INTERNATIONAL STANDARD

ISO 23551-2

Second edition
2018-09

Safety and control devices for gas burners and gas-burning appliances — Particular requirements —

Part 2: Pressure regulators

Dispositifs de commande et de sécurité pour brûleurs à gaz et appareils à gaz — Exigences particulières —

Partie 2: Régulateurs de pression

Reference number
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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 161, *Controls and protective devices for gas and/or oil.*

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

This second edition cancels and replaces the first edition (ISO 23551-2:2006), which has been technically revised. The main changes compared to the previous edition are as follows:

a) this document has been aligned with the structure of ISO 23550:2018;

b) the following have been merged into one document:

   — pressure regulators (ISO 23551-2),

   — zero pressure regulators (new functions), and

   — gas/air ratio controls, pneumatic types (ISO 23551-3);

c) the Introduction has been rewritten;

d) Clause 1 now extends to pressure regulators and pneumatic gas/air ratio pressure regulators at inlet pressures up to and including 500 kPa; auxiliary energy may be used to change the set point;

e) Clause 2 has been updated;

f) Clause 3 has been updated and new definitions have been updated;

g) in Clause 4, new regulator class D has been added for supply situations with low fluctuations;

h) Clause 5 now refers to Annexes including the new Annex L for gas/air ratio pressure regulators;

i) requirements for breather holes have been moved from Clause 6 to ISO 23550:2018;

k) Clause 7 has been structured into “General”, “Requirements” and “Test”;

l) Clause 8 has been added without reflecting structure and requirements as in ISO 23550:2018;

m) Clause 9 has been renumbered;

n) Clause 10 has been renumbered and amended to cover the additional regulator types;

o) new Annex I has been added;

p) former Annex B has been updated and renumbered into Annex J;

q) former Annex C has been updated and renumbered into Annex K;

r) new Annex L has been added;

s) former Annex E has been updated and renumbered into Annex M;

t) new Annexes F, G and H have been added for regional requirements.

A list of all the parts in the ISO 23551 series can be found on the ISO website.

Introduction

This document is designed to be used in combination with ISO 23550. Together with ISO 23550, this document establishes the full requirements as they apply to the product covered by this document.

Where needed, this document adapts ISO 23550 by stating in the corresponding clause:

— “with the following modification”;

— “with the following addition”;

— “is replaced by the following”; or

— “is not applicable”.

In order to identify specific requirements that are particular to this document, that are not already covered by ISO 23550, this document may contain clauses or subclauses that are additional to the structure of ISO 23550. These subclauses are indicated by the introductory sentence: “Subclause (or Annex) specific to this document.”

To ensure global relevance of this document, the differing requirements resulting from practical experience and installation practices in various regions of the world have been taken into account. The variations in basic infrastructure associated with gas and/or oil controls and appliances have also been recognized, some of which are addressed in Annexes F, G and H. This document intends to provide a basic framework of requirements that recognize these differences.

Safety and control devices for gas burners and gas-burning appliances — Particular requirements —

Part 2: Pressure regulators

1 Scope

This document specifies safety, construction, performance and testing requirements for pressure regulators and pneumatic gas/air ratio pressure regulators intended for use with gas burners and gas-burning appliances.

This document applies to pressure regulators and pneumatic gas/air ratio pressure regulators of nominal connection size up to and including DN 250 at inlet pressures up to and including 500 kPa, for use with natural gas, manufactured gas or liquefied petroleum gas (LPG). It is not applicable to corrosive and waste gases.

This document is specifically applicable to:

— positive, zero and negative pressure regulators which can use auxiliary energy to change the outlet pressure setting;

— pneumatic gas/air ratio pressure regulators, which function by controlling a gas outlet pressure in response to an air signal pressure, air signal differential pressure, and/or to a combustion chamber pressure signal;

— gas/air ratio pressure regulators, which function by controlling an air outlet pressure in response to a gas signal pressure or a gas signal differential pressure.

This document does not cover:

— pressure regulators connected directly to gas distribution network or to a container that maintains a standard distribution pressure;

— pressure regulators intended to be installed in the open air and exposed to the environment;

— mechanically linked gas/air ratio controls;

— electronic pressure regulators and gas/air ratio regulators, which are contained in ISO 23552-1.

This document covers type testing only.

NOTE Annexes A to H reference the relevant annexes of ISO 23550, general requirements and are applicable where required.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 23550, *Safety and control devices for gas burners and gas-burning appliances — General requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 23550 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1 Pressure regulators

3.1.1
pressure regulator
device that maintains the outlet pressure constant within given limits, independently of the variations in inlet pressure and/or flow rate

Note 1 to entry: For examples refer to Annex I.

3.1.2
adjustable pressure regulator
pressure regulator (3.1.1) provided with means for changing the outlet pressure setting

3.1.3
pneumatic gas
air ratio pressure regulator
pressure regulator (3.1.1) which supplies gas at specified pressure at its outlet in response to control pressure

3.1.4
zero pressure regulator
pressure regulator (3.1.1) which maintains the outlet pressure constant at or below atmospheric pressure

3.2 Pressures

3.2.1
test pressure
pressure to be applied during a test

3.2.2
pressure drop
differential pressure with the control member open to its fullest extent

3.2.3
maximum inlet pressure
p_{1max}
highest inlet pressure at which tests have been conducted to determine that the regulator is able to control the outlet pressure within acceptable limits as declared by the manufacturer

3.2.4
minimum inlet pressure
p_{1min}
lowest inlet pressure at which tests have been conducted to determine that the regulator is able to control the outlet pressure within acceptable limits declared by the manufacturer

3.2.5
inlet pressure range
difference between the minimum and the maximum values of the inlet pressure

3.2.6
maximum outlet pressure
p_{2max}
highest outlet pressure at which tests have been conducted to determine that the regulator is able to control the outlet pressure within acceptable limits declared by the manufacturer

3.2.7
minimum outlet pressure
p_{2min}
lowest outlet pressure at which tests have been conducted to determine that the regulator is able to control the outlet pressure within acceptable limits declared by the manufacturer

3.2.8
outlet pressure range
difference between the minimum and the maximum values of the outlet pressure

3.2.9
setting point
inlet and outlet pressures declared by the manufacturer, at which the regulator is initially adjusted for test purposes at a declared flow rate

Note 1 to entry: The respective pressures and flow rate are termed *inlet setting pressure* (3.2.10), *outlet setting pressure* (3.2.11) and setting flow rate.

3.2.10
inlet setting pressure
p_{1s}
inlet pressure at which the *pressure regulator* (3.1.1) is set for test purposes

3.2.11
outlet setting pressure
p_{2s}
outlet pressure at which the *pressure regulator* (3.1.1) is set for test purposes

3.2.12
signal pressure
p_3
pressure, differential pressure or a combination of both applied to the regulator in order to provide the specified outlet pressure

3.2.13
load determining pressure
p_4
negative pressure as a result of an air flow, e.g. produced by a sucking fan, through a restriction

3.2.14
combustion chamber pressure
p_{sc}
pressure of combustion gases from the combustion chamber connected to the *pressure regulator* (3.1.1)

3.2.15
gas/air ratio
slope of a straight line relationship between the outlet pressure, p_2, and *signal pressure* (3.2.12), p_3

3.2.16
withstand pressure
pressure that is withstood without degraded characteristic after returning to or below the *maximum inlet pressure* (3.2.3)

3.2.17
excessive pressure
EP
optional rating for a regulator that is leak and flow resistant to abnormally high inlet pressures

Note 1 to entry: Regulators may be EP rated according to the tests herein.

3.3 Flow rates

3.3.1
maximum flow rate
q_{max}
maximum rate, as a function of inlet and outlet pressures, declared by the manufacturer and expressed in m^3/h of air at standard conditions

Note 1 to entry: For a non-adjustable regulator, there is only one maximum flow rate.

3.3.2
minimum flow rate
q_{min}
minimum rate, as a function of inlet and outlet pressures, declared by the manufacturer and expressed in m^3/h of air at standard conditions

Note 1 to entry: For a non-adjustable regulator, there is only one minimum flow rate.

3.3.3
flow rate range
range of flow rate between the maximum and minimum value

3.4 Component parts

3.4.1
breather hole
orifice that allows atmospheric pressure to be maintained in a compartment of variable volume

3.4.2
diaphragm
flexible member which, under the influence of the forces arising from loading and pressure, operates the control member

3.4.3
diaphragm plate
stiffening plate fitted to the *diaphragm* (3.4.2)

3.4.4
valve
device which varies the gas flow directly

3.4.5
signal chamber
part of the regulator to which the air *signal pressure* (3.2.12), gas pressure, or *combustion chamber pressure* (3.2.14) signal is connected

3.5 Performance

3.5.1
lock-up pressure
p_{2f}
outlet pressure at which a regulator closes when the outlet of the regulator is sealed

Note 1 to entry: The increase in outlet pressure is expressed either in kilopascals or as a percentage.

3.5.2
put out of action, verb
deactivate a regulator by putting the regulator to the full open position thereby ensuring that this setting does not undergo any changes

3.5.3
offset
outlet pressure shift at *pneumatic gas/air ratio pressure regulators* (3.1.3) independent of signal or *load determining pressure(s)* (3.2.13)

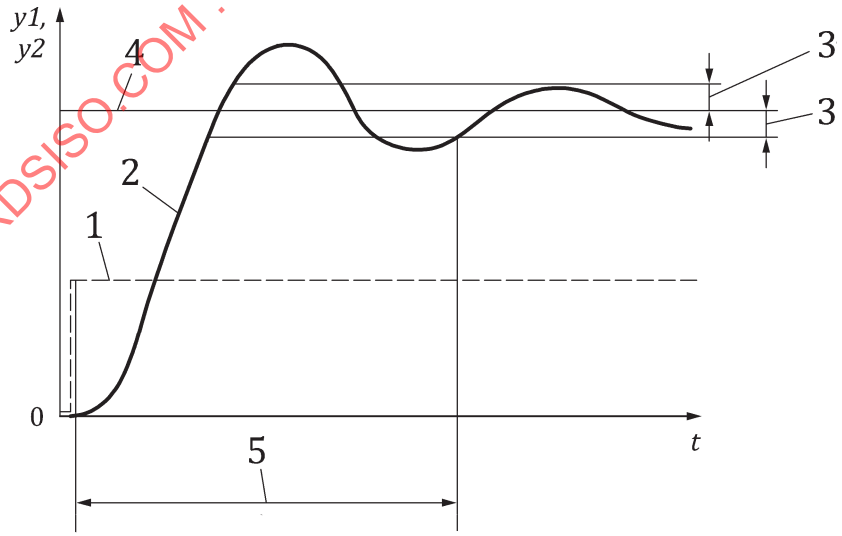
Note 1 to entry: Typically, this is achieved by means of a spring.

3.5.4
steady state value
outlet pressure measured after step response (control signal remains constant)

3.5.5
settling tolerance
maximum difference between the current outlet pressure and its *steady state value* (3.5.4)

3.5.6
settling time
time counted from start of the step change of the *signal pressure* (3.2.12) or *load determining pressure* (3.2.13) until the outlet pressure remains in the *settling tolerance* (3.5.5)

Note 1 to entry: For further information refer to Figure 1.



Key

1	step change ($y1$)	4	state value
2	step response ($y2$)	5	settling time
3	settling tolerance	t	time

Figure 1 — Settling time after a step change

4 Classification

4.1 Classes of control

Shall be according to ISO 23550:2018, 4.1 with the following addition:

Pressure regulators are classified as class A, class B, class C or class D according to the appropriate inlet pressure and flow rate limits, as given in Table 1.

Regulators may be classified as types for industrial use.

Regulators may be classified as circle "P" Ⓟ or triangle "P" ▽ when the range of regulation capacity also includes pilot load (see Annex K). This classification does not apply to modulating regulators.

Regulators may be classified as EP when tested in accordance with 7.12.

Gas/air ratio pressure regulators are not classified.

NOTE In the USA, regulators are classified either for main burner load application or for main burner and pilot load application.

