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Transportable gas containers —

**Part 7: Specification for seamless steel
gas containers of water capacity 0.5 L
up to 15 L for special portable
applications**

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to the Pressure Vessels Standards Committee PVE/3/-, to Technical Committee PVE/3, upon which the following bodies were represented:

- Associated Offices Technical Committee
- Association of Shell Boilermakers
- British Chemical Engineering Contractors' Association
- British Compressed Gases Association
- British Gas Corporation
- British Insurance (Atomic Energy) Committee
- British Steel Industry
- Chemical Industries Association
- Department of Trade (Marine Division)
- Engineering Equipment Users' Association
- Health and Safety Executive
- Institution of Chemical Engineers
- Institution of Gas Engineers
- Institution of Mechanical Engineers
- Lloyd's Register of Shipping
- Oil Companies Materials Association
- Process Plant Association
- United Kingdom Atomic Energy Authority
- University of Manchester (Institute of Science and Technology)
- Water-tube Boilermakers' Association
- Welding Institute

The following bodies were also represented in the drafting of this standard, through subcommittee PVE/3:

- Aluminium Federation
- Association of Drum Manufacturers
- British Railways Board
- British Sub-aqua Club
- Chief and Assistant Chief Fire Officers' Association
- Department of Industry (National Engineering Laboratory)
- Department of Industry (National Physical Laboratory)
- Fire Extinguishing Trades Association
- Home Office
- Industrial Safety (Protective Equipment) Manufacturers' Association
- Institute of Refrigeration
- Institution of Fire Engineers
- Liquefied Petroleum Gas Industry Technical Association (UK)
- Ministry of Defence
- National Association of Soft Drinks Manufacturers
- Society of Motor Manufacturers and Traders Limited
- Coopted members

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Foreword

This British Standard has been prepared under the direction of the Pressure Vessel Standards Committee. Together with BS EN 1964-1:2000 it supersedes BS 5045-1:1982 which is withdrawn. When first published, BS 5045-1:1982 was one of a series which dealt with materials, design, construction, testing, filling and maintenance of containers intended for the conveyance by road of permanent, liquefiable and dissolved gases under pressure. The requirements for seamless steel containers for general applications in BS 5045-1:1982 were superseded by the publication of BS EN 1964-1:2000. However, requirements for small portable containers for special applications remain current.

This new edition therefore renumbers BS 5045-1:1982 as BS 5045-7:2000 and modifies its scope to restrict its applicability to these special application containers. It does not, however, constitute a full revision of the standard.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 29 and a back cover.

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1 Scope

This part of BS 5045 specifies the requirements for the materials, design, construction and testing of seamless steel containers of water capacity greater than 0.5 litre up to 15 litres for the conveyance and storage of gases under pressure used in the following portable applications:

- for use in aircraft;
- for breathing apparatus;
- for underwater breathing dress apparatus;
- for resuscitation apparatus;
- for fire extinguishers;
- for life raft inflation apparatus.

It includes appendices giving examples of design calculations, a description of the methods for pressure testing of containers, a description of the methods for ultrasonic examination of containers, model forms of design and acceptance certificates.

2 Normative references

The following normative documents contain provisions which, through reference in this text constitute provisions of this British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 341-1, *Transportable gas container valves — Part 1: Valves with taper stems (excluding valves used for breathing and medical purposes)*.

BS 341-2, *Transportable gas container valves — Part 2: Valves with taper stems for use with breathing apparatus*.

BS 2915, *Specification for bursting discs and bursting disc devices*.

BS 3894-1, *Method for converting elongation values for steel — Part 1: Carbon and low alloy steels*.

BS 4500-1, *ISO limits and fits — Part 1: General tolerances and deviations*.

BS 5355, *Specification for filling ratios and developed pressures for liquefiable and permanent gases*.

BS 6200-2-2.1:1993, *Sampling and analysis of iron, steel and other ferrous metals — Part 2: Sampling and sample preparation — Section 2.1: Methods for iron and steel*.

BS 10109-1:1996, *Metallic materials. Hardness test — Part 1: Rockwell test (scales A, B, C, D, E, F, G, H, K) and Rockwell superficial test (scales 15 N, 30 N, 45 N, 15 T, 30 T and 45 T)*.

BS EN 837-1:1998, *Pressure gauges — Part 1: Bourdon tube pressure gauges — Dimensions, metrology, requirements and testing*.

BS EN 850:1997, *Transportable gas cylinders — Pin-index, yoke-type valve outlet connections for medical use*.

