Proposal for amendments to Regulation No. 110 (CNG

Submitted by the expert from Italy

Informal document GRSG-114-32
(114th GRSG, 9-13 April 2018
agenda item 6.(b))

Four points related to CNG4 cylinders with shoulder pads but with very different aims

Annex 3A

Paragraph 4.1.4., amend to read:

«4.1.4. **Periodic requalification**

1 Recommendations for periodic requalification…conditions specified herein. Each cylinder shall be visually inspected at least every 48 months after the date of its entry into service on the vehichle (vehicle registration) and at the time of any reinstallation to verify the absence of damage and deterioration, including under the support straps **and under any ogive protective covers**. The visual inspection…»

To make possible the visual inspection of the domes of CNG4 cylinders

Paragraph 10.7.1., amend to read:

«10.7.1. General

2 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

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

When ogive protective covers are fitted on the cylinder, this test shall be carried out in the absence of such covers.»

Annex 3A, Appendix A:

Paragraph A.20., amend to read:

«A.20. Impact damage test

4 One or more finished cylinders shall be drop tested at ambient temperature without internal pressurization, without **ogive protection covers or** attached valves. The surface…»

To improve the reliability of CNG4 cylinders

GFBM research is related to the second subject (points 2-3-4 of the proposal)

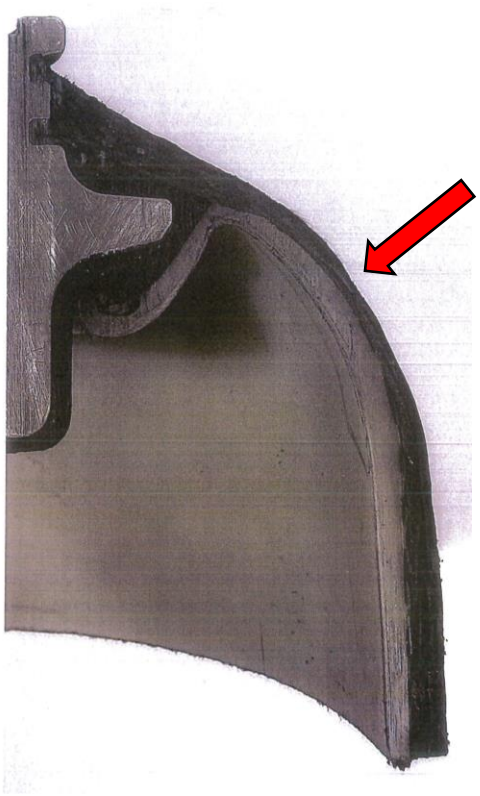
The research started following 3 in service failures of CNG4 cylinders, with glued dome protective covers, which have been ascribed to impact damage.

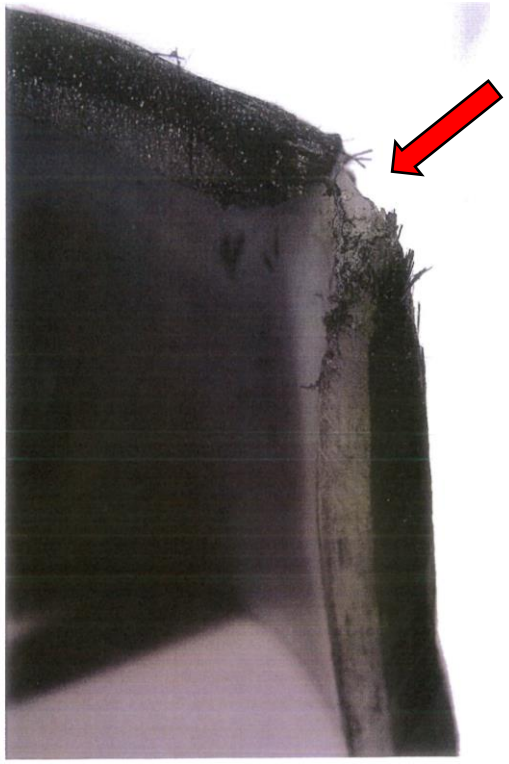
To verify the impact damage safety level of this kind of construction, 24 CNG4 cylinders with glued dome covers have been impact damage tested according to the cited paragraph A20 (impact, hydraulic test, 20000 fatigue cycles).

- THE 12 CYLINDERS OF 11.4 *l* (ORIGINAL APPROVAL) FULFILLED WHAT REQUIRED. To verify which one was the weakest point, the already tested cylinders have been submitted to the same dropt tests after removal of the dome covers. All but one failed, always in the same zone of the dome.
- THE 12 CYLINDERS OF 12.5 *l* (EXTENSION OF APPROVAL OF THE 11.4 *l* AND WITH DIFFERENT SHOULDER PADS) DID NOT FULFIL WHAT REQUIRED: 10 over 12 failed, always in the same zone of the dome (2 in the hydraulic test, 8 after a limited number of cycles in the fatigue test). It should be noted that 6 of them, at the opening of the boxes, had shown cracks on one of the shoulder pads. Since the crack was not due to impact damage, they have been tested and not discarded.

