INTERNATIONAL STANDARD

ISO 6953-2

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Pneumatic fluid power — Compressed air pressure regulators and filter-regulators —

Part 2: Test methods to determine the main characteristics to be included in literature from suppliers

Transmissions pneumatiques — Régulateurs de pression et filtre-régulateurs pour air comprimé —

Partie 2: Méthodes d'essai pour déterminer les principales caractéristiques à inclure dans la documentation des fournisseurs

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Foreword

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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 part of ISO 6953 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 6953-2 was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 5, *Control products and components*.

ISO 6953 consists of the following parts, under the general title *Pneumatic fluid power — Compressed air pressure regulators and filter-regulators*:

— *Part 1: Main characteristics to be included in literature from suppliers and product-marking requirements*

— *Part 2: Test methods to determine the main characteristics to be included in literature from suppliers*

Introduction

In pneumatic fluid power systems, power is transmitted and controlled through air under pressure circulating within a circuit. Where reduction and regulation of the pressure is desired, the regulators and filter-regulators are components designed to maintain the compressed air pressure approximately constant.

Pneumatic fluid power — Compressed air pressure regulators and filter-regulators —

Part 2: Test methods to determine the main characteristics to be included in literature from suppliers

1 Scope

This part of ISO 6953 specifies tests, test procedures and a method of presenting the results concerning the parameters which define the main characteristics to be included in literature from suppliers of regulators and filter-regulators conforming to ISO 6953-1.

The aim of this part of ISO 6953 is

— to facilitate the comparison of pressure regulators and filter-regulators by standardizing test methods and presentation of test data;

— to assist in the proper application of pressure regulators and filter-regulators in compressed air systems.

The tests specified are intended to allow comparison between the different type of regulators and filter-regulators; they are not production tests to be carried out on each pressure regulator or filter-regulator manufactured.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 6953. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 6953 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 3:1973, *Preferred numbers — Series of preferred numbers.*

ISO 65:1981, *Carbon steel tubes suitable for screwing in accordance with ISO 7-1.*

ISO 2944:2000, *Fluid power systems and components — Nominal pressures.*

ISO 3448:1992, *Industrial liquid lubricants — ISO viscosity classification.*

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

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

ISO 6953-1:2000, *Pneumatic fluid power — Compressed air pressure regulators and filter-regulators — Part 1: Main characteristics to be included in literature from suppliers and product-marking requirements.*

3 Terms and definitions

For the purposes of this part of ISO 6953, the terms and definitions given in ISO 5598 and ISO 6953-1 apply.

4 Units

Units from ISO 1000 are generally used in pneumatic fluid power systems, in particular:

— gauge pressure, expressed in kilopascals (in bars, between parentheses) [kPa (bar)];

— temperature, expressed in degrees Celsius (°C);

— flow rate, expressed in cubic decimetres per second [dm^3/s (ANR)].

5 Test conditions

5.1 Temperature

For all tests, maintain the temperature of the process air, the equipment and the ambient air temperature at 25 °C ± 10 °C.

5.2 Pressures

The specified pressures shall be held to within ± 2 %. The preferred test pressures are those given in clause 4.3.2 of ISO 6953-1:2000, from Table 1 below, or from ISO 2944. Where other test pressures are required, the values shall be chosen from series R5 of preferred numbers, according to ISO 3.

6 Test procedure to verify rated pressure

6.1 Perform this test on three random samples if a single rated pressure is proposed for the entire product, or on six random samples if separate ratings are proposed for the inlet and outlet sections. If the product uses a diaphragm, modify or replace it to withstand the pressure applied (diaphragms are excluded from the test criteria, but not the diaphragm support plates or any pistons). Other product sealing means may be modified to prevent leakage and allow structural failure to occur during the test, but modifications may not increase the structural strength of the pressure-containing envelope.

6.2 Prepare the test samples as follows:

6.2.1 If a single pressure rating is proposed for the entire product, remove the control spring and replace it with a solid spacer whose length will maintain the poppet in its half-open position. Close the gauge ports and the inlet port with plugs, and perform all testing by applying pressure to the outlet port.

6.2.2 If a separate pressure rating is proposed for the inlet and outlet sections of the regulator, relieve the control spring force on three of the samples. Using a proposed pressure rating for the inlet, perform testing on the inlet port, allowing the poppet to be closed and keeping the outlet port open. Prepare the other three samples as described in 6.2.1 and test them using a proposed pressure rating for the outlet port.

6.3 Fill samples with a liquid that does not exceed ISO VG 32, according to ISO 3448, and maintain the temperatures given in 5.1.

6.4 After stabilization of the temperature, pressurize slowly to a level of 1,5 times the proposed rated pressure. Hold at this level for 2 min and observe for leakage or failure, as defined in 6.6.