Table 1 — Deviation of outlet pressure from outlet setting pressure

Class of regulators		Maximum outlet pressure deviation[a] %		
		Manufactured gas	Natural gas	Liquefied petroleum gas
Class A:	q_{max} to q_{min} and p_{1max} to p_{1min}			
	standard use	±15 or ±0,1 kPa	±15 or ±0,1 kPa	±15 or ±0,1 kPa
	industrial use	±20 or ±0,2 kPa	±20 or ±0,2 kPa	±20 or ±0,2 kPa
Class B:	by variation of the inlet pressure for each of the flow rates	+15 −20 or ±0,1 kPa	+10 −15 or ±0,1 kPa	±10 or ±0,1 kPa
	by variation of flow rates from q_{max} to q_{min} (constant inlet pressure) for each of the inlet pressures	+40 0	+40 0	+40 0
Class C:	at constant q (within the flow rate range)	+15 −20 or ±0,1 kPa	+10 −15 or ±0,1 kPa	±10 or ±0,1 kPa
Class D:	at constant q (within the flow rate range) and a fixed setting of p_{2s}	±15 or ±0,1 kPa	±15 or ±0,1 kPa	±15 or ±0,1 kPa

NOTE For the classification of fuel gases, see ISO 23550.

[a] See ISO 23550.

4.2 Groups of controls

Shall be according to ISO 23550:2018, 4.2 with the following modification:

Replace “control” by “regulator”.

4.3 Types of DC supplied controls

Shall be according to ISO 23550:2018, 4.3.

5 Test conditions

Shall be according to ISO 23550:2018, Clause 5, with the following addition:

NOTE Specific requirements for testing are given in Annexes J, K and L.

6 Construction

6.1 General

Shall be according to ISO 23550:2018, 6.1, with the following addition:

NOTE For examples of typical pressure regulators and pressure regulator parts, refer to Annex M.

6.2 Construction requirements

6.2.1 Appearance

Shall be according to ISO 23550:2018; 6.2.1.

6.2.2 Holes

Shall be according to ISO 23550:2018; 6.2.2.

6.2.3 Breather holes

Shall be according to ISO 23550:2018, 6.2.3.

6.2.4 Vent limiters

Shall be according to ISO 23550:2018, 6.2.4.

6.2.5 Screwed fastenings

Shall be according to ISO 23550:2018, 6.2.5.

6.2.6 Moving parts

Shall be according to ISO 23550:2018, 6.2.6.

6.2.7 Sealing caps

Shall be according to ISO 23550:2018, 6.2.7.

6.2.8 Disassembling and assembling for servicing and/or adjustment

Shall be according to ISO 23550:2018, 6.2.8.

6.2.9 Auxiliary channels and orifices

Shall be according to ISO 23550:2018, 6.2.9.

6.2.10 Pre-setting device

Shall be according to ISO 23550:2018, 6.2.10.

6.2.11 Adjustments

Subclause specific to this document.

The adjustments (e.g. outlet pressure, offset and gas/air-ratio) shall be readily accessible to authorized persons, but there shall be provision for sealing after adjustment. Means shall be provided to discourage interference by unauthorized persons. If it is stated in the installation and operating instructions that a pressure regulator can be put out of action, appropriate means shall be provided to put the pressure regulator out of action.

6.2.12 Resistance to pressure

Subclause specific to this document.

Parts of the pressure regulator that are subjected to inlet pressure under normal operating conditions, or can be subjected to inlet pressure in the event of a failure, shall resist a pressure equal to the withstand pressure.

The withstand pressure shall be stated in the installation and operating instructions. If no withstand pressure is stated, the withstand pressure is equal to the maximum inlet pressure.

6.2.13 Blockage of canals and orifices

Subclause specific to this document.

Blockage of auxiliary canals and orifices shall not lead to an unsafe situation. Otherwise, they shall be protected against blockage by suitable means.

6.2.14 Signal tube connections

Subclause specific to this document.

Requirements on connections for gas pressure, air pressure or combustion chamber pressure signal tubes shall be stated in the installation and operating instructions.

6.3 Materials

6.3.1 General material requirements

Shall be according to ISO 23550:2018, 6.3.1.

6.3.2 Housing

6.3.2.1 General

Shall be according to ISO 23550:2018, 6.3.2.1.

6.3.2.2 Requirements

Shall be according to ISO 23550:2018, 6.3.2.2 with the following modification:

The withstand pressure shall be used instead of maximum inlet pressure, if applicable.

6.3.2.3 Test

Shall be according to ISO 23550:2018, 6.3.2.3.

6.3.3 Springs providing closing force and sealing force

ISO 23550:2018, 6.3.3 is not applicable.

6.3.4 Resistance to corrosion and surface protection

Shall be according to ISO 23550:2018, 6.3.4.

6.3.5 Impregnation

Shall be according to ISO 23550:2018, 6.3.5.

6.3.6 Seals for glands for moving parts

Shall be according to ISO 23550:2018, 6.3.6.

6.3.7 Jointing

Shall be according to ISO 23550:2018, 6.3.7.

6.4 Connections

6.4.1 General

Shall be according to ISO 23550:2018, 6.4.1.

6.4.2 Connection sizes

Shall be according to ISO 23550:2018, 6.4.2.

6.4.3 Connection types

Shall be according to ISO 23550:2018, 6.4.3.

6.4.4 Threads

Shall be according to ISO 23550:2018, 6.4.4.

6.4.5 Union joints

Shall be according to ISO 23550:2018, 6.4.5.

6.4.6 Flanges

Shall be according to ISO 23550:2018, 6.4.6.

6.4.7 Compression fittings

Shall be according to ISO 23550:2018, 6.4.7.

6.4.8 Flare connections

Shall be according to ISO 23550:2018, 6.4.8.

6.4.9 Nipples for pressure test

Shall be according to ISO 23550:2018, 6.4.9.

6.4.10 Strainers

6.4.10.1 General

Shall be according to ISO 23550:2018, 6.4.10.1.

6.4.10.2 Requirements

Shall be according to ISO 23550:2018, 6.4.10.2 with the following addition:

Strainers intended to be serviceable shall be accessible for cleaning or replacement without the need to remove the control body by dismantling threaded or welded pipe work.

6.4.10.3 Test

Shall be according to ISO 23550:2018, 6.4.10.3.

6.4.11 Gas connections by GQC

Shall be according to ISO 23550:2018, 6.4.11.

6.5 Gas controls employing electrical components in the gas way

Shall be according to ISO 23550:2018, 6.5.

7 Performance

7.1 General

Shall be according to ISO 23550:2018, 7.1.

7.2 Leak-tightness

7.2.1 General

Shall be according to ISO 23550:2018, 7.2.1.

7.2.2 Requirements

Shall be according to ISO 23550:2018, 7.2.2 with the following modification:

Requirements for internal leakage rates given in ISO 23550:2018, Table 2 shall not apply (see 7.2.3.3).

7.2.3 Test

7.2.3.1 General

Shall be according to ISO 23550:2018, 7.2.3.1.

7.2.3.2 Test for external leak-tightness

Shall be according to ISO 23550:2018, 7.2.3.2 with the following addition:

If the signal chamber is intended to be gas-tight, the following external leak test shall be used. Apply a pressure of 1,5 times the maximum operating pressure to the signal chamber. The tests results shall meet the requirements of 7.2.2.

If the signal chamber is pressurized by a non-combustible gas or air, the manufacturer shall specify the allowable leak rate and the test method for the specific application. The leak rate shall meet this specification before and after the endurance tests.

7.2.3.3 Test for internal leak-tightness of controls

ISO 23550:2018, 7.2.3.3 is not applicable.

7.3 Torsion and bending

Shall be according to ISO 23550:2018, 7.3.

7.4 Rated flow rate

7.4.1 General

Shall be according to ISO 23550:2018, 7.4.1.

7.4.2 Requirements

Shall be according to ISO 23550:2018, 7.4.2.

7.4.3 Test

7.4.3.1 Apparatus

Shall be according to ISO 23550:2018, 7.4.3.1.

7.4.3.2 Test procedure

Shall be according to ISO 23550:2018, 7.4.3.2 with the following addition:

If the rated flow rate for pressure regulators, as stated in the installation and operating instructions, is specified for the control member in the fully open position, the test shall be performed with the control member in that position.

7.4.3.3 Conversion of air flow rate

Shall be according to ISO 23550:2018, 7.4.3.3.

7.5 Durability

Shall be according to ISO 23550:2018, 7.5.

7.6 Functional requirements

Shall be according to ISO 23550:2018, 7.6 with the following addition:

Alternative methods for functional requirements and testing of pressure regulators are given in Annexes J and K.

Annex L shall be used for functional requirements for gas/air ratio controls.

7.7 Endurance

Shall be according to ISO 23550:2018, 7.7.

7.8 Vibration test

Shall be according to ISO 23550:2018, 7.8.

7.9 Putting the regulator out of action

Subclause specific to this document.

7.9.1 Requirement

If it is stated in the installation and operating instructions that the pressure regulator can put out of action, for example for Liquefied Petroleum Gas applications, the method shall be given in the manufacturer's installation and operating instructions and shall result in the control member being fixed in the fully open position.

The control shall include or the manufacturer shall provide a means to comply with 6.2.3 when the regulator is blocked in the open position.

When the regulator is put back into operation, it shall comply with the requirements of this document.

7.9.2 Test putting the regulator out of action

The regulator shall be deactivated in accordance with the procedure described in the manufacturer's instructions. After visually checking that the valve is in its fully open position, the leak tightness is to be determined in accordance with the method given in 7.2.3.2. When it is operative again, the regulator is to be tested by the methods given in this document.

7.10 Endurance

Subclause specific to this document.

For pressure regulators, alternative methods for endurance are given in J.2.9 or K.1.6 and K.2.6.

For gas/air ratio controls, test requirements for endurance shall be according to L.2.7.

7.11 Lock-up pressure

Subclause specific to this document.

7.11.1 Requirement

When it is stated in the installation and operating instructions that a pressure regulator has the ability to lock up, the outlet pressure, p_2, shall not increase by more than 15 % or 0,75 kPa, whichever is greater, above an outlet pressure, p_2, at 5 % of q_{max}. Such a regulator shall be tested in accordance with the test method described in 7.11.2.

7.11.2 Lock-up pressure test

Proceed as follows.

a) Install the regulator in the apparatus shown for example in Figure J.1.

b) Adjust the inlet pressure to p_{1max} and adjust the control valve 6 to $q_{max}/20$ (proposed 0,1 q_{max}).

c) Measure the outlet pressure.

d) Slowly close control valve No. 6 in not less than 5 s.

e) Measure the outlet pressure 30 s after the control valve No. 6 has been completely closed.

f) Repeat steps b) to e) with the outlet pressure p_2 adjusted to p_{2max}.

g) Repeat steps b) to f) for every outlet pressure range (typically determined by a different spring).

7.12 Optional EP-rating

Subclause specific to this document.

7.12.1 General

The following tests are applicable only to regulators rated at 3,5 kPa and optionally classified as EP when tested in accordance to 7.12.2 and 7.12.3.

7.12.2 External leakage resistance

7.12.2.1 Requirement

An EP classified regulator shall not leak when subjected to a pressure of 414 kPa when tested according to 7.12.3.

7.12.2.2 Test

Air pressure at 414 kPa shall be admitted into both the inlet and the outlet of the regulator simultaneously and shall be maintained for 3 min at that pressure. During this time, the regulator shall not leak in excess of the equivalent of 2,8 l/h.

Following this test, the regulator shall comply with 7.2.

7.12.3 Internal flow resistance

7.12.3.1 Requirement

A regulator classified as EP rated shall not allow more than 2,8 l/h of air to flow through it when subjected to an outlet back pressure of 3,5 kPa and inlet pressures up to 414 kPa when tested in accordance with 7.12.3.2.

7.12.3.2 Test

The inlet of the regulator shall be connected to a pressure-controlled source of clean air followed by a flow measuring device, capable of accurately indicating flows up to 5,6 l/h, and a suitable pressure gage between the flow measuring device and the inlet of the regulator. The outlet of the regulator shall be connected by means of a flexible tube to a glass tube at least 457 mm in length and having an internal diameter of 4,8 mm, extending vertically down 356 mm below the surface of water in a large bottle, jar or standpipe.

With the regulator set to deliver its maximum rated outlet pressure, the inlet test pressure shall be gradually increased to 414 kPa with observations made of the flow rate and the air level in the vertical glass tube. If, at any time, air bubbles issue from the end of the tube, the inlet test pressure shall be maintained until the flow rate is recorded. The inlet test pressure shall then continue to be increased up to 414 kPa. The recorded flow rate shall not exceed a flow equivalent to 2,8 l/h.

8 Electrical requirements

Shall by according to ISO 23550:2018, Clause 8 if electronic circuits are used.

9 Electromagnetic compatibility (EMC)

Shall by according to ISO 23550:2018, Clause 9 if electronic circuits are used.

