

Automotive fuels — LPG — Requirements and test methods

The European Standard EN 589:2004 has the status of a
British Standard

ICS 75.160.30

National foreword

This British Standard is the official English language version of EN 589:2004, including Corrigendum September 2004. It supersedes BS EN 589:2000 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PTI/15, Natural gas and gas analysis, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

The principal differences between this edition of BS EN 589 and the 2000 edition are given in the European Standard foreword.

EN 589 requires that each country implementing it establishes national annexes detailing requirements for sampling and pump marking, as well as climate-dependent requirements. These requirements are given in National annex NA, National annex NB and National annex NC respectively.

WARNING. Attention is drawn to the warning given in Annex A. Attention is also drawn to the guidance notes associated with the Control of Substances Hazardous to Health Regulations 2002, such as the current version of Guidance Note EH 40, *Occupational exposure limits*, published by the Health and Safety Executive.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 16, an inside back cover and a back cover.

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Amendments issued since publication

| Amd. No. | Date | Comments |
|----------------------------|-------------------|---|
| 15384 Corrigendum No. 1 | 28 September 2004 | Replacement of National annexes NA, NB and NC |
| | | |
| | | |
| | | |

English version

Automotive fuels - LPG - Requirements and test methods

Carburant pour automobiles - GPL - Exigences et
méthodes d'essaiKraftstoffe für Kraftfahrzeuge - Flüssiggas - Anforderungen
und Prüfverfahren

This European Standard was approved by CEN on 24 December 2003.

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Foreword

This document EN 589:2004 has been prepared by Technical Committee CEN/TC 19 "Petroleum products, lubricants and related products", 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 July 2004, and conflicting national standards shall be withdrawn at the latest by July 2004.

This document supersedes EN 589:2000 in whole. In this fourth edition of EN 589 all relevant characteristics, requirements and test methods are specified. Significant technical changes between this European Standard and the previous edition are on:

- requirement of sulfur content
- test method for sulfur
- test method for vapour pressure, including introduction of an additional seasonal grade (E)
- requirement for methanol

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

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In this standard Annex A, B and C are normative, Annex D is informative.

1 Scope

This European Standard specifies requirements and test methods for marketed and delivered automotive LPG (Liquefied Petroleum Gas). It is applicable to automotive LPG for use in LPG engine vehicles designed to run on automotive LPG.

NOTE: For the purposes of this European Standard, the term “% (V/V)” is used to represent the volume fraction.

WARNING - Attention is drawn to the risk of fire and explosion when handling LPG and to the hazard to health which arises 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 European Standard involves the sampling, handling and testing of LPG. All procedures should be conducted away from sources of ignition such as naked flames, unprotected electrical equipment and electrostatic hazards. Testing should be performed as far as practicable under an electrically-safe ventilation hood.

LPG in the liquid form can cause cold burns to the skin. Protective clothing such as gloves and goggles should be worn if contact with the skin is likely to occur.

Unnecessary inhalation of LPG vapour should be avoided. The operator should not be exposed to atmospheres containing more than 1 800 mg/m³ over an 8 h time-weighted average (TWA) reference period, or more than 2 250 mg/m³ over a short term, 10 min reference period. One of the tests described in this European Standard 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

This European Standard incorporates by dated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN ISO 3993:1995, *Liquefied petroleum gas and light hydrocarbons - Determination of density or relative density - Pressure hydrometer method (ISO 3993:1995)*.

EN ISO 4256:1998, *Liquefied petroleum gases - Determination of gauge vapour pressure - LPG method. (ISO 4256:1996)*.

EN ISO 4257:2001, *Liquefied petroleum gases - Method of sampling (ISO 4257:2001)*.

EN ISO 4259:1995, *Petroleum products - Determination and application of precision data in relation to methods of test (ISO 4259:1992, including Cor.1: 1993)*.

EN ISO 6251:1998, *Liquefied petroleum gases - Corrosiveness to copper - Copper strip test (ISO 6251:1996)*.

EN ISO 8819:1995, *Liquefied petroleum gases - Detection of hydrogen sulfide - Lead acetate method (ISO 8819:1993)*.

