Submitted by the expert from ISO

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Proposal for amendments to Regulation No. 110 (CNG and LNG vehicles)

Submitted by the expert from the International Organization for Standardization

The text reproduced below was prepared by the expert from the International Organization for Standardization (ISO) to harmonize the requirements on Compressed Natural Gas (CNG) and/or Liquefied Natural Gas (LNG) vehicles of UN Regulation No. 110 with those of the international standard ISO 11439:2013 (see report ECE/TRANS/WP.29/GRSG/91, para. 28). It is based on official document ECE/TRANS/WP.29/GRSG/2017/31 distributed at the 113th session of the Working Party on General Safety Provisions (GRSG). The modifications to the current text of UN Regulation No. 110 are marked in bold characters for new and strikethrough for deleted characters.

I. Proposal

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*

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

* American Society for Testing and Materials.

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 G53-93~~	~~Standard Practice for Operating Light and Water Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of non-metallic materials~~
ASTM G154-~~12a~~16	**Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials**
BSI Standards[†]	
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 Acceptability of Flaws in Fusion Welded Structures; Metallic Materials
EN Standards[‡]	
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:~~2009~~2016	Metallic materials. Tensile test
EN 10045-1:1990	Charpy impact test on metallic materials. Test method (V- and U-notches)
ISO Standards[§]	
ISO 37:2011	Rubber, vulcanized or thermoplastic – Determination of tensile stress-strain properties.
ISO 148-1983	Steel – Charpy Impact Test (v-notch)

[†] British Standards Institution.
[‡] European Norm.
[§] International Organization for Standardization.

ISO 188:2011	Rubber, volcanized or thermoplastic – Accelerated ageing and heat resistance tests
ISO 306~~-1987~~:2004	Plastics - Thermoplastic Materials – Determination of Vicat Softening Temperature
~~ISO 527 Pt 1 93~~	~~Plastics – Determination of Tensile Properties – Part I: General principles~~
ISO 527-2:2012	**Plastics – Determination of tensile properties – Part 2: Test conditions for moulding and extrusion plastics**
ISO 642~~-79~~:1999	Steel-Hardenability Test by End Quenching (Jominy Test)
~~ISO 12991~~	~~Liquefied natural gas (LNG) – transportable tanks for use on board vehicles~~
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
ISO 2808~~-91~~:2007	Paints and Varnishes – Determination of film Thickness
~~ISO 3628-78~~	~~Glass Reinforced Materials – Determination of Tensile Properties~~
ISO 4080:2009	Rubber and plastics hoses and hose assemblies – Determination of permeability to gas
ISO 4624~~-78~~:2016	Plastics and Varnishes – Pull-off Test for adhesion
ISO ~~4672~~10619:2011	Rubber and plastics hoses and tubing - Measurement of flexibility and stiffness - Part 2: Bending tests at sub-ambient temperatures~~Rubber and plastics – Sub-ambient temperature flexibility tests~~
ISO **6892:2016** ~~6982-84~~	Metallic Materials – Tensile Testing
ISO 6506-1:2014~~1981~~	Metallic Materials – ~~H~~Brinell hardness test – Part 1: Test method~~Brinell Test~~
ISO 6508-1:215~~1986~~	Metallic Materials – Rockwell ~~H~~hardness Test~~s~~ – ~~Rockwell –~~Part 1: Test method ~~(Scales, ABCDEFGHK)~~
ISO 7225:2005	Precautionary Labels for Gas Cylinders

ISO~~/DIS~~ 7866-2012~~-1992~~	Refillable ~~Transportable~~ seamless aluminium alloy cylinders ~~for Worldwide Usage~~ – Design, **construction and testing** ~~Manufacture and Acceptance~~
ISO 9001:2015~~1994~~	Quality Assurance in Design/Development. Production, Installation and Servicing
ISO/TS 9002:2016~~1994~~	Quality management systems - Guidelines for the application of ISO 9001:2015~~Assurance in Production and Installation~~
~~ISO/DIS 12737~~	~~Metallic Materials – Determination of the Plane-Strain Fracture Toughness~~
ISO12991:2012	Liquefied natural gas (LNG) – transportable tanks for use on board of vehicles
~~ISO14469-1:2004~~	~~Road Vehicles: compressed natural gas CNG refuelling connector: Part I: 20 MPa (200 bar) connector~~
ISO14469~~-2~~:2017~~2007~~	Road Vehicles: compressed natural gas CNG refuelling connector~~: Part II: 20 MPa (200 bar) 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~~2004~~	Cryogenic vessels – Toughness requirements for materials at cryogenic temperature – Part I: Temperatures below -80 °C
ISO 21029-1:2015~~2004~~	Cryogenic vessels – Transportable vacuum insulated vessels of not more than 1,000 litres volume – Part I: Design, fabrication, inspection and tests
~~ISO/IEC Guide 25-1990~~	~~General requirements for the Technical Competence of Testing Laboratories~~
ISO/IEC 17025:2005	General requirements for the competence of testing and calibration laboratories
~~ISO/IEC Guide 48-1986~~	~~Guidelines for Third Party Assessment and Registration of Supplies Quality System~~
~~ISO/DIS 9809~~	~~Transportable Seamless Steel Gas Cylinders Design, Construction and Testing – Part I: Quenched and Tempered Steel Cylinders with Tensile Strength < 1,100 MPa~~
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[**]	
NACE TM0177-90	Laboratory Testing of Metals for Resistance to Sulphide Stress Cracking in H_2S Environments
ECE Regulations[††]	
Regulation No. 10	Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility
USA Federal Regulations[‡‡]	
49 CFR 393.67	Liquid fuel tanks
SAE Standards[§§]	
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 UN Regulation shall refuse to grant or refuse to accept UN type-approvals under this UN Regulation as amended by the 03 series of amendments.