10 Marking, installation and operating instructions

10.1 Marking

ISO 23550:2018, 10.1 is replaced by the following:

The following information, at least, shall be durably marked on the regulator in a clearly visible position:

a) manufacturer and/or trade mark;

b) type reference;

c) in EU, class and group references; in USA and Canada, or Ⓟ or Ⓟ or EP, as applicable; in Japan industrial designation if applicable;

d) inlet pressure range in Pa or kPa (mbar or bar);

e) ambient temperature range;

f) direction of gas flow; in the EU by an arrow (e.g. cast or embossed);

g) date of manufacture (at least the year); this may be in coded form;

h) maximum working pressure;

i) outlet pressure setting;

j) identification of signal inlet(s) (if applicable).

10.2 Installation and operating instructions

Shall be according to ISO 23550:2018, 10.2 with the following addition:

a) regulator class (if applicable);

b) regulator group 1 or 2 (if applicable);

c) gas types for which the regulator is suitable;

d) maximum inlet pressure in Pa or kPa (mbar or bar);

e) withstand pressure in kPa (bar) (if different from maximum inlet pressure);

f) ambient temperature range;

g) mounting position(s);

h) gas connection(s), ISO, NPT or JIS;

i) strainer mesh or micron size (if applicable);

j) offset adjustment range in Pa or kPa (mbar) (if applicable);

k) inlet pressure range in Pa or kPa (mbar);

l) outlet pressure range in Pa or kPa (mbar);

m) rated flow rate in m^3/h (and rated flow rate range if applicable); alternatively performance limits can be given in a curve, which is Δ_p across the regulator in Pa or kPa (mbar) versus rated flow rate in m^3/h (e.g. Figure 2);

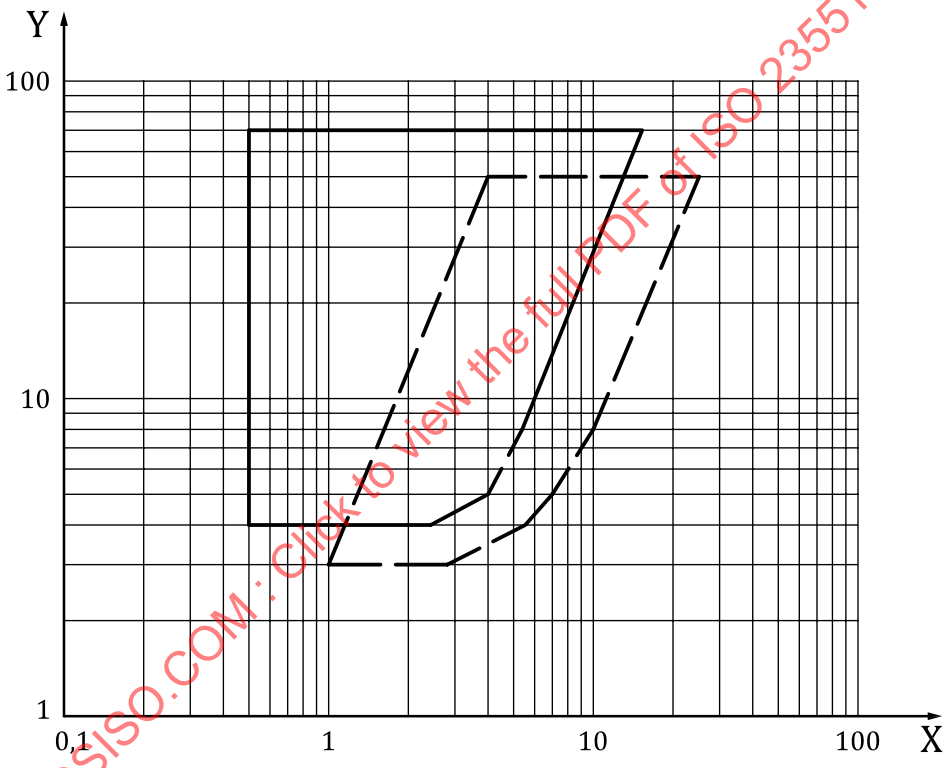
n) recommendations for inlet pressure regulation (if any, see Table 1);

o) performance curves including inlet pressure range, outlet pressure range and flow rate range (see, for example, Figures J.1 and J.2) according to the declared classification;

p) performance limits, which is Δp across the regulator in Pa or kPa (mbar) versus rated flow rate in m^3/h (e.g. Figure 2);

q) instructions for changing from one gas family to another, e.g. changing the spring or putting the pressure regulator out of action (if applicable);

r) lock-up ability (if applicable).



Key

X rated flow rate gas or air in m^3/h

Y Δp in Pa or kPa (mbar or bar)

— — — performance limits regulator 1

——— performance limits regulator 2

Figure 2 — Differential pressure versus rated flow rate curve

10.3 Warning notice

Shall be according to ISO 23550:2018, 10.3.

Annex A
(informative)

Leak-tightness test — Volumetric method

Shall be according to ISO 23550:2018, Annex A.

Annex B
(informative)

Leak-tightness test — Pressure-loss method

Shall be according to ISO 23550:2018, Annex B.

Annex C
(normative)

Conversion of pressure loss into leakage rate

Shall be according to ISO 23550:2018, Annex C.

Annex D
(normative)

Gas quick connector (GQC)

Shall be according to ISO 23550:2018, Annex D.

Annex E
(normative)

Elastomers/requirements resistance to lubricants and gas

Shall be according to ISO 23550:2018, Annex E.

Annex F
(normative)

Specific regional requirements in European countries

Shall be according to ISO 23550:2018, Annex F.

Annex G
(normative)

Specific regional requirements in Canada and USA

Shall be according to ISO 23550:2018, Annex G.

Annex H
(normative)

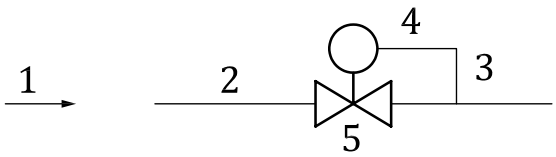
Specific regional requirements in Japan

Shall be according to ISO 23550:2018, Annex H.

Annex I
(informative)

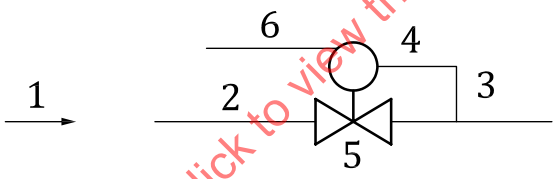
Regulator application examples

Annex specific to this document.



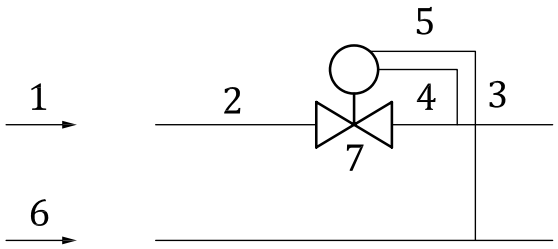
Key
1 direction of gas flow
2 gas inlet pressure, p_u
3 gas outlet pressure, p_d
4 signal pressure gas, p_{sg}
5 pressure reducing regulator

Figure I.1 — Pressure reducing regulator (constant pressure control)



Key
1 direction of gas flow
2 gas inlet pressure, p_u
3 gas outlet pressure, p_d
4 signal pressure gas, p_{sg}
5 pressure reducing regulator
6 auxiliary energy connection

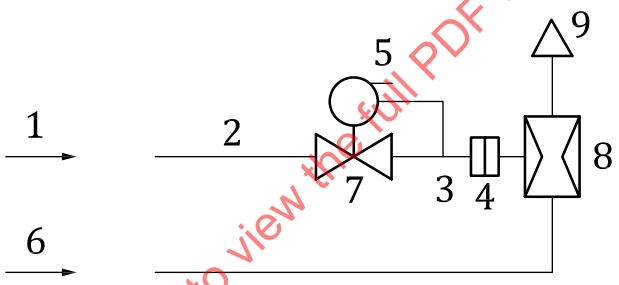
Figure I.2 — pressure reducing regulator with auxiliary energy (constant pressure control)



Key

1 direction of gas flow
2 gas inlet pressure, p_u
3 gas outlet pressure, p_d
4 signal pressure gas, p_{sg}
5 signal pressure air, p_{sa}
6 direction of air flow
7 air/gas ratio control

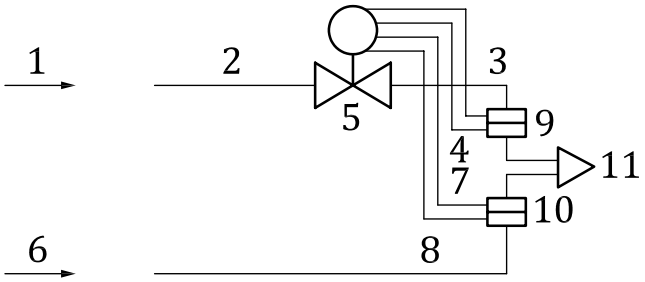
Figure I.3 — Gas/air ratio control (modulating control)



Key

1 direction of gas flow
2 gas inlet pressure, p_u
3 gas outlet pressure, p_d
4 orifice
5 atmospheric pressure air, p_{se}
6 direction of air flow
7 zero pressure regulator
8 e.g. venturi
9 burner

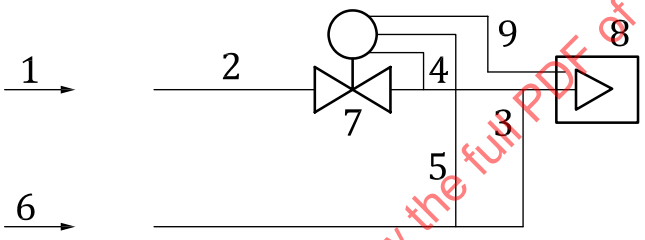
Figure I.4 — Zero pressure regulator (zero pressure control)



Key

1	direction of gas flow	6	direction of air flow
2	gas inlet pressure. p_u	7	differential signal pressure air. p_{sa-}
3	gas outlet pressure. p_d	8	signal pressure air, p_{sa}
4	differential signal pressure gas. p_{d-}	9, 10	orifice
5	flow rate regulator	11	burner

Figure I.5 — Flow rate regulator (staged flow rate control / preheated air)



Key

1	direction of gas flow	6	direction of air flow
2	gas inlet pressure, p_u	7	variable gas/air ratio regulator
3	gas outlet pressure, p_d	8	combustion chamber
4	signal pressure gas, p_{sg}	9	signal pressure combustion chamber, p_{sc}
5	signal pressure air, p_{sa}		

Figure I.6 — Variable Gas/air ration regulator (modulating control)

Annex J
(normative)

Functional requirements and regulator performance testing — Method A

Annex specific to this document.

J.1 General

Regulators shall be tested as described in J.2 for outlet pressure variations over the range of inlet pressure from p_{1max} to p_{1min} and/or over the range of flow rate from q_{min} to q_{max}.

When carrying out performance tests at any particular setting, the minimum inlet pressure used shall be at least 0,25 kPA (2,5 mbar) in excess of the set outlet pressure.

The minimum, nominal and maximum pressures shall be declared by the manufacturer.

The outlet pressure variation from the outlet setting pressure p_{2s} shall not exceed that given in Table J.5 or ±0,1 kPa, whichever is greater.

For any change of flow rate within the declared range of flow rate q_{min} to q_{max} at any inlet pressure within the permissible inlet pressure range p_{1min} to p_{1max}, the deviation of the outlet pressure from the outlet setting pressure shall not exceed the values given in Table 1 or ±0,1 kPa, whichever is greater.

J.2 General test procedure

J.2.1 General

The regulator shall be tested in the sequence shown in Table J.1.

Table J.1 — Sequence of testing

Subclause No.	Test
7.9.2	Putting the regulator out of action
7.2.3.2	External leak tightness of pressure regulator
J.2.4, J.2.5, J.2.6, J.2.7	Regulator performance
J.2.9	Endurance
J.2.10	Lock-up pressure
7.3.2	Torsion and bending
ISO 23550:2018, 7.5.4.2	Test for marking resistance
ISO 23550:2018, 7.5.5.2	Scratch test
ISO 23550:2018, 7.5.6.2	Humidity test
6.3.2.2	External leak tightness of regulator with non-metallic part(s) removed
ISO 23550:2018, 7.5.1	Elastomers in contact with gas
6.2	Construction requirements

If adhesive labels are used, it is necessary to provide two additional parts carrying the label.

If special equipment is necessary for the test, it should be supplied with the samples.

