

2 November 2018

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## **Agreement**

### **Concerning the Adoption of Harmonized Technical United Nations Regulations for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these United Nations Regulations\***

(Revision 3, including the amendments which entered into force on 14 September 2017)

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## **Addendum 109 – UN Regulation No. 110**

### **Revision 4 – Amendment 2**

03 series of amendments – Date of entry into force: 16 October 2018

#### **Uniform provisions concerning the approval of:**

- I. Specific components of motor vehicles using compressed natural gas (CNG) and/or liquefied natural gas (LNG) in their propulsion system**
- II. Vehicles with regard to the installation of specific components of an approved type for the use of compressed natural gas (CNG) and/or liquefied natural gas (LNG) in their propulsion system**

This document is meant purely as documentation tool. The authentic and legal binding texts is: - ECE/TRANS/WP.29/2018/22.



**UNITED NATIONS**

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\* Former titles of the Agreement:

Agreement concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, done at Geneva on 20 March 1958 (original version); Agreement concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions, done at Geneva on 5 October 1995 (Revision 2).

*Table of contents, Annexe 3A, remove the entry for Appendix H.*

*Paragraph 2. (References), amend to read:*

## **"2. References**

The following standards contain provisions that, through reference in this text, constitute provisions of this Regulation.

### ASTM Standards<sup>1</sup>

|               |  |
|---------------|--|
| ASTM B117-90  | Test method of Salt Spray (Fog) Testing  |
| ASTM B154-92  | Mercurous Nitrate Test for Copper and Copper Alloys  |
| ASTM D522-92  | Mandrel Bend Test of attached Organic Coatings   |
| ASTM D1308-87 | Effect of Household Chemicals on Clear and Pigmented Organic Finishes                                  |
| ASTM D2344-84 | Test Method for Apparent interlaminar Shear Strength of Parallel Fibre Composites by Short Beam Method |
| ASTM D2794-92 | Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)            |
| ASTM D3170-87 | Chipping Resistance of Coatings  |
| ASTM D3418-83 | Test Method for Transition Temperatures Polymers by Thermal Analysis                                   |
| ASTM D4814-17 | Standard Specification for Automotive Spark-Ignition Engine Fuel                                       |
| ASTM E647-93  | Standard Test, Method for Measurement of Fatigue Crack Growth Rates                                    |
| ASTM E813-89  | Test Method for $J_{IC}$ , a Measure of Fracture Toughness   |
| ASTM G154-16  | Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials   |

### BSI Standards<sup>2</sup>

|            |   |
|------------|---|
| BS 5045    | Part 1 (1982) Transportable Gas Containers – Specification for Seamless Steel Gas Containers Above 0.5 litre Water Capacity   |
| BS 7448-91 | Fracture Mechanics Toughness Tests Part I – Method for Determination of $K_{IC}$ , Critical COD and Critical J Values of BS PD 6493-1991. Guidance an Methods for Assessing the A |

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<sup>1</sup> American Society for Testing and Materials.

<sup>2</sup> British Standards Institution.

Acceptability of Flaws in Fusion Welded Structures; Metallic Materials

EN Standards<sup>3</sup>

|                 |  |
|-----------------|--|
| EN1251-2 2000   | Cryogenic vessels. Vacuum insulated vessels of not more than 1,000 litres volume |
| EN 895:1995     | Destructive tests on welds in metallic materials. Transverse tensile test        |
| EN 910:1996     | Destructive test methods on welds in metallic materials. Bend tests              |
| EN 1435:1997    | Non-destructive examination of welds. Radiographic examination of welded joints  |
| EN 6892-1:2016  | Metallic materials. Tensile test   |
| EN 10045-1:1990 | Charpy impact test on metallic materials. Test method (V- and U-notches)         |

