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Kraftstoffe - Flüssiggas - Anforderungen und
Prüfverfahren

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European foreword

This document (EN 589:2024) has been prepared by Technical Committee CEN/TC 19 "Gaseous and liquid fuels, lubricants and related products of petroleum, synthetic and biological origin", the secretariat of which is held by NEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2024, and conflicting national standards shall be withdrawn at the latest by September 2024.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 589:2018+A1:2022.

This is the 7th edition of EN 589. The main technical changes compared to the 2nd version EN 589:2018+A1:2022 of the 6th edition EN 589:2018 include:

- a) change of vapour pressure requirement, increase of minimum vapour pressure;
- b) change of limit value for 1,3 butadiene to $< 0,10 \% m/m$ [4].

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

1 Scope

This document specifies requirements and test methods for marketed and delivered automotive LPG (commonly known as low pressure gas or liquefied petroleum gas).

This document is applicable to automotive LPG for use in LPG engine vehicles designed to run on automotive LPG.

NOTE For the purposes of this document, the terms “% (m/m)” and “% (V/V)” are used to represent respectively the mass fraction, μ , and the volume fraction, φ .

WARNING — Attention is drawn to the risk of fire and explosion when handling LPG and to the hazard to health arising through inhalation of excessive amounts of LPG.

LPG is a highly volatile hydrocarbon liquid which is normally stored under pressure. If the pressure is released large volumes of gas will be produced which form flammable mixtures with air over the range of approximately 2 % (V/V) to 10 % (V/V). This document involves the sampling, handling and testing of LPG. Naked flames, unprotected electrical equipment electrostatic hazards etc. are sources of ignition for LPG.

LPG in liquid form can cause cold burns to the skin. National health and safety regulations can apply.

LPG is heavier than air and accumulates in cavities. There is a danger of suffocation when inhaling high concentrations of LPG.

CAUTION — One of the tests described in this document involves the operator inhaling a mixture of air and LPG vapour. Particular attention is drawn to the cautionary statement provided in A.1, where this method is referred to.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 15469, *Petroleum products — Test method for free water in liquefied petroleum gas by visual inspection*

EN 15470, *Liquefied petroleum gases — Determination of dissolved residues — High temperature Gas chromatographic method*

EN 15471, *Liquefied petroleum gases — Determination of dissolved residues — High-temperature gravimetric method*

EN 16423, *Liquefied petroleum gases — Determination of dissolved residue — Gas chromatographic method using liquid, on-column injection*

EN 16942+A1, *Fuels — Identification of vehicle compatibility — Graphical expression for consumer information*

EN 17178:2019, *Liquid petroleum products — Determination of the total volatile sulfur content in liquefied petroleum gases by ultraviolet fluorescence spectroscopy*

EN 27941, *Commercial propane and butane — Analysis by gas chromatography (ISO 7941)*

EN ISO 4256, *Liquefied petroleum gases — Determination of gauge pressure — LPG method (ISO 4256)*

EN ISO 4257, *Liquefied petroleum gases — Method of sampling (ISO 4257)*

EN ISO 4259-2, *Petroleum and related products — Precision of measurement methods and results — Part 2: Interpretation and application of precision data in relation to methods of test (ISO 4259-2)*

EN ISO 6251, *Liquefied petroleum gases — Corrosiveness to copper — Copper strip test (ISO 6251)*

EN ISO 8819, *Liquefied petroleum gases — Detection of hydrogen sulfide — Lead acetate method (ISO 8819)*

EN ISO 8973, *Liquefied petroleum gases — Calculation method for density and vapour pressure (ISO 8973)*

DIN 51619, *Testing of mineral oil hydrocarbons — Determination of the composition of liquid petroleum gases — Gas chromatographic analysis under special consideration of 1,3-butadiene with mass fractions $\leq 0,1$ % (m/m)*

ASTM D6667, *Standard Test Method for Determination of Total Volatile Sulfur in Gaseous Hydrocarbons and Liquefied Petroleum Gases by Ultraviolet Fluorescence*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

liquefied petroleum gas low pressure gas

low pressure liquefied gas of petroleum, synthetic or biological origin that can be stored and/or handled in the liquid phase under moderate conditions of pressure and at ambient temperature, consisting predominantly of propane and butanes, with small proportions of other compounds, including propene, butenes and pentanes/pentenenes

4 Sampling

Samples shall be taken as described in EN ISO 4257. Requirements of national standards or regulations for the sampling of automotive LPG can also apply. If present, national requirements shall be set out in detail or shall be referred to by reference in a national annex to this document.