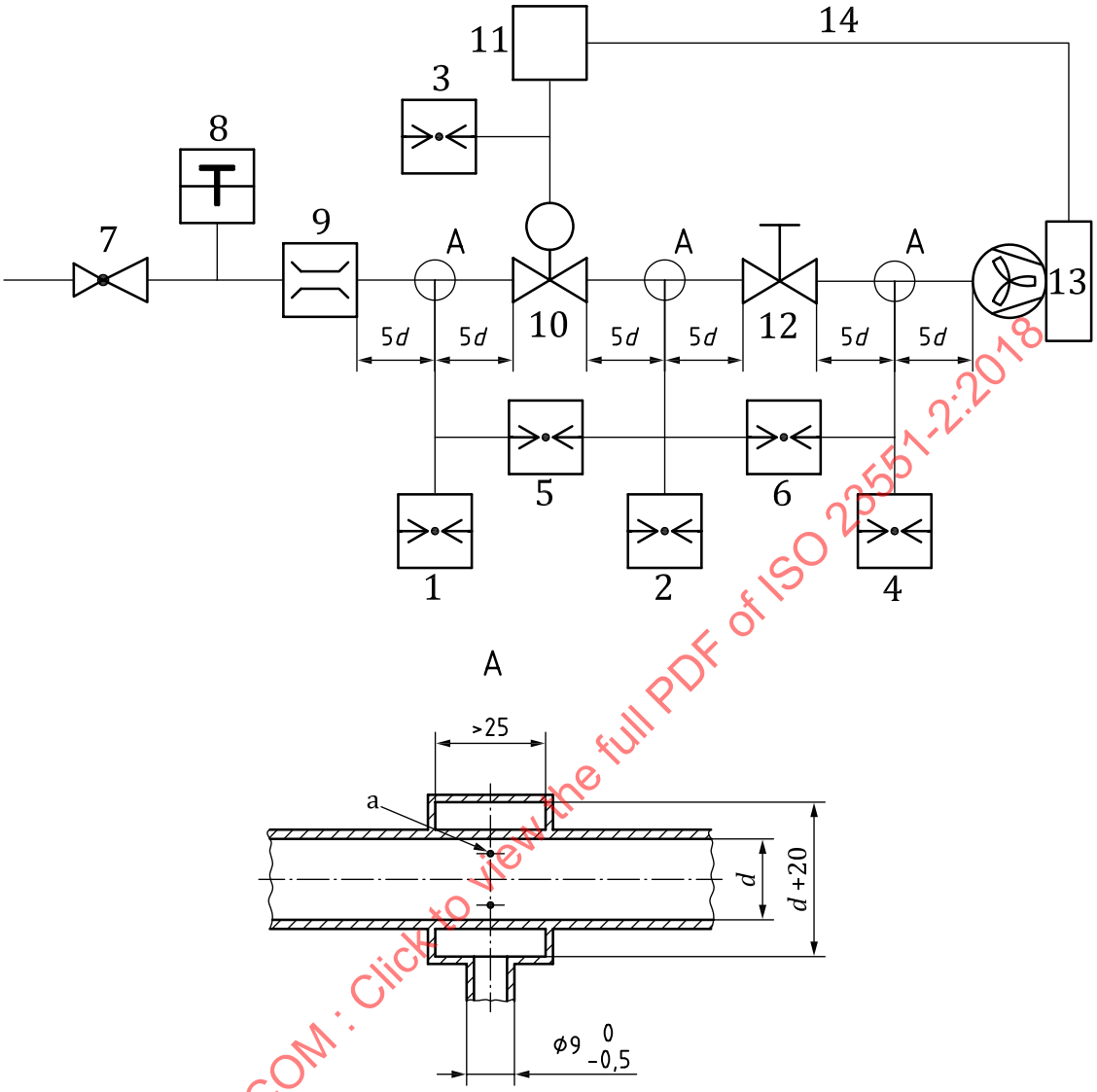
J.2.2 Apparatus

Carry out the tests using the apparatus shown in Figure J.1.

Table J.2 — Nominal size and internal diameter according to Figure J.1

Nominal size (DN)	Internal diameter (mm)
6	6
8	9
10	13
15	16
20	22
25	28
32	35
40	41
50	52
65	67
80	80
100	106
125	131
150	159
200	209
250	260

Dimensions in millimetres



Key

1	inlet pressure gauge p_1	9	flow meter
2	outlet pressure gauge p_2	10	control under test
3	signal pressure gauge p_3 (see NOTE)	11	signal pressure inlet (optional) (see NOTE)
4	load determining pressure gauge p_4 (see NOTE)	12	manual control tap (injector orifice)
5,6	differential pressure gauges (see NOTE)	13	fan (optional) (see NOTE)
7	adjustable regulator for inlet pressure	14	combustion chamber pressure p_{sc}
8	thermometer	a	4 holes ⌀ 1,5 mm.

NOTE Key numbers 3, 4, 5, 6, 11 and 13 are only applicable for pneumatic gas/air ratio pressure regulators (refer to 3.5 and Annex L).

Figure J.1 — Performance test apparatus

J.2.3 Conversion of the air flow rate

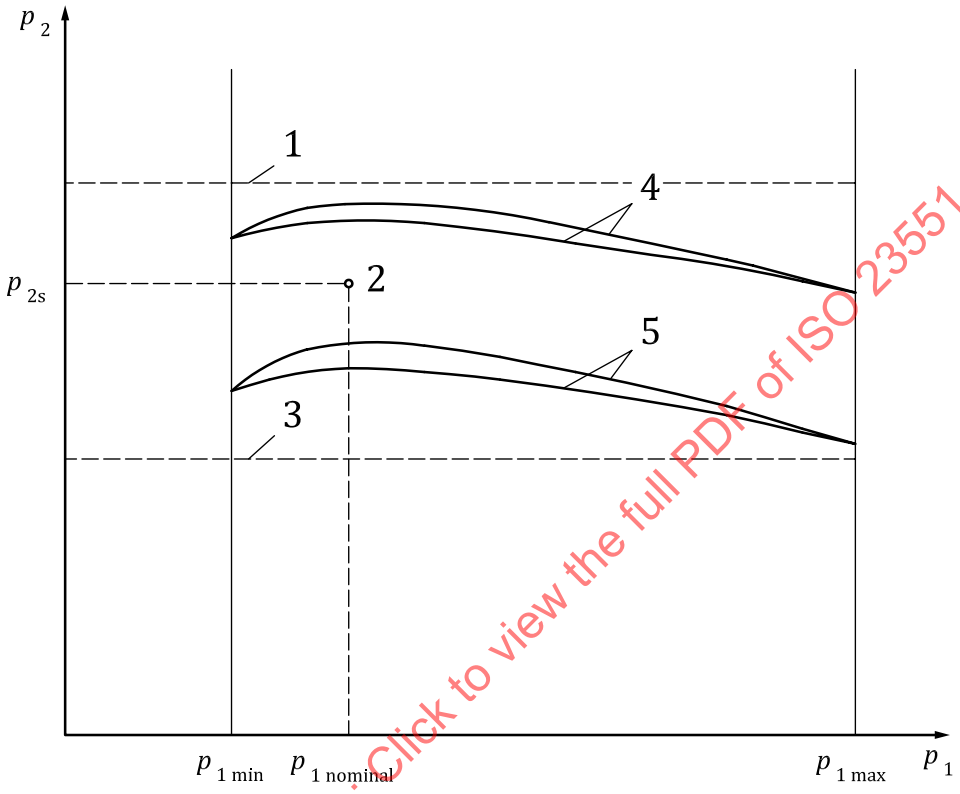
Shall be according to ISO 23550:2018, 7.4.3.3.

J.2.4 Methods of test

Classes A, B, C and D regulators shall be tested in accordance with the test sequences given in J.2.4, J.2.5, J.2.6, J.2.7 respectively (see also J.3).

Steady state conditions shall always be reached before readings are taken.

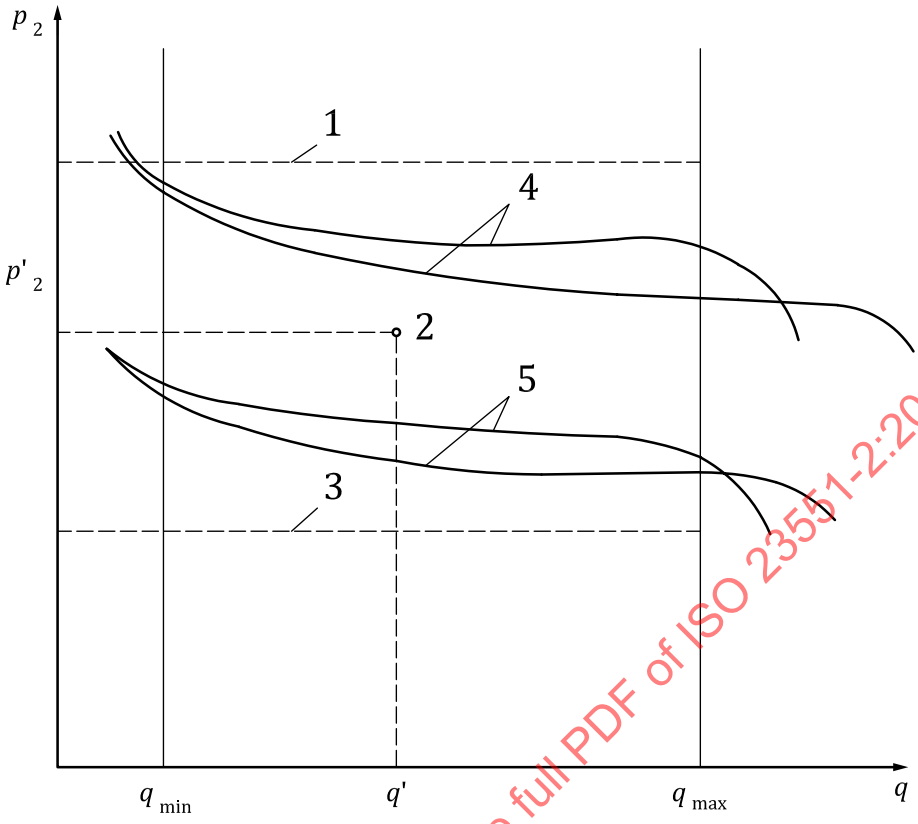
Examples of performance curves with p_2 as ordinate and p_1 as abscissa, with variable inlet pressure, are shown in Figure J.2 and those with variable flow rate, in Figure J.3.



Key

1 upper tolerance limit
2 setting point
3 lower tolerance limit
4 control characteristic at q_{min}
5 control characteristic at q_{max}

Figure J.2 — Graph of performance using inlet pressure variation



Key

1 upper tolerance limit
2 setting point
3 lower tolerance limit
4 control characteristic at p_{1max}
5 control characteristic at p_{1min}

Figure J.3 — Graph of performance using flow rate variation

J.2.5 Class A pressure regulator performance

J.2.5.1 Requirement

Over the full range of inlet pressure from p_{1min} to p_{1max} and over the whole rated flow rate range from q_{min} to q_{max} as stated in the installation and operating instructions the outlet pressure variation from the outlet setting pressure p_{2s} shall not exceed the values given in Table J.5 or ±0,1 kPa, whichever is the greater. The stated minimum rated flow rate q_{min} shall be 10 % of q_{max} or lower.

J.2.5.2 Test

Class A pressure regulators shall be tested by measuring the outlet pressure p_2 with variation of the inlet pressure p_1 and of the flow rate q as follows:

a) In order to adjust the outlet setting pressure p_{2s} of the pressure regulator, set the manual control tap to obtain a rated flow rate of 50 % of q_{max} (or any other value declared by the manufacturer).

   For adjustable pressure regulators, adjust the outlet setting pressure p_{2s} to the maximum outlet pressure p_{2max}, the inlet pressure p_1 being the nominal pressure (or respectively any other value declared by the manufacturer).

Once the outlet setting pressure p_{2s} is set, there shall be no further adjustment of the pressure regulator.

b) With inlet pressure p_{1min} kept constant, vary the rated flow rate q to q_{max} to q_{min} and back to q_{max} by using the manual control tap and record the outlet pressure p_2 for at least 5 values of q in each case. Ensure that there is no change of the inlet pressure p_1 during the whole time of this procedure.

c) Readjust the inlet pressure p_1 from p_{1min} to p_{1max} and then vary the rated flow rate from q_{max} to q_{min} and back to q_{max} (as in step b).

d) For adjustable pressure regulators readjust the outlet setting pressure p_{2s} to p_{2min} according to step a) and repeat steps b) and c).

