall be placed adjacent to the **CNG and/or** LNG fill receptacle stating the fuelling requirements **with the following data**. The fuelling requirements shall be as recommended by the manufacturer**:**

(a) **The marking "CNG" and/or "LNG";**

(b) **Working pressure [MPa]**."

Annex 3

Paragraph 1.1., amend to read:

"1. Scope

1.1. Annex 3A sets out minimum requirements for light-weight refillable gas cylinders. The cylinders are intended only for the on-board storage of high pressure compressed natural gas as a fuel for automotive vehicles to which the cylinders are to be fixed. Cylinders may be of any steel, aluminium or non-metallic material, design or method of manufacture suitable for the specified service conditions. This annex also covers stainless steel metal liners of seamless ~~or welded~~ construction. **This annex does not cover metal liners or cylinders of welded construction.**"

Annex 3A

Delete paragraphs 6.3.2.4. and 6.3.2.5.

Paragraph 6.3.2.6. (former), renumber as paragraph 6.3.2.4., and amend to read:

"6.3.2.4. Sulphide stress cracking resistance

The ultimate tensile strength of the steel from a finished cylinder shall not exceed 1,200 MPa. If the upper limit of the specified tensile strength for the steel exceeds 950 MPa, the steel from a finished cylinder shall be subjected to a sulphide stress cracking resistance test in accordance with Appendix A to this annex, paragraph A.3. and meet the requirements listed therein."

Table 6.1, amend to read:

"Table 6.1

Material design qualification test

	Relevant paragraph of this annex				
	Steel	*Aluminium*	*Resins*	*Fibres*	*Plastic liners*
Tensile properties	6.3.2.2.	6.3.3.4.		6.3.5.	6.3.6.
Impact properties	6.3.2.3.				
~~Bending properties~~	~~6.3.2.4.~~				
~~Weld examination~~	~~6.3.2.5.~~				
Sulphide stress cracking resistance	**6.3.2.4.**~~6.3.2.6.~~				
Sustained load crack resistance		6.3.3.3.			
Stress corrosion cracking		6.3.3.2.			
Shear strength			6.3.4.2.		
Glass transition temperature			6.3.4.3.		
Softening/Melting temperature					6.3.6.
Fracture mechanics*	6.7.	6.7.			

* Not required if flawed cylinder test approach in paragraph A.7. of Appendix A to this annex is used ."

Annex 3A - Appendix A

Paragraphs A.1. and A.2., amend to read:

"A.1. Tensile tests, steel and aluminium

A tensile test shall be carried out on the material taken from the cylindrical part of the finished cylinder using a rectangular test piece shaped in accordance with the method described in ISO 9809 for steel and ISO 7866 for aluminium. ~~For cylinders with welded stainless steel liners, tensile tests shall be also carried out on material taken from the welds in accordance with the method described in paragraph 8.4. of EN 13322-2.~~ The two faces of the test piece**s** representing the inside and outside surface of the cylinder shall not be machined. The tensile test shall be carried out in accordance with ISO 6892.

NOTE - Attention is drawn to the method of measurement of elongation described in ISO 6892, particularly in cases where the tensile test piece is tapered, resulting in a point of fracture away from the middle of the gauge length.

A.2. Impact test, steel cylinders and steel liners

The impact test shall be carried out on the material taken from the cylindrical part of the finished cylinder on three test pieces in accordance with ISO 148. The impact test pieces shall be taken in the direction as required in Table 6.2 of Annex 3A from the wall of the cylinder. ~~For cylinders with welded stainless steel liners, impact tests shall be also carried out on material taken from the weld in accordance with the method described in paragraph 8.6. of EN 13322-2.~~ The notch shall be perpendicular to the face of the cylinder wall. For longitudinal tests the test

piece shall be machined all over (on six faces), if the wall thickness does not permit a final test piece width of 10 mm, the width shall be as near as practicable to the nominal thickness of the cylinder wall. The test pieces taken in transverse direction shall be machined on four faces only, the inner and outer face of the cylinder wall unmachined."

Paragraph A.28., shall be deleted.

