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Pneumatic fluid power — Polyurethane and polyamide tubings for use primarily in pneumatic installations — Dimensions and specification

Transmissions pneumatiques — Tubes en polyuréthane et en polyamide destinés à être utilisés principalement dans des installations pneumatiques — Dimensions et spécifications

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 4, *Connectors and similar products and components*.

This first edition cancels and replaces the first edition of ISO/TS 11619:2014, which has been technically revised.

The main changes are as follows:

— extension of the scope to polyamide tubings;

— addition of new sizes for polyurethane tubings.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

This document has been prepared to provide minimum acceptable requirements for the satisfactory performance of thermoplastic polyurethane and polyamide tubing used mainly in pneumatic applications.

The tubing conveys compressed air which controls and powers pneumatic systems.

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Pneumatic fluid power — Polyurethane and polyamide tubings for use primarily in pneumatic installations — Dimensions and specification

WARNING — Users of this document should be familiar with normal laboratory practice. This document does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate health and safety practices and to ensure compliance with any national regulatory conditions.

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1 Scope

This document specifies the requirements for flexible thermoplastic polyurethane and polyamide tubing conveying compressed air, in sizes from 3 mm to 16 mm (1/8 inch to 1/2 inch) outside diameter.

Polyurethane tubings are dedicated for use in the temperature range from –20 °C to 60 °C, while polyamide tubings are dedicated for use in the temperature range from –20 °C to 80 °C. Working pressure depends on the tube size, the service temperature (see Table 13 and Table 14) and tubing material (see Table 15 and Table 16).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1307, *Rubber and plastics hoses — Hose sizes, minimum and maximum inside diameters, and tolerances on cut-to-length hoses*

ISO 1402, *Rubber and plastics hoses and hose assemblies — Hydrostatic testing*

ISO 8330, *Rubber and plastics hoses and hose assemblies — Vocabulary*

ISO 10619-1:2017, *Rubber and plastics hoses and tubing — Measurement of flexibility and stiffness — Part 1: Bending tests at ambient temperature*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8330 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Materials and construction

The polyurethane tubing shall be manufactured from polyester or polyether based. For applications where there is moisture or water present above 40 °C, polyurethane materials with good hydrolysis resistance are required. The user shall specify this to the supplier of the tubing.

The polyamide tubing shall be manufactured from polyamide such as but not limited to PA12, PA6, etc.

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Tubing shall be homogenous and free from surface imperfections. The tubing is extruded and can be coloured to user requirements.

5 Dimensions and tolerances

5.1 Outside and inside diameters, wall thickness and tolerances

5.1.1 Polyurethane tubing

The outside diameter, inside diameter, wall thickness and tolerances of the tubing shall meet the requirements given in Table 1 and Table 2.

Table 1 — Metric outside and inside diameters, wall thickness and tolerances

Outside diameter		Inside diameter		Wall thickness
Diameter mm	Tolerance [a] mm	Diameter mm	Tolerance [a] mm	Minimum Thickness [a] mm
2	±0,10	1,20	±0,10	0,3
3	±0,10	1,8	±0,10	0,5
3	±0,10	2	±0,10	0,4
4	±0,10	2,5	±0,10	0,65
5	±0,10	3	±0,10	0,9
6	±0,10	4	+ 0,10 - 0,20	0,9
8	±0,10	5,5	+ 0,10 - 0,20	1,15
8	±0,10	5,7	+ 0,10 - 0,20	1,05
8	±0,10	6	+ 0,10 - 0,20	0,9
10	±0,15	7	+ 0,10 - 0,20	1,4
10	±0,15	8	+ 0,10 - 0,20	0,9
12	±0,15	8	+ 0,10 - 0,20	1,9
14	±0,15	9,5	+ 0,10 - 0,20	2,15
14	±0,15	9,8	+ 0,10 - 0,20	2,0
14	±0,15	10,0	+ 0,10 - 0,20	1,9
16	±0,15	11	+ 0,10 - 0,20	2,4

[a] Tolerance and limit specified for outside diameter, inside diameter and wall thickness cannot all be met and coaxiality ensured at the same time.