In view of the sensitivity of some of the test methods referred to in this document, particular attention shall be paid to compliance with any guidance on sampling containers which is included in the test method standard.

IMPORTANT — It is important that the sampling procedure is followed in detail in order to avoid evaporation losses.

Before sampling from the dispenser hose, 20 l of product should be pumped or recirculated, in order to obtain a representative sample.

5 Pump marking

Information to be marked on dispensing pumps and nozzles used for delivering automotive LPG, and the dimensions of the label shall be in accordance with EN 16942+A1.

6 Requirements and test methods

When tested by the methods of test given in Table 1, automotive LPG fuel shall comply with the limiting requirements specified in that table.

For the minimum vapour pressure, five grades, A, B, C, D and E are given to allow for seasonal limits to be set nationally for each period of the year. In a national annex to this document, each country shall indicate which grade(s) it adopts to achieve a minimum vapour pressure of 200 kPa (gauge) throughout the entire year and shall detail the date range in which the selected grade applies.

Liquefied petroleum gases for automotive purposes shall be free from any adulterant or contaminant that may render the fuel unacceptable for use in appropriate engines.

Automotive LPG fuel shall not contain free water at 0 °C and at the saturated vapour pressure on visual inspection.

NOTE For propane rich mixtures with a minimum of 60 % (m/m) of propane, compliance with EN ISO 13758 [1] equally satisfies this requirement.

For operational purposes it is allowed to add up to 2 000 mg/kg methanol. No other antifreeze agents shall be added.

When tested in accordance with the procedure described in Annex A, the odour of the gas shall be characteristic (i.e. distinctive and unpleasant), detectable at a concentration in air of 20 % of the lower flammability limit.

NOTE Unpleasant being subjective, the odour is to be a caution and inviting to the user to search for the leak.

For odour testing, alternative test methods may be used if this detection methods demonstrates the ability to measure the odour and/or a correlated parameter at least equal to that of the test method described in Annex A. Such alternative procedures shall be set out in detail or referred to by reference in a national annex to this document.

If a density report is required, EN ISO 3993 [2] or EN ISO 8973 are recommended.

6.5.1 All test methods referred to in this document include a precision statement. In cases of dispute, the procedures for resolving the dispute and interpretation of the results based on test method precision, described in EN ISO 4259-2, shall be used.

6.5.2 In case of dispute concerning the evaporation residue, EN 15470 or EN 15471 shall be used.

6.5.3 In case of dispute concerning the vapour pressure, EN ISO 4256 shall be used.

6.5.4 In case of dispute concerning the total diene content and the propane content EN 27941 shall be used.

6.5.5 In cases of dispute concerning total sulfur content, EN 17178:2019 shall be used. See EN 17178:2019, 14.1 for additional information on precision.

6.5.6 In case of dispute concerning the 1,3 butadiene content DIN 51619 shall be used.

Table 1 — Requirements and test methods

Property	Unit	Limits		Test method ^a (See Clause 2, Normative references)
		Minimum	Maximum	
Motor octane number, MON		89,0		Annex B
Total dienes content ^h	% (m/m)		0,5	EN 27941 DIN 51619
1,3 Butadiene ^j	% (m/m)		< 0,10	DIN 51619 EN 27941
Propane content ^h	% (m/m)	20		EN 27941 DIN 51619
Hydrogen sulfide		negative		EN ISO 8819
Total sulfur content (after odorization) ⁱ	mg/kg		30	EN 17178 ASTM D6667
Copper strip corrosion (1 h at 40 °C)	rating	class 1		EN ISO 6251
Evaporation residue ^b	mg/kg		60	EN 15470 EN 15471 EN 16423
Vapour pressure, gauge at 40 °C ^c	kPa		1 550	EN ISO 4256 EN ISO 8973 and Annex C
Vapour pressure, gauge at a temperature of: d e - grade A: -10 °C - grade B: -5 °C - grade C: 0 °C - grade D: +10 °C - grade E: +20 °C	kPa	200		EN ISO 8973 and Annex C
Water content ^f		pass		EN 15469
Odour ^g		unpleasant and distinctive at 20 % LFL		See 6.3 and Annex A
^a See also 6.5.1.				
^b See also 6.5.2.				
^c See also 6.5.3.				
^d For the purpose of this document EN ISO 8973 together with Annex C shall be applied at the indicated temperatures. For internal routine quality control purposes, the values as given in the informative Annex D may also be used.				