ISO Standards<sup>4</sup>

|                |  |
|----------------|--|
| ISO 37:2011    | Rubber, vulcanized or thermoplastic – Determination of tensile stress-strain properties.                                     |
| ISO 148-1983   | Steel – Charpy Impact Test (v-notch)   |
| ISO 188:2011   | Rubber, vulcanized or thermoplastic – Accelerated ageing and heat resistance tests   |
| ISO 306:2004   | Plastics - Thermoplastic Materials – Determination of Vicat Softening Temperature  |
| ISO 527-2:2012 | Plastics – Determination of tensile properties – Part 2: Test conditions for moulding and extrusion plastics                 |
| ISO 642:1999   | Steel-Hardenability Test by End Quenching (Jominy Test)  |
| ISO1307:2006   | Rubber and plastics hoses – Hose sizes, minimum and maximum inside diameters, and tolerances on cut-to-length hoses          |
| ISO 1402:2009  | Rubber and plastics hoses and hose assemblies – Hydrostatic testing  |
| ISO 1431:2009  | Rubber, vulcanized or thermoplastic – Resistance to ozone cracking   |
| ISO 1436:2009  | Rubber hoses and hose assemblies – Wire-braid-reinforced hydraulic types for oil-based or water-based fluids – Specification |
| ISO 1817:2015  | Rubber, vulcanized or thermoplastic – Determination of the effect of liquids   |

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<sup>3</sup> European Norm.

<sup>4</sup> International Organization for Standardization.

|                    |  |
|--------------------|--|
| ISO 2808:2007      | Paints and Varnishes – Determination of film Thickness   |
| ISO 4080:2009      | Rubber and plastics hoses and hose assemblies – Determination of permeability to gas   |
| ISO 4624:2016      | Plastics and Varnishes – Pull-off Test for adhesion  |
| ISO 10619:2011     | Rubber and plastics hoses and tubing - Measurement of flexibility and stiffness - Part 2: Bending tests at sub-ambient temperatures  |
| ISO 6892:2016      | Metallic Materials – Tensile Testing   |
| ISO 6506-1:2014    | Metallic Materials – Brinell hardness test – Part 1: Test method   |
| ISO 6508-1:2015    | Metallic Materials – Rockwell hardness Test – Part 1: Test method  |
| ISO 7225:2005      | Precautionary Labels for Gas Cylinders   |
| ISO 7866:2012      | Refillable seamless aluminium alloy cylinders – Design, construction and testing   |
| ISO 9001:2015      | Quality Assurance in Design/Development, Production, Installation and Servicing  |
| ISO/TS 9002:2016   | Quality management systems - Guidelines for the application of ISO 9001:2015   |
| ISO12991:2012      | Liquefied natural gas (LNG) – transportable tanks for use on board of vehicles   |
| ISO14469:2017      | Road Vehicles: compressed natural gas CNG refuelling connector   |
| ISO15500-2:2016    | Road vehicles – Compressed natural gas (CNG) fuel system components Part 2: Performance and general test methods   |
| ISO 15500-17:2012  | Road vehicles - Compressed natural gas (CNG) fuel system components - Part 17: Flexible fuel line  |
| ISO 21028-1:2016   | Cryogenic vessels – Toughness requirements for materials at cryogenic temperature – Part I: Temperatures below -80 °C  |
| ISO 21029-1:2015   | Cryogenic vessels – Transportable vacuum insulated vessels of not more than 1,000 litres volume – Part I: Design, fabrication, inspection and tests                                  |
| ISO/IEC 17025:2005 | General requirements for the competence of testing and calibration laboratories  |
| ISO 9809-1:2010    | Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing — Part 1: Quenched and tempered steel cylinders with tensile strength less than 1,100 MPa |

|                                      |   |
|--------------------------------------|---|
| ISO 11439:2013                       | Gas cylinders — High pressure cylinders for the on-board storage of natural gas as a fuel for automotive vehicles |
| NACE Standard <sup>5</sup>           |   |
| NACE TM0177-90                       | Laboratory Testing of Metals for Resistance to Sulphide Stress Cracking in H <sub>2</sub> S Environments          |
| UN Regulations <sup>6</sup>          |   |
| UN Regulation No. 10                 | Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility               |
| USA Federal Regulations <sup>7</sup> |   |
| 49 CFR 393.67                        | Liquid fuel tanks (as amended in 78 FR 58484 on 24 September 2013)  |
| SAE Standards <sup>8</sup>           |   |
| SAE J2343-2008                       | Recommended Practice for LNG Medium and Heavy-Duty Powered Vehicles"  |