J.2.6 Class B pressure regulator performance

J.2.6.1 Requirement

Over the full range of inlet pressure from p_{1min} to p_{1max} at any rated flow rate q within the rated flow rate range q_{min} to q_{max}, as stated in the installation and operating instructions, the outlet pressure variation from the outlet setting pressure, p_{2s}, shall not exceed the values given in Table J.5 or ±0,1 kPa, whichever is the greater.

For any change of rated flow rate q within the rated flow rate from q_{min} to q_{max}, as stated in the installation and operating instructions, at any inlet pressure p_1 within the full inlet pressure range from p_{min} to p_{max}, the outlet pressure variation from the outlet setting pressure, p_{2s}, shall not exceed the values given in Table J.5 or ±0,1 kPa, whichever is the greater.

J.2.6.2 Test

Class B pressure regulators shall be tested by measuring the outlet pressure, p_2, with variation of the inlet pressure, p_1, and of the rated flow rate, q, as follows:

a) In order to adjust the outlet setting pressure, p_{2s}, of the pressure regulator, set the rated flow rate to q_{max} by adjusting the manual control tap. For adjustable pressure regulators, adjust the outlet setting pressure, p_{2s}, to the maximum outlet pressure, p_{2max}, the inlet pressure, p_1, being the nominal pressure (or another value declared by the manufacturer).

Once the outlet setting pressure, p_{2s}, is set, there shall be no further adjustment of the pressure regulator.

b) Vary the inlet pressure, p_1, from the nominal pressure over the minimum inlet pressure, p_{1min}, to the maximum inlet pressure, p_{1max}, and back to p_{1min}, and record the outlet pressure, p_2, for at least 5 values of p_1 in each direction without resetting the rated flow rate.

c) With inlet pressure, p_1, at the nominal pressure or at the value declared under a), readjust the rated flow rate q from q_{max} to q_{min} by using the manual control tap without any other adjustment of the previously set value of the outlet pressure, p_2.

d) Repeat step b).

e) For adjustable pressure regulators, readjust the outlet setting pressure, p_{2s}, according to a) to p_{2min} and repeat steps b) to d).

J.2.7 Class C pressure regulator performance

J.2.7.1 Requirement

Over the full range of inlet pressure from p_{1min} to p_{1max} at any rated flow rate q within the manufacturers declared rated flow rate range from q_{min} to q_{max}, as stated in the installation and operating instructions,

the outlet pressure variation from the outlet setting pressure, p_{2s}, shall not exceed the values given in Table J.5 or ±0,1 kPa, whichever is the greater.

J.2.7.2 Test

Class C pressure regulators shall be tested by measuring the outlet pressure, p_2, with variation of the inlet pressure, p_1, as follows:

a) In order to adjust the outlet setting pressure, p_{2s}, of the pressure regulator, set the rated flow rate to q_{max} by adjusting the manual control tap. For adjustable pressure regulators, adjust the outlet setting pressure, p_{2s}, to the maximum outlet pressure, p_{2max}, the inlet pressure, p_1, being the nominal pressure (or another value declared by the manufacturer).

   Once the outlet setting pressure, p_{2s}, is set, there shall be no further adjustment of the pressure regulator.

b) Vary the inlet pressure, p_1, to the minimum inlet pressure, p_{1min}, to the maximum inlet pressure, p_{1max}, and back to p_{1min}, and record the outlet pressure, p_2, for at least 5 values of p_1 in each direction without resetting the rated flow rate.

c) By means of the manual control tap, adjust the rated flow rate to q_{min}, the outlet setting pressure, p_{2s}, readjusted as in step a).

d) Repeat step b).

e) For adjustable pressure regulators, readjust the outlet setting pressure, p_{2s}, according to a) to p_{2min} and repeat steps b) to d).

J.2.8 Class D pressure regulator performance

J.2.8.1 Requirement

Over the full range of inlet pressure from p_{1min} to p_{1max} at a rated flow rate, q_s, declared by the manufacturer and stated in the installation and operating instructions, the outlet pressure variation from the outlet setting pressure, p_{2s}, shall not exceed the values given in Table J.5 or ±0,1 kPa, whichever is the greater.

J.2.8.2 Test

Class D pressure regulators shall be tested by measuring the outlet pressure, p_2 with variation of the inlet pressure, p_1, as follows:

a) In order to adjust the outlet setting pressure, p_{2s}, of the pressure regulator, set the rated flow rate to q_s by adjusting the manual control tap. For adjustable pressure regulators, adjust the outlet setting pressure, p_{2s}, to the value declared by the manufacturer, the inlet pressure, p_{1s}, being the nominal pressure (or another value declared by the manufacturer).

b) Once the outlet setting pressure, p_{2s}, is set, there shall be no further adjustment of the pressure regulator. Vary the inlet pressure, p_1, to the minimum inlet pressure, p_{1min}, to the maximum inlet pressure, p_{1max}, and back to p_{1min}, and record the outlet pressure, p_2, for at least 4 values of p_1 in each direction without changing the rated flow rate.

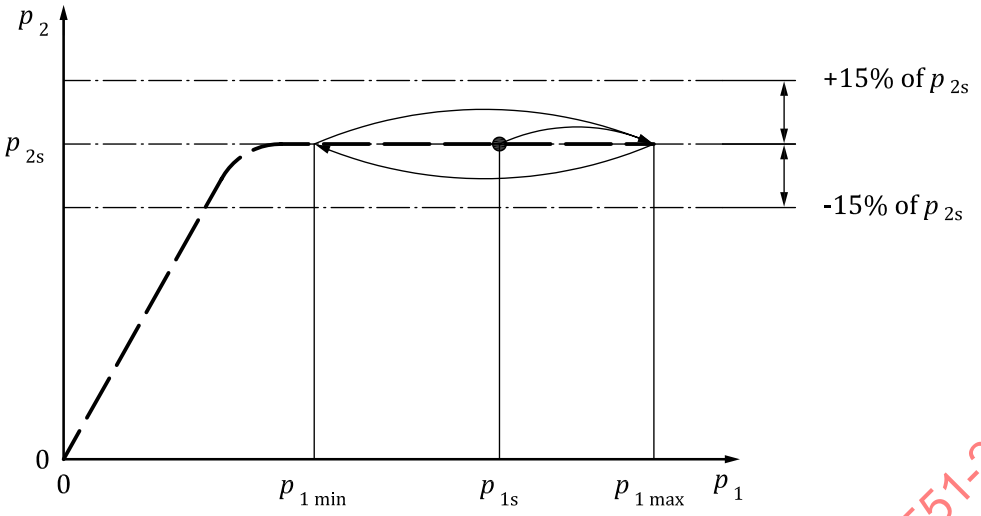


Figure J.4 — Graph of performance Class D regulator

J.2.9 Pressure drop

Adjust the inlet pressure, p_1, to 0,1 kPa less than the value of the outlet pressure obtained at minimum inlet pressure and at maximum flow. The regulator valve shall then be fully open.

Measure the differential pressure between the inlet and outlet pressures under these conditions.

For regulators that can be set over a range, measure the differential pressure for the lowest setting pressure.

J.2.10 Endurance

J.2.10.1 Requirement

The leak tightness and performance shall remain within the limits specified in, 7.2.3.1, 7.2.3.2, J.1, J.2.4, J.2.5, J.2.6, J.2.7 respectively, after testing according to J.2.9.2.

J.2.10.2 Test

J.2.10.2.1 Regulator Classes A, B and C and ratio regulators — Cycling and temperature

Position the pressure regulator in a temperature controlled chamber with an air supply at ambient temperature and maximum inlet pressure, p_{1max}, as stated in the installation and operating instructions. Connect quick acting shut-off valves upstream and downstream of the pressure regulator. The valves are controlled by a time switch so that as one opens the other closes with a complete cycle every 10 s. The pressure regulator is controlled according to manufacturer's instructions to ensure that the working diaphragm and safety diaphragm, if any, are fully flexed and the control member moves between fully open and fully closed position. For ratio controls one test cycle consists of varying the control pressure from minimum to maximum and back to minimum.

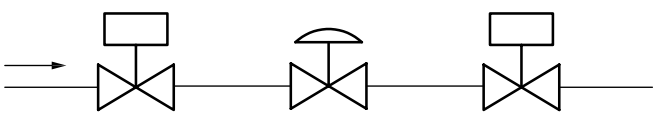


Figure J.5 — Endurance test

The test consists of 50 000 cycles with each fully open and fully closed position of the control member is held for at least 5 s.

Alternatively, if the valves can provide feedback for the fully open and fully closed position, the cycle time of 10 s can be reduced to the respective travel time for opening and closing plus at least 1 s each. In that case the test is based on 100 000 cycles.

In addition, where the pneumatic gas/air ratio regulator incorporates an electric actuator device which can be required to run continuously, it shall be additionally operated in a condition where the electric actuator operates continuously for a period of 3 000 h at 110 % of maximum rated voltage.

For the test based on 50 000 cycles, the influence of temperature is being covered as follows:

— 25 000 cycles are with the pressure regulator environment at the maximum ambient temperature stated in the installation and operating instructions, declared by the manufacturer but at least 60 °C; and

— 25 000 cycles are with the pressure regulator environment at the minimum ambient temperature stated in the installation and operating instructions, declared by the manufacturer but at most 0 °C.

For tests based on 100 000 cycles, the temperature influence is tested separately as follows:

a) Maintain the pressure regulator at a temperature of 60 °C for a period of 6 h;

b) Decrease temperature to –10 °C gradually for 4 h;

c) Maintain the pressure regulator at a temperature of –10 °C for a period of 10 h;

d) Increase temperature to 60 °C gradually for 4 h;

e) Repeat these steps for two weeks;

f) Carry out performance tests [leak tightness (7.2.3) and regulator performance (J.2.4, J.2.5, J.2.6, J.2.7)];

g) Place the pressure regulator in a constant temperature bath and leave it for more than 2 h at each of 65 °C and –25 °C;

h) Remove the regulator from the bath and immediately carry out the leakage-tightness test (7.2.3) and the performance test (J.2.4, J.2.5, J.2.6, J.2.7) without adjusting the setting pressure of the regulator.

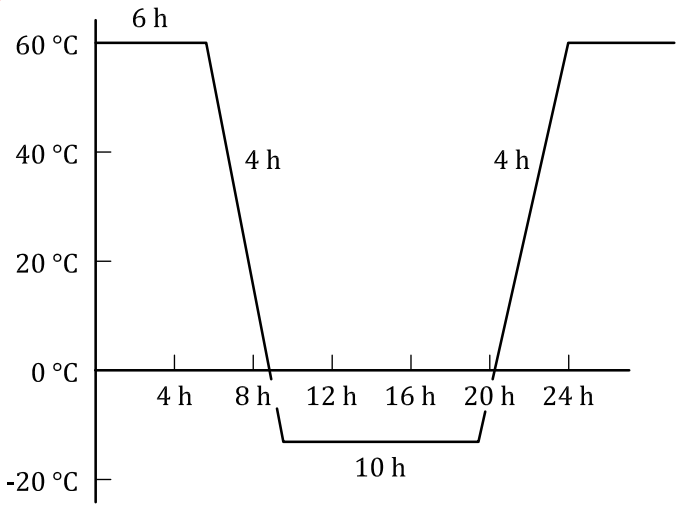


Figure J.6 — Temperature cyclic test

J.2.10.2.2 Regulators Class D Cycling and Temperature

Class D pressure regulators shall be tested as follows:

a) With the nominal pressure and the rated flow rate declared by the manufacturer, measure the outlet pressure.

b) Repeat 30 000 cycles of operation to flow and stop at intervals of approximately 2 s or 3 s.

c) With the nominal pressure and the rated flow rate declared by the manufacturer, measure the outlet pressure, p_{1b} with Formula (J.1):

$$p_{drift} = |p_{1a} - p_{1b}| \leq (p_{1a} \times 0{,}05) + 30 \quad \text{(J.1)}$$

where

p_{drift} is drift of the outlet pressure after testing (Pa);

p_{1a} is outlet pressure before testing (Pa);

p_{1b} is outlet pressure after testing (Pa).

d) With the nominal pressure and the rated flow rate declared by the manufacturer, measure the outlet pressure.

e) Maintain the pressure regulator for a period of 24 h at temperature given in Table J.3.

f) Remove the regulator from the bath and wait until it return to room temperature.

With the nominal pressure and the rated flow rate declared by the manufacturer, measure the outlet pressure, p_{1b}. The drift of the outlet pressure shall remain within the limits specified under c).

