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Pneumatic fluid power — Directional control valves — Measurement of shifting time

Transmissions pneumatiques — Distributeurs de commande directionnels — Mesure du temps de commutation

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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 12238 was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 5, *Control products and components*.

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Introduction

In pneumatic fluid power systems, power is transmitted and controlled through a gas under pressure circulating within a circuit. In some applications, the designer of a fluid power system needs to know the time required to cause the valving elements in a pneumatic directional control valve to move and to generate an output signal.

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Pneumatic fluid power — Directional control valves — Measurement of shifting time

1 Scope

This International Standard

— specifies test procedures for measuring the shifting times of electrically- or pneumatically-operated directional control valves and moving-part logic elements,

— establishes a definition for shifting time, and

— is intended to improve the application of pneumatic fluid power by providing users and manufacturers of pneumatic valves with a standardized test procedure for measuring the shifting time it defines.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 1000, *SI units and recommendations for the use of their multiples and of certain other units*.

ISO 1219-1:1991, *Fluid power systems and components — Graphic symbols and circuit diagrams — Part 1: Graphic symbols*.

ISO 5598:1985, *Fluid power systems and components — Vocabulary*.

ISO 6358:1989, *Pneumatic fluid power — Components using compressible fluids — Determination of flow-rate characteristics*.

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO 5598 and the following apply.

3.1

shifting time

time lapse measured from a change in the control signal (electrical or pneumatic) until the time at which the pressure in the associated outlet port changes by 10 % between specified pressure levels, with only a pressure transducer connected to the outlet

NOTE This definition is very similar to that of “dead time” in ISO 5598:1985, 4.0.7.1.1 and 4.0.7.1.2. The only difference between the two definitions is the specification of the outlet pressure change. Many national standards, as well as ISO 5598, give additional (and sometimes conflicting) definitions for other terms related to the shifting characteristics of valves. A number of these are given in annex A.

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3.2
shifting on-time
shifting time when the control signal is applied

3.3
shifting off-time
shifting time when the control signal is removed

4 Symbols and units

4.1 The symbols and units for parameters used in this International Standard shall be as given in Table 1.

Table 1 — Symbols and units

Symbol	Parameter	Unit (in accordance with ISO 1000)
d	Inside diameter of pressure measuring tube	mm
p_1	Supply reservoir pressure	kPa (bar)[a]
p_3	Control pressure	kPa (bar)
t_o	Base for time measurement	ms
t_E	Exhaust shifting time	ms
t_F	Fill shifting time	ms
θ_1	Supply reservoir temperature	°C

[a] 1 bar $= 10^5$Pa $=$ 100 kPa $=$ 0,1 MPa; 1 Pa $=$ 1 N/m^2.

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

5 Test equipment

5.1 Basic test equipment

The basic test equipment shall be as shown in Figures 1 and 2.

5.2 Pressure measuring tubes

5.2.1 A straight pressure measuring tube shall be made to thread into the valve inlet port, as well as into the valve pilot port when applicable, and shall be made in accordance with 5.5 of ISO 6358:1989.

5.2.2 Select and attach pressure measuring tubes to the test valve whose threads correspond to each port size of the valve flow path, and to the valve pilot port when applicable.