B. JUSTIFICATION

Add paragraph 2., Annex 3, paragraphs 1.1., Annex 3A, 6.3.1., 6.3.2.4., 6.3.2.5., Annex 3A – Appendix A, paragraphs A.1., A.2. and A.28.:

The main drawback of welded metal cylinders relates to fatigue. It is very difficult to eliminate defects of welding and inspection technology or its application may not be adequate to identify infinitesimal defects in the welding. Because both the production and quality control of welded metal cylinders are extremely difficult, welded metal cylinders with operating pressure of 20 MPa should be removed from this regulation to ensure that no unsafe CNG cylinders of this type are allowed to enter the market as fuel storage systems for vehicular applications subject to enforcement under UN Regulation No. 110.

According to our research, there are no manufacturers of welded metal cylinders for CNG vehicles in the world at the moment and, as such, there will be no negative effects on existing manufacturers or products if welded metal cylinders are removed from this regulation.

Annex 3A, paragraph 6.3.2.6.:

The presence of water or high humidity may cause deteriorations of strength (delayed fractures) of high-strength steel. Reports indicate that high-strength steel with a tensile strength of more than 1,200 MPa often undergoes a conspicuous deterioration of strength (see informal document GRSG-107-09e and GRSG-107-37e). Accordingly, in highly humid regions the risk of delayed fracture increases because of the increased possibility of cylinders being exposed to moisture.

UN Regulation No. 110 requires sulphide stress cracking resistance test for CNG-1 and CNG-2 cylinders using high-strength steel with a tensile strength of more than 950 MPa. But there is no upper requirement for tensile strength.

For steel cylinders (CNG-1 cylinder) and steel liner cylinders (CNG-2 cylinder) built with high-strength steel, setting an upper limit of tensile strength should be required to ensure safety so that they could be considered suitable for use environments with high humidity.

Paragraphs 6.3., 6.4., 6.5., 6.6. and 18.1.8.4.:

An accident in Japan causing one fatality and one serious injury happened during the scrapping work of a CNG cylinder in September, 2012. The cylinder was displaced by the Tsunami caused by the Great East Japan Earthquake.

As the market for NGVs expands so too will the number of scraping works of CNG cylinders increase in

the future, therefore, some measures should be required to show the kind of gas inside the cylinder so that the workers can recognize it and take proper safety precautions to avoid accidents and injuries.

Furthermore, the number of compressed hydrogen gas(CHG) cylinder accessories will increase in the future. In order to prevent CNG accessories from being fitted improperly to CHG cylinders, accessories should be marked with certain data as a minimum requirement. The above-mentioned consideration should be made for LNG tank accessories as well.

For further reference, in Japan cylinders/tanks, accessories fitted to the cylinder/tank and fill receptacles all must be marked with the following information:

(1) Cylinder/tank (Engraving and the following data)

- (a) The marking "CNG" and/or "LNG";
- (b) Pressure;
  - CNG: Working pressure [MPa]
  - LNG: Test pressure [MPa]
- (c) Symbol for name of inspection institute;
- (d) Name or symbol of manufacturer;
- (e) Type of cylinder/tank;
  - CNG: V1, V2, V3 or V4
  - LNG: VL
- (f) Model number and serial number;
- (g) Internal volume [L];
- (h) Date of inspection;
- (i) Date of removal from service;
- (j) (Composite cylinder) Depth of Cylinder(DC) [mm];
- (k) (Composite cylinder) Depth of Dome(DD) [mm];
- (l) Name of the person who installed;
- (m) Installed day;
- (n) Serial number of vehicle;

(2) Accessories fitted to the cylinder/tank (Engraving and the following data)

- (a) The marking "CNG" and/or "LNG";
- (b) Pressure;
  - CNG: Working pressure [MPa]
  - LNG: Test pressure [MPa]
- (c) Date of inspection;
- (d) Symbol for name of inspection institute;
- (e) Name or symbol of manufacturer;
- (f) Model number and serial number;
- (g) Mass [kg];
- (h) Test pressure [MPa];
- (i) Type of accessories;

CNG: CNGV

LNG: LNGV

(3) Fill receptacle

(a) The marking "CNG" and/or "LNG";

(b) Number of installed cylinder/tank;

(c) Date of removal from service;

(d) Validity period of inspection;

(e) Pressure;

CNG: Working pressure [MPa]

LNG: Test pressure [MPa]

(f) Serial number of vehicle.