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Pneumatic fluid power — Assessment of component reliability by testing —

Part 3: Cylinders with piston rod

Transmissions pneumatiques — Évaluation par essais de la fiabilité des composants —

Partie 3: Vérins avec tiges de piston

Reference number
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 19973-3 was prepared by Technical Committee ISO/TC 131, *Fluid power systems*.

ISO 19973 consists of the following parts, under the general title *Pneumatic fluid power — Assessment of component reliability by testing*:

— *Part 1: General procedures*

— *Part 2: Directional control valves*

— *Part 3: Cylinders with piston rod*

— *Part 4: Pressure regulators*

Introduction

In pneumatic fluid power systems, power is transmitted and controlled through a gas under pressure within a circuit. Pneumatic fluid power systems are composed of components and are an integral part of various types of machines and equipment. Efficient and economical production requires highly reliable machines and equipment. Within the ISO 19973 series, this Part 3 is intended to provide requirements and test conditions that permit the assessment of the inherent reliability of pneumatic cylinders with piston rod.

It is necessary that machine producers know the reliability of the components that make up their machine's pneumatic fluid power system. Knowing the reliability characteristic of the component, the producers can model the system and make decisions on service intervals, spare parts' inventory and areas for future improvements.

There are three primary levels in the determination of component reliability:

a) preliminary design analysis: finite element analysis (FEA), failure mode and effect analysis (FMEA);

b) laboratory testing and reliability modelling: physics of failure, reliability prediction, pre-production evaluation;

c) collection of field data: maintenance reports, warranty analysis.

Each level has its application during the life of a component. A preliminary design analysis is useful to identify possible failure modes and eliminate them or reduce their effect on reliability. When prototypes are available, in-house laboratory reliability tests are run and initial reliability can be determined. Reliability testing is often continued into the initial production run and throughout the production lifetime as a continuing evaluation of the component. Collection of field data is possible when products are operating and data on their failures are available.

Pneumatic fluid power — Assessment of component reliability by testing —

Part 3: Cylinders with piston rod

1 Scope

This part of ISO 19973 provides test procedures for determining reliability of pneumatic cylinders with piston rod by testing and the methods of reporting the results of testing. The general test conditions and the calculation method provided in Part 1 of ISO 19973 apply to the first failure without repairs, but exclude outliers.

The lifetime of pneumatic cylinders is usually given in number of cycles or in kilometres. Therefore, whenever the term “time” is used in this part of ISO 19973, this variable is to be understood as cycles or kilometres.

This part of ISO 19973 also specifies test equipment and threshold levels for tests to determine the reliability of pneumatic cylinders with piston rods, both single-acting and double-acting.

This part of ISO 19973 is intended to be applied to pneumatic piston rod cylinders that conform to ISO 6430, ISO 6432, ISO 15552 and ISO 21287; however, pneumatic piston rod cylinders that do not conform to these International Standards but are used in the same range of operating conditions can be tested in accordance with one of the classes defined in Tables 1 and 2 of this part of ISO 19973. It is necessary that any deviation from this part of ISO 19973 be documented in the test report.

2 Normative references

The following referenced documents are indispensable for the application 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 1000, *SI units and recommendations for the use of their multiples and of certain other units*

ISO 1219-1, *Fluid power systems and components — Graphic symbols and circuit diagrams — Part 1: Graphic symbols for conventional use and data-processing applications*

ISO 5598, *Fluid power systems and components — Vocabulary*

ISO 6430, *Pneumatic fluid power — Single rod cylinders, 1 000 kPa (10 bar) series, with integral mountings, bores from 32 mm to 250 mm — Mounting dimensions*

ISO 6432, *Pneumatic fluid power — Single rod cylinders — 10 bar (1 000 kPa) series — Bores from 8 to 25 mm — Mounting dimensions*

ISO 10099:2001, *Pneumatic fluid power — Cylinders — Final examination and acceptance criteria*

ISO 15552, *Pneumatic fluid power — Cylinders with detachable mountings, 1 000 kPa (10 bar) series, bores from 32 mm to 320 mm — Basic, mounting and accessories dimensions*

ISO 19973-1, *Pneumatic fluid power — Assessment of component reliability by testing — Part 1: General procedures*

ISO 21287, *Pneumatic fluid power — Cylinders — Compact cylinders, 1 000 kPa (10 bar) series, bores from 20 mm to 100 mm*

IEC 60050-191, *International Electrotechnical Vocabulary, chapter 191: Dependability and quality of service*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5598, ISO 19973-1 and IEC 60050-191 apply. Where a conflict of definitions exists for a term in any of these three documents, the following priority order applies: first, ISO 19973-1; second, ISO 5598; and third, IEC 60050-191.

4 Symbols and units

4.1 Units of measurement are in accordance with ISO 1000.

4.2 Graphic symbols used in this part of ISO 19973 conform to the requirements of ISO 1219-1.

5 Test equipment

The test circuit typically includes a pressure source, the cylinder(s) being tested, a solenoid valve(s) and an adjustable flow control valve, which acts as a speed controller. See Figure 1 for a circuit diagram of an example test circuit.

