

Proposal for amendments to Regulation No. 67 (LPG)
(new text is given in bold, deleted text is strikethrough)

A. PROPOSALS

Paragraph 2, amend to read:

2. DEFINITION AND CLASSIFICATION OF COMPONENTS

LPG components for use in vehicles shall be classified with regard to the maximum operating pressure and function, according to Figure 1.

Class 0 **High pressure parts including tubes and fittings containing liquid LPG with a pressure $\geq 3,000$ kPa.**

Class 1 High pressure parts including tubes and fittings containing liquid LPG at vapour pressure or increased vapour pressure up to 3,000 kPa.

Class 2 Low pressure parts including tubes and fittings containing vaporized LPG with a maximum operating pressure below 450 kPa and over 20 kPa above atmospheric pressure.

Class 2A Low pressure parts for a limited pressure range including tubes and fittings containing vaporized LPG with a maximum operating pressure below 120 kPa and over 20 kPa above atmospheric pressure.

Class 3 Shut-off valves and pressure relief valves, when operating in the liquid phase.

LPG components designed for a maximum operating pressure below 20 kPa above atmospheric pressure are not subjected to this Regulation.

A component can consist of several parts, each part classified in his own class with regard to maximum operating pressure and function.

Figure 1 (to be amended for inclusion of class 0)

Paragraph 2.5. amend to read:

2.5. "Accessories fitted to the container" means the following equipment which may be either separate or combined:

- (a) 80 per cent stop valve
- (b) level indicator
- (c) pressure relief valve
- (d) remotely controlled service valve with excess flow valve
- (e) fuel pump
- (f) multivalve
- (g) gas-tight housing
- (h) power supply bushing
- (i) non-return valve
- (j) pressure relief device
- (k) **fuel return line.**

Insert new paragraphs 2.20 and 2.21 as follows:

2.20 "Fuel return line" a fuel line used in Class 0 systems as pressure relieve line between high pressure parts (class 0) and the container.

2.21 "Fuel selector valve" means a valve used for the selection of the fuel.

Paragraph 6.1 amend to read:

6.1. General provisions

The specific equipment of vehicles using LPG in their propulsion system shall function in a correct and safe way.

The materials of the equipment which are in contact with LPG shall be compatible with it.

Those parts of equipment whose correct and safe functioning is liable to be influenced by LPG, high pressure or vibrations has to be submitted to relevant test procedures described in the annexes of this Regulation. In particular the provisions of paragraphs 6.2. to 6.13. are to be fulfilled.

The installation of LPG-equipment approved by this regulation shall comply with relevant electromagnetic compatibility (E.M.C) requirements according to Regulation No. 10, ~~02~~ **03** series of amendments, or equivalent.

Paragraph 4.2. amend to read:

- 4.2. All equipment shall have a space large enough to accommodate the approval mark including the classification of the component (see Annex 2A) **and in case of components of class 0 the working pressure**; this space shall be shown on the drawings referred to in paragraph 3.2.2. above.

Insert a new paragraph 6.3.8, reading:

6.3.8. The container used in Class 0 systems shall consist out of a fuel return line.

Paragraph 6.6. amend to read:

6.6.	Shut-off valves Non-return valves Gas-tube pressure relief valves Service couplings Fuel selector valve	7
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Paragraph 6.15.6.1. amend to read:

- 6.15.6.1. The pump **Class 1** shall be so designed that the outlet pressure never exceeds 3,000 kPa, when there is e.g. blocking of the tubing or not opening of a shut-off valve. This can be realized by switching off the pump or by recirculating to the container.

The pump Class 0 shall be so designed that the outlet pressure never exceeds the WP of the liquid system, when there is e.g. blocking of the tubing or not opening of a shut-off valve. This can be realized by switching off the pump or by recirculation to the container.

Insert a new paragraph 17.3.2.12, as follows:

17.3.2.12. fuel selector valve

Insert a new paragraph 17.7.11, as follows:

17.7.11 Gas tubes and hoses used in Class 0 systems shall comply with the overpressure tests mentioned in Annex 15.4.

Paragraph 17.8.1, amend to read:

- 17.8.1. Soldered or welded joints and bite-type compression joints are not permitted. **With the exception that MIG and or TIG welding joints made by the OEM parties and tested according the class 0 tests applicable are allowed.**

Annex 4, points 2 and 3 amend to read:

2. Component classification (according to Figure 1, para. 2.): **Fuel pump can be Class 0 or Class 1.**
3. Classification pressure:

Components class 0: $\geq 3,000$ kPa.
Components class 1 3,000 kPa.