Table J.3 — Heat-resisting class and temperature

Heat-resisting class	Temperature °C
15	150
14	140
13	130
12	120
11	110
10	100
9	90
8	80

J.3 Summary of requirements and test procedures

J.3.1 Requirements

Table J.4 — Requirements

Parameter	Outlet pressure, p_2											
	Class A regulator Test for variation of q for range limit settings of p_1, p_2			**Class B regulator** Test for variation of p_1 for range limit settings of q, p_2			**Class C regulator** Test for variation of p_1 for range limit settings of q			**Class D regulator** Test for variation of p_1 for a fixed setting of q, p_2		
	Manufactured gas	Natural gas	LPG	Manufactured gas	Natural gas	LPG	Manufactured gas	Natural gas	LPG	Manufactured gas	Natural gas	LPG
Standard												
Tolerance on the outlet pressure, p_2 (as percentage of the outlet setting pressure)	±15	±15	±15	+15 −20	+10 −15	±10	+15 −20	+10 −15	±10	±15	±15	±15
— with change of inlet pressure from p_{1min} to p_{1max}	or ±0,1 kPa			or ±0,1 kPa			or ±0,1 kPa			or ±0,1 kPa		
— with change of flow rate from q_{max} to q_{min}				+40 0	+40 0	+40 0	N/A			N/A		
Industrial												
— with change of inlet pressure from p_{1min} to p_{1max}	±20	±20	±20	N/A			N/A			N/A		
— with change of flow rate from q_{max} to q_{min}	or ±0,2 kPa											
Setting pressure	Nominal pressure as declared by the manufacturer.											
Inlet pressure range	As declared by the manufacturer.											
Maximum inlet pressure	As declared by the manufacturer.											

J.3.2 Test procedure

Table J.5 — Test procedure

Setting or testing	Class A regulator	Class B regulator	Class C regulator	Class D regulator
1 Setting Set the outlet pressure, p_2 to	p_{2max}	p_{2max}	p_{2max}	p_{2s}
1.1 at an inlet pressure, p_{1s} equal to	Nominal pressure according as declared by the manufacturer			
1.2 and at a flow rate, q_s equal to	0,5 q_{max}	q_{max}	q_{max}	q_s

Table J.5 *(continued)*

Setting or testing	Class A regulator	Class B regulator	Class C regulator	Class D regulator
	Once the outlet pressure is set, there shall be no further adjustment of the regulator.			
2 Testing	After each change of p_1 or q record the outlet pressure p_2			
2.1 Change p_1 to	p_{1min}	p_{1min}	p_{1min}	p_{1min}
2.2 Change q from → to	0,5 $q_{max} \rightarrow q_{min} \rightarrow q_{max}$	No change	No change	No change
2.3 Change p_1 to	p_{1max}	$p_{1min} \rightarrow p_{1max} \rightarrow p_{1min}$	$p_{1min} \rightarrow p_{1max} \rightarrow p_{1min}$	$p_{1min} \rightarrow p_{1max} \rightarrow p_{1min}$
2.4 Change q from → to	$q_{max} \rightarrow q_{min} \rightarrow q_{max}$	No change	No change	No change
2.5 Change q to	—	q_{min}	q_{min}	—
3 Setting				
Reset the outlet pressure, p_{2s} to	—	—	p_{2max}	—
3.1 at an inlet pressure, p_{1s}	—	—	as indicated in 1.1	—
3.2 and at a flow rate, q_s of	—	—	q_{min}	—
	Once the outlet pressure is set, there shall be no further adjustment of the regulator.			
4 Testing	After each change of p_1 or q, record the outlet pressure, p_2			
4.1 Change p_1 to	—	p_{1min}	p_{1min}	—
4.2 Change q from → to	—	No change	No change	—
4.3 Change p_1 to	—	$p_{1min} \rightarrow p_{1max} \rightarrow p_{1min}$	$p_{1min} \rightarrow p_{1max} \rightarrow p_{1min}$	—

For regulators of Classes A, B or C, repeat the complete test procedure including steps 1 to 4, but with the outlet pressure reset to p_{2min}.

Annex K
(normative)

Functional requirements and regulator performance testing — Method B

Annex specific to this document.

K.1 Requirements

K.1.1 Mounting regulator for test

The regulator shall be installed in the appropriate test rig shown in Figure K.1. The regulator shall be placed in the mounting position specified for the particular test to be conducted.

K.1.2 Outlet pressure range

Non-adjustable regulators shall be tested as described in K.2.2.1 for outlet pressure performance as specified in Table K.2. Adjustable regulators shall be tested for outlet pressure performance as specified.

K.1.3 Range of regulation capacity

The range of regulation capacity as determined by test described in K.2.3 shall include the upper and lower limits specified by the manufacturer.

K.1.4 Regulators designated to operate at pilot flow rate

The specified maximum regulation capacity for main burner and pilot load application shall not be greater than the specified maximum regulation capacity for main burner load only. The pressure variation in the pilot line, resulting from the change of flow rate through the regulator from the specified regulation capacity for main burner and pilot load to a pilot flow rate, shall not exceed 373 Pa (1,5 in water column) or 20 %, whichever is greater, when tested as per K.2.4.1.

The pressure in the pilot line resulting from changing the flow through the regulator from pilot rate to the maximum individual load capacity shall not be less than 65 % of the stabilized pilot line pressure at pilot rate when examined under the test specified in K.2.4.2.

K.1.5 Integrity of operation

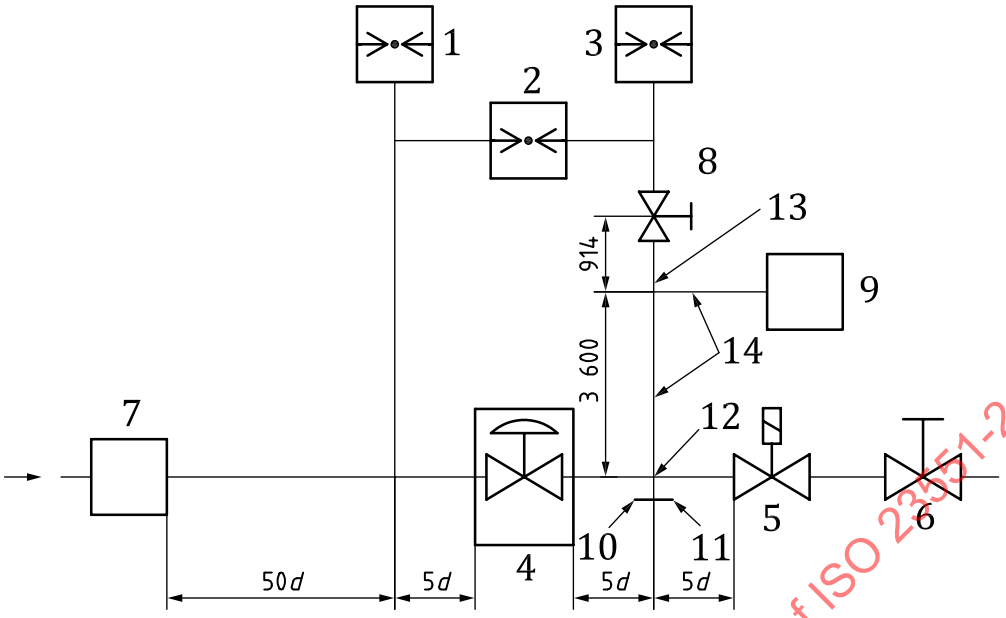
The opening characteristics of the outlet pressure of the regulator shall stay within the tolerances specified in K.2.5 at the extreme temperature and mounting position conditions specified.

A regulator with a separate vent limiter shall have curves developed for outlet pressure versus time with and without the vent limiter installed. If more than one vent limiter is used with the regulator, an additional curve shall be developed with each vent limiter in place. A convertible regulator shall have a curve developed for each operating pressure range. A multi-stage regulator shall have curves developed at the settings which deliver the maximum and minimum outlet pressure, respectively.

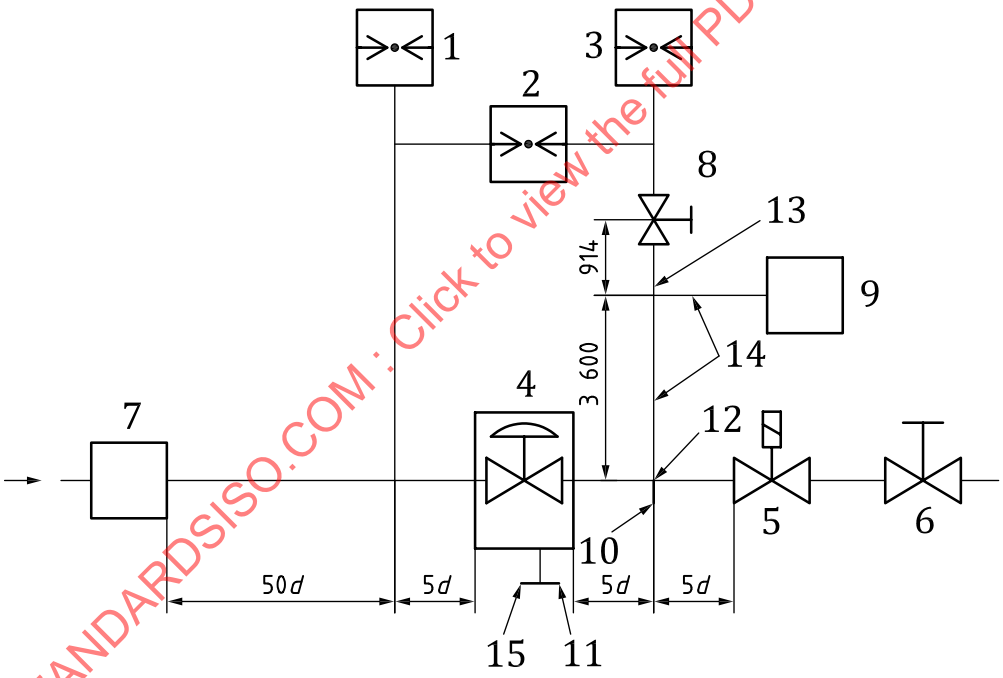
K.1.6 Enduranace

The performance and leak tightness of the regulator shall remain within the limits specified in K.2.6 and 7.2.2 after testing in accordance with K.2.6.

Dimensions in millimetres



a) Regulator without pilot take-off



b) Regulator with pilot take-off

Key

1 inlet pressure measuring device
2 differential pressure measuring device
3 outlet pressure measuring device
4 regulator under test
5 instantaneous opening automatic valve
6 outlet adjustment control valve
7 constant pressure source
9 pressure transducer
10 optional tap
11 pilot flow line, length 69,9
12 outlet pressure tap for manometer or pressure transducer (hole through pipe wall, diameter 1,6)
13 type II tube
14 type I tube

8 shut-off valve

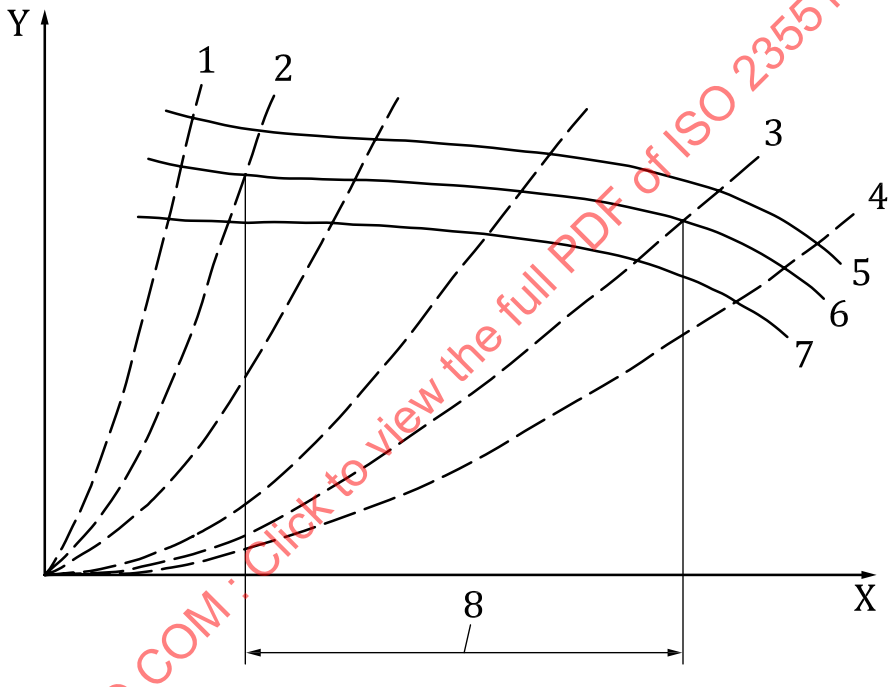
15 tap for manometer or pressure transducer, (hole trough pipe wall, diameter 1,6 mm)

Figure K.1 — Typical arrangement of test apparatus

K.2 Test

K.2.1 General test procedures

Regulators shall be tested in accordance with the test sequences specified in K.2.2 to K.2.6. Unless otherwise noted, equilibrium conditions shall always be reached before readings are taken. Examples of "Range of regulation" are shown in Figures K.2 and K.3 and "Opening characteristics" curves are shown in Figures K.2 and K.5, respectively.