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Table 2 — Inch outside and inside diameters, wall thickness and tolerances

Outside diameter		Inside diameter		Wall thickness
Diameter inch	**Tolerance** [a] inch	**Diameter** inch	**Tolerance** [a] inch	**Minimum Thickness** [a] inch
1/8	±0.004	0.065	±0.004	0.026
1/8	±0.004	0.083	±0.004	0.017
5/32	±0.005	0.098	±0.005	0.024
3/16	±0.005	0.108	±0.005	0.035
3/16	±0.005	0.121	±0.005	0.028
1/4	±0.005	0.157	±0.005	0.042
1/4	±0.005	0.160	±0.005	0.040
5/16	±0.005	0.217	±0.005	0.043
3/8	±0.006	0.250	±0.006	0.057
1/2	±0.006	0.330	±0.006	0.079
5/8	±0.006	0.421	±0.006	0.096

[a] Tolerance and limit specified for outside diameter, inside diameter and wall thickness cannot all be met and coaxiality ensured at the same time.

5.1.2 Polyamide tubings

The outside diameters, inside diameters and tolerances of the tubing shall meet the requirements given in Table 3 and Table 4.

Table 3 — Metric outside and inside diameters, wall thickness and tolerances

Outside diameter		Inside diameter		Wall thickness
Diameter mm	**Tolerance** [a] mm	**Diameter** mm	**Tolerance** [a] mm	**Minimum thickness** [a] mm
3	±0,10	1,80	±0,10	0,55
4	±0,10	2,50	±0,20	0,65
4	±0,10	2,70	±0,20	0,60
5	±0,10	3,00	±0,20	0,90
6	±0,10	4,00	±0,20	0,90
8	±0,10	6,00	±0,20	0,90
10	±0,15	7,50	±0,20	1,12
10	±0,15	8,00	±0,20	0,90
12	±0,15	9,00	±0,30	1,35
14	±0,15	10,00	±0,30	1,80
14	±0,15	11,00	±0,30	1,35
16	±0,15	12,00	±0,30	1,80
16	±0,15	13,00	±0,30	1,35

[a] Tolerance and limit specified for outside diameter, inside diameter and wall thickness cannot all be met and coaxiality ensured at the same time.

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Table 4 — Inch outside and inside diameters, wall thickness and tolerances

Outside diameter		Inside diameter		Wall thickness
Diameter inch	Tolerance [a] inch	Diameter inch	Tolerance [a] inch	Minimum thickness [a] inch
1/8	±0.005	0.065	±0.005	0.022
5/32	±0.005	0.098	±0.005	0.026
3/16	±0.005	0.129	±0.005	0.026
1/4	±0.005	0.172	±0.005	0.036
5/16	±0.005	0.234	±0.005	0.036
3/8	±0.005	0.257	±0.006	0.053
1/2	±0.005	0.324	±0.007	0.082

[a] Tolerance and limit specified for outside diameter, inside diameter and wall thickness cannot all be met and coaxiality ensured at the same time.

5.1.3 Length tolerances

The tolerances on cut lengths shall be in accordance with ISO 1307.

6 Performance requirements

6.1 Hydrostatic testing at 23 °C ± 2 °C

6.1.1 General

Fittings that conform to ISO 14743 should be used for this hydrostatic testing. Tubing used for these hydrostatic tests should be pre-conditioned with regard to humidity as described in ISO 14743.

6.1.2 Polyurethane tubing hydrostatic testing

When subjected to the burst pressure test specified in ISO 1402 at 23 °C ± 2 °C, tubing shall meet the requirements specified in Table 5 and Table 6.