Annex 4, point 6.1 amend to read:

- 6.1. Fuel pump mounted inside the container (**Class 1 only**):
LPG compatibility Annex 15, para. 11 **/

Annex 7, the heading amend to read:

Annex 7

**PROVISIONS REGARDING THE APPROVAL OF THE SHUT-OFF VALVE,
THE NON-RETURN VALVE, THE GAS-TUBE PRESSURE RELIEF VALVE,
THE SERVICE COUPLING AND FUEL SELECTION VALVE**

Annex 7, insert new points 5 to 5.6, reading as follows:

- 5. Provisions regarding the approval of the Fuel selection valve.**
- 5.1 Definition:** see paragraph 2.21. of this Regulation.
- 5.2 Component classification (according to Figure 1, para. 2.):**
Class 0: for the part which is in contact with the fluid LPG with a pressure $\geq 3,000$ kPa.
Class 1: for the part which is in contact with the pressure of the containers
- 5.3 Classification pressure:**
Parts of Class 0: $\geq 3,000$ kPa
Parts of Class 1: 3,000 kPa.
- 5.4 Design temperatures:**
-20 °C to 120 °C
For temperatures exceeding the above-mentioned values, special tests conditions are applicable.
- 5.5 General design rules:**
Paragraph 6.15.2., Provisions regarding the electrical insulation.
Paragraph 6.15.3.1., Provisions on valves activated by electrical power.
- 5.6. Applicable test procedures:**
- | | |
|------------------------|---|
| Over pressure test | Annex 15, para. 4 |
| External leakage | Annex 15, para. 5 |
| High temperature | Annex 15, para. 6 |
| Low temperature | Annex 15, para. 7 |
| Seat leakage | Annex 15, para. 8 |
| Endurance | Annex 15, para. 9
(with 20,000 operation cycles) |
| LPG compatibility | Annex 15, para. 11 **/ |
| Corrosion resistance | Annex 15, para. 12 */ |
| Resistance to dry heat | Annex 15, para. 13 **/ |
| Ozone ageing | Annex 15, para. 14 **/ |
| Creep | Annex 15, para. 15 **/ |
| Temperature cycle | Annex 15, para. 16 **/ |

Annex 8, heading amend to read:

Annex 8

PROVISIONS REGARDING THE APPROVAL OF FLEXIBLE HOSES WITH COUPLINGS

Scope

The purpose of this annex is to determine the provisions regarding the approval of flexible hoses for use with LPG, having an inside diameter up to 20 mm.

This annex covers ~~three~~ **four** types of flexible hoses:

- (i) High pressure rubber hoses (Class 1, e.g. Filling hose)
- (ii) Low pressure rubber hoses (Class 2)
- (iii) High pressure synthetic hoses (Class 1)
- (iiii) High pressure synthetic hoses (Class 0)**

Annex 8, insert new points 4. to 4.8.2, reading:

4. HIGH PRESSURE SYNTHETIC HOSES, CLASS 0 CLASSIFICATION

4.1. General specifications

4.1.1. The purpose of this chapter is to determine the provisions regarding the approval of synthetic flexible hoses for use with LPG, having an inside diameter up to 10 mm.

4.1.2. This chapter covers, in addition to general specifications and tests for synthetic hoses, also specifications and tests applicable for specific material types or a synthetic hose.

4.1.3. The hose shall be so designed as to withstand a maximum operating pressure of WP.

4.1.4. The hose shall be so designed as to withstand temperatures between -25 °C and +125 °C. For operating temperatures exceeding the above-mentioned values, the test temperatures must be adapted.

4.1.5. The inside diameter shall be in compliance with Table 1 of standard ISO 1307.

4.2. Hose construction

4.2.1. The synthetic hose must embody a thermoplastic tube and a cover of suitable thermoplastic material, oil and weatherproof, reinforced with one or more synthetic interlayer(s). If for the reinforcing interlayer(s) a corrosion-resistant material is used (i.e. stainless-steel) a cover is not required.