BS EN 10002-1:1990, *Tensile testing of metallic materials — Part 1: Method of test at ambient temperature*.

BS EN 10002-3:1995, *Tensile testing of metallic materials — Part 3: Calibration of force proving instruments used for the verification of uniaxial testing machines*.

BS EN 10003-1:1995, *Metallic materials — Brinell hardness test — Part 1: Test method*.

3 Manufacture and testing of containers

The manufacture, inspection and testing of containers conforming to the requirements of this British Standard shall be carried out to the satisfaction of an Independent Inspecting Authority to be approved by the Health and Safety Executive.

4 Classification of gases

For the purposes of the design and filling of the container, gases are classified as follows.

- a) *Permanent gases*. Those gases that have a critical temperature below -10°C ;
- b) *Liquefiable gases*. Those gases that are liquefiable by pressure at -10°C and that are completely vaporized at 17.5°C and 1 013 mbar¹⁾. High pressure liquefiable gases are those having a critical temperature between -10°C and 70°C . Low pressure liquefiable gases are those having a critical temperature above 70°C .
- c) *Dissolved gas*. A gas that is dissolved under pressure in a solvent contained in a porous substance at ambient temperature and that is released from the solvent without application of heat.

This classification is illustrated in Table 1.

5 Information to be supplied by the purchaser and the manufacturer

5.1 Information to be supplied by the purchaser

The purchaser shall inform the manufacturer of the following, as appropriate:

- a) name or classification of gas(es);
- b) service application;
- c) volumetric capacity (for liquefiable gases this shall be the minimum);
- d) for permanent gases, the filling pressure at 15°C ;
- e) for liquefiable gases, the mass of gas or filling ratio at the prescribed reference temperature or the required developed pressure in service;

¹⁾ 1 mbar = 10^2 N/m² = 0.1 kPa.

- f) material of construction;
- g) preferred dimensions;
- h) shape of base;
- i) internal and/or external neck screwing dimensions;
- j) fittings required;
- k) external/internal finish required;
- l) any special or adverse conditions under which the container will be required to operate, and any corrosion allowance required (see note 2 of 12.3);
- m) any requirements in excess of those specified in this standard;
- n) the name of the Independent Inspecting Authority.

Permanent gases	Liquefiable gases		Dissolved gases
	High pressure	Low pressure	
$(T_c < -10\text{ }^{\circ}\text{C})$	$(-10\text{ }^{\circ}\text{C} \leq T_c \leq 70\text{ }^{\circ}\text{C})$	$(T_c > 70\text{ }^{\circ}\text{C})$	
Air	Carbon dioxide	—	—
Argon	Nitrous oxide		
Helium			
Nitrogen			
Oxygen			

NOTE T_c is the critical temperature.

5.2 Information to be supplied by the manufacturer

The manufacturer shall supply the purchaser and the Independent Inspecting Authority with the following:

- a) fully dimensioned sectional drawing of the container including:
 - 1) name or classification of gas(es);
 - 2) volumetric capacity (for liquefiable gases this shall be the minimum);
 - 3) filling pressure at 15 °C for permanent gas(es), or mass of liquefiable gas(es);
 - 4) material of construction;
 - 5) test pressure;
 - 6) minimum and maximum masses of container;
 - 7) statement that the container will conform to the requirements of this standard;
 - 8) design approval (see clause 14);
 - 9) corrosion allowance (if any);
- b) method of manufacture;
- c) fittings to be supplied;
- d) drawing showing layout of stamped marking (see clause 28);
- e) certificates of test for materials and container (see annex D).

6 Certificate of compliance

The manufacturer shall certify that the manufacture, inspection and testing of the container were carried out in compliance with the requirements of this standard.

The Independent Inspecting Authority shall certify acceptance of the above certification.

NOTE A suitable form of certificate is shown in annex D.

7 Permissible materials — General

Containers shall be made only from materials whose compositions are given in Table 2; the mechanical properties of the finished container shall be as specified in Table 3.

8 Permissible materials — Chemical composition

8.1 The ladle analyses shall conform to the appropriate requirements of Table 2.

In the event of one melt being divided between more than one ladle, samples shall be analyzed from each ladle and separate analyses provided for each ladle. Each of these ladles shall subsequently be regarded as a specific cast and identified accordingly.

8.2 Variation between the product analysis and the ladle analysis, which occurs because of heterogeneity arising during the casting and solidification of the ingot, shall not exceed the permitted deviations given in Tables 4 and 5.