Table 5 — Burst testing at 23 °C ± 2 °C, metric size

Outside diameter mm	Wall thickness mm	Minimum burst pressure MPa
2	0,4	2,40
3	0,5	2,40
3	0,6	3,00
4	0,75	3,00
5	1,0	3,00
6	1,0	2,55
8	1,25	2,55
8	1,15	2,25
8	1,0	1,80
10	1,5	2,55
10	1,0	1,50
12	2,0	2,55
14	2,25	2,55

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Table 5 *(continued)*

Outside diameter mm	Wall thickness mm	Minimum burst pressure MPa
14	2,1	2,40
14	2,0	2,40
16	2,5	2,55

Table 6 — Burst testing at 23 °C ± 2 °C, inch size

Outside diameter inch	Wall thickness inch	Minimum burst pressure MPa
1/8	0.030	3,00
1/8	0.021	2,40
5/32	0.029	2,70
3/16	0.040	3,00
3/16	0.033	2,70
1/4	0.047	3,00
1/4	0.045	2,70
5/16	0.048	2,40
3/8	0.063	2,70
1/2	0.085	2,70
5/8	0.102	2,70

6.2 Polyamide hydrostatic testing

When subjected to the burst pressure test at 23 °C ± 2 °C, tubing shall meet the requirements specified in Table 7 and Table 8.

Table 7 — Burst testing at 23 °C ± 2 °C, metric size

Outside diameter mm	Wall thickness mm	Minimum burst pressure MPa
2	0,4	2,4
3	0,6	8,1
4	0,75	9,3
4	0,65	6,4
5	1,0	6,4
6	1,0	7,2
8	1,0	5,1
10	1,25	5,7
10	1,0	4,0
12	1,5	5,4
14	2,0	6,6
14	1,5	4,5
16	2,0	5,7
16	1,5	3,9

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Table 8 — Burst testing at 23 °C ± 2 °C, inch size

Outside diameter inch	Wall thickness inch	Minimum burst pressure MPa
1/8	0.024	7,8
5/32	0.029	6,4
3/16	0.029	6,4
1/4	0.039	7,2
5/16	0.039	5,1
3/8	0.059	4,0
1/2	0.088	5,4

6.3 Hydrostatic testing at high temperature

6.3.1 General

Fittings that conform to ISO 14743 should be used for this hydrostatic testing. Tubing used for these hydrostatic tests should be pre-conditioned with regard to humidity as described in ISO 14743.

6.3.2 Polyurethane hydrostatic testing

When subjected to the burst pressure test specified in ISO 1402 at 60 °C ± 2 °C, tubing shall meet the requirements given in Table 9 and Table 10. Tests shall be conducted at 60 °C in a temperature-controlled cabinet. Compressed gas (either air or nitrogen) can be used as a burst test media.

Alternatively, heated water can be used, with the testing condition to make sure that the liquid has enough time to increase the tube temperature at 60 °C.

Table 9 — Burst testing at 60 °C ± 2 °C, metric size

Outside diameter mm	Wall thickness mm	Minimum burst pressure MPa
2	0,4	1,2
3	0,6	1,5
3	0,5	1,2
4	0,75	1,5
5	1,0	1,5
6	1,0	1,35
8	1,25	1,2
8	1,15	1,05
8	1,0	0,9
10	1,5	1,2
10	1,0	0,75
12	2,0	1,35
14	2,25	1,35
14	2,1	1,20
14	2,0	1,2
16	2,5	1,2

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Table 10 — Burst testing at 60 °C ± 2 °C, inch size

Outside diameter inch	Wall thickness inch	Minimum burst pressure MPa
1/8	0.030	1,5
1/8	0.021	1,2
5/32	0.29	1,35
3/16	0.040	1,5
3/16	0.033	1,35
1/4	0.047	1,5
1/4	0.045	1,35
5/16	0.048	1,2
3/8	0.063	1,35
1/2	0.085	1,35
5/8	0.102	1,35

6.3.3 Polyamide hydrostatic testing

When subjected to the burst pressure test specified at 50 °C and 80 °C ± 2 °C, tubing shall meet the requirements given in Table 11 and Table 12. Tests shall be conducted at 50 °C and 80 °C in a temperature-controlled cabinet. Compressed gas (either air or nitrogen) can be used as a burst test media.

Alternatively, heated water can be used, with the testing condition to make sure that the liquid has enough time to rise the tube temperature at 50 °C and 80 °C.

