

Pressure relief valves for transportable refillable cylinders for Liquefied Petroleum Gas (LPG)

The European Standard EN 13953:2003 has the status of a
British Standard

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National foreword

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Pressure relief valves for transportable refillable cylinders for
Liquefied Petroleum Gas (LPG)

Soupapes de sûreté des bouteilles transportables et
rechargeables pour gaz de pétrole liquéfiés (GPL)

Sicherheitsventile für ortsbewegliche, wiederbefüllbare
Flaschen für Flüssiggas (LPG)

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Foreword

This document (EN 13953:2003) has been prepared by Technical Committee CEN/TC 286 "Liquefied petroleum gas equipment and accessories", the secretariat of which is held by NSAI.

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of an identical text or by endorsement, at the latest by November 2003, and conflicting national standards shall be withdrawn at the latest by November 2003.

Annexes A, C and D are informative, Annex B is normative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies the design, testing and marking requirements for spring loaded pressure relief valves, for use in liquefied petroleum gas (LPG) cylinders.

These valves can be either an integral part of a cylinder valve (see EN 13152 and EN 13153) or a separate device.

This European Standard does not exclude the use of other designs of pressure relief devices that provide a similar level of safety.

2 Normative references

This European Standard incorporates by dated or undated 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 549, *Rubber materials for seals and diaphragms for gas appliances and gas equipment.*

EN 751 (all parts), *Sealing materials for metallic threaded joints in contact with 1st, 2nd and 3rd family gases and hot water.*

EN 837-1, *Pressure gauges - Part 1: Bourdon tube pressure gauges - Dimensions, metrology, requirements and testing.*

EN 1563, *Founding – Spheroidal graphite cast irons.*

EN 10270-3, *Steel wire for mechanical springs - Part 3: Stainless spring steel wire.*

EN 12164, *Copper and copper alloys – Rod for free machining purposes.*

EN 12420, *Copper and copper alloys – Forgings.*

EN 13906-1, *Cylindrical helical springs made from round wire and bar – Calculation and design - Part 1: Compression springs.*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply:

3.1.1

LPG

mixture of light hydrocarbons, gaseous under standard atmospheric conditions, which can be liquefied by increased pressure or decreased temperature. The main components are propane, propene, butane and butene isomers

3.1.2

pressure relief valve

valve which automatically, without the assistance of any energy other than that of the fluid concerned, discharges a quantity of fluid so as to prevent a predetermined safe pressure being exceeded, and which is designed to re-close and prevent the further flow of fluid after normal pressure conditions of service have been restored. The loading due to the fluid pressure underneath the valve-sealing element is opposed by a spring

3.1.3**pressure/flow terms**

NOTE 1 Terms used with LPG pressure relief valves are described graphically in annex A.

NOTE 2 All pressures are gauge pressures unless otherwise specified.

3.1.3.1**nominal set pressure**

predetermined pressure of the pressure relief valve at which the valve is set to start to discharge

3.1.3.2**start to discharge pressure**

inlet pressure at which the first of a stream of bubbles appears at the outlet of a pressure relief valve through a water seal of not more than 50 mm water column, or other equivalent method

3.1.3.3**pop action**

rapid opening of the valve sealing element to achieve full lift, resulting from an increase of inlet pressure creating a sudden increase in force and compression of the spring

3.1.3.4**overpressure**

pressure range between the nominal set pressure and the flow rating pressure

3.1.3.5**re-seat pressure**

inlet pressure at which the sealing element effects a seal with the valve seat after the valve has been subjected to pop action

3.1.3.6**flow rating pressure**

inlet pressure at which the discharge capacity is measured

3.1.4**nominal discharge capacity**

minimum discharge capacity at the flow rating pressure expressed in cubic metres per minute of free air at STP rounded down to one decimal place

3.1.5**discharge capacity**

capacity at the flow rating pressure of a pressure relief valve expressed in cubic metres per minute of free air at STP

3.1.6**sealing element**

non-metallic resilient component which effects the seal by contact with the pressure relief valve seat

3.1.7**valve seat**

normally raised area of the pressure relief valve body on to which the sealing element effects a seal

3.1.8**cylinder valve**

valve fitted to transportable refillable LPG cylinders from 0,5 l up to 150 l water capacity intended to convey LPG only

3.1.9**leak tightness**

resistance to leakage to atmosphere across the valve seat or any other pressure containing component when the valve is closed

3.2 Abbreviations

STP Standard Temperature and Pressure [15,6 °C (288,7 K), 1,013 bar absolute (0,1013 MPa absolute)]

4 Operating temperatures

Valves designed in accordance with this European Standard shall be suitable for:

- a minimum operating temperature of - 20 °C in service. Temperatures below this are acceptable for short periods for example, when filling;
- a minimum operating temperature of - 40 °C for those parts of Europe where valves are subject to more severe temperature conditions. The material and design shall be shown to be satisfactory for operations under these conditions and shall meet the requirements of annex B;
- a maximum operating temperature of 60 °C. Temperatures above this are acceptable for short periods.