Property	Unit	Limits		Test method ^a (See Clause 2, Normative references)
		Minimum	Maximum	
e	See also 6.1.			
f	See also 6.2.			
g	National safety requirements must be followed in any case and may overwrite this document.			
h	See also 6.5.4.			
i	See also 6.5.5. ASTM D6667 is intended to be no longer referenced when sufficient data on EN 17178 is available.			
j	See also 6.5.6.			

7 Remarks concerning vehicle application issues like residues in vaporizers or injectors

The presence of plasticizer additives (e.g. phthalates) in elastomer hoses or other materials which can come into contact with LPG can lead to increased contamination of LPG by high molecular substances. Therefore, great care should be taken by the automotive industry and LPG retailers to avoid such contacts, e.g. by internal coating or introducing materials which do not release those plasticizers.

Annex A

(normative)

Test method for odour of LPG

A.1 General

This annex describes a method for assessing the odour of commercial LPG whatever the odour is due to the presence of unsaturated hydrocarbons and/or sulfur compounds or an odour imparted by the addition of odorants.

WARNING — In order to minimize the exposure of personnel conducting the odour test against toxic impurities, it is strongly recommended that the test should only be performed when it has been ascertained that LPG already meets the other specification limits detailed in Table 1. The test involves the operator inhaling a mixture of LPG vapour and air. There is a risk that the nationally regulated short-term and/or long-term (8 h TWA reference period) occupational exposure limits for substances contained in the LPG may be exceeded. The person responsible for the testing (for example, the employer) should consult relevant safety and health regulations and ensure that exposure during the sampling, handling and testing of LPG does not exceed the limits set in the respective country.

As a guide, and provided the LPG being tested complies with the quality requirements listed in Table 1, an operator will usually remain within the corresponding national legal occupational exposure limits, provided inhalation of the LPG/air mixture does not exceed three 10 s periods during each test and not more than two tests per hour are performed in the course of an 8 h working day. This shall be confirmed by a hazard assessment.

This guidance only takes account of the operator's exposure whilst conducting odour tests. Other potential exposures should be assessed in order to estimate total exposure.

A.2 Principle

A sample of liquid gas is completely vaporized and diluted with purified air so that the mixture contains the gas at a concentration of 20 % of the lower limit of its flammability in air. The odour of the gaseous mixture is assessed by at least three observers.

The lower limits of flammability in air may be considered as:

- butane 1,9 % (V/V);
- propane 2,4 % (V/V).

A.3 Material

Activated charcoal, particle size 1,18 mm to 1,70 mm, for purifying the air stream.

A.4 Apparatus

The apparatus is shown diagrammatically in Figure A.1 and consists of the parts detailed in A.4.1 to A.4.5.