Table 11 — Burst testing at 50 °C and 80 °C ± 2 °C, metric size

Outside diameter mm	Wall thickness mm	Minimum burst pressure at 50 °C MPa	Minimum burst pressure at 80 °C MPa
3	0,6	4,9	3,6
4	0,75	4,0	3,0
4	0,65	4,0	3,0
5	1,0	4,0	3,0
6	1,0	3,7	3,3
8	1,0	3,3	2,4
10	1,25	3,3	2,4
10	1,0	2,4	1,9
12	1,5	3,3	2,4
14	2,0	3,3	2,4
14	1,5	2,8	2,1
16	2,0	2,8	2,1
16	1,5	2,4	1,8

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Table 12 — Burst testing at 50 °C and 80 °C ± 2 °C, inch size

Outside diameter inch	Wall thickness inch	Minimum burst pressure at 50 °C MPa	Minimum burst pressure at 80 °C MPa
1/8	0.024	6,3	4,8
5/32	0.029	4,0	3,0
3/16	0.029	4,0	3,0
1/4	0.039	3,7	3,3
5/16	0.039	3,3	2,4
3/8	0.059	3,0	2,1
1/2	0.088	3,0	2,1

6.4 Maximum working pressure

6.4.1 Polyurethane tubing

The maximum working pressure shall be as specified in Table 13 and Table 14.

Table 13 — Maximum working pressures at 23 °C and 60 °C, metric size

Outside diameter mm	Wall thickness mm	Maximum working pressure at 23 °C MPa	Maximum working pressure at 23 °C bar	Maximum working pressure at 60 °C MPa	Maximum working pressure at 60 °C bar
2	0,4	0,8	8,0	0,4	4,0
3	0,6	1,00	10,00	0,50	5,0
3	0,5	0,8	8,0	0,4	4,0
4	0,75	1,00	10,00	0,50	5,0
5	1,0	1,0	10,0	0,50	5,0
6	1,0	0,85	8,5	0,425	4,25
8	1,25	0,85	8,5	0,4	4,0
8	1,15	0,75	7,5	0,35	3,5
8	1,0	0,60	6,00	0,3	3,0
10	1,5	0,85	8,5	0,4	4,0
10	1,0	0,50	5,00	0,25	2,5
12	2,0	0,85	8,5	0,425	4,25
14	2,25	0,85	8,5	0,425	4,25
14	2,1	0,8	8,0	0,4	4,0
14	2,0	0,8	8,0	0,4	4,0
16	2,5	0,85	8,5	0,4	4,0
NOTE Maximum working pressures are based on a factor of safety of 3:1 on minimum burst pressures because the main use of this tubing is for conveying compressed air.					

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Table 14 — Maximum working pressures at 23 °C and 60 °C, inch sizes

Outside diameter inch	Wall thickness inch	Maximum working pressure at 23 °C MPa	Maximum working pressure at 23 °C bar	Maximum working pressure at 60 °C MPa	Maximum working pressure at 60 °C bar
1/8	0.030	1,00	10,0	0,50	5,0
1/8	0.021	0,80	8,0	0,40	4,0
5/32	0.29	0,90	9,0	0,45	4,5
3/16	0.040	1,00	10,0	0,50	5,0
3/16	0.033	0,90	9,0	0,45	4,5
1/4	0.047	1,00	10,0	0,50	5,0
1/4	0.045	0,85	8,5	0,425	4,25
5/16	0.048	0,85	8,5	0,40	4,0
3/8	0.063	0,85	8,5	0,425	4,25
1/2	0.085	0,85	8,5	0,425	4,25
5/8	0.102	0,90	9,0	0,45	4,5

NOTE Maximum working pressures are based on a factor of safety of 3:1 on minimum burst pressures because the main use of this tubing is for conveying compressed air.

6.4.2 Polyamide tubing

The maximum working pressure shall be as specified in Table 15 and Table 16.

