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# International Standard



# 6537

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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

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## **Pneumatic fluid power systems — Cylinder barrels — Requirements for non-ferrous metallic tubes**

*Transmissions pneumatiques — Tubes pour vérins — Caractéristiques des tubes en métaux non ferreux*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 6537 was developed by Technical Committee ISO/TC 131, *Fluid power systems*, and was circulated to the member bodies in September 1981.

It has been approved by the member bodies of the following countries :

Australia	Hungary	South Africa, Rep. of
Austria	India	Sweden
Belgium	Ireland	Switzerland
Canada	Mexico	United Kingdom
China	Netherlands	USA
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The member bodies of the following countries expressed disapproval of the document on technical grounds :

France  
Japan

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## Contents

	Page
<b>0</b> Introduction .....	1
<b>1</b> Scope and field of application .....	1
<b>2</b> References .....	1
<b>3</b> Definitions .....	1
<b>4</b> Symbols .....	1
<b>5</b> Manufacture of base tubes .....	2
<b>6</b> Pressures .....	2
<b>7</b> Temperature .....	2
<b>8</b> Tolerances .....	2
<b>9</b> Surface finish .....	4
<b>10</b> Protection and packing .....	4
<b>11</b> Test certification .....	4
<b>12</b> Identification statement .....	4
 <b>Annexes</b>	
<b>A</b> Non-ferrous metallic pneumatic cylinder tube dimensions and tolerances .....	5
<b>B</b> Method of ordering .....	6

# Pneumatic fluid power systems — Cylinder barrels — Requirements for non-ferrous metallic tubes

## 0 Introduction

In pneumatic fluid power systems, power is transmitted and controlled through gas under pressure circulating within a circuit. One component of such systems is the fluid power cylinder. This is a device which converts power into linear mechanical force and motion. It consists of a movable element, i.e. a piston rod operating within a cylindrical bore.

For the majority of applications, tubing is specified in terms of outside diameter and thickness. For pneumatic fluid power cylinders, however, the important dimensions are bore diameter and thickness (taking account of the pressure rating).

This International Standard covers non-ferrous metallic pneumatic cylinder tubes.

## 1 Scope and field of application

**1.1** This International Standard defines the mechanical properties, dimensional tolerances, surface finishes and technical delivery conditions of the following tubes and bores for pneumatic fluid power cylinders :

- round non-ferrous metallic tubes, seamless or welded type, in the as-drawn stress-relieved or fully heat-treated condition;
- bores, specially finished, with or without metal removal.

**1.2** The tubes covered by this International Standard are intended for use as barrels in a wide variety of pneumatic cylinders.

NOTE — Brass and aluminium have been considered as a basis in this document but should not be considered the only materials suitable for such applications.

**1.3** Annex A specifies the dimensions and tolerances on inside diameters for non-ferrous metallic pneumatic cylinder tubes.

**1.4** Annex B provides a recommended method of ordering.

## 2 References

ISO 286/1, *ISO systems of limits and fits — Part 1 : General, tolerances and deviations.*<sup>1)</sup>

ISO 468, *Surface roughness — Parameters, their values and general rules for specifying surfaces.*

ISO 3322, *Fluid power systems and components — Cylinders — Nominal pressures.*

ISO 5598, *Hydraulic and pneumatic fluid power — Vocabulary.*<sup>2)</sup>

## 3 Definitions

For definitions of terms used, see ISO 5598.

## 4 Symbols

The following symbols are used in this International Standard :

$D$	= nominal outside diameter of the tube
$d$	= nominal inside diameter of the tube
$a$	= nominal thickness of the tube
$R_m$ <sup>3)</sup>	= tensile strength at ambient temperature

1) At present at the stage of draft. (Revision of ISO/R 286-1962.)

2) At present at the stage of draft.

3) Symbols for supplier and purchaser reference only.

- $R_{eL}^{1)}$  = lower yield stress (aluminium only)
- $R_{p(0,2)}^{1)}$  = 0,2% proof stress (this figure will be used if the yield stress is not clearly indicated)
- $S_0^{1)}$  = cross-sectional area of gauge length
- $A^{2)}$  = elongation after fracture on gauge length  
=  $5,65 \sqrt{S_0}$
- $R_a$  = arithmetical mean deviation from the mean line of the profile; roughness parameter (see ISO 468)
- $R_{ma}$  = maximum height of the profile; roughness parameter (see ISO 468)

**5 Manufacture of base tubes**

**5.1 Manufacturing process**

**5.1.1** Use seamless base tubes without special finishing, supplied stress-relieved, annealed, or in fully heat-treated condition.

