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Item 5.4. of the provisional agenda

PROPOSAL FOR DRAFT AMENDMENTS TO REGULATION No. 110

(Specific components for CNG)

Submitted by the expert from Germany

Note: The text reproduced below was prepared by the expert from Germany to extend the requirements for the design of seamless and welded metal liners to the use of stainless steels. The text is based on documents without a symbol (informal document No. GRPE-52-11), distributed during the fifty-second GRPE session (ECE/TRANS/WP.29/GRPE/52, para. 39). The modifications to the current text of the Regulations are marked in **bold** characters or marked as strikethrough.

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Note: This document is distributed to the Experts on Pollution and Energy only.

A. PROPOSAL

Annex 3

Paragraph 1., amend to read:

"1. SCOPE

This annex sets out minimum requirements for light-weight refillable gas cylinders. The cylinders are intended only for the onboard 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 ~~does not cover~~ **also covers stainless steel metal liners or cylinders of stainless steels or of seamless or welded construction.** Cylinders covered by this annex are classified in Class 0, as described in paragraph 2. of this Regulation, and are:  
....."

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

"2. REFERENCES

.....

BS 7448-91 Fracture Mechanics ..... Structures; Metallic Materials.

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

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

ISO Standards 3/

....."

Insert new paragraphs 6.3.2.4. and 6.3.2.5., to read:

**"6.3.2.4. Bending properties**

**The bending properties of the welded stainless steel in the finished liner shall be determined in accordance with paragraph A.3. (Appendix A).**

**6.3.2.5. Macroscopic weld examination**

**A macroscopic weld examination for each type of welding procedure shall be performed. It shall show complete fusion and shall be free of any assembly faults or unacceptable defects as specified according to level C in EN ISO 5817."**

Paragraph 6.3.2.4. (former), renumber as paragraph 6.3.2.6.

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.
<b>Impact properties</b>	<b>6.3.2.3.</b>				
<b>Bending properties</b>	<b>6.3.2.4.</b>				
<b>Weld examination</b>	<b>6.3.2.5.</b>				
Sulfide stress cracking resistance	<b>6.3.2.6.</b>				
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 <b>if flawed</b> cylinder test approach in paragraph A.7. <b>of Appendix A is used</b>					

"

Annex 3, 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 pieces 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 3 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."

Insert a new paragraph A.29., to read:

**"A.29. Bend test, welded stainless steel liners**

**Bend tests shall be carried out on material taken from the cylindrical part of a welded stainless steel liner and tested in accordance with the method described in paragraph 8.5. of EN 13322-2. The test piece shall not crack when bent inwards around a former until the inside edges are not further apart than the diameter of the former."**

B. JUSTIFICATION

Ad Annex 3, paragraphs 1., 2., 6.3.1., 6.3.2.4. and 6.3.2.5.:

The further development of composite cylinders allows the safe use of stainless steels for the design of seamless and welded metal liners, provided that the properties of the materials selected fulfil the same requirements as defined in the respective standards for high pressure, monolithic cylinders.

The excellent corrosion and fatigue resistance, and the good workability of these materials enables the design of particularly light weight and safe fuel tanks for natural gas vehicles.

Ad Annex 3, Appendix A, paragraphs A.1., A.2., and A.29.:

The proposed amendments extend the materials requirements as well as the related testing procedures, outlined in the present Regulation, to the use of stainless steels as liner material by referring to the relevant paragraphs of existing standards for monolithic pressure vessels.

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