5 Materials

5.1 General

5.1.1 Materials in contact with LPG shall be physically and chemically compatible with LPG under all normal operating conditions for which the valve is intended.

5.1.2 Materials for valve components shall be selected to give adequate strength in service. Consideration shall be given to all modes of failure including atmospheric corrosion, brass dezincification, stress corrosion, impact or material failure.

5.1.3 Alternative materials to those listed in 5.2 are not precluded, providing they can be shown to be equivalent.

5.1.4 Where pressure relief valves are an integral part of a cylinder valve, the material requirement of the cylinder valve standard shall be complied with.

5.2 Metallic materials

5.2.1 Metallic materials for valves shall be stainless steel, copper alloys, aluminium alloys, zinc alloys, or other suitable materials, and shall comply with 5.1.1 and 5.1.2.

5.2.2 Hot stamped brass shall be non-porous and shall be suitable for machining or other processes. Sand-cast brass shall not be used.

Leaded brass shall be CW614N or CW617N in accordance with EN 12420 and EN 12164.

Cold drawn brass rods up to 45 mm wide in cross-section shall only be used after heat treatment and testing for internal cracking. Cold drawn brass rods greater than 45 mm wide in cross-section shall not be used.

Components produced from stamping brass shall not exhibit cold shuts, also known as folds, or surface defects.

5.2.3 Components, when made from stainless steel, shall contain not less than 17 % chromium and not less than 7% nickel.

Springs shall be manufactured from stainless steel in accordance with EN 10270-3 or material with an equivalent resistance to corrosion.

5.2.4 Castings shall be free from inclusions and surface defects, which adversely affect the strength, leak tightness or performance of the valve.

5.2.5 Spheroidal graphite cast iron in accordance with EN 1563, with an elongation at fracture of more than 18 % shall be used. Other ductile irons or cast irons shall not be used.

5.3 Non-metallic components

5.3.1 All non-metallic materials in contact with LPG shall not distort, harden or adhere to the body or seat face to such an extent as to impair the function of the valve.

All rubber materials shall also comply with the requirements of EN 549. The ozone test in EN 549 shall only be carried out where gaskets/seals are exposed to atmosphere.

5.3.2 For guidance on the choice of non-metallic materials, see [3] ISO 11114-2.

5.4 Lubricants, sealants and adhesives

Where used on operating threads and seals, lubricants, sealants and adhesives shall be compatible with LPG and not interfere with the operation of the valve. Sealants shall comply with the requirements of EN 751.

6 Design

6.1 General

6.1.1 Pressure relief valves shall be designed to operate with a pop action within the overpressure of the valve.

The valve components shall be designed with adequate strength and adequate clearances to ensure correct operation in service.

6.1.2 The sealing element carrier shall be manufactured from a metallic material with a minimum melting point of 450 °C. Non metallic materials can be used if they are able to meet the same requirements without deformation or degradation which would impair the operation of the valve.

6.1.3 The design shall incorporate guiding arrangements of the sealing element to ensure reliable operation and leak tightness.

6.1.4 The sealing element shall be secured to prevent it becoming loose in operation.

6.1.5 Means shall be provided to lock and/or to seal the pressure relief valve in order to prevent and/or reveal any tampering with the settings. Adhesive shall not be used.

6.1.6 When pressure relief valves are provided with a means of protection (such as a disc or cap) to prevent the ingress of foreign matter, such protection shall be designed so as not to be easily displaced except by the discharge from the pressure relief valve and shall not interfere with the proper operations of the valve.

6.1.7 The minimum required discharge capacity of the pressure relief valve can be calculated in accordance with annex C.

6.1.8 The nominal set pressure for pressure relief valves shall have a value between 2,4 MPa and 3,5 MPa (24 bar and 35 bar) as specified to the manufacturer.

NOTE The nominal set pressure should be greater than the maximum operating pressure of the LPG and less than the permanent deformation pressure of the cylinder.