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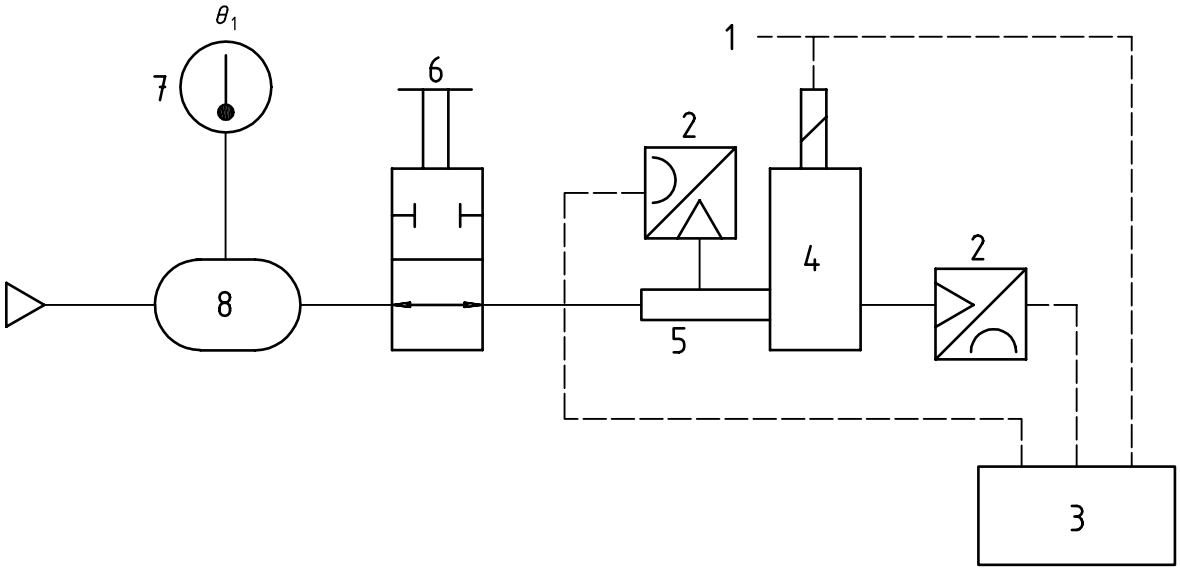

Key

1 Control signal
2 Pressure transducers
3 Output recording device(s)
4 Valve under test
5 Pressure measuring tube in accordance with ISO 6358
6 Shut-off valve (optional)
7 Thermometer
8 Supply reservoir

Figure 1 — Test equipment for electrically-operated valves

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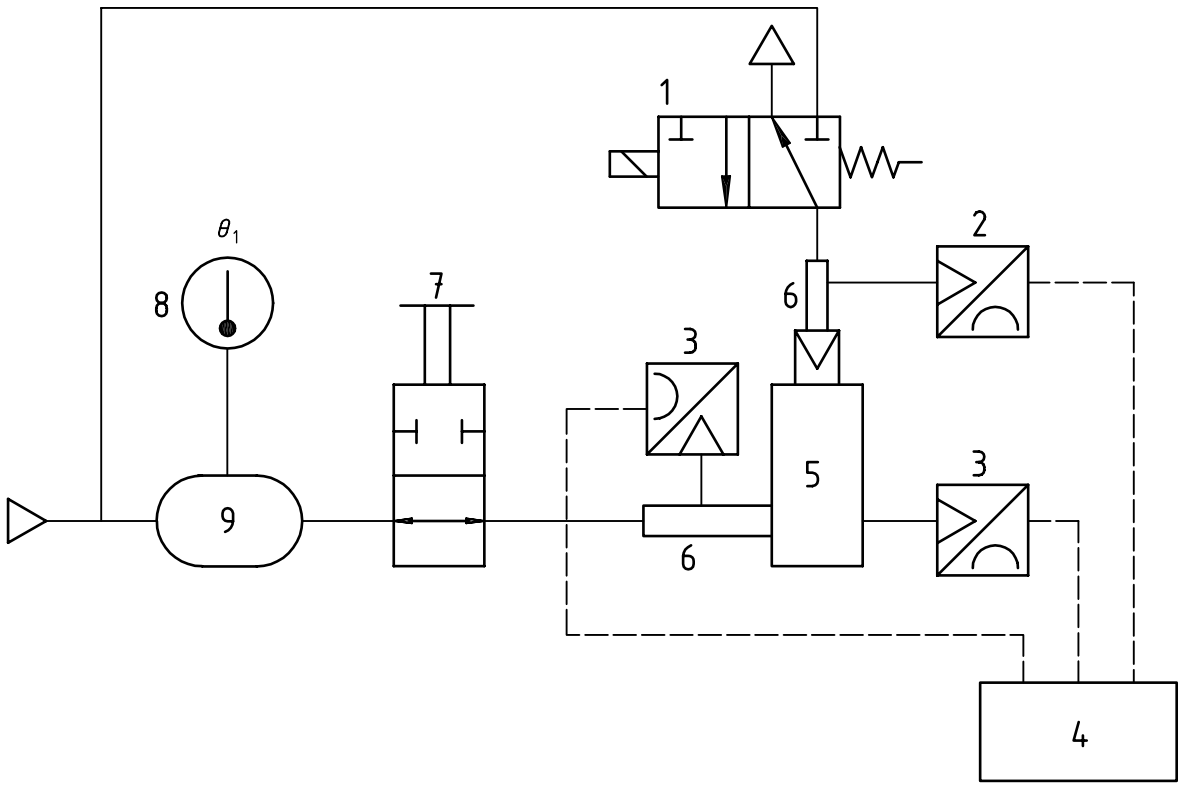