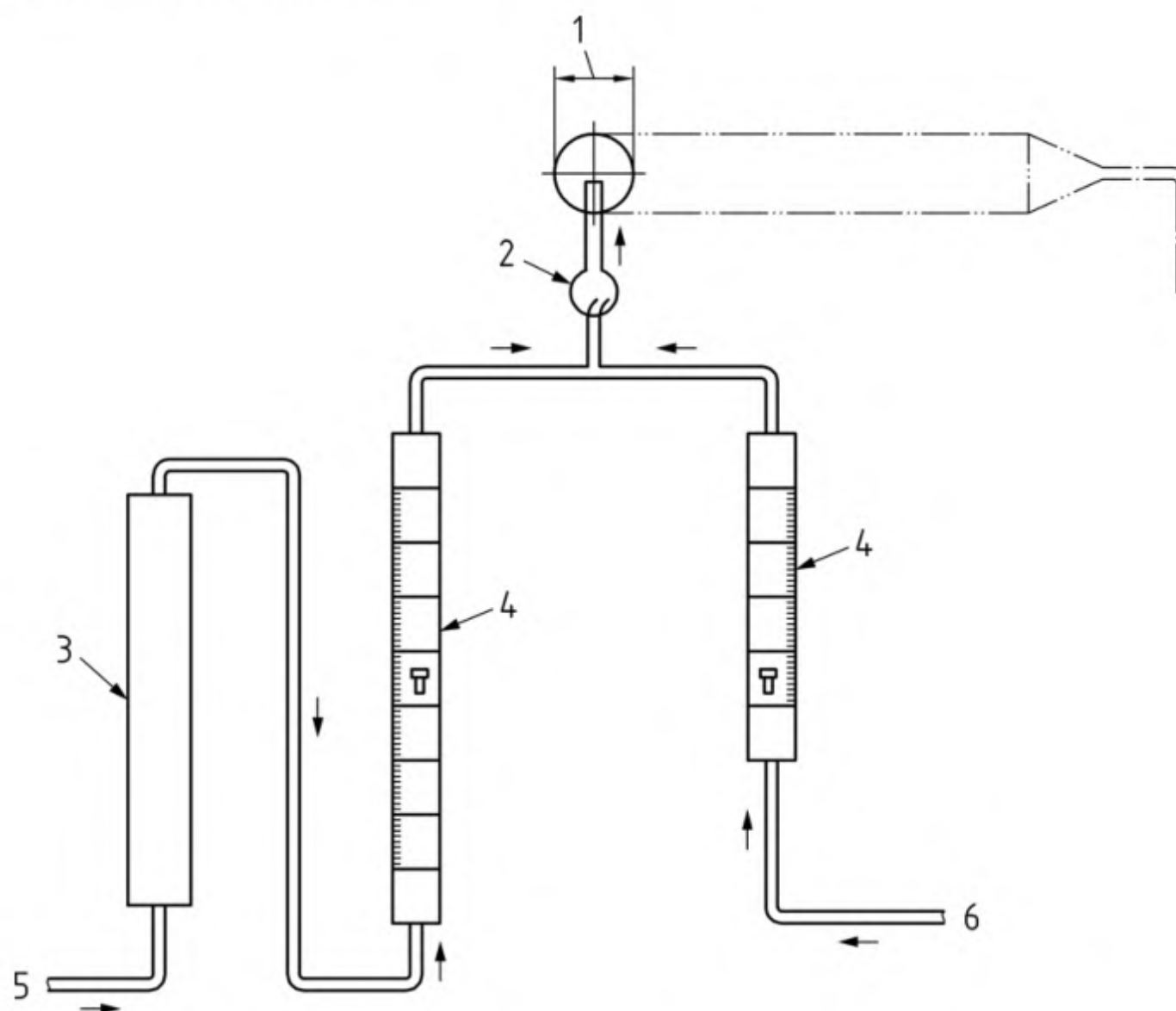
A.4.1 Air purifying column, consisting of a drying tower of approximately 200 ml capacity.

A.4.2 Flowmeter, such as one operating on the floating element principle, for air; range 5 l/min to 15 l/min.

A.4.3 Flowmeter, such as one operating on the floating element principle, for gas; range 5 ml/min to 150 ml/min.

A.4.4 Gas mixing bulb, 30 mm in diameter with a jet 4 mm in diameter.

A.4.5 Glass funnel, diameter 75 mm.



Key

1	Ø 75 glass funnel (A.4.5)	4	flowmeters (A.4.2 or A.4.3)
2	mixing bulb (A.4.4)	5	air
3	air purifying column (A.4.1)	6	stenched gas

Figure A.1 — Apparatus for assessing odour of LPG

A.5 Procedure

Pass air through the air purification column (A.4.1) at the specified rate as measured by the air flowmeter (A.4.2). The air flow rate for propane shall be 8,5 l/min and that for butane shall be 10,5 l/min. For mixtures the flow rate can be calculated by a linear approach based on the share of propane and butane.

Place the nose inside the rim of the funnel (A.4.5) and inhale gently; check that the air is odourless.

Pass the stench gas through the gas flowmeter (A.4.3) at a rate of 40 ml/min. Assess the odour of the gas-air mixture using at least three observers.

A.6 Expression of results

If the odour is judged to be distinctive and unpleasant by all observers, the batch, which the sample represents, shall be reported as complying with this document.

Annex B (normative)

Method of calculation of the Motor Octane Number (MON) from compositional analysis of LPG

B.1 General

This annex describes a method for the calculation of the motor octane number from a compositional analysis of LPG, using the method described in EN 27941 or in DIN 51619.

B.2 Principle

The composition of a sample of LPG is obtained using gas chromatography. The motor octane number of the sample is calculated from the partial motor octane factors of the constituents and their concentrations determined from the analysis.

B.3 Determination

Determine the concentration of each constituent present at a concentration in excess of 0,1 % (*m/m*) in the gas sample, using the method described in EN 27941 or DIN 51619.

B.4 Calculation and expression of results

B.4.1 Calculate the partial motor octane number for each component in the mixture as follows:

$$\text{Partial octane number} = M \cdot C \quad (\text{B.1})$$

where

- M* is the motor octane factor of specific component (see Table B.1), in the same units as used for *C*;
- C* is the fraction of specific component in the mixture, either in molar, mass or volume percentage.