**5.1.2** For tubes of welded construction, supply with special finishing.

**5.2 Mechanical and chemical properties**

**5.2.1** At the discretion of the manufacturer, or unless otherwise agreed to at the time of order, supply the tubes in the heat-treated condition necessary to achieve the mechanical properties.

**5.2.2** When brass tubing is used, stress-relieve it after the final drawing operation.

**5.2.3** The alloy and metallurgic condition are chosen by the technical departments of the tube manufacturer and cylinder manufacturer together, to ensure mechanical and chemical properties suited to the conditions of use of the cylinder.

**5.3 Finishing**

The finishing process required to achieve the bore tolerances and surface finishes covered by this International Standard is subject to agreement between supplier and purchaser.

**6 Pressures**

**6.1** Limit the normal operating pressure of pneumatic cylinders in general to 25 bar (2 500 kPa) in the standard range, i.e. 6,3 – 10 – 16 – 25 bar (630 – 1 000 – 1 600 – 2 500 kPa) (see ISO 3322).

**6.2** Use the permissible pressures as determined by the cylinder manufacturer in line with the established technology of

the trade and applying the safety factors set by the regulations or standards which are in force.

**7 Temperature**

Utilize a working temperature range as determined by the manufacturer, but which is at least within the range of – 40 and + 100 °C.

**8 Tolerances**

**8.1 Ordering**

Refer to annex B for the method of ordering.

**8.2 Inside diameter**

**8.2.1** Four classes of tolerances are recognized, H11, H12, H13 and H14, in accordance with ISO 286 (see annex A).

**8.2.2** The bore tolerances include all possible deformations of the internal cylinder such as ovality, lobing, etc. with the exception of straightness faults.

**8.2.3** At the request of the purchaser, special tolerances are subject to agreement between purchaser and supplier if the material is stress-relieved.

**8.3 Thickness and eccentricity**

**8.3.1** The thickness measured at any cross-section along the tube length shall not vary from the mean thickness as shown in the table below.

**Table 1 – Mean thickness and eccentricity**

Thickness, mm <i>a</i>	Tolerances %
0,5 < <i>a</i> < 1 1 < <i>a</i> < 2 2 < <i>a</i> < 3 <i>a</i> > 3	± 10

NOTE — This table includes the eccentricity between inside and outside diameters.

**8.3.2** When the inside and outside diameters are specified, maintain the tolerance on the outside diameter to ensure the minimum and maximum wall thickness as determined in the table above, anywhere along the tube.

**8.4 Straightness**

**8.4.1** The measure of straightness is defined in this International Standard as the maximum deviation that can be measured with feeler gauges between the tube and a straight edge of 1 000 mm length resting on the outside surface of the tube and parallel to its axis.

1) Symbols for supplier and purchaser reference only.

2) Elongation on  $5,65 \sqrt{S_0}$  for tubes with a wall thickness of 3 mm and thinner, and on 50 mm for tubes with thicker walls (aluminium only).

**8.4.2** As an alternative to 8.4.1, support the tubes by two rollers placed at intervals of 1 000 mm and measure their maximum deviation from the straight while the tubes are being rotated.

NOTE — Applying this method, the deviation from straightness is half the value of the total indicator reading (TIR).

**8.4.3** For tubes 1 000 mm and longer, measure the deviation over 1 000 mm lengths set at consecutive intervals of 500 mm starting at one end.

**8.4.4** For tubes longer than 1 000 mm, ensure that the deviation is not greater than 1/1 000.

**8.4.5** Measure tubes up to and including 1 000 mm long over their entire length, and with deviations not exceeding values deduced from figure 1.