Key

1 Control valve
2 Control pressure transducer
3 Pressure transducers
4 Output recording device(s)
5 Valve under test
6 Pressure measuring tube in accordance with ISO 6358
7 Shut-off valve (optional)
8 Thermometer
9 Supply reservoir

Figure 2 — Test equipment for pneumatically-operated valves

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5.3 Pressure transducers

5.3.1 Install a pressure transducer directly into each outlet port to be tested, as well as into the inlet pressure measuring tube.

5.3.2 When a pneumatically-operated valve is tested, mount the control pressure transducer into the pilot pressure measuring tube.

5.3.3 Use pressure transducers, amplifiers and recording devices that together have a system frequency response of within −3,0 dB at 2 000 Hz and a reference time to a known base resolvable to less than 0,1 ms.

5.3.4 Changes in the shifting time caused by limitation of the negative voltage peaks due to the test equipment should not exceed 0,1 ms.

5.4 Supply reservoir

5.4.1 Use a supply reservoir of sufficient capacity so that the pressure drop in the flow tube during the test does not exceed 3 % of the supply pressure. A larger pressure drop is permissible but will increase the shifting time and result in a less favourable rating for the product under test. Connections from the supply reservoir should be several times larger than the pressure measuring tube and as short as possible, to minimize the pressure drop.

5.4.2 Use a supply reservoir that provides for measuring of the internal air temperature of the reservoir.

5.4.3 Locate the optional shut-off valve, and the control valve when applicable, as close as possible to the reservoir outlet. Use a valve whose flow area is larger than that of the pressure measuring tube, because a smaller valve can restrict flow and increase shifting time.

5.5 Control signal

5.5.1 For solenoid pilot-operated valves (see Figure 1), maintain pilot supply pressure at either the pressure supplied to the valve or the maximum rated pilot supply pressure, whichever is less.

5.5.2 For a.c. solenoid-operated valves, generate the control signal with a trigger device set to trigger at the zero voltage crossover point. Maintain voltage to within ± 5 % of the rated voltage.

5.5.3 For d.c. solenoid-operated valves, maintain steady-state voltage to within ± 5 % of the rated voltage.

5.5.4 For pneumatically-operated valves (see Figure 2), maintain the pilot pressure at the same pressure as in the supply reservoir or at the maximum permitted pilot pressure, whichever is less.

5.6 Data recording system

During a test run, record the pressure variations with time for all transducers in the system. Figure 3 gives examples of how data from an analogue recorder would appear. Other data recording techniques, including digital methods, which do not produce data in this form, may be used.

