Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labelling of Chemicals

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Transport of Gases:
Miscellaneous

Response to Comments, on updated ISO standards in Class 2 and document ST/SG/AC.10/C.3/2024/11, made by expert from Germany in informal document INF.34

Transmitted by International Organization for Standardization (ISO)

I. Introduction

1. The Expert from Germany has submitted document informal document INF.34 which makes comments on the different standards submitted by ISO in document ST/SG/AC.10/C.3/2024/11.

In this document, ISO provides responses to the comments made by the Expert from Germany.

II. Comments on proposal 1 in document ST/SG/AC.10/C.3/2024/11

2. Proposal 1 in document ST/SG/AC.10/C.3/2024/11 refers to ISO 23876:2022, Gas cylinders – Cylinders and tubes of composite construction – Acoustic emission examination (AT) for periodic inspection and testing.

3. The expert from Germany states that “We share the opinion that acoustic emission testing (AT) is the most promising non-destructive examination (NDE) technique for the retesting of composite cylinders. In fact, we are of the opinion that the hydraulic proof testing has a very limited value when performed on composite cylinders and tubes when performed without any additional non-destructive testing (NDT) method. Therefore, a powerful NDT method should be developed and introduced into regulations. But we have some severe doubts that proposal 1 is an appropriate proposal for solving this.”

4. This is a late informal document from Germany and whilst discussions have taken place with the relevant ISO Leadership Teams and Working Group (WG) Convenor, responsible for this standard there is a need to spend more time reviewing this with the Expert from Germany and the experts of the ISO WG responsible for this standard.

5. It is proposed that ISO come back to the next meeting with a revised document that addresses the German, and any other comments received.

III. Comments on proposal 2 in document ST/SG/AC.10/C.3/2024/11

6. Proposal 2 in document ST/SG/AC.10/C.3/2024/11 refers to ISO 11623:2023, Gas cylinders – Composite cylinders and tubes – Periodic inspection and testing.

7. This standard specifies the requirements for periodic inspection and testing to verify the integrity for further service of hoop-wrapped and fully-wrapped composite transportable gas cylinders and tubes, with aluminium-alloy, steel or non-metallic liners or of linerless construction (Types 2, 3, 4, and 5), intended for compressed, liquefied or dissolved gases under pressure, of water capacity from 0.5 l up to 3 000 l. The significant changes compared to the previous edition are as follows are that the scope has been revised to include cylinders and tubes with a water capacity up to 3 000 l, i.e. the limit was previously set at 450 l. It is understood that this standard would be of significant benefit to the gases industry.

8. In Chapter 9 "Pressure test", its states that "In the case when a pneumatic pressure test is carried out, appropriate measures should be taken to ensure safe operation and to contain any energy that can be released". UN *Model Regulations* 6.2.1.6.1 Note 1 indicates that this is permitted. Note 1 reads as follows: "With the agreement of the competent authority, the hydraulic pressure test may be replaced by a test using gas, where such an operation does not entail danger".

9. In addition, Chapter 9 "Pressure test", states that: "The pressure test may be replaced by a suitable non-destructive examination (NDE) technique (e.g. ISO 23876, ISO/TS 19016) with agreement between the manufacturer and the competent authority." However, as indicated by the Expert from Germany according to 6.2.1.6.1 (d) Note 2 of the UN *Model Regulations* a replacement is only allowed for seamless steel cylinders.

ISO proposes that a note is included with the entry for ISO 11623:2023, Gas cylinders – Composite cylinders and tubes – Periodic inspection and testing, in 6.2.2.4, stating that "The pressure test shall not be replaced by a non-destructive examination (NDE) technique, though such techniques can be used for monitoring purposes".

ISO will continue its work to find an appropriate NDE test regime, that is acceptable to the Sub-Committee of Experts on the Transport of Dangerous Goods and come forward with a proposal at a subsequent meeting.

