

Hydraulic fluid power — Gas loaded accumulators —

**Part 1: Specification for seamless steel
accumulator bodies above 0.5 L water
capacity**

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Foreword

This Part of BS 7201 has been prepared under the direction of the Machinery and Components Standards Policy Committee. It is the first of a series for the materials, design, construction, testing and maintenance of accumulator bodies intended for use in fluid power hydraulic systems. When fully assembled the accumulator body houses an elastomeric separator bag which is precharged with nitrogen gas. This Part of this standard closely follows the requirements for transportable gas containers specified in BS 5045-1. If additional steelmaking processes are included in BS 5045-1, they may also be added to this standard.

It is expected that the manufacture, inspection and testing of accumulator bodies will be carried out to the satisfaction of an independent testing authority.

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.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 28, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

1 Scope

This Part of BS 7201 specifies requirements for the materials, design, calculations, manufacture and performance of seamless steel accumulator bodies having a water capacity greater than 0.5 L.

It does not specify requirements for the design of body end shape and dimensions.

It includes appendices which give examples of design calculations and specimen certificates, and which describe methods for pressure testing and ultrasonic examination of the accumulator body.

NOTE The titles of the publications referred to in this Part of this British Standard are listed on the inside back cover.

2 Definition

For the purposes of this Part of this British Standard the following definition applies.

independent inspecting authority
a third party certification body, independent of the manufacturer, who verifies that accumulator bodies comply with this Part of this standard

3 Symbols

For the purposes of this Part of this British Standard the following symbols apply.

Symbol	Description	Unit
C	The compressibility of water	mL
D_1	Maximum internal diameter of accumulator body	mm
e	Minimum spherical wall thickness to resist pressure and external forces but excluding any additional thickness for corrosion and any other influences	mm
E_p	Permanent expansion of accumulator body	mL
E_t	Total expansion of accumulator body	mL
E_v	Total volumetric expansion of accumulator body	mL
f_b	Nominal hoop stress at which destruction of accumulator body occurs	N/mm ²
f_e	Maximum permissible equivalent stress at design pressure (see Table 2), either: $f_e = 0.5 Y$ of the material of construction, or	N/mm ²

Symbol	Description	Unit
	$f_e = 0.38 T$ of the material of construction, whichever is the least	
K	Factor for the compressibility of water (see Table 5)	—
l	Length of additional reinforcement of area Y (see Figure 3)	mm
m	Mass of water at test pressure, P_1	kg
P	Pressure, i.e. design or maximum permissible	bar ^a
P_1	Test pressure (applicable to design $P_1 = 1.5 P$)	bar
P_b	Internal pressure at which destruction of accumulator body occurs	bar
R	Percentage ratio of permanent expansion to total expansion	%
S_0	Minimum elongation	%
t	Minimum cylindrical wall thickness to resist pressure and external forces but excluding any additional thickness for corrosion and any other influences	mm
t^1	Actual wall thickness of accumulator body	mm
T	Tensile strength of material of construction (see Table 2)	N/mm ²
Y	Minimum specified yield stress (see Table 2)	N/mm ²
^a 1 bar = 0.1 N/mm ² = 0.1 MPa.		

4 Information to be exchanged

In addition to the definitive requirements, this Part of this standard also requires the items detailed in Appendix A to be documented. For compliance with this Part, both the definitive requirements and the documented items have to be satisfied.

5 Certificate of compliance

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

NOTE It is expected that an independent inspecting authority will verify the above certification. A suitable form of certificate is shown in Appendix B.

Section 2. Materials

6 General

Accumulator bodies shall be made only from materials whose compositions are given in Table 1. The mechanical properties of the finished container shall be as specified in Table 2.

7 Chemical composition

7.1 The ladle analyses shall comply with the appropriate requirements of Table 1.

In the event of one melt being divided between more than one ladle, samples shall be analysed 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.

7.2 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 permissible deviations given in Table 3 and Table 4.

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 in Table 1, the deviations are positive only.

7.3 Any ingot, bar or container that, on chemical analysis, is outside the limits of permissible deviation from the composition range specified in Table 1 for a specified element shall be deemed not to comply with the requirements of this Part of this standard.