EN ISO 8973:1999, *Liquefied petroleum gases - Calculation method for density and vapour pressure (ISO 8973:1997)*.

EN ISO 13757:1996, *Liquefied petroleum gases - Determination of oily residues - High-temperature method (ISO 13757:1996)*.

EN 24260:1994, *Petroleum products and hydrocarbons - Determination of sulfur content - Wickbold combustion method (ISO 4260:1987)*.

EN 27941:1993, *Commercial propane and butane - Analysis by gas chromatography (ISO 7941:1988)*.

ASTM D 3246:96, *Standard test method for sulfur in petroleum gas by oxidative microcoulometry*.

ASTM D 6667:01, *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 European Standard, the following term and definition apply.

3.1

liquefied petroleum gas

LPG

petroleum gas which can be stored and/or handled in the liquid phase under moderate conditions of pressure and at ambient temperature, consisting predominantly of propane, butanes, with small proportions of propene, butenes and pentanes/pentenenes

4 Sampling

Samples shall be taken as described in EN ISO 4257 and/or in accordance with the requirements of national standards or regulations for the sampling of automotive LPG. The national requirements shall be set out in detail or shall be referred to by reference in a national annex to this European Standard.

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

NOTE 1 It is important that the sampling procedure is followed in detail in order to avoid evaporation losses.

NOTE 2 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 used for delivering automotive LPG, and the dimensions of the mark shall be in accordance with the requirements of national standards or regulations for the marking of pumps for automotive LPG. Such requirements shall be set out in detail or shall be referred to by reference in a national annex to this European Standard.

6 Requirements and test methods

6.1 General

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 European Standard, each country shall indicate which grade(s) it adopts to achieve a minimum vapour pressure of 150 kPa (gauge) throughout the entire year and shall detail the date range in which the selected grade applies.

Table 1 - Requirements and test methods

| Property | Unit | Limits | | Test method ^a (See 2. Normative references) |
|---|--------|--|----------------------------------|---|
| | | Minimum | Maximum | |
| Motor octane number, MON | | 89,0 | | Annex B |
| Total dienes content (including 1.3 butadiene) | mole % | | 0,5 | EN 27941 |
| Hydrogen sulfide | | negative | | EN ISO 8819 |
| Total sulfur content ^b (after stenching) | mg/kg | | 50 | EN 24260 ASTM D 3246 ASTM D 6667 |
| Copper strip corrosion (1 h at 40 °C) | rating | class 1 | | EN ISO 6251 |
| Evaporation residue | mg/kg | | 100 | EN ISO 13757 |
| Vapour pressure, gauge, at 40 °C ^c | kPa | | 1 550 | EN ISO 4256 EN ISO 8973 and Annex C |
| Vapour pressure, gauge, min. 150 kPa at a temperature of ^{d, e} - for grade A - for grade B - for grade C - for grade D - for grade E | °C | | - 10 - 5 0 + 10 + 20 | EN ISO 8973 and Annex C |
| Water content | | No free water at 0 °C | | See 6.2 |
| Odour | | 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 standard 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. ^e See also 6.1 | | | | |

6.2 Water content

Liquefied petroleum gases for automotive purposes shall not contain free water at 0 °C and at the saturated vapour pressure on visual inspection.

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

NOTE 2 For this purpose the equipment as described in EN ISO 3993 may be used.

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

6.3 Odour

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 (LFL).

6.4 Density

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

6.5 Precision and dispute

6.5.1 All test methods referred to in this European Standard 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, shall be used.

6.5.2 In cases of dispute concerning the total sulfur content, ASTM D 6667 shall be used.

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

Annex A (normative)

Test method for odour of LPG

A.1 Introduction

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

WARNING In order to minimize the exposure of personnel conducting the odour test, 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 of this European Standard. The test involves the operator inhaling a mixture of LPG vapour and air. There is a risk that the short-term and/or long-term (8 h TWA reference period) occupational exposure limits for substances contained in the LPG may be exceeded. The operator should consult relevant safety and health regulations and ensure that exposure during the sampling, handling and testing of LPG does not exceed the prescribed limits.

