INTERNATIONAL STANDARD

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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.

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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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 131, *Fluid power systems*.

This second edition cancels and replaces the first edition (ISO 19973-3:2007), which has been technically revised.

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*

— *Part 5: Non-return valves, shuttle valves, dual pressure valves (AND function), one-way adjustable flow control valves, quick-exhaust valves.*

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. This part of ISO 19973 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 are 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 assessing the reliability of pneumatic cylinders with piston rod, both single-acting and double-acting, by testing and the methods of reporting the results of testing. General test conditions and the calculation method are provided in ISO 19973-1. The methods specified in ISO 19973-1 apply to the first failure, as obtained with the three-point moving average (*3PMA*) method, without repairs, but excluding 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 assess the reliability of pneumatic cylinders with piston rods.

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.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

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

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

ISO 80000-1, *Quantities and units — Part 1: General*

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.

NOTE 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

Units of measurement shall be in accordance with ISO 80000-1.

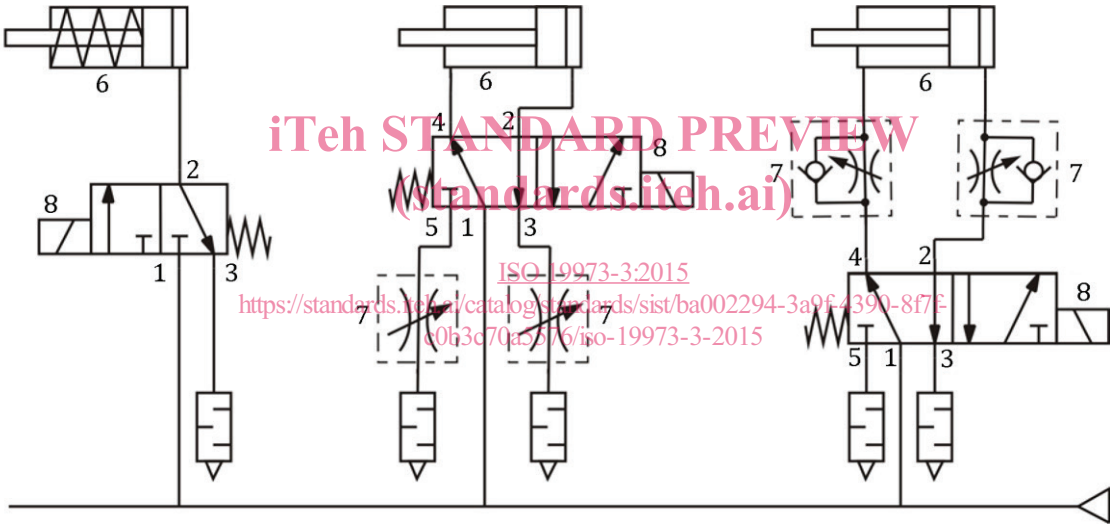
NOTE Graphical symbols used in this part of ISO 19973 conform to the requirements given in ISO 1219-1.

5 Test equipment

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

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.

5.2 Cylinders to be tested shall be rigidly installed in the horizontal position and fixed to a secure base to reduce vibration. They shall be fixed at both ends. If necessary, alternate the motion of the cylinders to allow one to extend while another retracts.



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 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 Initial condition

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

6.3 Endurance test conditions

6.3.1 Orientation

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

6.3.2 Side loads

6.3.2.1 No side loads shall be applied to single-acting cylinders. Test results can be related only to the tested stroke.