IV. Reply to comments made by the German expert, in informal document INF.34, on proposal 3 in document ST/SG/AC.10/C.3/2024/11

10. Proposal 3 in document ST/SG/AC.10/C.3/2024/11 refers to ISO 4706:2023, Gas cylinders – Refillable welded steel cylinders – Test pressure 60 bar and below.

11. The Expert from Germany stated that a comparison between the standards in the versions 2023 and 2008 show additional changes, which are not minor. These comments are discussed below.

12. The German Expert stated that in chapter 6 "Design" the requirement "A minimum pressure of 30 bar shall be used in the design of LPG cylinders." is missing. This was removed by the Experts during a video conference held 06-23-21 based on a comment from Portugal. The reason the sentence was removed was because test pressure (Ph) is defined by ISO 4706 as well as the UN *Model Regulations*. The experts' opinion was that stating a specific test pressure for LPG was incorrect and did not follow the guideline of the UN *Model Regulations*. It was the opinion of the experts that this was not considered a significant change in ISO 4706 and was editorial since the information on test pressure for LPG is covered by the UN *Model Regulations*. No comments were noted on this matter during ballot of the FDIS document.

13. The German Expert stated that in chapter 7 "Calculation of minimum wall thickness (sidewall and ends)" the calculation of the guaranteed minimum sidewall thickness of the cylindrical shell is changed. The CD of ISO 4706 contained the following "significant changes". Further the Expert went on to say "This change allows a reduction of the guaranteed minimum wall thickness for cylinders with a water capacity of 251 l to 500 l down to 80 % of the value according to standard ISO 4706:2008.

The CD of ISO 4706 contained the following "significant changes", see below. However, the experts elected to modify the significant changes in the FDIS and excluded those items **in Bold**.

- **Format conforms to current ISO requirements**,
- References have been updated,
- **F factor has been mathematically validated,**
- X-Ray is required on 3-piece designs,
- Changed x-ray frequency from 50 to 250,
- Added criteria for x-ray retesting requirements.

The experts' opinion was the statement on the "F" factor was discussing validation and therefore was not considered a significant change. On reflection by the convenor of the working group, maybe a statement on the "F" factor should have been included.

The "F" factor in the formula was discussed in several video conferences held from 2020 through 2023. The concern by the experts was that an "F" factor of 0.77 for all cylinder sizes and test pressures was not appropriate. The experts compared different size cylinders and test pressure cylinders to adequately qualify the "F" factor.

After reviewing the information available, the experts agreed that allowing a "F" factor of 0.85 would increase the minimum sidewall thickness on some designs depending on diameter and test pressure, whilst decreasing minimum wall thickness on other designs. The experts agreed that an "F" factor of 0.85 was appropriate.

Calculations were conducted evaluating the minimum wall thicknesses of different cylinder diameters and test pressures. The model data that reviewed by the experts was based on the best knowledge available by manufacturers for guaranteed minimum yield strength and guaranteed minimum tensile strength. Below are typical findings for a 454 l cylinder design.

- 454 l cylinder, 33 bar test pressure 762 mm diameter revealed that "F" = .77 versus "F" = 0.85 and "J" = 1.0 would result in a reduction of 9.6% in wall thickness (5.2 vs 4.7 mm) yet was an increase over the minimum North American requirements by 3.8%.
- 454 l cylinder, 33 bar test pressure 762 mm diameter revealed that "F" = .77 versus "F" = 0.85 and "J" = 0.9 would result in a reduction of 8.7% in wall thickness (5.7 vs 5.2 mm) yet was an increase over the minimum the North American requirements by 3.9%.

The formula does permit somewhat lower minimum wall thicknesses (when conducting examination by x-ray), but is no different to the wall thicknesses required by ISO 4706: 2008 when using "J" factors of 1.0 or 0.9.

In addition, X-ray testing is now a requirement for three-piece designs and follows the manufacturing methods employed in countries throughout the world, including Europe and North America

Finally, it was reported that, significant experience, hundreds of thousands of cylinders have been manufactured and safely used, designed in accordance with the design criteria of ISO 4706, 2023.