As a guide, and provided the LPG being tested complies with the quality requirements listed in Table 1 of this European Standard, an operator will normally remain within recommended occupational exposure limits provided inhalation of the LPG/air mixture does not exceed three 10 second periods during each test and not more than two tests per hour are performed in the course of an 8-hour working day. 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 flammability¹⁾ in air. The odour of the gaseous mixture is assessed by at least three observers.

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.

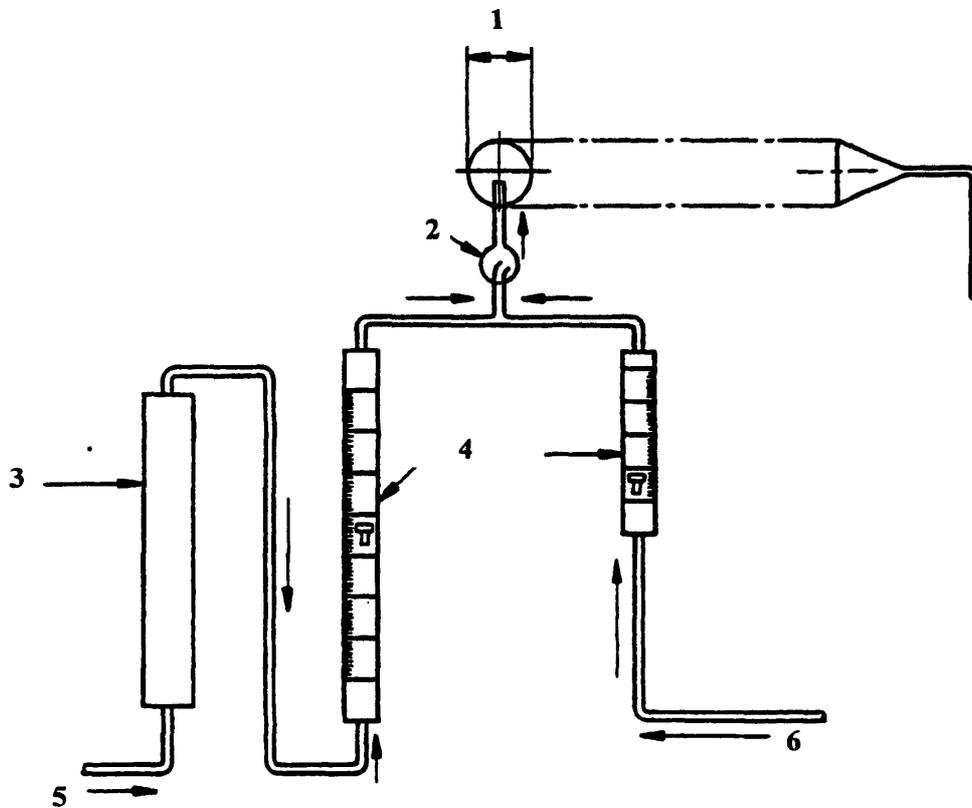
A.4.2 Flowmeter, such as one operating on the floating element principle, for air; range 5 l/min to 15 l/min.

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

1) The lower limits of flammability in air may be taken as:
- butane 1,9 % (V/V)
- propane 2,4 % (V/V)

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 | 4 | Flowmeters |
| 2 | Mixing bulb | 5 | Air |
| 3 | Air purifying column | 6 | Stenched gas |

Figure A.1 - Apparatus for assessing odour of LPG

A.5 Procedure

Pass air through the air purifying 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.

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

Pass the stenched 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 EN 589.

Annex B (normative)

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

B.1 Introduction

This Annex describes a method for the calculation of the motor octane number from a compositional analysis of LPG.

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 mole percent in the gas sample, using the method described in EN 27941.

B.4 Calculation and expression of results

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

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

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 cases 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.