NOTE The basic circuits in Figure 1 do not incorporate all the safety devices necessary to protect against damage in the event of component failure. It is important that those responsible for carrying out the test give due consideration to safeguarding both personnel and equipment.

6 Test conditions

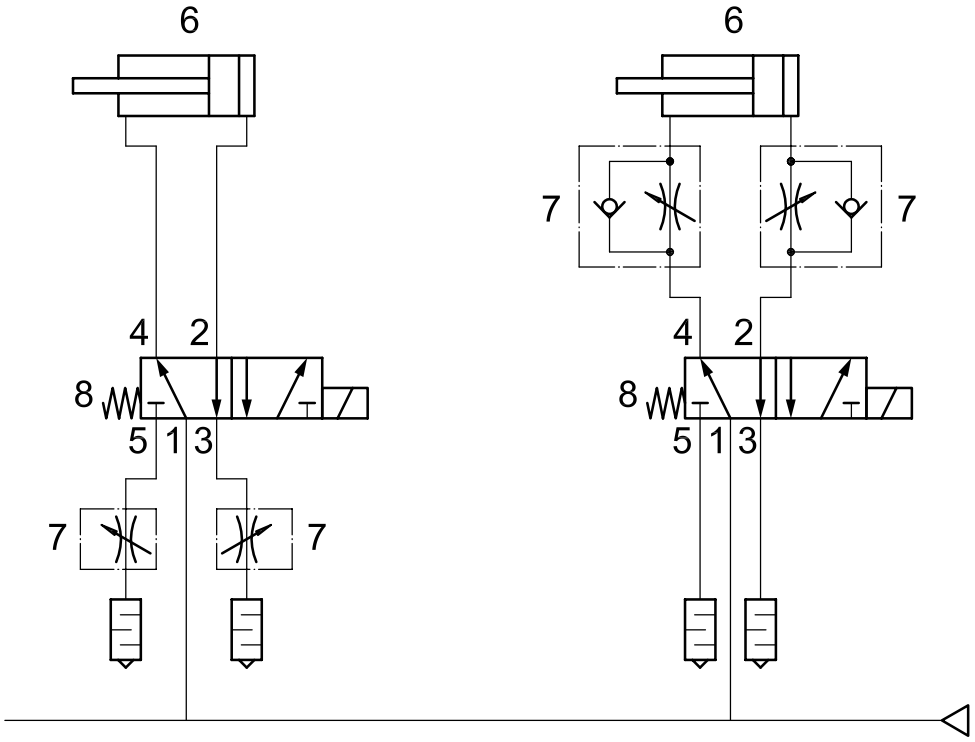
6.1 General test conditions

All test units shall have passed an acceptance test conducted in accordance with ISO 10099. The general test conditions shall be in accordance with ISO 19973-1.

6.2 Endurance test conditions

6.2.1 Orientation

The cylinder being tested shall be installed in the horizontal position.



Key

1 to 5 ports
6 pneumatic cylinder being tested
7 adjustable flow control valve (speed controller)
8 directional control valve

Figure 1 — Example of a test circuit for determining the reliability of a pneumatic piston rod cylinder by testing

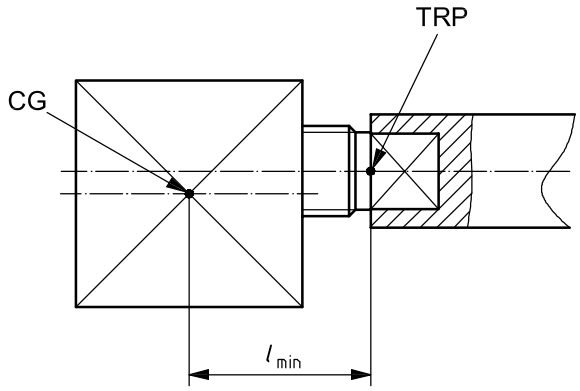
6.2.2 Side loads

6.2.2.1 No side loads shall be applied to single-acting cylinders.

6.2.2.2 For double-acting cylinders, the side load shall be mounted as follows.

a) The centre of gravity (CG) of the side load shall be situated at a minimum distance, l_{min}, from the theoretical reference point (TRP); see Figure 2.

b) The side load masses and the distances from the TRP for double-acting cylinders shall be in accordance with Table 1.



NOTE The centre of gravity (CG) is below the axis of the cylinder to prevent the piston rod from turning during the test.