Table 1 — Chart for outlet pressure set points

Values in kilopascals (bars)

Maximum of the adjustable pressure range	Inlet test pressure levels				
	250 (2,5)	630 (6,3)	1 000 (10)	1 600 (16)	2 500 (25)
less than 100 (less than 1)	Values of approximately 25 %, 40 %, 63 % and 80 % of the maximal adjustable pressure range.				
100 to < 125 (1 to < 1,25)	25 - 40 - 63 - 80 → (0,25 - 0,4 - 0,63 - 0,8)				
125 to < 160 (1,25 to < 1,6)	40 - 63 - 80 - 100 → (0,4 - 0,63 - 0,8 - 1)				
160 to < 200 (1,6 to < 2)	40 - 63 - 100 - 125 → (0,4 - 0,63 - 1 - 1,25)				
200 to < 250 (2 to < 2,5)	63 - 100 - 125 - 160 → (0,63 - 1 - 1,25 - 1,6)				
250 to < 315 (2,5 to < 3,15)		63 - 100 - 160 - 200 → (0,63 - 1 - 1,6 - 2)			
315 to < 400 (3,15 to < 4)		100 - 160 - 200 - 250 → (1 - 1,6 - 2 - 2,5)			
400 to < 500 (4 to < 5)		100 - 160 - 250 - 315 → (1 - 1,6 - 2,5 - 3,15)			
500 to < 630 (5 to < 6,3)		125 - 200 - 315 - 400 → (1,25 - 2 - 3,15 - 4)			
630 to < 800 (6,3 to < 8)		160 - 250 - 400 - 500 → (1,6 - 2,5 - 4 - 5)			
800 to < 1 000 (8 to < 10)			200 - 315 - 500 - 630 → (2,5 - 3,15 - 5 - 6,3)		
1 000 to < 1 250 (10 to < 12,5)			250 - 400 - 630 - 800 → (2,5 - 4 - 6,3 - 8)		
1 250 to < 1 600 (12,5 to < 16)				315 - 500 - 800 - 1 000 → (3,15 - 5 - 8 - 10)	
1 600 (16)				400 - 630 - 1 000 - 1 250 → (4 - 6,3 - 10 - 12,5)	

NOTE Wherever the pressure rating allows, an inlet test pressure of 630 kPa (6,3 bar) should be used for adjustable pressure ranges of up to 800 kPa (8 bar). For adjustable pressure ranges greater than 800 kPa (8 bar), and up to 1 250 kPa (12,5 bar), an inlet test pressure of 1 000 kPa (10 bar) should be used.

6.5 If there is no leakage or failure, increase the pressure by approximately half its proposed rating. Hold at this pressure for 2 min and observe for leakage or failure, as defined in 6.6.

6.5.1 Products constructed of light alloys, brass and steel

Continue raising the pressure as above until a level of four times the proposed rated pressure has been reached.

6.5.2 Products constructed of zinc diecast alloys or plastics

6.5.2.1 Design operating temperatures of up to 50 °C

Continue raising the pressure as above until a level of four times the proposed rated pressure has been reached.

6.5.2.2 Design operating temperature of between 50 °C to 80 °C

Continue raising the pressure as above until a level of five times the proposed rated pressure has been reached.

6.6 The criterion for a failure is a fracture, separation of parts, or a crack, or that which can allow enough liquid to pass across the pressure-containing envelope to wet the outer surface. Leakage across the port threads shall not constitute a failure, unless caused by a fracture or a crack.

6.7 The proposed rated pressure will be verified if all three samples pass their respective tests.

6.8 Where a unit or sub-assembly in the unit (for example, reservoir/sight glass) is constructed of different materials, the higher appropriate factor should be used. The applied pressure may be restricted to the area of the interface between the different materials.

6.9 Where the pressure-containing envelope design is covered by a pressure vessel code in the market of sale, the requirements of that code take precedence over the requirements stated in this part of ISO 6953.

7 Performance tests

7.1 Test installation

7.1.1 Test circuit

The test circuit shall comply fully with the one described in Figure 1. Only one flow-meter location is required per test. The following locations are optional:

— F1, F3 or F4 for forward-flow characteristics test and for pressure-regulation characteristics test;