B.5 Reporting

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

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 | 82,8 | 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 |

Annex C (normative)

Absolute vapour pressure blending factors (kPa)

This Annex describes factors for the calculation of the absolute vapour pressure of liquefied petroleum gas. The method of calculation as given in EN ISO 8973 shall be used ²⁾

Table C.1 – Absolute Vapour Pressure Blending Factors

| Component | Absolute Vapour Pressure 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 | 1 873,94 | 2 128,94 | 2 407,73 | 3 040,80 | 3 781,28 | 5 613,96 |
| Ethylene | 3 348,03 | 3 737,99 | 4 159,58 | 5 101,77 | 6 184,25 | 8 805,81 |
| Propane | 346,37 | 405,52 | 472,21 | 630,67 | 826,8 | 1 353,09 |
| Propylene | 437,34 | 510,04 | 591,79 | 785,36 | 1 024,02 | 1 661,44 |
| Butane | 71,26 | 86,64 | 104,57 | 149,22 | 207,68 | 376,99 |
| Isobutane | 109,95 | 132,34 | 158,16 | 221,45 | 302,73 | 531,46 |
| 1-Butene | 87,91 | 106,85 | 128,87 | 183,44 | 254,4 | 457,34 |
| Isobutene | 90,17 | 109,51 | 131,98 | 187,64 | 259,97 | 466,63 |
| Cis-2-Butene | 59,63 | 73,11 | 88,94 | 126,75 | 181,50 | 336,59 |
| Trans-2-Butene | 67,13 | 81,90 | 99,16 | 142,33 | 199,15 | 364,86 |
| 1,2-Butadiene | 43,65 | 54,08 | 66,49 | 98,26 | 141,31 | 272,28 |
| 1,3-Butadiene | 81,55 | 99,45 | 120,31 | 172,29 | 240,25 | 436,19 |
| Pentane | 15,23 | 19,41 | 24,48 | 37,85 | 56,53 | 115,51 |
| Isopentane | 21,98 | 27,68 | 34,52 | 52,25 | 76,57 | 151,32 |
| 1-Pentene | 19,75 | 25,00 | 31,33 | 47,85 | 70,67 | 141,54 |

2) Source of data: the vapour pressure blending factors of components present in liquefied petroleum gas, as indicated in the table, are primarily calculated using so-called Antoine coefficients as published in [2].

Annex D (informative)

Seasonal gauge vapour pressure limits at 40 °C

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

| Grade | Minimum ^a (kPa) | Equivalent to 150 kPa at (°C) |
|-------|-------------------------------|----------------------------------|
| A | 950 | -10 |
| B | 800 | -5 |
| C | 700 | 0 |
| D | 500 | +10 |
| E | 275 | + 20 |

^a These vapour pressures are calculated using the values given in EN ISO 8973 and are for internal routine quality control purposes only.

Bibliography

- [1] EN ISO 13758:1996, *Liquefied petroleum gases - Assessment of the dryness of propane - Valve freeze method (ISO 13758:1996)*.
- [2] *The Properties of Gases and Liquids*, Reid R.C., Pausnitz J.M. and Sherwood T.K., 3rd Ed., 1977, McGraw-Hill, New York

National annex NA (normative)

Sampling requirements

NA.1 Introduction

This national annex gives the sampling requirements to comply with Clause 4.

NA.2 Normative references

The following referenced documents are indispensable for the application of this national annex. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 5309-1:1976, *Methods for sampling chemical products — Part 1: Introduction and general principles*.

BS 5309-3:1976, *Methods for sampling chemical products — Part 3: Sampling of liquids*.

NA.3 Sampling

Samples shall be taken from an appropriate sample point on the storage tank at the retail outlet.

For all test methods, sampling shall be carried out from the liquid phase in accordance with the procedures described for liquefied gases in BS 5309-1:1976 and BS 5309-3:1976, Section 6, except that all bombs used shall be fitted with two valves and an ullage tube.

National annex NB (normative)

Pump marking requirements

NB.1 Introduction

This national annex gives the pump marking requirements to comply with Clause 5.