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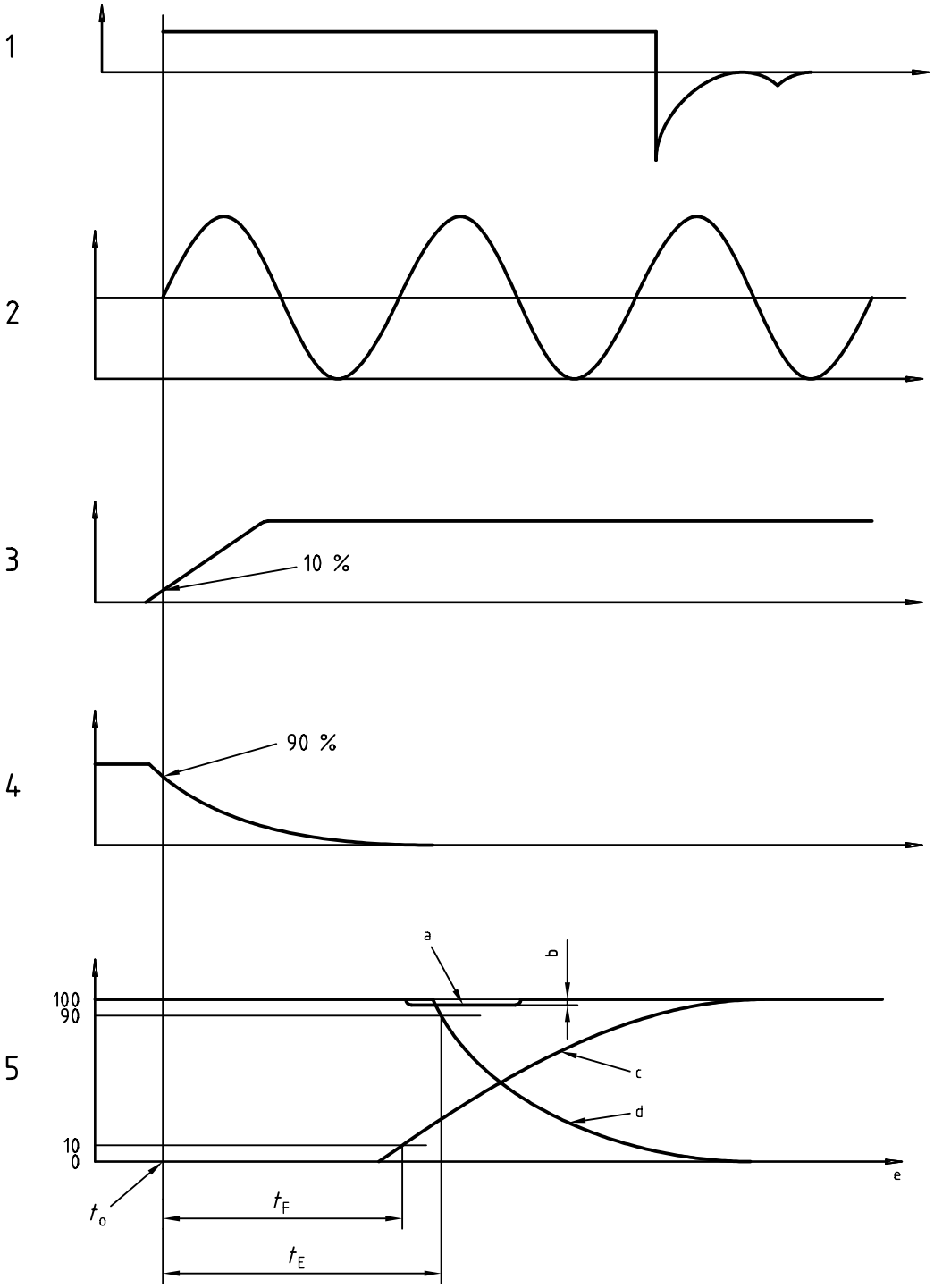

Key

1 Control — d.c. solenoid (V)
2 Control — a.c. solenoid (V)
3 Control — Pressure pilot (kPa [bar])
4 Control — Vented pilot (kPa [bar])
5 Percent of supply pressure

a p_1
b 3 % maximum recommended drop
c Fill test
d Exhaust test
e Time (ms)

Figure 3 — Typical data record generated from an analog recorder

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6 Test accuracy

Test conditions shall be maintained and data obtained within the accuracy limits given in Table 2.

