INTERNATIONAL STANDARD

**ISO 19973-2**

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# Pneumatic fluid power — Assessment of component reliability by testing —

## Part 2: Directional control valves

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

*Partie 2: Distributeurs*



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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 19973-2 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 2 is intended to provide requirements and test conditions that permit the assessment of the inherent reliability of pneumatic and electro-pneumatic directional control valves.

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 2: Directional control valves

## 1 Scope

This part of ISO 19973 provides test procedures for determining the reliability of pneumatic directional control valves by testing and the methods of reporting the results of testing. General test conditions and the calculation method are provided in part 1 of ISO 19973. The methods specified in that part of ISO 19973 apply to the first failure without repairs, but exclude outliers.

The lifetime of pneumatic and electro-pneumatic directional control valves is usually given as a number of cycles. Therefore, whenever the term “time” is used in this part of ISO 19973, this variable is be understood as cycles.

This part of ISO 19973 also specifies test equipment and threshold levels for tests to determine the reliability of pneumatic directional control valves.



## 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 6358, *Pneumatic fluid power — Components using compressible fluids — Determination of flow-rate characteristics*

ISO 8778, *Pneumatic fluid power — Standard reference atmosphere*

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

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.

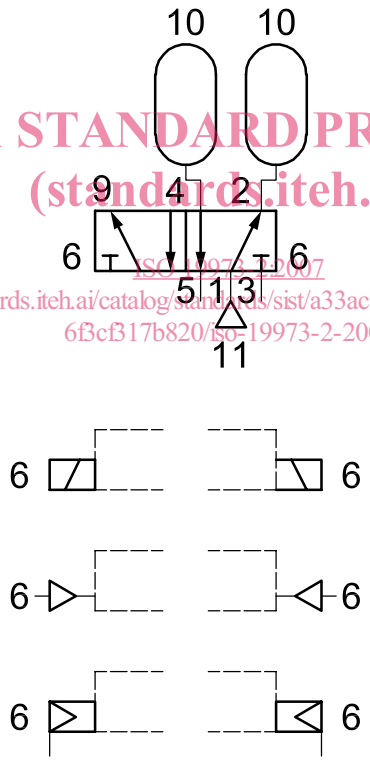
## 5 Test equipment

### 5.1 Basic test equipment

Basic test equipment shall conform to the requirements given in Table 1 and Figure 1. Any silencers fitted to exhaust ports shall not restrict the valve's flow rate.

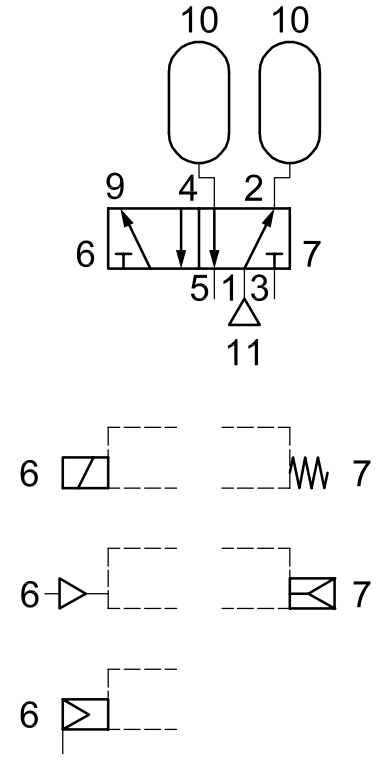
The basic circuits in Figure 1 do not incorporate all the safety devices necessary to protect against damage in the event of component failure. It is important that those responsible for carrying out the test give due consideration to safeguarding both personnel and equipment.