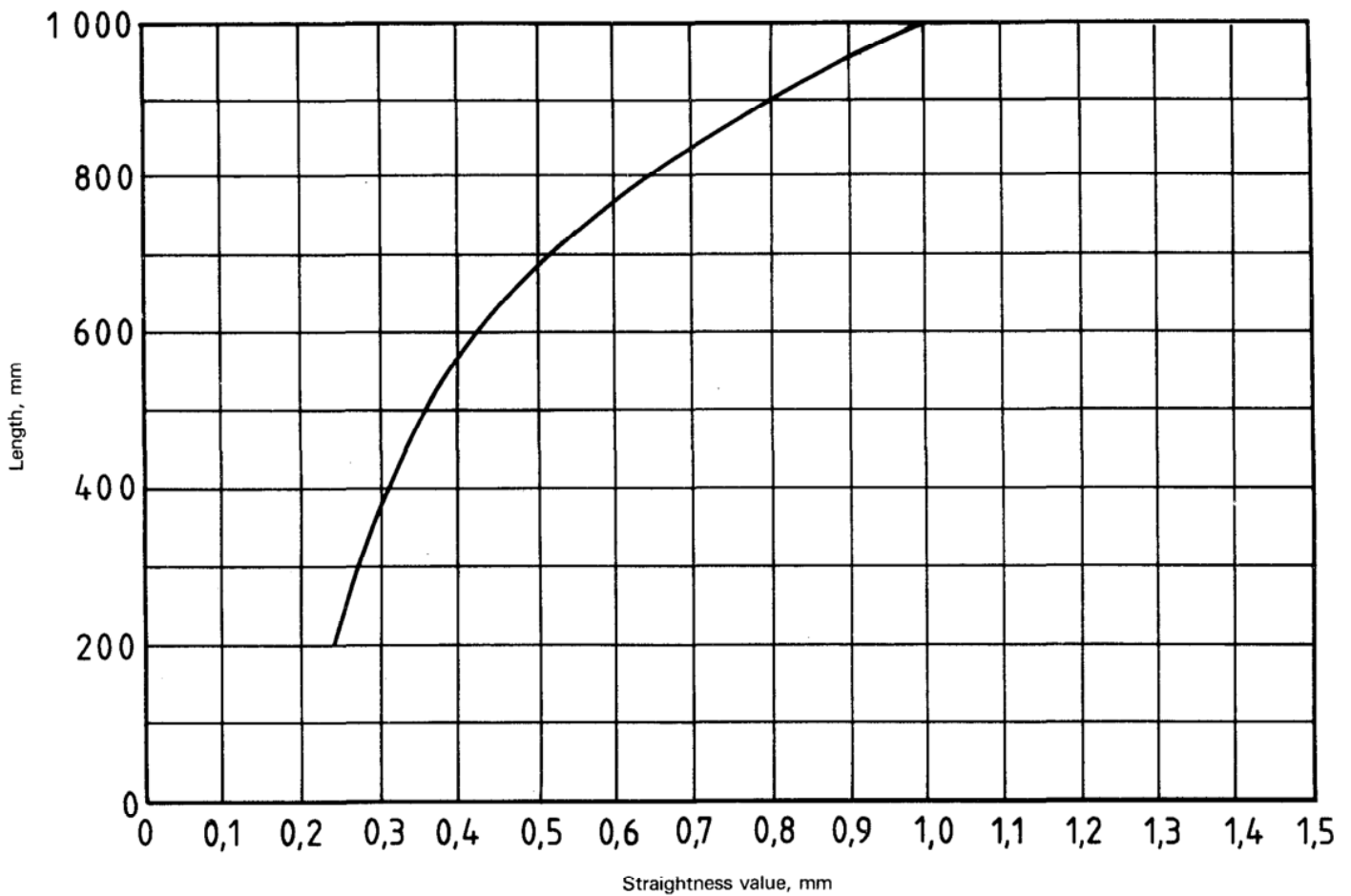


Figure — Permissible deviation from straightness : tubes shorter than 1 000 mm

**8.5 Length**

8.5.1 When specified on tubes ordered to cut length, apply tolerances that meet the following requirements :

**Table 2 — Tolerances for cut-length tubes**

Values in millimetres

Length		Tolerances	
over	to	Brass	Aluminium
0	2 000	+ 3 0	+ 5 0
2 000	5 000	+ 5 0	+ 10 0
5 000		+ 10 0	+ 12 0

NOTE — These tolerances include the possible out of squareness of the ends of the tubes.

8.5.2 Use random lengths of tube as agreed between purchaser and supplier.

**9 Surface finish**

**9.1 Bore surface**

9.1.1 Specific bore surface finish values with  $R_a$  and  $R_{ma}$  in accordance with ISO 468.

9.1.2 Use recognized equipment for the measurement of the surface finish.

9.1.3 On a bore surface with a longitudinal or no predominant lay, for example cold drawn surfaces, traverse the stylus circumferentially and approximately perpendicular to the tube axis.