Table 2 — Test accuracy parameters

Parameter of measuring instrument	Permissible systematic error
Pressure	± 10 kPa (± 0,1 bar)
Temperature	± 2 °C
Time	± 0,4 ms

7 Test procedure

7.1 Set up the test circuit as shown in Figure 1 or, when appropriate, Figure 2, with components as specified in clause 5.

7.2 The fill and exhaust test time for each outlet port shall be measured based on the operation capabilities of the valve, either shifting on-time or shifting off-time. The following data shall be recorded:

— the fill time from inlet to each outlet port, and

— the exhaust time from each outlet to exhaust port.

Additional data on other possible flow paths through the valve (for example, two inlets for dual pressure valves) may also be recorded.

7.3 The fill test time shall be determined as follows.

7.3.1 Maintain supply reservoir pressure at a gauge pressure of 630 kPa (6,3 bar) or at the maximum rated pressure, whichever is less.

7.3.2 Vent the outlet port under test to atmosphere.

7.3.3 Maintain the supply reservoir temperature between 18 °C and 30 °C.

7.3.4 Perform several preliminary valve shifts by energizing or de-energizing the solenoid on electrically-operated valves, or by operating the control valve to pressurize or depressurize the pilot control mechanism on pneumatically-operated valves.

7.3.5 Perform three test runs for each flow path, venting the outlet port each time and waiting at least 1 min before performing the next test run, to ensure temperature stabilization.

7.4 The exhaust test time shall be determined as follows.

7.4.1 Charge the outlet port under test to a gauge pressure of 630 kPa (6,3 bar) or to the maximum rated pressure, whichever is less.

7.4.2 Maintain the supply reservoir temperature between 18 °C and 30 °C.

7.4.3 Perform several preliminary valve shifts by energizing or de-energizing the solenoid on electrically-operated valves, or by operating the control valve to pressurize or depressurize the pilot control mechanism on pneumatically-operated valves.

7.4.4 Perform three test runs for each flow path, pressurizing the outlet port each time and waiting at least 1 min before performing the next test run, to ensure temperature stabilization.

7.5 Testing to measure exhaust and fill testing may be combined to run in sequence.

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8 Data calculations

8.1 For electrically-operated valves, establish the time base (t_o) as the point at which a definite change in the voltage is noted (see Figure 3).

8.2 For pneumatically-operated valves, establish the time base (t_o) as the point at which a 10 % change in pilot pressure is noted (see Figure 3).

8.3 Measure the time to fill from t_o to the point at which the pressure reaches 10 % of its supply reservoir pressure value for each test run of an outlet port. Determine the average of the data from the several test runs for each outlet port; this is the fill shifting time for each outlet port (see Table B.1 for an example of test data).

8.4 Measure the time to exhaust from t_o to the point at which the pressure reaches 90 % of its supply reservoir pressure value for each test run of an outlet port. Determine the average of the data from the several test runs for each outlet port; this is the exhaust shifting time for each outlet port (see Table B.1 for an example of test data).

9 Reporting of test data

9.1 Report the average shifting time for each flow path in the valve; see the column titled “Each flow path” in Table B.1 for an example of this type of reporting.

9.2 As an alternative to 9.1, report the average of shifting time for all flow paths in a valve, with a bilateral tolerance that includes the extremes of the data recorded; see the column titled “Valve as a whole” in Table B.1 for an example of this type of reporting.

10 Identification statement (reference to this International Standard)

It is strongly recommended that manufacturers use the following statement in test reports, catalogues and sales literature when electing to comply with this International Standard:

“Shifting time of pneumatic directional control valves or moving part logic devices was measured in accordance with ISO 12238:2001, *Pneumatic fluid power — Directional control valves — Measurement of shifting time*.”