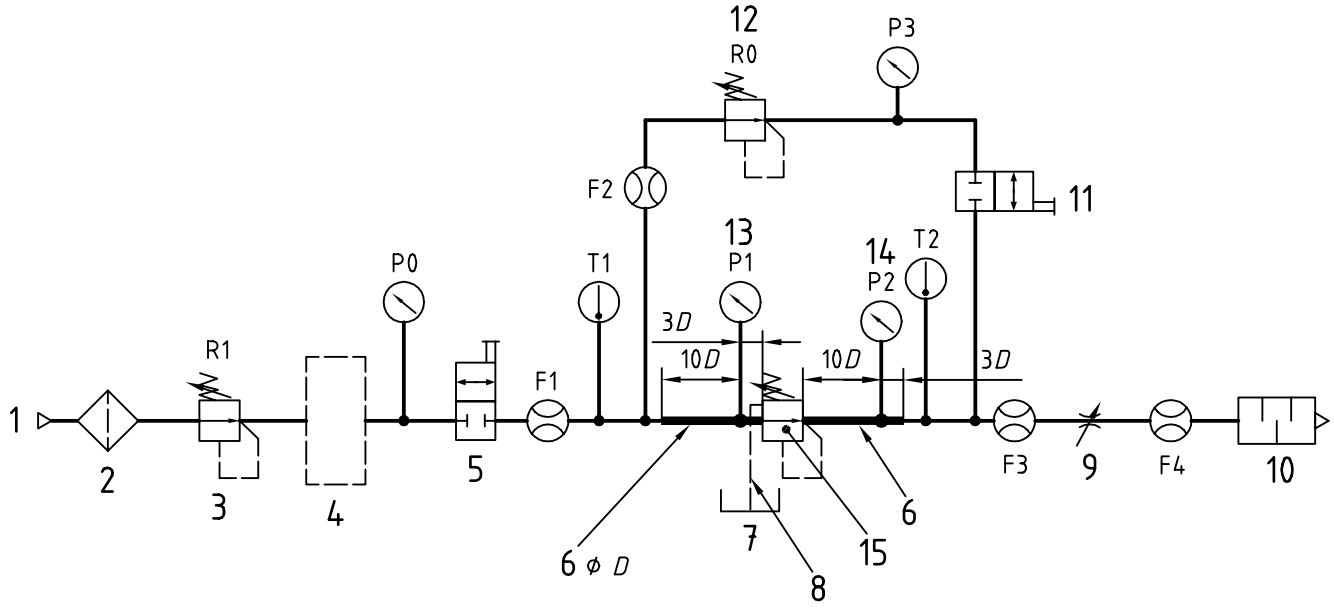
— F1 or F2 for relief-flow characteristics test.

7.1.2 Pressure-measuring tube

The pressure-measuring tubes shall comply fully with those described in ISO 6358:1989, Figure 3, Table 4, clauses 5.5 and 5.6.

7.2 General test procedure

7.2.1 Recordings for each series of tests shall be conducted under essentially steady-state conditions. This may be accomplished either with continuous recording equipment or point-by-point measurements, provided that the recordings are conducted with care and with a sufficiently slow change in conditions to avoid a drift in the steady-state characteristics.



Key

1	Air inlet	9	Flow-control valve
2	Inlet filter	10	Optional silencer
3	Inlet regulator	11	By-pass shut-off valve
4	Optional surge chamber	12	Control regulator (non-relieving)
5	Supply shut-off valve	13	Primary
6	Pressure-measuring tube	14	Secondary
7	Water	15	Tested regulator
8	Hose		

NOTE Graphical symbols, in conformance with ISO1219-1.

Figure 1 — Test circuit

7.2.2 For each point, the permitted variation in the parameters is given in clause 5.

7.2.3 A periodic check shall be made to confirm that none of the measuring instruments' pressure intakes are blocked by solid or liquid particles.

7.3 Forward flow characteristics test

7.3.1 With the test regulator installed as in Figure 1, and without flow, with the by-pass shut-off valve closed, and the supply shut-off valve open, select and apply an inlet pressure from Table 1.

7.3.2 Using the regulator's adjustable pressure range, select at least two outlet pressure set points from Table 1 to be used in this test. Adjust the regulator outlet to the lowest level, making certain that the pressure is increasing (instead of decreasing) to reach this point.

7.3.3 Using the flow-control valve, allow air to pass through the regulator, recording its flow rate and corresponding outlet pressures. If point-by-point data is recorded, obtain closely spaced data in the low flow region.

7.3.4 Continue recording data until maximum flow has been achieved in the test circuit, then record additional data for a decreasing flow rate back to zero flow.

7.3.5 During the conduct of the changing flow rate (both increasing and decreasing), continuously adjust the inlet supply pressure to keep it constant at the test level.

7.3.6 Record the inlet test temperature at the beginning and end of the test.

7.3.7 Repeat the above procedures at the other outlet pressure set point values, making certain that the pressure is increasing, without flow, to reach the set point.

7.4 Pressure regulation characteristics test

7.4.1 With the regulators installed as in Figure 1, and without flow, apply a maximum inlet pressure that is as much above the regulator adjustment range as can be reasonably tested, but that does not exceed the regulator inlet capacity.