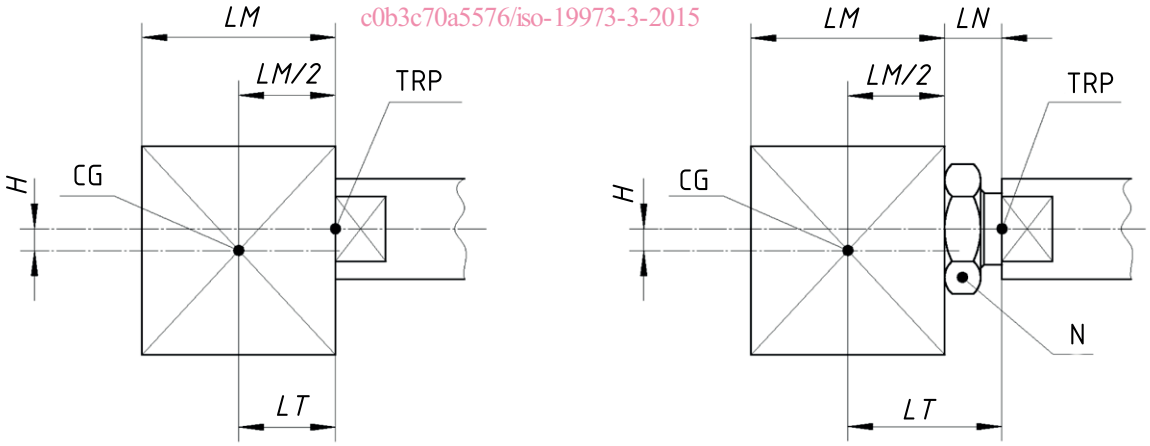
6.3.2.2 For double-acting cylinders, the side load shall be mounted as follows.

a) The side load shall be tightened against the shoulder of the piston rod close to the theoretical reference point (TRP) [see ISO 6099 and Figure 2 a)]. This mounting type should be preferred.

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

c) When a counter nut is required, the side load shall be mounted with a clearance *LN* from the TRP [see Figure 2 b)]. However, the distance *LT* shall be maintained as shown in Table 1.

d) The side load shall be mounted to engage the piston rod at a distance *H* below the centre of gravity (CG). Values for *H* are given in Table 1.



a) Figure 2a) **b) Figure 2b)**

Key

CG centre of gravity of the side load
H eccentricity of the side load
LT distance between TRP and CG
LM longitudinal length of the side load
LN optional space for a counter nut
N counter nut (optional)
TRP theoretical reference point

Figure 2 — Distance of centre of gravity of the side load from the cylinder's theoretical reference point (TRP) and its eccentricity

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

Cylinder bore size	Side load kg[a]			H mm ±0,5 mm	LT_{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	—	1,5	20
10		0,05			
12		0,07			
16		0,13			
20	0,20	0,20			
25	0,25	0,30			
32	0,40	—	2	3	50
40	0,60		3		
50	1,00		4		
63	1,50		6		
80	2,50		9		
100	3,50		12		
125	—		16	5	
160			20		
200			30		
250			40		
320			50		

[a] ±5 %.

6.3.3 Stroke lengths

The stroke lengths of cylinders to be tested shall be in accordance with Table 2. Methods to calculate side load masses for deviating test stroke lengths are given in Annex A.

Table 2 — Test stroke lengths for cylinders

Dimensions in millimetres

<table>
<tr><th rowspan="3">Cylinder bore size</th><th colspan="5">Cylinder test stroke</th></tr>
<tr><th colspan="2">Class 1
(e.g. ISO 21287)</th><th colspan="2">Class 2
(e.g. ISO 6432)</th><th>Class 3
(e.g. ISO 6430 or ISO 15552)</th></tr>
<tr><th>double-acting</th><th>single-acting</th><th>double-acting</th><th>single-acting</th><th>double-acting</th></tr>
<tr><td>8</td><td rowspan="4">—</td><td rowspan="4">—</td><td rowspan="2">20</td><td rowspan="2">10</td><td rowspan="5">—</td></tr>
<tr><td>10</td></tr>
<tr><td>12</td><td>25</td></tr>
<tr><td>16</td><td>30</td><td rowspan="3">25</td></tr>
<tr><td>20</td><td>20</td><td rowspan="4">10</td><td>40</td></tr>
<tr><td>25</td><td>25</td><td>50</td></tr>
<tr><td>32</td><td>30</td><td rowspan="4"></td><td rowspan="4"></td><td rowspan="2">160</td></tr>
<tr><td>40</td><td>40</td></tr>
<tr><td>50</td><td rowspan="4">50</td><td rowspan="4">25</td><td rowspan="3">250</td></tr>
<tr><td>63</td></tr>
<tr><td>80</td></tr>
<tr><td>100</td><td>—</td><td>—</td><td rowspan="5">320</td></tr>
<tr><td>125</td><td rowspan="5">—</td><td rowspan="5">—</td><td rowspan="5"></td><td rowspan="5"></td></tr>
<tr><td>160</td></tr>
<tr><td>200</td></tr>
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<tr><td>320</td></tr>
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