*Insert new paragraphs 24.15. to 24.21., to read:*

- "24.15. As from the official date of entry into force of the 03 series of amendments, no Contracting Party applying this Regulation shall refuse to grant or refuse to accept type-approvals under this Regulation as amended by the 03 series of amendments.
- 24.16. As from 1 September 2019, Contracting Parties applying this Regulation shall not be obliged to accept type-approvals of components approved to the requirements of Part I of this Regulation to the 02 series of amendments, first issued after 1 September 2019.
- 24.17. As from 1 September 2021, Contracting Parties applying this Regulation shall not be obliged to accept type-approvals of vehicles approved to the requirements of Part II of this Regulation to the 02 series of amendments, first issued after 1 September 2021.
- 24.18. Contracting Parties applying this Regulation shall continue to accept type-approvals issued according to the 02 series of amendments to this Regulation first issued before 1 September 2019 in the case of components approved to the requirements of Part I of this Regulation, and before 1 September 2021 in the case of vehicles approved to the requirements of Part II of this Regulation.
- 24.19. Contracting Parties applying this Regulation shall not refuse to grant type-approvals according to any preceding series of amendments to this Regulation or extensions thereof.
- 24.20. Contracting Parties applying this Regulation shall continue to accept type-approvals of, and to grant extensions of approvals to the equipment and part to the preceding series of amendments to this Regulation which are not affected by the changes introduced by the 03 series of amendments.

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<sup>5</sup> National Association of Corrosion Engineers.

<sup>6</sup> United Nations Economic Commission for Europe; Regulations.

<sup>7</sup> United States of America Federal Regulations.

<sup>8</sup> Society of Automotive Engineers.

- 24.21. Contracting Parties applying this Regulation shall continue to accept type-approvals to the 02 series of amendments to this Regulation, first issued before 1 September 2021."

*Annex 3A*

*Table 6.4*, replace the entry "Acid environment test" by "Environmental test".

*Paragraph 6.3.6.*, amend to read:

"6.3.6. Plastic liners

The tensile yield strength and ultimate elongation shall be determined in accordance with paragraph A.22. (Appendix A to this annex). Tests shall demonstrate the ductile properties of the plastic liner material at temperatures of -50 °C or lower by meeting the values specified by the manufacturer; the polymeric material shall be compatible with the service conditions specified in paragraph 4. of this annex. In accordance with the method described in paragraph A.23. (Appendix A to this annex), the softening temperature shall be at least 100 °C."

*Paragraph 6.12.*, amend to read:

"6.12. Exterior environmental protection

The exterior of cylinders shall meet the requirements of the environmental test conditions of paragraph A.14. (Appendix A to this annex). Exterior protection shall be provided by using any of the following:

- (a) A surface finish giving adequate protection (e.g. metal sprayed on aluminium, anodizing); or
- (b) The use of a suitable fibre and matrix material (e.g. carbon fibre in resin); or
- (c) A protective coating (e.g. organic coating, paint) that shall meet the requirements of paragraph A.9. (Appendix A to this annex).

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

*Paragraph 8.6.4.*, amend to read:

"8.6.4. Environment test

One cylinder shall be tested in accordance with paragraph A.14. (Appendix A to this annex) and meet the requirements therein."

*Annex 3A, Appendix A*

*Paragraph A.14.*, amend to read (inserting new sub-paragraphs A.14.1. to A.14.6., based mainly on the text of Annex 3A, Appendix H):

"A.14. Environmental test

A.14.1. Scope

This test is applicable to type CNG-2, CNG-3 and CNG-4 designs only.

A.14.2. Cylinder set-up and preparation

The upper section of the cylinder will be divided into 5 distinct areas and marked for preconditioning and fluid exposure (see Figure A.1). The areas will be nominally 100 mm in diameter. The areas shall not overlap on the cylinder surface. While convenient for testing, the areas need not be oriented along a single line, but shall not overlap the immersed section of the cylinder.

Although preconditioning and fluid exposure is performed on the cylindrical section of the cylinder, all of the cylinder, including the domed sections, should be as resistant to the exposure environments as are the exposed areas.

Figure A.1  
**Cylinder orientation and layout of exposure areas**



A.14.3. Pendulum impact preconditioning

The impact body shall be of steel and have the shape of a pyramid with equilateral triangle faces and a square base, the summit and the edges being rounded to a radius of 3 mm. The centre of percussion of the pendulum shall coincide with the centre of gravity of the pyramid; its distance from the axis of rotation of the pendulum shall be 1 m. The total mass of the pendulum referred to its centre of percussion shall be 15 kg. The energy of the pendulum at the moment of impact shall be not less than 30 Nm and as close to that value as possible.