NOTE 1 Product analysis is any analysis of the steel subsequent to the ladle analysis.

The deviations are permitted in the individual elements either above or below the specified range but shall not be applied both above and below the specified range for any one element from any one ladle of steel.

NOTE 2 When maxima only are specified, the deviations are positive only.

8.3 Any ingot, bar or container that on chemical analysis is outside the limits of permissible deviation from the specified composition range for a specified element shall be deemed not to conform to the requirements of this standard.

8.4 In the event of a single sample falling outside the permitted deviations on the product analysis, further samples shall be selected for check analysis from the remainder of the consignment as follows:

- at least two samples from the same ladle for delivered masses up to 5 t;
- at least five samples from the same ladle for delivered masses up to 20 t; and
- at least eight samples from the same ladle for delivered masses over 20 t.

These samples shall fall within the permitted deviations. If any of these further samples are proved to be outside the permitted deviations for any specified element, the consignment shall be deemed not to conform to the requirements of this standard.

8.5 Samples for product analysis shall be taken in accordance with BS 6200-2-2.1.

9 Permissible materials — Steelmaker's certificate

The steelmaker shall supply a certificate stating:

- a) the steelmaking process; and
- b) the ladle analysis.

10 Permissible materials — Identification of steel

The steel shall be marked and records shall be kept so as to enable the cast from which each container is made to be identified.

Table 2 — Steelmaking process and chemical composition of permissible materials

Material	Code	Steelmaking process	Chemical composition													
			Carbon		Silicon		Manganese		Phosphorus	Sulfur	Chromium		Molybdenum		Nickel	
											min.	max.	min.	max.	min.	max.
Carbon steels	M	Open hearth electric furnace or basic oxygen process	%	%	%	%	%	%	%	%	%	%	%	%	%	%
	0.15		0.25	0.05	0.35	0.40	0.90	0.050	0.050	—	—	—	—	—	—	
	C	Steels made by the oxygen process shall not contain more than 0.008 % of nitrogen	0.35	0.45	0.05	0.35	0.60	1.00	0.050	0.050	—	—	—	—	—	—
Carbon manganese steels	Mn and MnH		—	0.40	0.10	0.35	1.30	1.70	0.050	0.050	—	—	—	—	—	—
Chromium molybdenum alloy steel	CM	Open hearth, electric furnace or basic oxygen process	—	0.37	0.10	0.35	0.40	0.90	0.050	0.050	0.80	1.20	0.15	0.25	—	0.50 ^a
Nickel chromium molybdenum alloy steel	NCM	Steels made by the oxygen process shall not contain more than 0.010 % nitrogen	0.27	0.35	0.10	0.35	0.50	0.70	0.050	0.050	0.50	0.80	0.40	0.70	2.30	2.80
Residual nickel.																

Table 3 — Heat treatment and mechanical properties of steel in finished containers

Material	Code	Heat treatment	Tensile strength		Yield stress (Y) ^a , specified min. value	Ratio of specified min. yield stress to specified min. tensile strength $\frac{Y}{T}$	Minimum elongation on $5.65\sqrt{S_0}$	Max. radius of bend test forming tool
			Specified min. (T)	Max.				
Carbon steels	M	normalized or normalized and tempered	N/mm ² 430	N/mm ² 510	N/mm ² 250	—	% 22	$1\frac{1}{2} t_a$ ^b
	C	normalized or normalized and tempered	570	680	310	—	19	$2 t_a$
Carbon manganese steels	Mn	normalized or normalized and tempered at not less than 550 °C and cooled in air	650	760	445	—	20	$2\frac{1}{2} t_a$
	MnH	hardened from 800 °C to 850 °C and tempered at 530 °C to 670 °C	890 max.	1 030	755	0.85 max.	14	$3 t_a$
Chromium molybdenum alloy steel	CM	hardened from 850 °C to 920 °C and tempered at 550 °C to 720 °C	890 max.	1 030	755	0.85 max.	14	$3 t_a$
Nickel chromium molybdenum alloy steel	NCM	hardened from 820 °C to 850 °C and tempered at 550 °C to 660 °C	890 max.	1 030	755	0.85 max.	14	$3 t_a$
^a Yield stress refers to the upper yield stress (R_{eh}) or, if applicable, the 0.2 % non-proportional elongation proof stress ($R_{p0.2}$). Values in excess of this shall not be used for calculation purposes. ^b t_a is the actual thickness of the specimen.								
NOTE For hardness properties see Figure 1.								