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Annex A
(informative)

Terms and definitions on switching characteristics taken from other international, regional and national standards

A.1 From ISO 5598:1985

2.2.9.5
response time
time lapse between the initiation point of an operation and its point of completion, these points being defined for each type of component

4.0.7.1
valve response time
the initial point is the moment when the pilot pressure rises/falls past a given point; the completion point is when a given value of the outlet pressure or flow has been reached

4.0.7.1.1
dead time of a pneumatic directional control valve with pneumatic control
the initial point is the moment when the pilot pressure rises/falls past a given level; the completion point is the moment when the outlet pressure reaches a specified percentage of its maximum, the outlet being connected to zero capacity (outlet port closed)

4.0.7.1.2
dead time of a pneumatic directional control valve with electrical control
the initial point is the opening (or closing) of the electrical circuit; the completion point is the moment when the outlet pressure reaches a specified percentage of its maximum, the outlet being connected to zero capacity (outlet port closed)

4.0.7.1.3
switching time
switch-on time for an output going from the 0-state to the 1-state; switch-off time for an output going from the 1-state to the 0-state

4.0.8.1
switching pressure
minimum pilot pressure necessary to cause a change of state at an output port

4.0.8.2
switching time
time the initial point is the moment when the control or pilot pressure reaches the level of switching pressure; the completion point is when a given value of the outlet pressure has been reached

A.2 From CETOP RP111P - 1989-11-01

3.1.3
switching threshold
the joint effect of two limiting values, rising or falling, on the one hand the signal pressure and on the other signal voltage, which causes or allows switching

switching time
the complete transition from an initial to a final state under the normal operating conditions foreseen by the manufacturer (no oscillations, correct sealing, normal flow values, etc.)

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3.2.2
switching time
the time which elapses between the closing or opening of the electric circuit and the instant when the pressure at the outlet port reaches 50 % of its maximum value, the outlet port being blocked at the valve body or at the subplate if the valve is mounted on a subplate

A.3 From JIS B8375-1981

response time
time lapse between the arrival of an input signal to a valve, a circuit and the like, and the point at which output reaches a specified value (according to JIS B0142)

From subclause 4.3
dynamic performance
“The dynamic performance shall be represented by the response time obtained when the specimen valve is tested according to 10.3 [of JIS B8375], and its value shall conform to Table 3.”

From subclause 10.3
dynamic performance test
“With the pressure of 5 kgf/cm^2 (500 kPa) applied to port P, a pressure detecting device shall be connected to either port A or port B, and after applying or disconnecting the rated voltage to or from the exciting circuit, the time required before a pressure is detected shall be measured by the pressure detecting device.”

A.4 From ANSI/(NFPA) T3.21.8-1990

3.1
response time
the time interval in which the pressure in a test chamber connected to an outlet port of a pneumatic directional control valve changes by 90 % between specified pressure levels in response to a change in the control signal to that valve

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Annex B
(informative)

Example of generated test data and values to be reported

Table B.1 — Example of shifting time test data generated from testing a 5/2 monostable valve and values to be reported

Description of flow path in accordance with ISO 11727	**Shifting time data from each test run**	**Average shifting time**	**Shifting times to be reported**	
			each flow path	valve as a whole
Fill with ports 1 to 4 energized	31 ms	32 ms	32 ms	35 ms ± 4 ms
	32 ms			
	33 ms			
Exhaust with ports 2 to 3 energized	37 ms	38 ms	38 ms	
	38 ms			
	39 ms			
Fill with ports 1 to 2 de-energized	33 ms	34 ms	34 ms	
	34 ms			
	35 ms			
Exhaust with ports 4 to 5 de-energized	35 ms	36 ms	36 ms	
	36 ms			
	37 ms			

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Bibliography

[1] ISO 11727:1999, *Pneumatic fluid power — Identification of ports and control mechanisms of control valves and other components*.

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