V. Comments on proposal 4 in document ST/SG/AC.10/C.3/2024/11

14. Proposal 4 in document ST/SG/AC.10/C.3/2024/11 refers to ISO 11119-2:2020/Amd 1:2023, Gas cylinders – Design, construction and testing of refillable composite gas cylinders and tubes, Part 2: Fully wrapped fibre reinforced composite gas cylinders and tubes up to 450 l with load-sharing metal liners, Amendment 1.

15. The amendment to ISO 11119-2:2020 was carried out to correct a mismatch between the procedure and the criteria in the drop/impact test. The procedure said to cycle at 2/3 test pressure, but the criteria said, "The tubes shall withstand 3 000 pressurisation cycles at maximum developed pressure pmax without failure by burst or leakage".

It was always the intention to cycle the post drop/impact cylinder at 2/3 test pressure. ISO 11119-2 2012 has a drop test for cylinders above 50 litre (8.5.8) and the cycling post drop is correctly identified at 0.67 times test pressure in both the procedure and criteria. ISO 11119-2 2020 also has a drop test for cylinders above 50 litre (8.5.8) and the cycling post drop is correctly identified at 2/3 times test pressure in the procedure and criteria. There have never been any objections to cycle testing at 2/3 test pressure for tests where the cylinders are damaged by flaws or impact. This has been well established since 2012.

In ISO 11119-2 2020 the drop test was renamed drop/impact test, and an impact test for tubes above 150 litres was added. The post impact cycling was correctly specified at 2/3 test pressure in the procedure, but the criteria added maximum developed pressure. It was always the intention to use the 2/3 test pressure cycling for tubes above 150 l as indicated above.

Germany raised this matter at an ISO/TC 58/SC 3/WG 27 meeting in Berlin, where the matter was thoroughly discussed. A single negative vote, from Germany, was received on the final ballot.

The safety factor of the drop/impact test for tubes above 150 l is now in-line with the established procedure and criteria for cylinders above 50 litres.

VI. Reply to comments made by the German expert, in informal document INF.34, on proposal 5 in document ST/SG/AC.10/C.3/2024/11

16. Proposal 5 in document ST/SG/AC.10/C.3/2024/11 refers to ISO 11119-3:2020/Amd 1:2023, Gas cylinders – Design, construction and testing of refillable composite gas cylinders and tubes, Part 3: Fully wrapped fibre reinforced composite gas cylinders and tubes up to 450 l with non-load-sharing metallic or non-metallic liners or without liners, Amendment 1

17. As the German Expert acknowledged Proposal 5 is very similar to proposal 4, and the Expert makes the same argumentation: “Chapter 8.5.9.5 addresses tubes over 150 l water capacity. Consequently, the criteria in paragraph 8.5.9.5.2 should be defined for tubes as in ISO 11119-3:2020 and not for cylinders as ISO 11119-3:2020/Amd.1:2023”.

The rationale for the amendment is the same as for standards ISO 11119-2:2020 and ISO 11119-2:2020/Amd.1:2023.

It was not the intention to change the criteria to maximum developed pressure for tubes above 150 l in ISO 11119-3. This was an error that was not picked up during the review of the standard. The amendment corrects the error and restores the post impact cycle requirement to 3000 cycles at 2/3 test pressure.

Germany raised this matter at an ISO/TC 58/SC 3/WG 27 meeting in Berlin, where the matter was thoroughly discussed. A single negative vote, from Germany, was received on the final ballot.

The safety factor of the drop/impact test for tubes above 150 l is now in-line with the established procedure and criteria for cylinders above 50 litres.

The use of “cylinders” in the amendment (clause 8.5.9.5.2), rather than “tubes”, is an error. However, it is not seen as a significant concern, and it is proposed that any change is carried out at the next revision of the standard. Cylinder is a general term that can be used for cylinders and tubes and generic text is under consideration.