Figure 2 — Distance of centre of gravity of the side load from the cylinder's theoretical reference point

Table 1 — Side load masses and distances from the cylinder's theoretical reference point

Cylinder bore size	Side load [a] kg			l_{min} mm
	Class 1 — Light (e.g. ISO 21287)	**Class 2 — Medium** (e.g. ISO 6432)	**Class 3 — Heavy** (e.g. ISO 6430 or ISO 15552)	
8	—	0,03	—	20
10		0,05		
12		0,07		
16		0,13		
20	0,20	0,20		
25	0,25	0,30		
32	0,40	—	2	50
40	0,60		3	
50	1,00		4	
63	1,50		6	
80	2,50		9	
100	3,50		12	
125	—		16	
160			20	
200			30	
250			40	
320			50	

[a] ± 5 %.

6.2.3 Stroke length

The stroke length of the cylinder to be tested shall be in accordance with Table 2.

Table 2 — Test stroke lengths

Dimensions in millimetres

Cylinder bore size	Cylinder test stroke				
	Class 1 (e.g. ISO 21287)		Class 2 (e.g. ISO 6432)		Class 3 (e.g. ISO 6430 or ISO 15552)
	double-acting	single-acting	double-acting	single-acting	double-acting
8	—	—	20	10	—
10					
12			25		
16			30	25	
20	20	10	40		
25	25		50		
32	30		—	—	160
40	40				
50	50	25			250
63					
80					
100					
125	—	—			320
160					
200					
250					
320					

6.2.4 Initial test stroke time

The initial test stroke time of the cylinder to be tested shall be in accordance with Table 3.

Table 3 — Initial test stroke times

Cylinder bore sizes mm	Maximum initial stroke time s
8, 10, 12, 16, 20, 25 and 32	0,5
40, 50, 63, 80 and 100	0,8
125, 160 and 200	1,2
250 and 320	1,6

7 Test procedure

7.1 Operating adjustments

Operate the test cylinders so that the stroke time does not exceed that specified in Table 3. The stroke time shall include the effects of any adjustable cushioning mechanism used to prevent impact at the end of the stroke. This cushioning shall be adjusted during the course of the test to offset the effect of cushion seal wear.

7.2 Timing of checks and measurements

7.2.1 The following checks and measurements shall be made before, during and after the endurance test:

a) functional check in accordance with 7.3.1;

b) leakage measurement in accordance with 7.3.2;

c) measurement of the pressure characteristics accordance with 7.3.3.

7.2.2 Measuring intervals shall be determined in accordance ISO 19973-1.

7.3 Type and scope of the checks and measurements

7.3.1 Functional check

Test units shall be checked acoustically, optically and tactilely under test conditions to determine whether the test units and the valves controlling them are operating correctly. The functional check is to see whether both end positions are reached. Record the stroke time in each direction.

If test units fail between consecutive observations, the termination cycle count shall be determined in accordance with ISO 19973-1.

7.3.2 Leakage measurement

Leakage rate shall be measured in both cylinder-end positions at the pressurized port at working pressure.

7.3.3 Minimum working pressure performance test (for double-acting cylinders)

A performance test with the side load mounted in accordance with 6.2.2.2 shall be carried out to determine the minimum working pressure after cycling the cylinder five to 10 times. Increase the pressure to the cylinder being tested continuously until the cylinder moves smoothly in both directions. Record the pressure at which this occurs as the minimum working pressure.

8 Threshold levels

8.1 General

The test unit shall be considered to have failed if any one of the threshold levels or failure criteria specified in 8.2 through 8.5 is reached.

8.2 Functional failure

The test unit shall be considered to have failed if it does not provide the functionality specified in 7.3.1.

8.3 Failure due to leakage

8.3.1 The leakage rate of new cylinders shall not exceed the values for this characteristic specified in ISO 10099:2001, Table 1.

8.3.2 The test unit shall be considered to have failed the endurance test if the leakage rate measured in accordance with 7.3.2 exceeds 10 times the values specified in ISO 10099:2001, Table 1.

8.4 Failure due to minimum working pressure

The test unit shall be considered to have failed if the minimum working pressure for the cylinder, measured in accordance with 7.3.3, exceeds the minimum working pressure given Table 4.

Table 4 — Threshold level for minimum working pressure

Cylinder bore size	Minimum working pressure kPa (bar)
8	300 (3,0)
10	260 (2,6)
12	
16	160 (1,6)
20	
25	120 (1,2)
32	
40	80 (0,8)
50	
63	60 (0,6)
80	
100	40 (0,4)
125	
160	
200	30 (0,3)
250	
320	
NOTE Values are valid for both directions.	

8.5 Failure due to excess stroke time

The test unit shall be considered to have failed if the stroke time exceeds twice the maximum stroke time specified in Table 3.

9 Data analysis

Test data shall be analysed in accordance with ISO 19973-1.

10 Test report

Data shall be reported in accordance with ISO 19973-1.

11 Identification statement (reference to this part of ISO 19973)

It is strongly recommended to manufacturers who have chosen to conform to this International Standard that the following statement be used in test reports, catalogues and sales literature:

"Reliability and lifetime of pneumatic piston rod cylinders determined in accordance with ISO 19973-3, *Pneumatic fluid power — Assessment of component reliability by testing — Part 3: Cylinders with piston rod*."

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