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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 documents 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 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.

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.

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

WARNING — Persons using 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.

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 for metric sizes and from 1/8' to 1/2' for inch size outside diameter.

Polyurethane tubing are dedicated for use in the temperature range from – 20 °C to 60 °C, while polyamide tubing from – 20 °C to 80 °C. Working pressure depends on the tube size, the service temperature (see Tables 13 and 14) and tubing material (see Tables 15 and 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 8331, *Rubber and plastics hoses and hose assemblies — Guidelines for selection, storage, use and maintenance*

ISO 10619-1:2011, *Rubber and plastics hoses and tubing — Measurement of flexibility and stiffness — Part 1: Bending tests at ambient temperature*

ISO 14743, *Pneumatic fluid power — Push-in connectors for thermoplastic tubes*

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 would be required. It shall be specified by the user to the supplier of the tubing.

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

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, inside diameters, wall thickness and tolerances of 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 [1)] mm	Diameter mm	Tolerance [1)] mm	Minimum Thickness [1)] mm
2	±0,10	1,20	±0,10	0,3
3	±0,10	2	±0,10	0,4
3	±0,10	1,8	±0,10	0,5
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

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

Outside diameter		Inside diameter		Wall thickness
Diameter inch	**Tolerance 1)** inch	**Diameter** inch	**Tolerance 1)** inch	**Minimum Thickness 1)** 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	0,160	±0,005	0,040
1/4	±0,005	0,157	±0,005	0,042
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

5.1.2 Polyamide tubings

The outside diameters and tolerances of 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	**Tolerance1)** mm	**Diameter** mm	**Tolerance1)** mm	**Minimum Thickness 1)** mm
3	±0,10	1,80	±0,10	0,55
4	±0,10	2,70	±0,20	0,60
4	±0,10	2,50	±0,20	0,65
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	8,00	±0,20	0,90
10	±0,15	7,50	±0,20	1,12
12	±0,15	9,00	±0,30	1,35
14	±0,15	11,00	±0,30	1,35
14	±0,15	10,00	±0,30	1,80
16	±0,15	13,00	±0,30	1,35
16	±0,15	12,00	±0,30	1,80

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

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

Outside diameter		Inside Diameter		Wall thickness
Diameter inch	Tolerance[1)] inch	Diameter inch	Tolerance[1)] inch	Minimum Thickness [1)] 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	0,071

[1)] 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 compliant for 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 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	2,40
8	1,0	1,80
8	1,15	2,25
10	1,5	2,40
10	1,0	1,5
12	2,0	2,55
14	2,25	2,55

Table 5 *(continued)*

Outside diameter mm	Wall thickness mm	Minimum burst pressure MPa
14	2,1	2,40
14	2,0	2,4
16	2,5	2,40

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	0,29	2,70
3/16	0,040	3,00
3/16	0,033	2,70
1/4	0,045	2,70
1/4	0,047	3,00
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	7,8
4	0,65	6,4
4	0,75	9,3
5	1,0	6,4
6	1,0	7,2
8	1,0	5,1
10	1,0	4,0
10	1,25	5,7
12	1,5	5,4
14	1,5	4,5
14	2,0	6,6
16	1,5	3,9
16	2,0	5,7

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 compliant with 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 proper temperature controled cabinet, and 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 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	0,5	1,2
3	0,6	1,5
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

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	0,045	1,35
1/4	0,047	1,5
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 proper temperature controlled cabinet and 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	0,65	4,0	3,0
4	0,75	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	1,0	2,4	1,9
10	1,25	3,3	2,4
12	1,5	3,3	2,4
14	1,5	2,8	2,1
14	2,0	3,3	2,4
16	1,5	2,4	1,8
16	2,0	2,8	2,1

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

Table 12 *(continued)*

Outside diameter inch	Wall thickness inch	Minimum burst pressure at 50 °C MPa	Minimum burst pressure at 80 °C MPa
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 MAWP

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	0,5	0,8	8,0	0,4	4,0
3	0,6	1,00	10,00	0,50	5,0
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	0,8	8,0	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	0,8	8,0	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	0,8	8,0	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.