Key

X flow rate

Y outlet pressure

1 orifice curves at which maximum obtainable outlet pressure varies from minimum obtainable outlet pressure by 20 %

2 orifice curves at which outlet pressure at maximum inlet test pressure varies from minimum obtainable outlet pressure by 20 %

3 orifice curves at which maximum obtainable outlet pressure varies from minimum obtainable outlet pressure by 20 %

4 orifice curves at which outlet pressure at maximum inlet test pressure varies from minimum obtainable outlet pressure by 20 %

5 curve B, maximum obtainable outlet pressure curve

6 curve A, minimum obtainable outlet pressure curve

7 curve C, outlet pressure curves at maximum inlet test pressure

8 range of regulation

Figure K.2 — Range of regulation curves for non-adjustable regulators

K.2.2 Outlet pressure range

K.2.2.1 General

These tests shall be conducted at room temperature. The regulator initially shall be mounted in the upright position.

K.2.2.2 Non-adjustable regulator

The inlet pressure and flow rate shall be established as specified by the manufacturer.

The outlet pressure shall be observed and shall be within the tolerances specified in Table K.1.

The above test shall be repeated with the regulator mounted in each mounting position specified by the manufacturer.

The regulator mounting position that produces the minimum outlet pressure shall be designated position A.

The regulator mounting position that produces the maximum outlet pressure shall be designated position B.

These are the two mounting positions used for the tests in accordance with K.2.3.

K.2.2.3 Convertible regulator

Convertible regulators shall be tested with the same test method used for non-adjustable regulators, as described above.

The outlet pressure, at each outlet pressure setting, of convertible regulators for use other than on domestic gas ranges shall be within the tolerances in accordance with Table K.1 of the outlet pressure as specified by the manufacturer.

K.2.2.4 Adjustable regulator

Adjustable regulators shall be tested twice using the same test method used for non-adjustable regulators, as described above: once with the regulator adjusted to deliver its minimum outlet pressure and once with the regulator adjusted to deliver its maximum outlet pressure.

The regulator mounting position that produces the minimum outlet pressure shall be designated position A. The regulator mounting position that produces the maximum outlet pressure shall be designated position B.

These are the two mounting positions used for the tests in accordance with K.2.3.

K.2.3 Range of regulation capacity

These tests are to be conducted at room temperature.

K.2.3.1 Non-adjustable regulator

The regulator shall be mounted as for test specified in K.1 in position A (as determined in K.2.2.2).

The inlet test pressure shall be adjusted to the appropriate minimum value specified in Table K.2. If this minimum value exceeds the rated inlet pressure, the rated inlet pressure shall be used as the minimum inlet test pressure. The initial flow rate shall be set at a value less than the lower limit of the manufacturer's specified range of regulation capacity. The lower limit of the range of regulation capacity shall be:

— 1,18 cm^3/s (0,15 ft^3/h) for regulators designated by the symbol “circle P”; and

— 3,93 cm^3/s (0,50 ft^3/h) for regulators designated by the symbol “delta P”.

The inlet test pressure shall be gradually increased to the rated inlet pressure. Over this range of inlet pressures, the minimum and maximum obtainable outlet pressures observed and their corresponding flow rates shall be recorded and used to construct a smooth orifice curve.

The inlet test pressure shall then be increased to the maximum inlet test pressure (see Table K.2) and the outlet pressure observed shall be recorded.

This procedure shall be repeated for increased flow rates to a flow rate exceeding the upper limit of the manufacturer's specified range of regulation capacity. A sufficient number of readings shall be recorded to establish smooth curves when minimum obtainable outlet pressures are joined (Figure K.2, curve A), maximum obtainable outlet pressures are joined (Figure K.2, curve B), and outlet pressures obtained at the maximum inlet test pressure are joined (Figure K.2, curve C).

Pressure variations and flow rates shall be examined along the orifice curves.

a) Examine the minimum and maximum obtainable outlet pressure curves to determine the minimum and maximum flow rates between which the outlet pressure variation does not exceed 20 % of the minimum obtainable outlet pressure. (See Figure K.2).

b) Examine the maximum inlet test pressure curve to determine the minimum and maximum flow rates between which the pressure does not vary more than ±20 % from the minimum obtainable outlet pressure (see Figure K.2).

The largest minimum flow rate and the smallest maximum flow rate determined from a) and b) above shall include the lower and upper limits of the manufacturer's specified range of regulation capacity.

K.2.3.2 Convertible regulator

Each outlet pressure setting of a convertible regulator shall be evaluated independently as a non-adjustable regulator.

K.2.3.3 Adjustable regulator

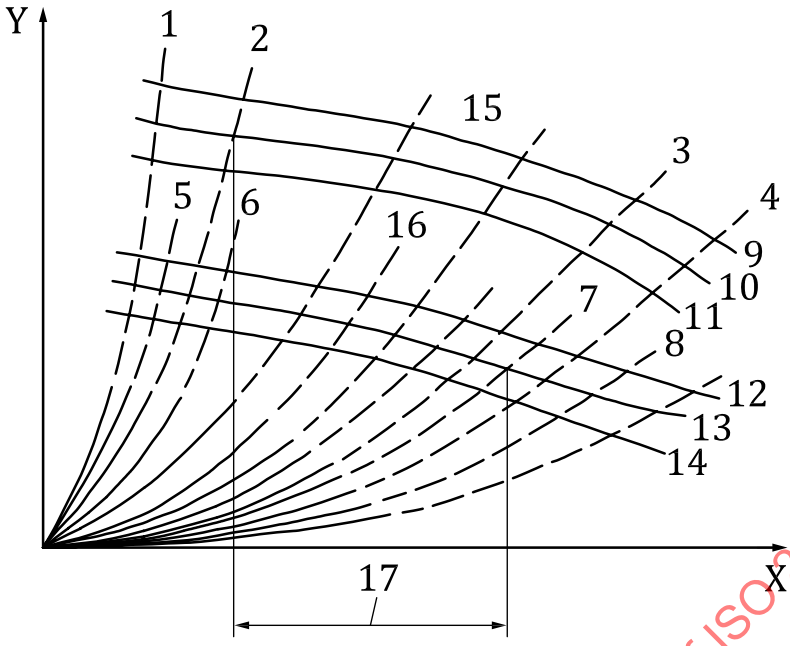
The regulator shall be mounted in position B (as determined in K.2.2.4).

Adjust the regulator to deliver the manufacturer's specified maximum outlet pressure at the manufacturer’s specified inlet pressure and flow rate.

The procedure outlined above for non-adjustable regulators shall then be followed to develop curves A, B and C (see Figure K.3).

The regulator shall then be mounted in position A (as determined in K.2.2.4). Adjust the regulator to deliver the manufacturer's specified minimum outlet pressure at the manufacturer’s specified inlet pressure and flow rate. The procedure outlined above for non-adjustable regulators shall then be followed to develop curves D, E and F (see Figure K.3).

The largest minimum flow rate and the smallest maximum flow rate determined from all of the tests above shall include the lower and upper limits of the manufacturer’s specified range of regulation capacity.



Key

X flow rate

Y outlet pressure

1 orifice curves at which maximum obtainable outlet pressure varies from minimum obtainable outlet pressure by 20 %

2 orifice curves at which outlet pressure at maximum inlet test pressure varies from minimum obtainable outlet pressure by 20 %

3 orifice curves at which maximum obtainable outlet pressure varies from minimum obtainable outlet pressure by 20 %

4 orifice curves at which outlet pressure at maximum inlet test pressure varies from minimum obtainable outlet pressure by 20 %

5 orifice curves at which maximum obtainable outlet pressure varies from minimum obtainable outlet pressure by 20 %

6 orifice curves at which outlet pressure at maximum inlet test pressure varies from minimum obtainable outlet pressure by 20 %

7 orifice curves at which maximum obtainable outlet pressure varies from minimum obtainable outlet pressure by 20 %

8 orifice curves at which outlet pressure at maximum inlet test pressure varies from minimum obtainable outlet pressure by 20 %

9 curve B, maximum obtainable outlet pressure curve

10 curve A, minimum obtainable outlet pressure curve

11 curve C, outlet pressure curve at maximum inlet test pressure

12 curve E, maximum obtainable outlet pressure curve

13 curve D, minimum obtainable outlet pressure curve

14 curve F, outlet pressure curve at maximum inlet test pressure

15 maximum outlet pressure adjustment

16 minimum outlet pressure adjustment

17 range of regulation

Figure K.3 — Range of regulation curves for adjustable regulators

K.2.3.4 Multi-stage regulator

Multi-stage regulators are tested at the highest and lowest stages.

These stages may be adjustable or non-adjustable. The minimum inlet test pressure is determined by the highest stage.

The regulator shall then be mounted in position B (as determined in either K.2.2.2 or K.2.2.4, as applicable) and set to the highest pressure stage.

If the highest pressure stage is non-adjustable, the procedure outlined above for non-adjustable regulators shall be followed to construct curves A, B and C.

If the highest pressure stage is adjustable, the procedure outlined above for adjustable regulators shall be followed to construct curves A, B, C, D, E and F.

The regulator shall be mounted for test in position A (as determined in K.2.2) and set at the lowest pressure stage.

If the lowest pressure stage is non-adjustable, the procedure outlined above for non-adjustable regulators shall be followed.

If the lowest pressure stage is adjustable, set the regulator to deliver the manufacturer's specified minimum outlet pressure at the manufacturer's specified inlet pressure and flow rate. The procedure outlined above for non-adjustable regulators shall be followed. However, it is not necessary for the maximum flow rate to exceed the flow rate on the orifice curve for the maximum regulation capacity determined for the highest pressure stage.

Within the limits of the flow rates obtained from the orifice curves at the lower and upper limits of the manufacturer's specified range of regulation capacity, the observed outlet pressure shall not vary by more than 20 % of the lower outlet pressure reading or 74,7 Pa (0,3 in water column), whichever is greater. The observed outlet pressure shall not be less than 50 Pa (0,2 in water column).

K.2.4 Regulators designated to operate at pilot flow rate

K.2.4.1 General

These tests shall be conducted at room temperature.

K.2.4.2 Regulation capacity

The regulator and pilot flow line shall be installed as specified in K.1, but a manometer shall be installed at either the inlet pressure measuring device (Figure K.1, key item 1) or the outlet pressure measuring device (Figure K.1, key item 3).

Convertible regulators shall be tested at each outlet pressure setting.

With a flow rate through the regulator equivalent to the maximum specified regulation capacity and the pilot flow adjusted to 1,18 cm^3/s (0,15 ft^3/h) for regulators designated by the symbol "circle P", or 3,93 cm^3/s (0,50 ft^3/h) for regulators designated by the symbol "delta P", the settings specified below shall be made within the rated inlet pressure of the regulator and the minimum inlet test pressure specified in K.2.3. The main flow shall be cycled off and on to establish the reliability of the setting. The pilot line pressure at each of the established settings shall be recorded.

a) Mount the regulator in position B (in accordance with either K.2.2.2 or K.2.2.4, as applicable).

b) Adjust the regulator, if adjustable, to deliver the manufacturer's specified maximum outlet pressure, with the related inlet pressure and flow rate established as specified by the manufacturer. Then set the inlet pressure to produce the maximum outlet pressure.

c) Adjust the regulator, if adjustable, as described in b)" Then set the inlet pressure to produce the minimum outlet pressure.

d) Then mount the regulator in position A (in accordance with K.2.2).

e) Adjust the regulator, if adjustable, to deliver the manufacturer's specified minimum outlet pressure, with the related inlet pressure and flow rate established as specified by the manufacturer. Then set the inlet pressure to produce the maximum outlet pressure.

f) Adjust the regulator, if adjustable, as described in "e." Then set the inlet pressure to produce the minimum outlet pressure. At the end of the established settings, the instantaneous opening valve shall be closed and, without reopening the valve, the stabilized pilot line pressure shall again be noted. The pressure shall be within 373 Pa (1,5 in water column) or 20 %, whichever is greater, of the previously recorded pilot line pressure.