NOTE The factors for motor octane number in Table B.1 are empirical values to be used only in the calculation procedures described in this annex.

In case of dispute the molar factors shall be used.

B.4.2 Add the partial motor octane numbers for all of the components determined and round the sum down to the nearest 0,1.

Table B.1 — Factors for determining the Motor Octane Number of LPG

Component	Motor octane number factor, <i>M</i>		
	Molar	Mass	Volume
Propane (+ C2)	95,4	95,9	95,6
Propene	83,9	82,9	83,1
Butane (+ C5)	89,0	88,9	88,9
2-Methylpropane (Isobutane)	97,2	97,1	97,1
Butenes	75,8	76,8	75,7

B.5 Reporting

Report the total (B.4.2) as the LPG motor octane number of the sample.

Annex C (normative)

Absolute vapour pressure blending factors

This annex describes factors for the calculation of the absolute vapour pressure (AVP) of liquefied petroleum gas. The method of calculation as given in EN ISO 8973 shall be used.¹⁾

Table C.1 — Absolute Vapour Pressure Blending Factors

Component	AVP blending factors (kPa) at temperature (°C)					
	-10	-5	0	10	20	40
Methane	21 334	22 742	24 211	27 333	30 707	38 230
Ethane	1 873	2 128	2 407	3 040	3 781	5 613
Ethylene	3 348	3 737	4 159	5 101	6 184	8 805
Propane	346	405	472	630	826	1 353
Propylene	437	510	591	785	1 024	1 661
Butane	71,26	86,64	104,5	149,2	207,6	376,9
Isobutane	109,9	132,3	158,1	221,4	302,7	531
1-Butene	87,91	106,8	128,8	183,4	254,4	457
Isobutene	90,17	109,5	131,9	187,6	259,9	466
Cis-2-Butene	59,63	73,11	88,94	126,7	181,5	336,5
Trans-2-Butene	67,13	81,90	99,16	142,3	199,1	364,8
1,2-Butadiene	43,65	54,08	66,49	98,26	141,3	272,2
1,3-Butadiene	81,55	99,45	120,3	172,2	240,2	436
Pentane	15,23	19,41	24,48	37,85	56,53	115,5
Isopentane	21,98	27,68	34,52	52,25	76,57	151,3
1-Pentene	19,75	25,00	31,33	47,85	70,67	141,5

1) The vapour pressure blending factors of components present in liquefied petroleum gas, as indicated in the Table C.1, are primarily calculated using so-called Antoine coefficients as published in [3].

Annex D (informative)

Seasonal gauge vapour pressure limits

Table D.1 presents the gauge vapour pressure (VP) limits at 40 °C that may be used for internal routine quality control purposes.

Table D.1 — Seasonal gauge vapour pressure limits at 40 °C

Grade	Minimum ^a (kPa)	Equivalent to 200 kPa at (°C)
A	1 100	-10
B	950	-5
C	825	0
D	600	+10
E	520 ^b	+20

^a These vapour pressures are calculated using the values given in EN ISO 8973 and are for internal routine quality control purposes only. Method of calculation: values of Table C.1 are used to calculate mixture propane/butane to be nearest to 200 kPa for the given temperature of the grade. Then this mixture is used to calculate pressure at 40 °C. Finally, a rounded value slightly above the calculated pressure are quoted in the table.

^b Minimum content of propane (20 % (m/m)) always meets the requirement of min. 200 kPa at 20 °C. Therefore, VP calculated for 20 °C at a composition of 20 % (m/m) of propane is specified.

Bibliography

- [1] EN ISO 13758, *Liquefied petroleum gases — Assessment of the dryness of propane — Valve freeze method (ISO 13758)*
- [2] EN ISO 3993, *Liquefied petroleum gas and light hydrocarbons — Determination of density or relative density — Pressure hydrometer method (ISO 3993)*
- [3] *The Properties of Gases and Liquids*, REID, R.C., PAUSNITZ, J.M. and SHERWOOD, T.K., 3rd ed., 1977
- [4] Regulation (EC) No 1272/2008, OJ L 353 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures - amending and repealing Directive 67/548/EEC and 1999/45/EC, and Regulation (EC) No 1907/2006

National Annex A (Normative)

Special conditions applicable in Spain

- 1 During the winter period, the automotive LPG shall comply with the requirements set in Table 1 for grade B.
- 2 The application period for such grade throughout the national territory shall be: from 1 November to 31 March.