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

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
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	0,045	0,85	8,5	0,425	4,25
1/4	0,047	1,00	10,0	0,50	5,0
5/16	0,048	0,80	8,0	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 MAWP

The maximum working pressure shall be as specified in Table 15 and 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	0,65	2,13	21,3	1,33	13,3	1,0	10,0
4	0,75	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	1,0	1,33	13,3	0,83	8,30	0,63	6,30
10	1,25	1,8	18,0	1,10	11,0	0,83	8,30
12	1,5	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
14	2,0	1,8	18,0	1,10	11,0	0,83	8,30
16	1,5	1,3	13,0	0,80	8,00	0,60	6,00
16	2,0	1,5	15,0	0,93	9,30	0,70	7,00
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.							

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

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
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 10619-1:2011 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.

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	0,50	7,5
3	0,60	10
4	0,75	11
5	1,00	14
6	1,00	15
8	1,00	20
8	1,15	20
8	1,25	20
10	1,00	25
10	1,50	25
12	2,00	35
14	2,25	45
14	2,00	40
14	2,10	40
16	2,5	45

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	10
1/8	0.021	10
5/32	0,029	12
3/16	0,040	14
3/16	0.033	12
1/4	0,045	15
1/4	0,047	15
5/16	0,048	20
3/8	0,063	25
1/2	0,085	50
5/8	0,102	60

6.5.2 Polyamide Tubing Bending radius

When tested in accordance with ISO 10619-1:2011 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	0,65	28,0
4	0,75	28,0
5	1,00	28,0
6	1,00	32,0
8	1,00	50,0
10	1,00	60,0
10	1,25	70,0
12	1,50	85,0
14	1,50	90,0
14	2,00	100,0
16	1,50	120,0
16	2,00	140,0

Table 20 — Minimum Bending Radius at 23 °C ± 2 °C. inch size

Outside diameter inch	Wall thickness inch	Minimum bend radius at 23 °C inch
1/8	0,029	15,0
5/32	0,031	30,0
3/16	0,039	35,0
1/4	0,045	35,0

Table 20 *(continued)*

Outside diameter inch	Wall thickness inch	Minimum bend radius at 23 °C inch
5/16	0,048	55,0
3/8	0,065	90,0
1/2	0,09	100,0

6.6 UV ageing testing

UV testing can be performed: testing protocol are related to usage condition and application requirements. UV ageing test parameters definition are under user's choice and responsibility.

7 Type, routine and production testing

For type testing, routine and production testing, the tests specified in Annex A shall be carried out.

8 Marking

Tubing shall be marked in characters which can be easily seen with the naked eye, either using a contrasting indelible ink or as otherwise agreed between the supplier and the purchaser, with at least the following information:

a) the manufacturer's name or trade mark, e.g. XXX;

b) material, e.g. PA12;

c) the reference to this document, i.e. ISO 11619:2021;

d) the outside diameter and wall thickness, e.g. 6 mm × 1 mm or alternatively inside diameter, e.g. 6 mm × 4 mm for metric size (e.g. 1-8x0,029 for inch size);

e) the maximum working pressure at 23 °C in MPa, e.g. 1,35 MPa at 23 °C; and

f) month/year of manufacture, e.g. 06/20.

EXAMPLE ABC/ISO 11619:2021/6 mm × 1 mm/MWP1,35 MPa at 23 °C – 06/20.

9 Recommendations for packing and storage

ISO 8331 provides suggestions for packing and storage.

Annex A
(normative)

Test frequency

A.1 Table A.1 gives the frequency of testing for routine tests and type tests.

A.2 Type tests are those carried out to verify that the tube meets all the requirements of this document.

A.3 Routine tests are those tests to be carried out on every manufactured length of tube.

A.4 Production tests are those tests to be carried out on each production batch.

NOTE This type of tubing is normally produced with continuous outside diameter measurement and also wall thickness gauging.

Table A.1 — Frequency of testing for routine tests and type tests

Test	Routine test	Type test	Production test
5.1 Outside diameter	X	X	X
5.1 Inside diameter or wall thickness	X	X	X
6.1 Hydrostatic testing at 23 °C	N.A.	X	N.A.
6.2 Hydrostatic testing at 60 °C	N.A.	X	N.A.
6.3 Hydrostatic testing at 50 °C and 80 °C (PA)	N.A.	X	N.A.
6.4 Bend radius test	N.A.	X	N.A.
NOTE N.A. = Not applicable			

Bibliography

[1] ISO 14743:2014, *Pneumatic fluid power — Push-in connectors for thermoplastic tubes*