Table 15 — Maximum working pressures at 23 °C to 50 °C and 80 °C, metric size

Outside diameter mm	Wall thickness mm	Maximum working pressure at 23 °C MPa	Maximum working pressure at 23 °C bar	Maximum working pressure at 50 °C MPa	Maximum working pressure at 50 °C bar	Maximum working pressure at 80 °C MPa	Maximum working pressure at 80 °C bar
3	0,6	2,6	26,0	1,63	16,3	1,2	12,0
4	0,75	2,13	21,3	1,33	13,3	1,0	10,0
4	0,65	2,13	21,3	1,33	13,3	1,0	10,0
5	1,0	2,13	21,3	1,33	13,3	1,0	10,0
6	1,0	2,4	24	1,24	12,4	1,10	11,0
8	1,0	1,7	17,0	1,10	11,0	0,8	8,0
10	1,25	1,8	18,0	1,10	11,0	0,83	8,30
10	1,0	1,33	13,3	0,83	8,30	0,63	6,30
12	1,5	1,8	18,0	1,10	11,0	0,83	8,30
14	2,0	1,8	18,0	1,10	11,0	0,83	8,30
14	1,5	1,5	15,0	0,93	9,30	0,70	7,00
16	2,0	1,5	15,0	0,93	9,30	0,70	7,00
16	1,5	1,3	13,0	0,80	8,00	0,60	6,00

NOTE Maximum working pressures are based on a factor of safety of 3:1 on minimum burst pressures because the main use of this tubing is for conveying compressed air.

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Table 16 — Maximum working pressures at 23 °C to 50 °C and 80 °C, inch sizes

Outside diameter inch	Wall thickness inch	Maximum working pressure at 23 °C MPa	Maximum working pressure at 23 °C bar	Maximum working pressure at 50 °C MPa	Maximum working pressure at 50 °C bar	Maximum working pressure at 80 °C MPa	Maximum working pressure at 80 °C bar
1/8	0.029	2,6	26,0	2,1	21	1,6	16
5/32	0.031	2,13	21,3	1,33	13,3	1,0	10,0
3/16	0.039	2,13	21,3	1,33	13,3	1,0	10,0
1/4	0.045	2,4	24,0	1,24	12,4	1,10	11,0
5/16	0.048	1,7	17,0	1,10	11,0	0,8	8,0
3/8	0.065	1,7	17,0	1,0	10,0	0,7	7,0
1/2	0.09	1,7	17,0	1,0	10,00	0,7	7,0

NOTE Maximum working pressures are based on a factor of safety of 3:1 on minimum burst pressures because the main use of this tubing is for conveying compressed air.

6.5 Minimum bend radius

6.5.1 Polyurethane tubing bending radius

When tested in accordance with ISO 10619-1:2017, method A1, the minimum bend radius shall be as specified in Table 17 and Table 18 and the value of T/D shall be greater than 0,9, where D represents the nominal external diameter and T represents the minimum tubing dimension measured in the bended area according to Figure 1 in ISO 10619-1:2017.

Table 17 — Minimum bending radius at 23 °C, metric size

Outside diameter mm	Wall thickness mm	Minimum bend radius at 23 °C mm
2	0,40	8
3	0,60	10
3	0,50	7,5
4	0,75	11
5	1,00	14
6	1,00	15
8	1,25	20
8	1,15	20
8	1,00	20
10	1,50	25
10	1,00	25
12	2,00	35
14	2,25	45
14	2,10	40
14	2,00	40
16	2,5	45

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Table 18 — Minimum bending radius at 23 °C, inch size

Outside diameter inch	Wall thickness inch	Minimum bend radius at 23 °C inch
1/8	0.030	0.39
1/8	0.021	0.39
5/32	0.029	0.47
3/16	0.040	0.55
3/16	0.033	0.47
1/4	0.047	0.59
1/4	0.045	0.59
5/16	0.048	0.79
3/8	0.063	0.98
1/2	0.085	1.97
5/8	0.102	2.36

6.5.2 Polyamide tubing bending radius

When tested in accordance with ISO 10619-1:2017, method A1, the minimum bend radius shall be as specified in Table 19 and Table 20.

Table 19 — Minimum bending radius at 23 °C ± 2 °C, metric size

Outside diameter mm	Wall thickness mm	Minimum bend radius at 23 °C mm
3	0,6	10,0
4	0,75	28,0
4	0,65	20,0
5	1,00	28,0
6	1,00	32,0
8	1,00	50,0
10	1,25	70,0
10	1,00	60,0
12	1,50	75,0
14	2,00	100,0
14	1,50	90,0
16	2,00	140,0
16	1,50	115

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