During pendulum impact, the cylinder shall be held in position by the end bosses or by the intended mounting brackets. The cylinder shall be unpressurized during preconditioning.

A.14.4. Environmental fluids for exposure

Each marked area is to be exposed to one of five solutions for 30 minutes. The same environment shall be used for each location throughout the test. The solutions are:

|                           |   |
|---------------------------|---|
| Sulphuric acid:           | 19 per cent solution by volume in water;                                  |
| Sodium hydroxide:         | 25 per cent solution by weight in water;                                  |
| 5% Methanol/95% gasoline: | gasoline concentration of M5 fuel meeting the requirements of ASTM D4814; |
| Ammonium nitrate:         | 28 per cent by weight in water;   |
| Windshield washer fluid   | 50 per cent by volume solution of methyl alcohol and water.               |

When exposed, the test sample will be oriented with the exposure area uppermost. A pad of glass wool (approximately 0.5 mm thick and between 90 and 100 mm in diameter) shall be placed on the exposure area. Apply an amount of the test fluid to the glass wool sufficient to ensure that the pad is wetted evenly across its surface and through its thickness for the duration of

the test, and that the concentration of the fluid is not changed significantly during the duration of the test.

A.14.5. Pressure cycle and hold

The cylinder shall be hydraulically pressure cycled between not more than 2 MPa and not less than 26 MPa for a total of 3,000 cycles. The maximum pressurization rate shall be 2.75 MPa per second. After pressure cycling, the cylinder shall be pressurized to 26 MPa and held at that pressure a minimum of 24 hours and until the elapsed exposure time (pressure cycling and pressure hold) to the environmental fluids equals 48 hours.

A.14.6. Acceptable results

The cylinder shall be hydraulically tested to destruction in accordance with the procedure in paragraph A.12. The burst pressure of the cylinder shall be not less than 85 per cent of the minimum design burst pressure."

*Through the whole text of the Regulation*, replace the references to "acid environmental test" by "environment test" and delete the references to Annex 3A, Appendix H.

*Paragraph A.16.*, amend to read:

"A.16. Penetration tests

A cylinder pressurised to 20 MPa  $\pm$  1 MPa with compressed gas shall be penetrated by an armour piercing bullet with a diameter of 7.62 mm or greater. The bullet shall completely penetrate at least one side wall of the cylinder. For type CNG-1 designs, the projectile shall impact the side wall at 90°. For type CNG-2, CNG-3 and CNG-4 designs, the projectile shall impact the side wall at an approximate angle of 45°. The cylinder shall reveal no evidence of fragmentation failure. Loss of small pieces of material, each not weighing more than 45 grams, shall not constitute failure of the test. The approximate size of entrance and exit openings and their locations shall be recorded."

*Paragraph A.22.*, amend to read:

"A.22. Tensile properties of plastics

The tensile yield strength and ultimate elongation of plastic liner material shall be determined at -50 °C using ISO 527-2, and meet the requirements of paragraph 6.3.6. of Annex 3A."

*Paragraph A.23.*, amend to read:

"A.23. Softening temperature of plastics

Polymeric materials from finished liners shall be tested in accordance with the method described in ISO 306. The softening temperature shall be at least 100 °C."

*Annex 3A, Appendix F, paragraph F.2.1., subparagraph (c)*, amend to read:

"(c) Fracture toughness of the finished cylinder or the liner from a finished cylinder, as determined at room temperature for aluminium and at -40 °C for steel, shall be established using a standardized testing technique (either ASTM 813-89 or BS 7448) in accordance with Sections 8.4 and 8.5 of BS PD6493"

*Annex 3A, Appendix H*, shall be deleted.

*Annex 4F, paragraph 2.2.*, amend to read:



"2.2. CNG filling units designed in accordance with ISO 14469 and meeting all the requirements therein are deemed to fulfill the requirements of paragraphs 3. and 4. of this annex."

*Annex 4J, paragraph 3.1.5., amend to read:*

"3.1.5. The LNG filling receptacle shall be made out of non-sparking material and should comply with the no igniting evaluation tests described in ISO 14469."

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