6.2 Threads

The end connections for pressure relief valves intended to be directly fitted into the cylinder, shall be either a taper thread or a parallel thread combined with a sealing and securing method.

6.3 Springs

Springs shall be designed in accordance with EN 13906-1 or shall be designed to prevent design stresses (as specified in EN 13906-1) being exceeded at the flow rating pressure. Stops may be provided to avoid excessive stresses.

6.4 Test requirements

6.4.1 The valve shall withstand a hydraulic test without permanent deformation, rupture or leak (see 7.2).

6.4.2 The leak tightness shall not exceed a leakage rate of 15 cm³/hour at STP.

6.4.3 The results of the three start to discharge tests (see 7.3) on each valve shall be within 5 % of the arithmetic average.

The start to discharge pressure shall be within ± 15 % of the nominal set pressure.

6.4.4 The flow rating pressure shall be 120 % of the nominal set pressure.

6.4.5 The range of results of the discharge capacity tests (see 7.3.3) shall be within – 0 % and + 20 % of the nominal discharge capacity of the pressure relief valve.

6.4.6 The re-seat pressure shall be not less than 70 % of the nominal set pressure, and in any case not less than the maximum operating pressure of the cylinder.

6.4.7 There shall be no chatter, flutter, sticking and/or harmful vibration during the tests.

7 Testing and inspection of the design

7.1 General

All sample valves shall be tested in accordance with this clause.

All sample valves shall initially be subject to visual inspection and dimensional checks.

The test medium shall be air or nitrogen for all tests unless otherwise stated.

The accuracy class for pressure measuring equipment used during the tests shall not be more than 0,6, with the test pressure within the middle third of the instrument range and shall be in accordance with EN 837-1.

The test equipment for use in measuring discharge capacity shall be accurate to within 2 %.

7.2 Hydraulic proof test

This test shall be carried out on one valve prior to other tests and following manner:

- a) the body seat of the relief valve shall be blanked off so that the pressure is only applied to those parts on the inlet side of the seat;
- b) the test medium shall be water or other suitable liquid;
- c) the valve shall be subjected to a hydraulic pressure of not less than 1,43 times the nominal set pressure;
- d) pressure shall be applied through a fitting reproducing the cylinder connection;
- e) the pressure shall be raised continuously and gradually,
- f) the test duration shall be two minutes minimum,

- g) e) and f) shall then be repeated with the relief valve operating mechanism in the open position, and with the outlet sealed.

The valve shall meet the requirements of 6.4.1 or the design shall be rejected.

NOTE Alternatively pneumatic testing may be carried out, if a similar level of sensitivity and safety is provided.

7.3 Start to discharge and discharge capacity test

7.3.1 At least three new samples of the pressure relief valve set at the same nominal set pressure shall be used. If the pressure relief valve forms part of a cylinder valve, any features, which can affect the flow characteristics, shall be included in the samples being tested.

7.3.2 The start to discharge pressure of each of the three pressure relief valves shall be determined by the following procedure which shall be carried out three times for each of the valves:

- apply pressure to lift the pressure relief valve sealing element off the seat to ensure that it is not sticking;
- remove all the pressure to allow the pressure relief valve to close;
- check the leak tightness is in accordance with 6.4.2;
- apply pressure to lift the pressure relief valve sealing element to determine the start to discharge pressure;

The valve shall meet the requirements of 6.4.3 and 6.4.7 or the design shall be rejected.

NOTE When testing a relief valve for flow, it is important that the effect of the non-metallic seat sticking does not influence the result.

7.3.3 The discharge capacity of each of the three pressure relief valves shall be determined in the following manner:

- the valve shall have already been subjected to the start to discharge pressure test;
- apply a gradually increasing pressure until the flow rating pressure is reached;
- maintain this pressure until the discharge capacity has been recorded;
- gradually decrease the pressure until the pressure relief valve re-seats and record the re-seat pressure.

The lowest of the test results shall be deemed to be the nominal discharge capacity of the pressure relief valve.

The valve shall meet the requirements of 6.4. 5, 6.4.6 and 6.4.7 or the design shall be rejected.

7.4 Leak test

Each valve shall then be tested to ensure leak tightness so that at any pressure below the start to discharge pressure and above 1,1 bar.

the valve shall meet the requirements of 6.4.2 or the design shall be rejected.

7.5 Test records

The following data shall be recorded for each valve design:

- nominal set pressure;
- discharge capacity;
- flow rating pressure to which the discharge capacity applies.