4.2.2. The lining and the cover must be free from pores, holes and strange elements. An intentionally provided puncture in the cover shall not be considered as an imperfection.

4.3. Specifications and tests for the lining

4.3.1. Tensile strength and elongation

4.3.1.1. Tensile strength and elongation at break according to ISO 37. Tensile strength not less than 20 MPa and elongation at break not less than 200 per cent.

4.3.1.2. Resistance to n-pentane according to ISO 1817 with the following conditions:

- (i) medium: n-pentane**
- (ii) temperature: 23 °C (tolerance acc. to ISO 1817)**
- (iii) immersion period: 72 hours**

Requirements:

- (i) maximum change in volume 20 per cent**
- (ii) maximum change in tensile strength 25 per cent**
- (iii) maximum change in elongation at break 30 per cent**

After storage in air with a temperature of 40 °C for a period of 48 hours the mass compared to the original value may not decrease more than 5 per cent.

4.3.1.3. Resistance to ageing according to ISO 188 with the following conditions:

- (i) temperature: 115 °C (test temperature = maximum operating temperature minus 10 °C)**
- (ii) exposure period: 336 hours**

Requirements:

- (i) maximum change in tensile strength 35 per cent**
- (ii) maximum change in elongation at break -30 per cent and +10 per cent**

4.3.2. Tensile strength and elongation specific for polyamide 6 material

4.3.2.1. Tensile strength and elongation at break according to ISO 527-2 with the following conditions:

- (i) specimen type: type 1 BA**
- (ii) tensile speed: 20 mm/min**

The material has to be conditioned for at least 21 days at 23 °C and 50 per cent relative humidity prior to testing.

Requirements:

- (i) tensile strength not less than 20 MPa**
- (ii) elongation at break not less than 50 per cent.**

4.3.2.2. Resistance to n-pentane according to ISO 1817 with the following conditions:

- (i) medium: n-pentane**
- (ii) temperature: 23 °C (tolerance according to ISO 1817)**
- (iii) immersion period: 72 hours**

Requirements:

- (i) maximum change in volume 2 per cent**
- (ii) maximum change in tensile strength 10 per cent**
- (iv) maximum change in elongation at break 10 per cent**

After storage in air with a temperature of 40 °C for a period of 48 hours the mass compared to the original value may not decrease more than 5 per cent.

4.3.2.3. Resistance to ageing according to ISO 188 with the following conditions:

- (i) **temperature: 115 °C (test temperature = maximum operating temperature minus 10 °C)**
 - (ii) **exposure period: 24 and 336 hours**
- After ageing the specimens have to be conditioned at 23 °C and 50 per cent relative humidity for at least 21 days prior to carrying out the tensile test according to paragraph 3.3.2.1.**

Requirements:

- (i) **maximum change in tensile strength 35 per cent after 336 hours ageing compared to the tensile strength of the 24 hours aged material**
- (ii) **maximum change in elongation at break 25 per cent after 336 hours ageing compared to the elongation at break of the 24 hours aged material.**

4.4. Specifications and test method for the cover

4.4.1.1. Tensile strength and elongation at break according to ISO 37. Tensile strength not less than 20 MPa and elongation at break not less than 250 per cent.

4.4.1.2. Resistance to n-hexane according to ISO 1817 with the following conditions:

- (i) **medium: n-hexane**
- (ii) **temperature: 23 °C (tolerance according to ISO 1817)**
- (iii) **immersion period: 72 hours**

Requirements:

- (i) **maximum change in volume 30 per cent**
- (ii) **maximum change in tensile strength 35 per cent**
- (iii) **maximum change in elongation at break 35 per cent**

4.4.1.3. Resistance to ageing according to ISO 188 with the following conditions:

- (i) **temperature: 115 °C (test temperature = maximum operating temperature minus 10 °C)**
- (i) **exposure period: 336 hours**

Requirements:

- (i) **maximum change in tensile strength 25 per cent**
- (ii) **maximum change in elongation at break -30 per cent and +10 per cent**

4.4.2. Resistance to ozone

4.4.3. Specifications and test method for the cover made of polyamide 6 material

4.4.3.1. Tensile strength and elongation at break according to ISO 527-2 with the following conditions:

- (i) **specimen type: type 1 BA**
- (ii) **tensile speed: 20 mm/min**

The material has to be conditioned for at least 21 days at 23 °C and 50 per cent relative humidity prior to testing.