24.16. As from 1 September 2019, Contracting Parties applying this UN Regulation shall not be obliged to accept UN 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 UN Regulation shall not be obliged to accept UN type-approvals of vehicles approved to the requirements of Part II of this regulation to the 02 series of amendments, first issued after 1 September2021.

24.18. Contracting Parties applying this UN Regulation shall continue to accept UN type-approvals issued according to the 02 series of amendments to the UN 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 UN Regulation shall not refuse to grant UN type-approvals according to any preceding series of amendments to this UN Regulation or extensions thereof.

24.20. Contracting Parties applying the UN Regulation shall continue to accept UN type-approvals of, and to grant extensions of approvals to the equipment and part to the preceding series of amendments to the UN

[**] National Association of Corrosion Engineers.
[††] United Nations Economic Commission for Europe; Regulations.
[‡‡] United States of America Federal Regulations.
[§§] Society of Automotive Engineers.

Regulation which are not affected by the changes introduced by the 03 series of amendments.

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

Annex 3A

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 ~~90 °C, and the melting temperature 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 ~~may~~ 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.

~~Manufacturers are advised that an environmental performance test that evaluates the suitability of coating systems is provided in the informative Appendix H to this annex.~~"

Paragraph 8.6.4., amend to read:

"8.6.4. ~~Acid~~ Environment test

One cylinder shall be tested in accordance with paragraph A.14. (Appendix A to this annex) and meet the requirements therein. ~~An optional environmental test is included in the informative Appendix H to this annex.~~"

Annex 3A, Appendix A

Paragraph A.14., amend to read (inserting new sub-paragraphs A.14.1. to A14.6., based mainly on the text of Annex 3A, Appendix H):

"A.14. ~~Acid e~~**E**nvironment**al** test

~~On a finished cylinder the following test procedure should be applied:~~

~~(a) Exposing a 150 mm diameter area on the cylinder surface for 100 hours to a 30 per cent sulfuric acid solution (battery acid with a specific gravity of 1.219) while the cylinder is held at 26 MPa;~~

~~(b) The cylinder shall then be burst in accordance with the procedure defined in paragraph A.12. above and provide a burst pressure that exceeds 85 per cent of the minimum design burst pressure.~~

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 un-pressurized 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 ~~less~~ more than 2 MPa and not ~~more~~ 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 ~~80~~ 85 per cent of the minimum design burst pressure."

Replace through the whole text the references to acid environmental 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 ± 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.16. 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** ~~3628~~, and meet the requirements of paragraph 6.3.6. of Annex 3A."

Pragraph A.23., amend to read:

"A.23. ~~Melting~~ **Softening** temperature of plastics

Polymeric materials from finished liners shall be tested in accordance with the method described in ISO 306~~, and meet the requirements of paragraph 6.3.6. of Annex 3A~~. **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 ~~ISO/DIS 12737 or~~ 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 ~~-1 first edition 2004-11-01 or ISO 14469-2:2007~~ 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."

II. Justification

A detailed justification on the modification proposed above can be found in GRSG-113-02, available at: www.unece.org/trans/main/wp29/wp29wgs/wp29grsg/grsginf113.html.

Furthermore, the following references shall be updated:

ISO 37 is now ISO 37: 2011
ISO 188 is now ISO 188 2011
ISO 306 is now ISO 306: 2004
ISO 527 Pt 1 is now ISO 527-2: 2012 (per the harmonization)
ISO 642 is ISO 642: 1999
ISO 12991 is repeated twice in the references, so this first one can be deleted.
ISO 1307 is now ISO 1307: 2006
ISO 1402 is now ISO 1402: 2009
ISO 1431 is now ISO 1431: 2009
ISO 1436 is now ISO 1436: 2009
ISO 1817 is now ISO 1817: 2015
ISO 2808 is now ISO 2808: 2007
ISO 3628 is deleted per harmonization
ISO 4080 is now ISO 4080: 2009
ISO 4624 is now ISO 4624: 2016
ISO 4672:1997 “Rubber and plastics hoses -- Sub-ambient temperature flexibility tests” replaced by ISO 10619-2: 2011 “Rubber and plastics hoses and tubing -- Measurement of flexibility and stiffness -- Part 2: Bending tests at sub-ambient temperatures”
ISO 6506-1981 replaced by ISO 6506-1:2014 “Metallic materials -- Brinell hardness test -- Part 1: Test method”