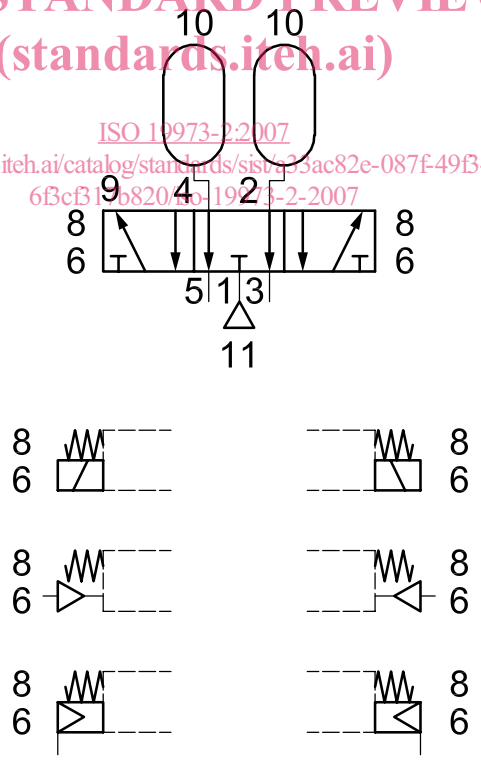

**a) Two-position bi-stable valves**

**Figure 1 — Basic test equipment requirements** (*continued*)




b) Two-position monostable valves with spring or air return






c) Three-position valves

**Key**

| | | | |
|---|---|---|---|
| 1 to 5 | ports | 9 | valve being tested |
| 6 | control signal: electrical, pneumatic, or pilot-operated | 10 | volume at working ports |
| 7 | spring or air-spring return | 11 | supply pressure to port 1 |
| 8 | spring return to centre position | | |

The pilot supply can be either internal or external as long as it has the capability described in 8.3.

**Figure 1 — Basic test equipment requirements**

## 5.2 Volume at working ports

The volume at the working ports depends on the valve's sonic conductance, $C$, as determined in accordance with ISO 6358. The volumes shall meet or exceed the minimum values given in Table 1.

**CAUTION — During testing, the volumes at working ports can become hot. It is necessary to take care to protect personnel.**

**Table 1 — Minimum volume at the working ports, based on valve's sonic conductance**

| Sonic conductance $C$ $dm^3/(s \cdot MPa)$ | Minimum volume at working ports ml |
|---|---|
| | |
| $C \leqslant 4$ | 2 |
| $4 < C \leqslant 40$ | 10 |
| $40 < C \leqslant 120$ | 25 |
| $120 < C \leqslant 200$ | 50 |
| $200 < C \leqslant 400$ | 100 |
| $C < 400$ | 200 |



## 5.3 Recommended tube sizes for supply line



**5.3.1** Connect the volume to the working ports of the test units either directly or by means of sections of tubes, in a manner that does not restrict flow.

**5.3.2** Tubes in the connecting lines shall be kept as short as possible so that the volumes can be charged and vented within the times provided by the control signal.

## 5.4 Simultaneous operation of multiple pneumatically operated valves

When testing pneumatically operated valves, several test units may be operated simultaneously from one control valve. In doing so, the control pressure described in 6.2.1 shall be applied to all test units.

# 6 Test conditions

## 6.1 General test conditions

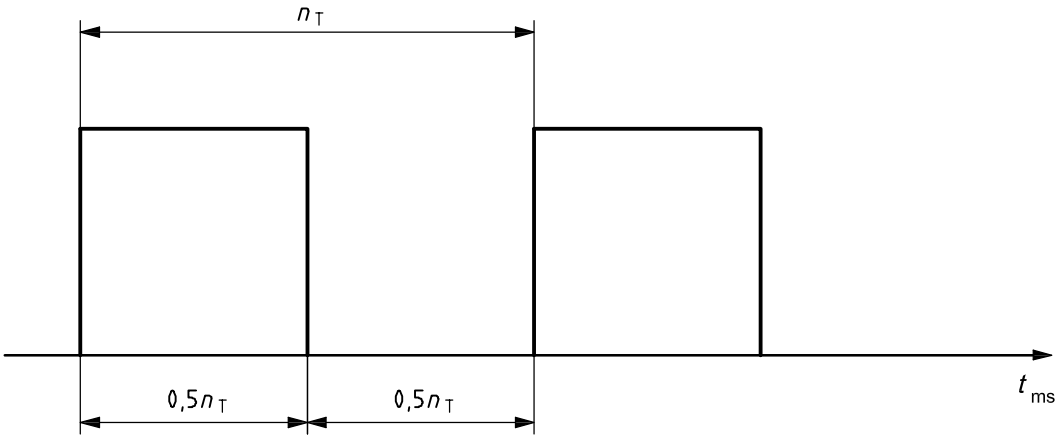
The general test conditions shall be in accordance with ISO 19973-1.