NB.2 Requirements

NB.2.1 Pump marking

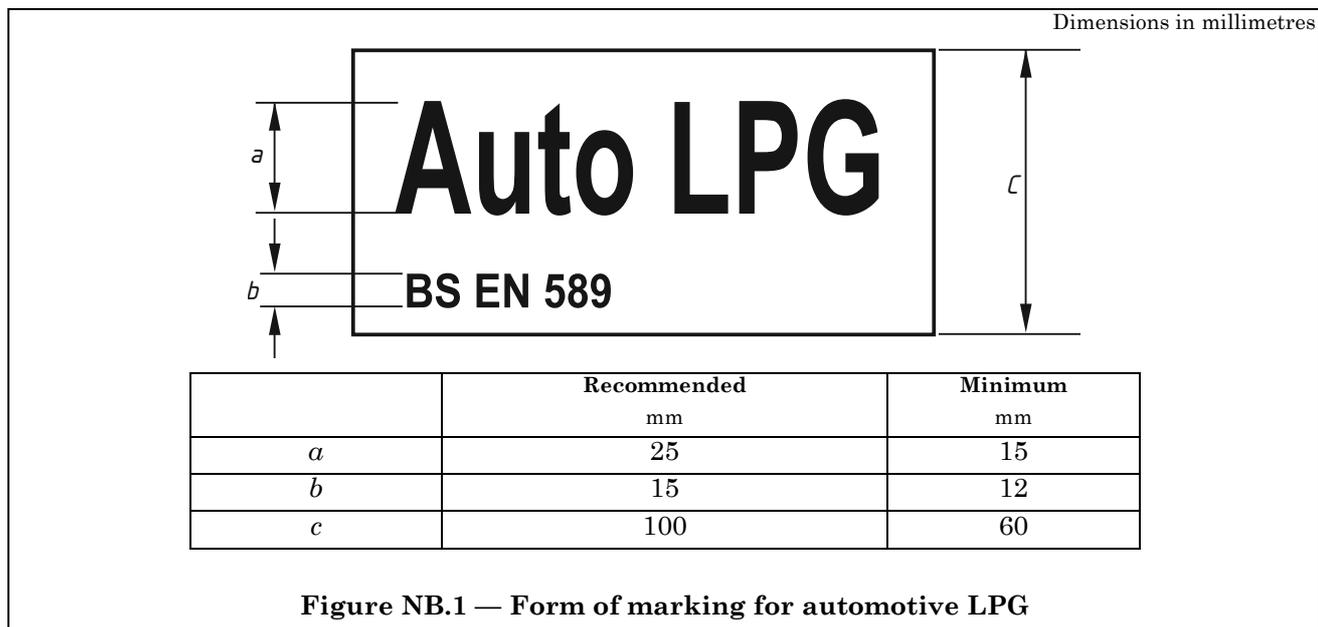
For the purposes of this British Standard the following information shall be marked on each dispensing pump or container used for delivering automotive LPG that conforms to this British Standard into the consuming vehicle.

- a) The name or mark of the supplier or vendor of the automotive LPG.
- b) The mark¹⁾ shown in Figure NB.1. The minimum dimensions of this mark shall be as shown in Figure NB.1 (see Note 1) and the colour used for the design and lettering shall be in clear contrast to the background colour (see Note 2).

Note 1 The minimum dimensions of the mark given in Figure NB.1 have been selected to enable its application to pumps of the smallest anticipated dimensions. It is strongly recommended that, in the interests of visibility to the motorist, the larger recommended dimensions be used wherever possible.

Note 2 It is recommended that the background colour be white.

¹⁾ Marking BS EN 589 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity, which may also be desirable.



National annex NC (normative) Climate-dependent requirements

NC.1 Introduction

This national annex gives the climate-dependent requirements to comply with Clause 6.

NC.2 Requirements

For the purposes of this British Standard, the following grades shall apply (see Table 1):

| Summer | Winter |
|--|--|
| 1 April to 15 October inclusive Any of the five grades: grade A, grade B, grade C, grade D or grade E | 16 October to 31 March inclusive Grade A |

NOTE The date for the change from summer grade to winter grade will be reviewed in the light of experience.

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