7.6 Design changes

When changes are made in the design of a pressure relief valve, which affect its flow path or discharge capacity, or if the set pressure is to be modified by more than 10 %, new tests shall be carried out.

8 Production testing

Each pressure relief valve shall be subjected to production testing. Annex D gives recommendations for production testing and inspection.

9 Marking

The following minimum information shall be marked on the body of all pressure relief valves, except where the information is already included on the integral cylinder valve:

- a) manufacturer's name or trademark;
- b) type number;
- c) date (code) indicating month and year of manufacture;
- d) nominal set pressure;
- e) discharge capacity of air, quoted in cubic metres per minute;
- f) “-40 °C”, for valves fulfilling the requirements of annex B.

NOTE The Council Directive 1999/36/EC also has marking requirements.

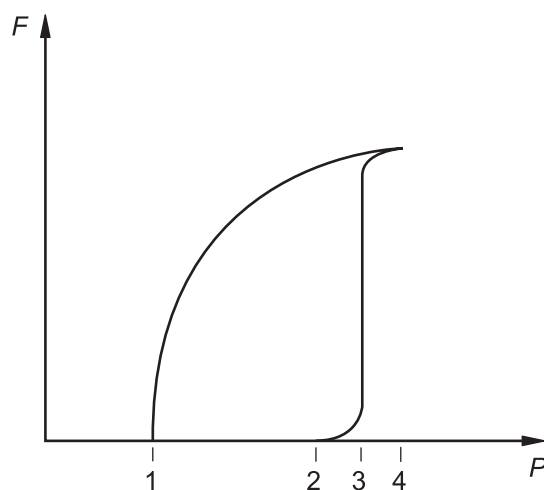
10 Documentation

The following information shall be supplied with pressure relief valves:

- performance characteristics;
- user/installation instructions including a requirement not to interfere with the setting of the valve;
- method and torque requirements for sealing taper threads, in order to provide the correct thread engagement;
- valve identification;
- manufacturers details and name;
- maintenance and reconditioning recommendations;
- declaration of conformity with this standard.

Annex A (informative)

Terms used with pressure relief valves



Key

- 1 Re-seat pressure
- 2 Start to discharge pressure
- 3 Pop action
- 4 Flow rating pressure

P Pressure
 F Flow

Figure A.1 — Terms used with LPG safety valve

Annex B (normative)

Special low temperature requirements for valves

B.1 In some parts of Europe where valves are subject to more severe temperature conditions, the design temperature range shall be extended to – 40 °C. The material and design shall be shown to be satisfactory for operations under these conditions.

B.2 The valve shall undergo the following:

The valve is subjected to a temperature of – 40 °C for 24 hours.

Its temperature is then raised to – 30 °C.

B.3 The valve shall then be tested in accordance with 7.4.

B.4 The minimum operating temperature "– 40 °C" shall be marked in accordance with the requirements of clause 9.

Annex C (informative)

Sizing of pressure relief valves for LPG cylinders

The minimum required discharge capacity of the valve can be calculated in accordance with the formula:

$$Q = 0,00278 \times P \times W$$

Where:

P is the flow rating pressure in bar absolute,

W is the water capacity of cylinder in litres, (*W* = 5 for cylinders of 5 litres capacity or less)

Q is the minimum required discharge capacity in cubic metres per minute of free air.

Annex D (informative)

Production testing

D.1 General

The manufacturer shall implement a conformity assessment procedure to ensure that the quality and performance of the manufactured valves comply with the quality and performance of the design.

D.2 Dimensional inspection

Critical dimensions shall be checked. Critical dimensions are any dimensions that can affect the safety, performance operation or installation of the pressure relief valve.

D.3 Setting and leak testing of pressure relief valves

Setting and leak testing shall be carried out pneumatically using air, or nitrogen.

Each pressure relief valve shall be adjusted so that the start to discharge pressure is at the nominal set pressure.

At any inlet pressure less than the re-seat pressure, the leakage rate through the valve shall not exceed 15 cm³ per hour at STP.

Any subsequent testing of the set pressure shall result in the start to discharge pressure being within 615 % of the nominal set pressure.

Bibliography

- [1] EN 13152, *Specifications and testing for LPG cylinder valves - Self closing.*
- [2] EN 13153, *Specifications and testing for LPG cylinder valves – Manually operated.*
- [3] ISO 11114-2, *Transportable gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 2: Non-metallic materials.*
- [4] Council Directive 1999/36/EC, *Council Directive 1999/36/EC of 29 April 1999 on transportable pressure equipment.*

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