## 6.2 Cycling frequencies

**6.2.1** Actuate the test valves in a manner to ensure that the pressure in the working port volumes drops below 10 %, and rises above 90 %, of the supply pressure during the cycle.

**6.2.2** The ratio between the actuation-impulse on/off times shall be 1:1.

**6.2.3** For monostable two-position valves, the control signal shall be applied in accordance with Figure 2.




**Key**

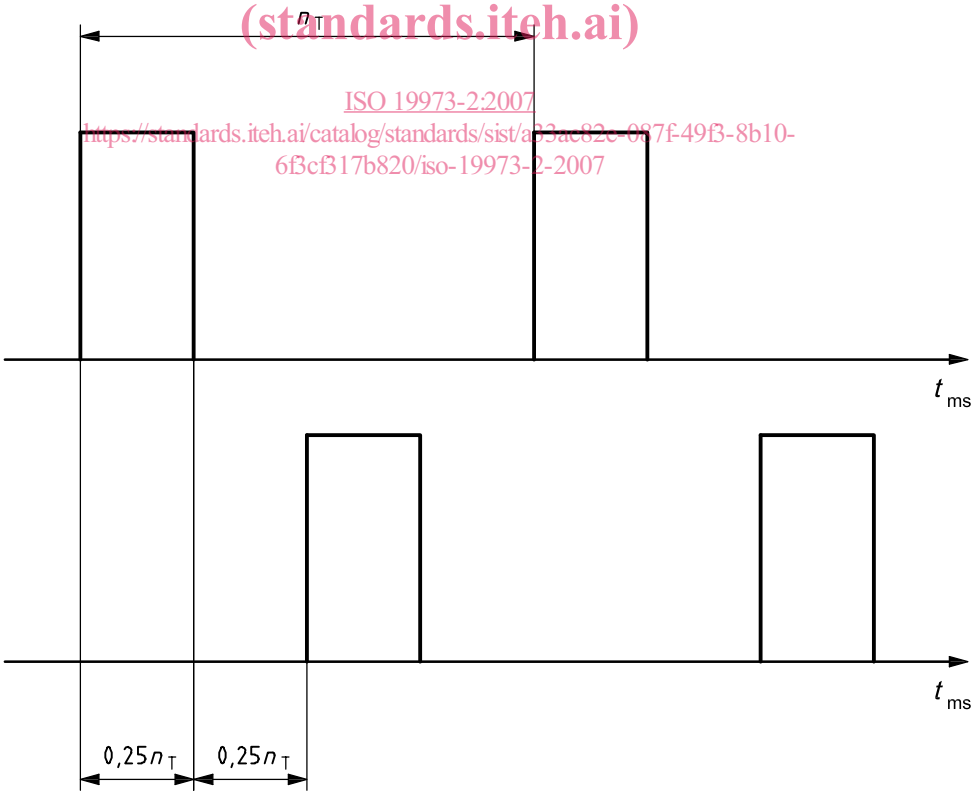
$n_T$ cycle

$t_{ms}$ time, expressed in milliseconds

**Figure 2 — Control signal for monostable two-position valves**

**6.2.4** For bistable and three-position valves, the control signal shall be applied in accordance with Figure 3.






**Key**

$n_T$ cycle

$t_{ms}$ time, expressed in milliseconds

**Figure 3 — Control signal for bistable and three-position valves**