ISO 6508-1986 replaced by ISO 6508-1:2015 “Metallic materials -- Rockwell hardness test -- Part 1: Test method”
ISO 6982-84 revised to 6892-1: 2016 ISO 6892-1:2016 “Metallic materials -- Tensile testing -- Part 1: Method of test at room temperature”
ISO 7225 is now ISO 7225: 2005
ISO/DIS 7866 is now ISO 7866: 2012
ISO 9001 is now ISO 9001: 2015
ISO 9002: 1994 replaced by ISO/TS 9002:2016 “Quality management systems -- Guidelines for the application of ISO 9001:2015”
ISO/DIS 9809 is now 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/DIS 12737 has been withdrawn by ISO, thus I would delete reference to this standard (in Annex 3A, Appendix F) as follows:

F.2. Leak-Before-Break (LBB)

F.2.1. Engineering critical assessment. This analysis may be carried out to establish that the finished cylinder will leak in the event of a defect in the cylinder or liner growing into a through-wall crack. A leak-before-break assessment shall be performed at the cylinder side wall. If the fatigue sensitive location is outside the side wall, a leak-before-break assessment shall also be performed at that location using a Level II approach as outlined in BS PD6493. The assessment shall include the following steps:

(a) Measure the maximum length (i.e. major axis) of the resultant through-wall surface crack (usually elliptical in shape) from the three cylinder cycle tested under the design qualification tests (according to paragraphs A.13. and A.14. of Appendix A to this annex) for each type of design. Use the longest crack length of the three cylinders in the analysis. Model a semi-elliptical through-wall crack with a major axis equal to twice the measured longest major axis and with a minor axis equal to 0.9 of wall thickness. The semi-elliptical crack shall be modelled at the locations specified in paragraph F.1. above. The crack shall be oriented such that the highest tensile principal stress shall drive the crack;

(b) Stress levels in the wall/liner at 26 MPa obtained from the stress analysis as outlined in paragraph 6.6. of Annex 3A shall be used for the assessment. Appropriate crack driving forces shall be calculated using either Section 9.2 or 9.3. of BS PD6493;

(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 ISO/DIS 12737 or ASTM 813-89 or BS 7448) in accordance with Sections 8.4 and 8.5 of BS PD6493;

Change (c) as follows: “…….testing technique (either ~~ISO/DIS 12737 or~~ ASTM 813-89 or BS 7448)…”
ISO 12991 is now ISO 12991: 2012
ISO 14469-1 and ISO 14469-2 have been replaced/consolidated into one standard: ISO 14469: 2017 “Road vehicles -- Compressed natural gas (CNG) refuelling connector”. This consolidation means that references to ISO 14469-1 and ISO 14469-2 must be changed in the following 2 locations:

Annex 4F

Provisions on the approval of the CNG filling unit (Receptacle)

1. The purpose of this annex is to determine the provisions on the approval of the CNG filling unit.

2. The CNG filling unit

2.1. The CNG filling unit shall comply with the requirements laid down in paragraph 3. below and shall have the dimensions of paragraph 4. Below.

2.2. CNG filling units designed in accordance with ISO 14469-1 first edition 2004-11-01[1] or ISO 14469-2:2007[2] and meeting all the requirements therein are deemed to fulfill the requirements of paragraphs 3. and 4. of this annex.

Change Annex 4F, para 2.2, "….designed in accordance with ISO 14469~~-1 first edition 2004-11-01 or ISO 14469-2: 2007~~….".

Also, in Annex 4J, change the reference in para 3.1.5 to ISO 14469-1:2004 to ISO 14469.

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 14469-1:2004.

Replace ISO 15500 with ISO 15500-2:2016 "Road vehicles -- Compressed natural gas (CNG) fuel system components -- Part 2: Performance and general test methods", and with ISO 15500-17:2012 "Road vehicles -- Compressed natural gas (CNG) fuel system components -- Part 17: Flexible fuel line". Note that both these references (ISO 15500-2 and ISO 15500-17) are already specified in the ECE R110, while ISO 15500 is not.

ISO 21028-1 is now ISO 21028-1: 2016

ISO 21029 is now ISO 21029-1: 2015

ISO/IEC Guide 25 has been replaced by ISO/IEC 17025:2005 "General requirements for the competence of testing and calibration laboratories". However ISO/IEC Guide 25 is not referenced in ECE R110, so delete.

ISO/IEC Guide 48 – 1986 does not exist – it has been withdrawn by ISO. However, ISO/IEC 48 is not referenced anywhere in ECE R110. Therefore delete.

ISO 11439 is now ISO 11439: 2013