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Item 9(b) of the provisional agenda

Amendments to gas-fuelled vehicle regulations:**UN Regulation No. 110 (CNG and LNG vehicles)****Proposal for amendments to UN Regulation No. 110 (CNG and LNG vehicles)****Submitted by the expert from Italy***

The text reproduced below was prepared by the expert from Italy to amend Annex 3A of the Regulation on the test requirements for Compressed Natural Gas (CNG) cylinders to avoid structural failures during their service life. It is based on ECE/TRANS/WP.29/GRSG/2017/29 distributed during the 113th and 114th sessions of the Working Party on General Safety Provisions (GRSG) (see reports ECE/TRANS/WP.29/GRSG/92, para. 40 and ECE/TRANS/WP.29/GRSG/93, para. 31). It was further revised taking into account the discussion in the Task Force on gas-fuelled vehicle regulations. The modifications to the current text of UN Regulation No. 110 are marked in bold for new characters and as strikethrough for deleted ones.

* In accordance with the programme of work of the Inland Transport Committee for 2014–2018 (ECE/TRANS/240, para. 105 and ECE/TRANS/2014/26, cluster 02.4), the World Forum will develop, harmonize and update UN regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

I. Proposal

Paragraph 4.56., amend to read:

"4.56. *"Finished cylinders"* means completed cylinders that are ready for use, typical of normal production, complete with identification marks and external coating including integral insulation **and/or protection** specified by the manufacturer **on the design drawing for the cylinder**, but free from non-integral insulation or protection.

Annex 3A

Paragraph 6.12., amend to read:

"6.12. Exterior environmental protection

The exterior of

(c) A protective coating A.9. (Appendix A to this annex).

Any coatings **or protections** applied to cylinders shall be such that the application process does not adversely affect the mechanical properties of the cylinder. The coating **or protection** shall be designed to facilitate subsequent in service inspection and the manufacturer shall provide guidance on coating **or protection** treatment during such inspection to ensure the continued integrity of the cylinder.

Manufacturers are advised Appendix H to this annex."

Paragraph 10.7.1., amend to read:

"10.7.1. General

Cylinder design qualification tests shall be in accordance with the requirements of paragraphs 8.6., 10.7.2., 10.7.3., **10.7.4. and 10.7.5.** of this annex, except that the LBB performance in paragraph 8.6.10. above is not required."

Add a new paragraph 10.7.5., to read:

"10.7.5. Impact damage test

One or more finished cylinders shall be subjected to an impact damage test according to Appendix A, paragraph A.20."

Paragraph 6.17., Table 6.7 (Change of design), twelfth row, in the first column replace "Dome shape" by "Dome **design**" and in the eighth column insert the figure "**X**" including a new note** to read: "**** Drop test A.20 only required for CNG3 and CNG4 designs**".

Annex 3A, Appendix A, paragraph A.17., amend to read:

"A.17. Composite flaw tolerance tests

For type CNG-2, CNG-3 and CNG-4 designs only, one finished cylinder, complete with protective coating, **shall perform a flaw tolerance test on the cylindrical wall as well as on the minimum composite wall thickness of the weakest part(s) of the container as identified by an appropriate stress analysis or full scale tests on finished cylinders.** The flaws shall be cut in the longitudinal direction into the composite. The flaws shall be greater than the visual inspection limits as specified by the manufacturer.

The flawed cylinder shall then be destroyed."

II. Justification

1. Ad paragraph 4.56: It seems to be obvious that a protection which is "integral" could not be changed at the will of the manufacturer, but shall be fully described in the "design drawing of the cylinder" as described in paragraph 5.3.1. of Annex 3A. To avoid any misunderstanding, it is necessary that this is clearly stated, as it is in paragraph 3.10. of standard ISO 11439.
 2. Ad Annex 3A, paragraph 6.12.: The paragraph is related to "protections" in general and not only to "coatings". As it has been shown by the tests carried out by Italy, it shall be clearly stated that the specified provisions do apply to any kind of protections accepted by UN Regulation No. 110, and not just limited to coatings.
 3. Ad Annex 3A, new paragraph 10.7.5.: This is simply a corrigendum, since the impact damage test, which is compulsory for CNG4 cylinders, does not appear between the cylinder design qualification tests listed in paragraph 10.7.
 4. Ad Annex 3A, Table 6.7.: The strength of the domes depends on their design (thickness, fibres orientation, shoulder pads etc.) not only on their shape. The drop test shall be required for CNG3 and CNG4 cylinders to avoid that a change of design of the domes would allow the production of cylinders approved according to UN Regulation No. 110 that do not guarantee the required impact damage strength, as it has been shown by the Italian tests.
 5. Ad Annex 3A, Appendix A, paragraph A.17.: It is obvious that the most dangerous flaw is the one in the weakest point of any structure and that it will not make any sense for the reliability of the cylinder to test the "flaw tolerance" in the strongest zone of the cylinder. It is necessary that this is clarified to avoid any misunderstanding. It could be very dangerous for the reliability of the cylinder as shown by the failures in service which occurred in Italy. All failures in service took place in the same zone of the domes, particularly the one of minimum composite wall thickness, where the wall thickness was about half the thickness of the cylindrical wall and where a composite flaw tolerance test is usually never performed. Since the reduction of thickness and strength of the domes to about one-half of those of the cylindrical part is correct only on the theoretical basis of absence of flaws, such a reduction is not allowed in case of flaws. The tests performed by Italy showed evidence that the failures in service could happen and that such a reduction results in the weakest zone of the domes of CNG4 cylinders. Thus, it is necessary to improve the composite flaw tolerance and reliability of CNG3 and CNG4 cylinders by clearly stating that it is necessary to evaluate the effect of flaws also in the zone of minimum thickness of the domes.
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