Requirements:

- (i) **tensile strength not less than 20 MPa**
- (ii) **elongation at break not less than 100 per cent.**

4.4.3.2. Resistance to n-hexane according to ISO 1817 with the following conditions:

- (i) medium: n-hexane**
- (ii) temperature: 23 °C (tolerance according to ISO 1817)**
- (iii) immersion period: 72 hours**

Requirements:

- (i) maximum change in volume 2 per cent**
- (ii) maximum change in tensile strength 10 per cent**
- (iii) maximum change in elongation at break 10 per cent**

4.4.3.3. Resistance to ageing according to ISO 188 with the following conditions:

- (i) temperature: 115 °C (test temperature = maximum operating temperature minus 10 °C)**
- (ii) exposure period: 24 and 336 hours**

After ageing the specimens have to be conditioned for at least 21 days before carrying out the tensile test according to paragraph 3.3.1.1.

Requirements:

- (i) maximum change in tensile strength 20 per cent after 336 hours ageing compared to the tensile strength of the 24 hours aged material**
- (ii) maximum change in elongation at break 50 per cent after 336 hours ageing compared to the elongation at break of the 24 hours aged material.**

4.4.2.1. The test has to be performed in compliance with standard ISO 1431/1.

4.4.2.2. The test-pieces, which have to be stretched to an elongation of 20 per cent shall have to be exposed to air of 40 °C and a relative humidity of 50 per cent \pm 10 per cent with an ozone-concentration of 50 parts per hundred million during 120 hours.

4.4.2.3. No cracking of the test pieces is allowed.

4.5. Specifications for uncoupled hose

4.5.1. Gas-tightness (permeability)

4.5.1.1. A hose at a free length of 1 m has to be connected to a container filled with liquid propane, having a temperature of 23 \pm 2 °C.

4.5.1.2. The test has to be carried out in compliance with the method described in standard ISO 4080.

4.5.1.3. The leakage through the wall of the hose shall not exceed 95 cm³ of vapour per metre of hose per 24 h. Leakage of the liquid LPG shall be measured and be lower than the gaseous leakage (95 cm³/hour).

4.5.2. Resistance at low temperature

4.5.2.1. The test has to be carried out in compliance with the method described in standard ISO 4672 method B.

4.5.2.2. Test temperature: -25 ± 3 °C.

4.5.2.3. No cracking or rupture is allowed.

4.5.3. Resistance at high temperature

4.5.3.1. A piece of hose, pressurized at WP, with a minimal length of 0.5 m must be put in an oven at a temperature of 125 ± 2 °C during 24 hours.

4.5.3.2. No leakage is allowed.

4.5.3.3. After the test the hose shall withstand the test pressure of $2.25 \times \text{WP}$ during 10 minutes. No leakage is allowed.

4.5.4. Bending test

4.5.4.1. An empty hose, at a length of approximately 3.5 m must be able to withstand 3,000 times the hereafter prescribed alternating-bending-test without breaking. After the test the hose must be capable of withstanding the test pressure as mentioned in paragraph 3.5.5.2.

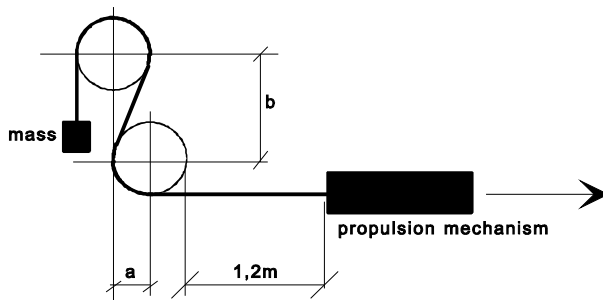


Figure 3 (example only) ($a = 102$ mm; $b = 241$ mm)

4.5.4.2. The testing machine (see Figure 3) shall consist of a steel frame, provided with two wooden wheels, with a rim-width of approximately 130 mm.