7.4 In the event of a single sample falling outside the permissible deviations given in Table 3 and Table 4 on the product analysis, further samples shall be selected for check analysis from the remainder of the consignment, as follows:

- a) at least two samples from the same ladle for delivered mass up to 5 t;
- b) at least five samples from the same ladle for delivered masses up to 20 t;
- c) at least eight samples from the same ladle for delivered masses over 20 t.

These samples shall fall within the permissible deviations given in Table 3 and Table 4. If any of these further samples are proved to be outside the permissible deviations for any specified element, the consignment shall be deemed not to comply with the requirements of this Part of this standard.

7.5 Samples for product analysis shall be taken in accordance with BS 1837.

8 Steelmaker's certificate

The steelmaker shall have supplied a certificate stating:

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

9 Identification of steel

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

Table 1 — Steelmaking process and chemical composition

Material	Code	Steelmaking process	Chemical composition													
			Carbon		Silicon		Manganese		Phosphorus	Sulphur	Chromium		Molybdenum		Nickel	
			min.	max.	min.	max.	min.	max.	max.	max.	min.	max.	min.	max.	min.	max.
Carbon steels	M	Electric furnace or basic oxygen process. Steels made by the oxygen process shall not contain more than 0.008 % of nitrogen	%	%	%	%	%	%	%	%	%	%	%	%	%	%
	C		0.15	0.25	0.05	0.35	0.40	0.90	0.050	0.050	—	—	—	—	—	—
	—		0.45		0.40		1.05	0.045	0.045	—	—	—	—	—	—	
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	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
			0.31	0.38	0.10	0.40	0.60	0.90	0.035	0.035	0.90	1.20	0.15	0.40	—	0.50 ^a
Nickel chromium molybdenum alloy steel	NCM		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
^a Residual nickel.																

^a Residual nickel.

Table 2 — Heat treatment and mechanical properties of steel in finished accumulator bodies^a

Material	Code	Heat treatment	Tensile strength (<i>T</i>)		Minimum yield stress (<i>Y</i>) ^b	Maximum permissible equivalent stress at design pressure (<i>f_e</i>)	Minimum elongation on $5.65\sqrt{S_0}$	Maximum radius of bend test forming tool ^c
			Min.	Max.				
Carbon steels	M	Normalized or normalized and tempered	N/mm ² 430	N/mm ² 510	N/mm ² 250	N/mm ² 125	% 22	$1\frac{1}{2} t_a$
	C	Normalized or normalized and tempered	570 550	680 680	310 310	155 155	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	222.5	20	$2\frac{1}{2} t_a$
	MnH	Hardened from 800 °C to 850 °C and tempered at 530 °C to 670 °C	890	1 030	755	338	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	1 030	755	338	14	$3 t_a$
			900	1 040	710	342		
			960	1 100	780	365		
			965	1 105	810	367		
Nickel chromium molybdenum alloy steel	NCM	Hardened from 820 °C to 850 °C and tempered at 550 °C to 660 °C	890	1 030	755	338	14	$3 t_a$

^a For hardness properties see Figure 1.^b 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 should not be used for calculation purposes.^c t_a is the actual thickness of the specimen.

Table 3 — Permissible deviation on product analysis from specified range for carbon and carbon manganese steels

Element	Maximum of the specified range	Permissible deviation on product analysis ^a
	%	%
Carbon	≤ 0.25	0.02
	> 0.25 to 0.50	0.03
Silicon		0.03
Manganese	≤ 1.0	0.04
	> 1.0 to 1.5	0.08
	> 1.5	0.10
Phosphorus		0.008
Sulphur		0.008
^a Maximum and minimum values do not apply simultaneously for individual elements (see 7.2).		

Table 4 — Permissible deviation on product analysis from specified range for alloy steels

Element	Maximum of the specified range	Permissible deviation on product analysis ^a
	%	%
Carbon	≤ 0.25	0.01
	> 0.25 to 0.50	0.02
Silicon		0.03
Manganese	≤ 0.70	0.03
	> 0.70 to 1.0	0.04
	> 1.0 to 2.0	0.05
Phosphorus		0.004
Sulphur		0.005
Chromium	≤ 0.60	0.03
	> 0.60 to 1.25	0.04
Molybdenum	≤ 0.50	0.02
	> 0.50	0.03
Nickel	≤ 1.0	0.03
	> 1.0 to 3.0	0.05
^a Maximum and minimum values do not apply simultaneously for individual elements (see 7.2).		