THE OBTAINED RESULTS HAVE SHOWN THAT:

- IN ALL CASES THE FAILURES OCCURRED ON A ZONE OF THE DOME ENDS UNDER THE SHOULDER PADS WHERE THE THICKNESS IS ABOUT ONE HALF OF THAT IN THE CYLINDRICAL PART





- AFTER A CHANGE OF DESIGN (RULED BY TAB. 6.7 OF ANNEX 3) IT IS POSSIBLE TO HAVE R110 APPROVED CNG4 CYLINDERS THAT DO NOT GUARANTEE THE REQUIRED STRENGTH AGAINST IMPACT DAMAGE.
- SHOULDER PADS (OR DOME COVER PROTECTIONS) ARE NOT MENTIONED IN ANY POINT OF R110. THEIR USE IS NOT RULED IN ANY WAY AND THEY ARE NOT CONSIDERED, IN TABLE 6.7, FOR A CHANGE OF DESIGN.

SOMETHING SHOULD BE DONE TO OVERCOME THE PROBLEMS EVIDENCED BY THE FAILURES IN SERVICE AND BY THE RESULTS OF THE ITALIAN RESEARCH.

It seems that there could be only two possible ways:

A) To explicitly introduce the dome end protective covers in R110, ruling their use and specifying the tests to be performed in case of their change of design.

B) To explicitly say that the R110 required reliability to impact damage shall be given by the CNG4 cylinder itself, and not by glued shoulder pads.

BUT WHY

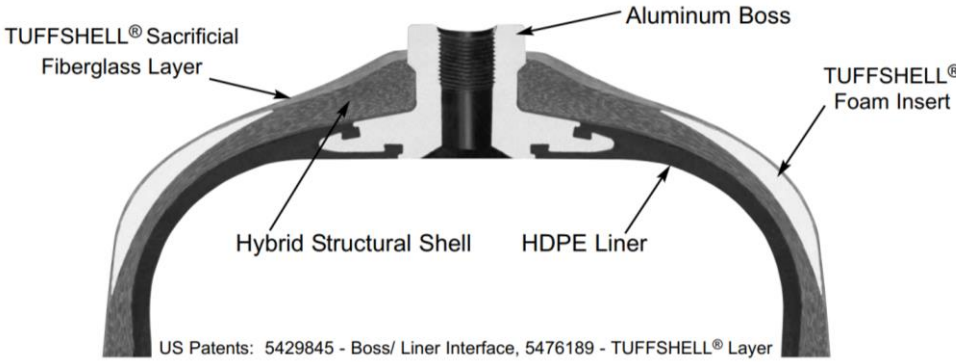
the Italian proposal has chosen the second solution, most unpopular since it is against some today adopted constructions?

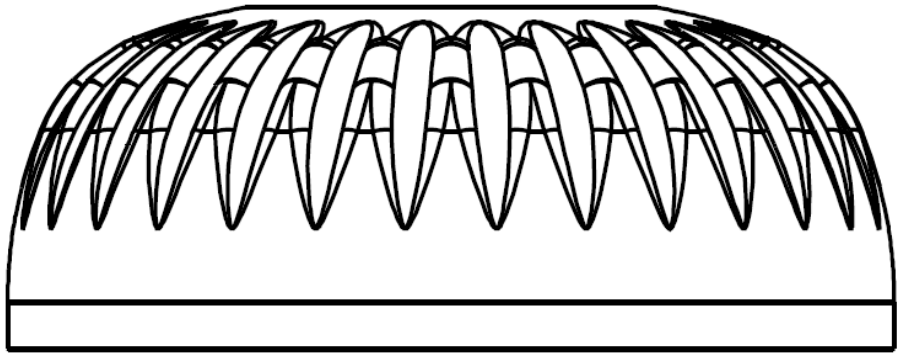
BECAUSE

the first solution, although it could consent to fulfil what required by paragraph A.20, it will also reduce the reliability of the cylinders, since it will allow to accept a lower strength of their weakest point, which is also the most exposed to defects of production.

COMING NOW TO THE POINT 1 OF THE ITALIAN PROPOSAL (PERIODIC REQUALIFICATION):

on the market there are CNG4 cylinders with and without protection of the dome ends. When a protection is adopted it is possible to have protections which are built as a part of the cylinder, or protections which are simply glued on the cylinder:





In case of simply glued protections the italian research has evidenced that some of them could break without any impact damage or even without any kind of utilization

At the opening of the box after 1 year of storage (6 broken over 12 cylinders)

At the opening of the box after 2 years of storage (9 broken over 13 cylinders)

Even more important, from the point of view of the visual inspection, is that the tests on the 12.5 *l* cylinders have evidenced that their shoulder pads are very good in resisting the drop tests without breaking. For this reason THE BLOWS, WHICH ALWAYS TOOK PLACE IN AN IMPACTED AREA OF THE DOMES, IN MOST CASES STARTED UNDER UNBROKEN SHOULDER PADS. Then it was absolutely impossible to detect the damage on the cylinders, since the shoulder pads had not been removed.

For these reasons, on the basis of the glued shoulder pads that today is possible to find in service, we strongly believe that, for the periodic requalification, IT SHALL BE REQUIRED «*TO VERIFY THE ABSENCE OF DAMAGE AND DETERIORATION*» ALSO UNDER THE GLUED SHOULDER PADS.

THANK YOU FOR

YOUR ATTENTION