The circumference of the wheels must be grooved for the guidance of the hose. The radius of the wheels, measured to the bottom of the groove, must be 102 mm.

The longitudinal median planes of both wheels must be in the same vertical plane. The distance between the wheel-centres must be vertical 241 mm and horizontal 102 mm.

Each wheel must be able to rotate freely round its pivot-centre.

A propulsion mechanism pulls the hose over the wheels at a speed of four complete motions per minute.

4.5.4.3. The hose shall be S-shape-like installed over the wheels (see Figure 3).

The end, that runs over the upper wheel, shall be furnished with a sufficient mass as to achieve a complete snugging of the hose against the wheels. The part that runs over the lower wheel is attached to the propulsion mechanism.

The mechanism must be so adjusted, that the hose travels a total distance of 1.2 m in both directions.

4.5.5. Hydraulic test pressure and determination of the minimum burst-pressure

4.5.5.1. The test has to be carried out in compliance with the method described in standard ISO 1402.

4.5.5.2. The test pressure of $2.25 \times \text{WP}$ shall be applied during 10 minutes, without any leakage.

4.5.5.3. The burst pressure shall not be less than $2.25 \times \text{WP}$.

4.6. Couplings

4.6.1. The couplings shall be made from steel or brass and the surface must be corrosion-resistant.

4.6.2. The couplings must be of the crimp-fitting type and made up of a hose-coupling or banjo bolt. The sealing shall be resistant to LPG and comply with paragraph 3.3.1.2.

4.6.3. The banjo bolt shall comply with DIN 7643.

4.7. Assembly of hose and couplings

4.7.1. The hose assembly has to be subjected to an impulse test in compliance with standard ISO 1436.

4.7.1.1. The test has to be completed with circulating oil having a temperature of $93 \text{ }^\circ\text{C}$, and a minimum pressure of WP.

4.7.1.2. The hose has to be subjected to 150,000 impulses.

4.7.1.3. After the impulse-test the hose has to withstand the test pressure as mentioned in paragraph 3.5.5.2.

4.7.2. Gas-tightness

4.7.2.1. The hose assembly (hose with couplings) has to withstand during five minutes a gas pressure of $1.5 \times \text{WP}$ without any leakage.

4.8. Markings

- 4.8.1. Every hose must bear, at intervals of not greater than 0.5 m, the following clearly legible and indelible identification markings consisting of characters, figures or symbols.**
- 4.8.1.1. The trade name or mark of the manufacturer.**
- 4.8.1.2. The year and month of fabrication.**
- 4.8.1.3. The size and type-marking.**
- 4.8.1.4. The identification marking "L.P.G. Class 0".**
- 4.8.2. Every coupling shall bear the trade name or mark of the assembling manufacturer.**

Annex 11, points 1.2 and 1.3 amend to read:

- 1.2. Component classification (according to Figure 1, para. 2.): **Class 1 or Class 0.**
- 1.3. Classification pressure:
Class 0: $\geq 3,000$ kPa.
Class 1: 3,000 kPa.

Annex 11, points 3.2. and 3.3 amend to read:

- 3.2. Component classification (according to Figure 1, para. 2.):
 Fuel rails can be of **Class 0, 1, 2 or 2A.**
- 3.3. Classification pressure:
Parts of Class 0: $\geq 3,000$ kPa.
 Parts of Class 1: 3,000 kPa.
 Parts of Class 2: 450 kPa.
 Parts of Class 2A: 120 kPa.

Annex 11, point 3.6.1. amend to read:

- 3.6.1. For fuel rails of **Class 0 and 1:**
- | | |
|------------------------|------------------------|
| Over pressure test | Annex 15, para. 4 |
| External leakage | Annex 15, para. 5 |
| High temperature | Annex 15, para. 6 |
| Low temperature | Annex 15, para. 7 |
| LPG compatibility | Annex 15, para. 11 **/ |
| Corrosion resistance | Annex 15, para. 12 */ |
| Resistance to dry heat | Annex 15, para. 13 **/ |
| Ozone ageing | Annex 15, para. 14 **/ |
| Creep | Annex 15, para. 15 **/ |
| Temperature cycle | Annex 15, para. 16 **/ |

Annex 13, points 2 and 3. amend to read:

2. Component classification (according to Figure 1, para. 2.):
 Pressure and temperature sensors can be of Class **0**, 1, 2 or 2A.
3. Classification pressure:
Parts of Class 0: ≥3,000kPa.
 Parts of Class 1: 3,000 kPa.
 Parts of Class 2: 450 kPa.
 Parts of Class 2A: 120 kPa.