7.4.2 From the design rating of the regulator adjustment range, select the outlet pressure set points to be tested from Table 1 and use only those that will be catalogued. Use the column of inlet pressure levels close to, or less than, the maximum inlet pressure applied in 7.4.1.

7.4.3 Adjust the regulator output to the lowest of the outlet pressure set points, making certain that the pressure is increasing (instead of decreasing) to reach this point.

7.4.4 From Table 2, select a flow rate corresponding to the regulator port size under test, and the selected outlet pressure set point.

7.4.5 Adjust the flow control valve to permit 10 % of the flow rate of 7.4.4. to pass through the regulator. Readjust the inlet pressure, outlet pressure and flow control valve to achieve a stable system under all these initial conditions.

7.4.6 Reduce the inlet pressure and record the corresponding outlet pressure while maintaining the flow rate constant, until the inlet pressure has been reduced to the outlet level or until the selected flow rate cannot be maintained.

7.4.7 Repeat the above procedures for all other outlet set points, changing the flow rate each time as per Table 2.

7.4.8 Record the inlet test temperature at the beginning and end of the test.

7.4.9 As an option, repeat all of the above tests again, at the same outlet set points, but using 100 % of the flow rate from Table 2.

7.5 Relief flow characteristics test

7.5.1 With the test regulator installed as described in 7.1, and without flow, select and apply an inlet pressure from Table 1.

7.5.2 From the design rating of the regulator adjustment range, select the same outlet set points from Table 1 as were used in clause 7.3.2. Adjust the regulator outlet to the lowest level, making certain that the pressure is increasing (instead of decreasing) to reach this point.

7.5.3 Set the by-pass control regulator at the same pressure as the outlet pressure of the regulator under test. Open the by-pass shut-off valve to apply this auxiliary pressure to the outlet side of the unit under test.

7.5.4 Increase the auxiliary pressure, recording the flow rate and outlet pressure as air passes through the vent passages of the test regulator (a hose submerged in water can assist in detecting the start of flow).

7.5.5 Continue recording data until maximum relief flow has been achieved in the test circuit, then record additional data for a decreasing flow rate back to zero flow.

7.5.6 Record inlet test temperature at the beginning and end of the test.

7.5.7 Repeat the foregoing procedures at the other outlet set point values, making certain that the pressure is increasing, without flow, to reach the set point.

Table 2 — Maximum recommended flow rates to be used for pressure regulation characteristics test

Flow rates in cubic decimetres per second (ANR)

Outlet pressure	Port size								
	1/8	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2
kPa (bar)	Maximum flow rates								
20 (0,2)	0,18	0,41	0,91	1,7	2,5	4,8	9,8	15	28
40 (0,4)	0,28	0,62	1,4	2,6	3,9	7,3	15	22	43
63 (0,63)	0,38	0,85	1,9	3,5	5,2	9,9	20	30	59
80 (0,8)	0,44	1,0	2,2	4,1	6,2	12	24	36	70
100 (1)	0,52	1,2	2,6	4,9	7,3	14	28	42	82
125 (1,25)	0,62	1,4	3,1	5,8	8,6	16	33	50	97
160 (1,6)	0,75	1,7	3,8	7,0	10	20	40	61	120
200 (2)	0,91	2,0	4,5	8,4	13	24	48	74	140
250 (2,5)	1,1	2,5	5,5	10	15	29	58	89	170
315 (3,15)	1,3	3,0	6,7	12	19	35	71	110	210
400 (4)	1,6	3,7	8,3	15	23	43	88	130	260
500 (5)	2,0	4,6	10	19	28	53	110	160	320
630 (6,3)	2,5	5,6	13	23	35	66	130	200	390
800 (8)	3,1	7,0	16	29	44	82	170	250	490
1 000 (10)	3,9	8,7	19	36	54	100	210	310	610
1 250 (12,5)	4,8	10	24	45	67	130	260	390	750
1 600 (16)	6,1	13	31	57	85	160	330	490	950

NOTE These flow rates are based upon the following pressure drops on 30 m of ISO 65 grade medium-wrought iron pipe at 20 °C:

— 10 % for pipe sizes 1/8, 1/4, 3/8, 1/2;

— 5 % for pipe sizes 3/4, 1, 1 1/4, 1 1/2, 2.

8 Presentation of data

8.1 Forward-flow characteristics

Data graphs are presented in accordance with Figure 2 of ISO 6953-1:2000.

8.2 Pressure-regulation characteristics

Data graphs are presented in accordance with Figure 3 of ISO 6953-1:2000.

8.3 Relief flow characteristics

Data graphs are presented in accordance with Figure 4 of ISO 6953-1:2000.

Bibliography

[1] ISO 1000:1992, *SI units and recommendations for the use of their multiples and of certain other units*.

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

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