K.2.4.3 Pressure variation

The regulator shall be installed as specified in K.2.4.2, but the manometer shall be replaced by a pressure transducer coupled to a fast response recording voltmeter or other equivalent instrumentation to measure pilot line pressure. The vent limiter, if supplied, shall be in place.

Convertible regulators shall be tested at each outlet pressure setting.

The regulator shall be mounted in position A (in accordance with either K.2.2.2 or K.2.2.4, as applicable).

a) The regulator, if adjustable, shall be adjusted to deliver the manufacturer's specified minimum outlet pressure, with the related inlet pressure and flow rate established as specified by the manufacturer. The inlet pressure shall then be adjusted to the minimum inlet test pressure specified in Table K.2, at a flow rate equivalent to the maximum individual load capacity specified and the pilot flow adjusted to:

   — 1,18 cm^3/s (0,15 ft^3/h) for regulators designated by the symbol "circle P"; or

   — (3,93 cm^3/s) (0,50 ft^3/h) for regulators designated by the symbol "delta P".

   The instantaneous opening valve shall be closed. The pressure in the pilot line shall be measured and recorded as the initial outlet pressure. With the inlet pressure held constant within ±24,9 Pa (±0,1 in water column), the instantaneous opening valve shall be opened and, starting at 0,25 s after flow has been initiated the outlet pressure shall be noted until it has become stabilized. At least two more tests shall be conducted to definitely establish the minimum outlet pressure. The minimum outlet pressure noted in the pilot line after 0,25 s of flow shall not be less than 65 % of the initial outlet pressure.

b) The inlet pressure shall then be adjusted to the rated inlet pressure of the regulator. No change in any flow adjustment shall be made. The outlet pressure curve shall be developed and evaluated as specified in "a" above. The regulator shall then be mounted in position B (in accordance with either K.2.2.2 or K.2.2.4, as applicable).

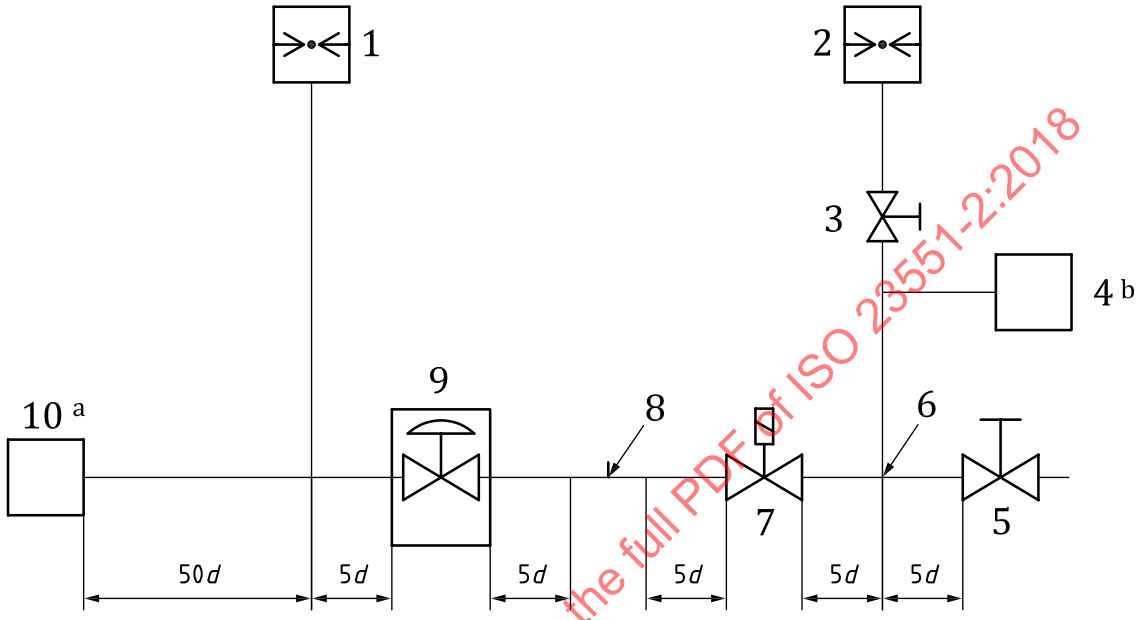
c) The regulator, if adjustable, shall be adjusted to deliver the manufacturer's specified maximum outlet pressure, with the related inlet pressure and flow rate established as specified by the manufacturer. The inlet test pressure shall then be adjusted to the minimum inlet test pressure specified in Table K.2, and flow rates adjusted as specified in a). The outlet pressure curve shall be developed and evaluated as specified in a).

d) The inlet pressure shall then be adjusted to the rated inlet pressure of the regulator. No change in any flow adjustment shall be made. The outlet pressure curve shall be developed and evaluated as specified in a).

K.2.5 Integrity of operation

K.2.5.1 Creating base curve

This test shall be conducted at room temperature. The regulator shall be installed in the manufacturer's specified upright position as shown in Figure K.4 and, where applicable, according to the equipment specifications in K.1.



Key

1 inlet pressure measuring device
2 outlet pressure measuring device
3 shut-off valve
4 pressure transducer
5 outlet adjustment control valve
6 tap for pressure transducer
7 instantaneous opening automatic valve
9 regulator under test
10 constant pressure source

a The constant-pressure source shall not permit a pressure variation for no flow to full flow, of more than ±24,9 Pa for each 2,83 m^3/h of air flow at full flow.

b Pressure transducer coupled to a fast response recording voltmeter or other equivalent instrumentation.

Figure K.4 — Arrangement for integrity of operation test

The inlet test pressure for each curve to be developed shall be set as indicated in Table K.1.

a) For each operating pressure range, the pressure regulator shall be set to obtain the manufacturer's specified minimum outlet pressure at a flow rate equivalent to the midpoint of the specified range of regulation capacity. For purpose of this initial setting, the pressure tap (Figure K.4, key item 1) shall be used. After the initial setting, the pressure measuring device used at this tap shall be isolated from the system for the remainder of these tests. The instantaneous opening valve shall then be closed. The instantaneous opening valve shall be energized and the outlet pressure, p_2, versus time, t, recorded until steady state outlet pressure is attained.

   The following points shall then be determined by examination of this curve:

— $p_{2,1}$ is the outlet pressure after 1 s of gas flow;

— $p_{2,2}$ is the outlet pressure after 2 s of gas flow;

— $p_{2,3}$ is the outlet pressure after 3 s of gas flow;

— $p_{2,4}$ is the outlet pressure after 4 s of gas flow;

— $p_{2,SS}$ is the steady state outlet pressure;

— t_1 is the time at which the curve crosses either 90 % $p_{2,SS}$ or 110 % $p_{2,SS}$ and remains within these limits;

— After 1 s of gas flow, the outlet pressure shall not exceed 120 % $p_{2,SS}$;

— After 4 s of gas flow, the outlet pressure shall be at least 50 Pa (0,2 in water column);

— Figure K.5 is an example of this curve when $p_{x,SS} = p_{2,SS}$ and $t_x = t_1$.

b) For a regulator designed for operation in mounting positions other than the manufacturer's specified upright position, an additional base curve(s) of the outlet pressure, p'_2, versus time, t, shall be developed in the manner prescribed above with no change in the flow rate adjustment and with the regulator mounted in the mounting position(s) that produces the extreme(s) of outlet pressure.

The following points shall then be determined by examination of this curve:

— $p'_{2,1}$ is the outlet pressure at 1 s of gas flow;

— $p'_{2,2}$ is the outlet pressure at 2 s of gas flow;

— $p'_{2,3}$ is the outlet pressure at 3 s of gas flow;

— $p'_{2,4}$ is the outlet pressure at 4 s of gas flow;

— $p'_{2,SS}$ is the steady state outlet pressure;

— t_2 is the time at which the curve crosses either 90 % $p'_{2,SS}$ or 110 % $p'_{2,SS}$ and remains within these limits;

— After 1 s of gas flow, the outlet pressure shall not exceed 120 % $p'_{2,SS}$;

— After 4 s of gas flow, the outlet pressure shall be at least 50 Pa (0,2 in water column);

— Figure K.5 is an example of this curve when $p'_{x,SS} = p_{2,SS}$ and $t_x = t_2$.

K.2.5.2 For a regulator designed for operation at temperatures above 51,5 °C (125 °F), a curve(s) of the outlet pressure, p_{2a}, versus time, t, shall be developed in accordance with K.2.5.1 a) or b), as appropriate, with no change in the flow rate adjustment and with the ambient temperature equal to the manufacturer's specified maximum ambient temperature.

a) The following points shall then be determined by examination of the curve(s):

— $p_{2a,1}$ is the outlet pressure at 1 s of gas flow.

— $p_{2a,2}$ is the outlet pressure at 2 s of gas flow.

— $p_{2a,3}$ is the outlet pressure at 3 s of gas flow.

— $p_{2a,4}$ is the outlet pressure at 4 s of gas flow.

— $p_{2a,SS}$ is the steady state outlet pressure.

— t_a is the time at which the curve crosses either 75 % $p_{2,SS}$ or 120 % $p_{2,SS}$ and remains within these limits.

b) The outlet pressure readings for each second of time determined from this/these curve(s) shall be compared with the corresponding outlet pressure points determined from the appropriate curve(s) developed in K.2.5.1 and shall comply with the following:

— $p_{2a,1}$ shall be within ±75 % $p_{2,1}$ or $p'_{2,1}$, as applicable.

— $p_{2a,2}$ shall be within ±70 % $p_{2,2}$ or $p'_{2,2}$, as applicable.

— $p_{2a,3}$ shall be within ±60 % $p_{2,3}$ or $p'_{2,3}$, as applicable.

— $p_{2a,4}$ shall be within ±50 % $p_{2,4}$ or $p'_{2,4}$, as applicable.

In addition, t_a shall not be greater than t_1 + 1 min or t_2 + 1 min, as applicable. After 1 s of gas flow, the outlet pressure shall not exceed 120 % $p_{2a,SS}$. After 4 s of gas flow, the outlet pressure shall be at least 50 Pa (0,2 in water column). Only the values determined from curves developed under similar test conditions (i.e., without a vent limiter or with the same vent limiter, upright or worst case mounting position) shall be compared.

Figure K.5 is an example of this curve when $p_{x,SS} = p_{2,SS}$ and $t_y = t_{1a}$.

K.2.5.3 For a regulator designed for operation at temperatures below 0 °C (32 °F), a curve(s) shall be developed as described under K.2.5.1 a) and b), as appropriate, with no change in the flow rate adjustment and with the ambient temperature equal to the manufacturer's specified minimum ambient temperature.

a) The following points shall then be determined by examination of this curve:

— $p_{2b,1}$ is the outlet pressure at 1 s of gas flow;

— $p_{2b,2}$ is the outlet pressure at 2 s of gas flow;

— $p_{2b,3}$ is the outlet pressure at 3 s of gas flow;

— $p_{2b,4}$ is the outlet pressure at 4 s of gas flow;

— $p_{2b,SS}$ is the steady state outlet pressure.

— t_b is the time at which the curve crosses either 75 % $p_{2,SS}$ or 120 % $p_{2,SS}$ and remains within these limits.

b) The outlet pressure readings for each second of time determined from this/these curve(s) shall be compared with the corresponding outlet pressure points determined from the appropriate curve(s) developed in K.2.5.1 and shall comply with the following:

— $p_{2b,1}$ shall be within ±75 % $p_{2,1}$ or $p'_{2,1}$, as applicable.

— $p_{2b,2}$ shall be within ±70 % $p_{2,2}$ or $p'_{2,2}$, as applicable.

— $p_{2b,3}$ shall be within ±60 % $p_{2,3}$ or $p'_{2,3}$, as applicable.

— $p_{2b,4}$ shall be within ±50 % $p_{2,4}$ or $p'_{2,4}$, as applicable.

In addition, t_b shall not be greater than t_1 + 1 min or t_2 + 1 min, as applicable. After 1 s of gas flow, the outlet pressure shall not exceed 120 % $p_{2b,SS}$. After 4 s of gas flow, the outlet pressure shall be at least 50 Pa (0,2 in water column). Only the values determined from curves developed under similar test conditions (i. e., without a vent limiter or with the same vent limiter, upright or worst case mounting position) shall be compared.

Figure K.5 is an example of this curve when $p_{x,SS} = p_{2,SS}$ and $t_y = t_{1b}$.