Annex 13, points 6.1. amend to read:

- 6.1. For parts of Class **0 and 1**:

Over pressure test	Annex 15, para. 4
External leakage	Annex 15, para. 5
High temperature	Annex 15, para. 6
Low temperature	Annex 15, para. 7
LPG compatibility	Annex 15, para. 11 **/
Corrosion resistance	Annex 15, para. 12 */
Resistance to dry heat	Annex 15, para. 13 **/
Ozone ageing	Annex 15, para. 14 **/
Creep	Annex 15, para. 15 **/
Temperature cycle	Annex 15, para. 16 **/

Annex 15, point 2 amend to read:

2. Applicable test procedures
 In Table 1 the applicable test procedures dependent on the classification are shown.

Table 1

Test	Class 0	Class 1	Class 2(A)	Class 3	Paragraph
Overpressure	x	x	x	x	4.
External leakage	x	x	x	x	5.
High temperature	x	x	x	x	6.
Low temperature	x	x	x	x	7.
Seat leakage	x	x		x	8.
Endurance / Functional tests	x	x		x	9.
Operational test	x			x	10.

LPG compatibility	x	x	x	x	11.
Corrosion resistance	x	x	x	x	12.
Resistance to dry heat	x	x		x	13.
Ozone ageing	x	x		x	14.
Creep	x	x		x	15.
Temperature cycle	x	x		x	16.
Compatibility with heat exchange fluid	x		x		

Annex 15, point 4, table 2 amend to read:

Table 2

Classification of component	Classification pressure [kPa]	Hydraulic test pressure for over-pressure test [kPa]
Class 0	WP	2,25 WP
Class 1, 3	3,000	6,750
Class 2A	120	270
Class 2	450	1,015

Annex 15, point 5.3, table 2, and points 5.4 to 7 amend to read:

Table 3: The classification and leakage test pressures according to the classification:

Classification of component	Classification pressure [kPa]	Test pressure for leakage test [kPa]
Class 0	WP	1.5 WP
Class 1	3,000	4,500
Class 2A	120	180
Class 2	450	675
Class 3	3,000	6,750

5.4. The external leakage must be lower than the requirements stated in the annexes or, if no requirements are mentioned, the external leakage shall be lower than 15 cm³/hour with the outlet plugged, when submitted to a gas pressure equal to the leakage test pressure. **In case Class 0 the leakage of the liquid LPG shall be measured and be lower than the gaseous leakage (15 cm³/hour).**

6. High temperature test

A LPG containing component shall not leak more than 15 cm³/hour with the outlet plugged when submitted to a gas pressure at maximum operating temperature, as indicated in the annexes, equal to the leakage test pressure (Table 3, paragraph 5.3.). The component shall be conditioned for at least 8 hours at this temperature. **In case Class 0 the leakage of the liquid LPG shall be measured and be lower than the gaseous leakage (15 cm³/hour).**

7. Low temperature test

A LPG containing component shall not leak more than 15 cm³/hour with the outlet plugged when submitted to a gas pressure, at the minimum operating temperature (-20 °C), equal to the leakage test pressure (Table 3, paragraph 5.3.). The component shall be conditioned for at least 8 hours at this temperature. **In case Class 0 the leakage of the liquid LPG shall be measured and be lower than the gaseous leakage (15 cm³/hour).**

B. JUSTIFICATION

The present version of Regulation 67 contains provisions for the approval of components with a working pressure up to 30 bars. Innovations like direct injection of liquid LPG working at higher pressure are technically possible without jeopardizing safety, but Regulation 67 does not contain provisions for the approval of such components like the fuel pump, the fuel rail, the injectors and a safety valve leading back fuel from the high pressure parts to the fuel tank. This proposal aims to introduce the required provisions for such components into Regulation 67, taking into account the provisions for the approval of CNG systems.