9.1.4 On tube surfaces with a predominantly circumferential lay, for example honed or burnished surfaces, obtain measurements by longitudinal traverses.

9.1.5 Take measurements at four positions around the circumference and spaced approximately 90° apart.

9.1.6 Take three measurements at each position, the measuring zones being not less than 6 mm apart and not less than 25 mm from an end of the cylinder tube.

9.1.7 Use the numerical  $R_a$  rating as the arithmetic mean of all readings taken.

NOTE — No individual reading is to be more than 25 % greater than the nominal  $R_a$  values.

9.1.8 Use the values of surface finish shown in table 3 for tubes with drawn or machined surfaces.

**9.2 Outside surface**

Exhibit a mill finish on the outside surface at least equivalent to the method of manufacture of the basic tube (see 5.1).

**10 Protection and packing**

The supplier's normal practice for protection and packing shall be adopted, unless the supplier and purchaser have agreed beforehand to special requirements for protection and packing.

**11 Test certification**

11.1 The tubes are supplied without test certification unless otherwise agreed at time of inquiry and order.

11.2 If test certification is required, the test procedure and number of tests shall be agreed at the time of inquiry and order.

**12 Identification statement** (reference to this International Standard)

Use the following statement in test reports, catalogues and sales literature when electing to comply with this International Standard :

“Requirements for non-ferrous metallic tubes with specially finished bores for pneumatic fluid power cylinders conform to ISO 6537, *Pneumatic fluid power systems — Cylinder barrels — Requirements for non-ferrous metallic tubes.*”

**Table 3 — Values of surface finish**

	Measurements parallel to the generatrix			Measurements vertical to the generatrix	
	$d < 80$ mm	$80$ mm $< d < 200$ mm	$d > 200$ mm	$d < 80$ mm	$d > 80$ mm
$R_a$ , $\mu$ m	0,63	0,8	1,25	1	1,25
$R_{ma}$ , $\mu$ m	3,2	4	6,3	5	6,3

NOTE — The computation of the rating of surface finish does not include the effect of isolated defects which are subject to agreement between purchaser and supplier.

## Annex A

### Non-ferrous metallic pneumatic cylinder tube dimensions and tolerances

Table 4 – Dimensions and tolerances of aluminium tubes

Bore mm	Wall thickness, mm										
	1,0	1,2	1,5	2,0	2,5	3,0	3,5	4,0	5,0	6,5	7,5
	Tolerance according to ISO 286										
8	H11			H11							
10			H11	H11							
12			H11	H11							
16			H11	H11							
20			H11		H11						
25			H11	H11	H11						
32				H11		H11					
40					H11	H11					
50					H11	H11					
63					H11	H11					
80						H11			H11		
100						H12			H12		
125							H12		H12		
160							H13			H13	
200								H14			H14
250									H14		H14

Table 5 – Dimensions and tolerances of brass tubes

Bore mm	Wall thickness, mm										
	1,0	1,2	1,5	2,0	2,5	3,0	3,5	4,0	5,0	6,5	7,5
	Tolerance according to ISO 286										
8		H11		H11							
10		H11		H11							
12		H11		H11							
16		H11		H11							
20			H11		H11						
25			H11		H11						
32				H11		H11					
40					H11	H11					
50					H12	H12					
63					H12	H12					
80						H12			H12		
100						H12			H12		
125							H12		H12		
160							H13			H13	
200								H14			H14
250									H14		H14



## Annex B

### Method of ordering

State the following in the inquiry and order when purchasing :

- a) method of manufacture, i.e. seamless or welded;
- b) the number and title of this International Standard;
- c) material type, i.e. brass or aluminium;
- d) the alloy and metallurgic condition, or at least mechanical and chemical properties, by agreement between the tube manufacturer and cylinder manufacturer;
- e) any special requirements relating to heat treatment;
- f) tube cross-sectional dimensions :

specify the tube by :

- 1) inside diameter and wall thickness, in which case the required inside diameter tolerance class shall be stated (see annex A);

or

- 2) inside diameter and outside diameter, in which case the wall thickness tolerance is important (see table 1 and 8.2).
- g) required degree of straightness (see 8.4);
- h) length and total number of lengths, or total length in specified random lengths;
- j) any special requirements for protection or packing (see clause 10);
- k) the name of the inspecting authority if any;
- m) if test certification and/or analysis certificates are required (see clause 11).