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Gas pressure safety and control devices for use in gas transmission, distribution and installations for inlet pressures up to and including 10 MPa —

Part 2:
Gas pressure regulator

Reference number
ISO 23555-2:2022(E)

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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*.

A list of all parts in the ISO 23555 series can be found on the ISO website.

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.

Introduction

This document is designed to be used in combination with ISO 23555-1. This document together with ISO 23555-1 establishes the complete standard as it applies to the specific control covered by the ISO 23555 series.

Where needed, this document adapts ISO 23555-1 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 but not already covered by ISO 23555-1, this document can contain clauses or subclauses that are additional to the structure of ISO 23555-1. These subclauses are indicated by the introductory sentence: "Subclause (or Annex) specific to this document.".

Gas pressure safety and control devices for use in gas transmission, distribution and installations for inlet pressures up to and including 10 MPa —

Part 2:
Gas pressure regulator

1 Scope

This document specifies safety, constructional, performance, testing and documentation requirements for gas pressure regulators for use in gas transmission and distribution installations (hereafter referred to as regulators).

This document is applicable to regulators with operating pressures greater than 500 kPa and up to and including 10 MPa (100 bar) and nominal diameters up to DN 400 for use with fuel gases as natural gas, manufactured gas, biomethane or liquefied petroleum gas (LPG).

This document is applicable to:

— test methods which are intended for product type test, routine tests and product surveillance tests;

— regulators which use the pipeline gas as a source of control energy unassisted by any external power source;

— regulators integrating on the same body a second regulator, used as monitor, complying with the requirements in this document;

— regulators integrating a safety shut off device (SSD) according to ISO 23555-3;

— regulators incorporating a creep (venting) relief device and/or a vent limiter complying with the requirements in this document.

This document does not apply to:

— regulators upstream from/on/in domestic gas-consuming appliances which are installed downstream of domestic gas meters;

— regulators designed to be incorporated into pressure control systems used in service lines (pipework from the main pipework in a gas infrastructure to the point of delivery of the gas) with declared volumetric flow rate ≤ 200 m^3/h at normal conditions and declared inlet pressure ≤ 500 kPa (5 bar);

— industrial process control valves, such as IEC 60534 (all parts);

— regulators used in aggressive/sour gas environments (gas environments containing water and H2S are considered sour) or severely corrosive conditions;

— regulators in service conditions with renewables (e.g. H2NG with hydrogen more than 10 %) and/or waste gases (e.g. biogas etc.), if additional information is not provided (e. g. contaminant, liquid, etc.).

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 23555-1:2022, *Gas pressure safety and control devices for use in gas transmission, distribution and installations for inlet pressures up to and including 10 MPa — Part 1: General requirements*

IEC 60534-1:2005, *Industrial-process control valves — Part 1: Control valve terminology and general considerations*

IEC 60534-2-3, *Industrial-process control valves — Part 2-3: Flow capacity — Test procedures*

IEC 60534-4, *Industrial-process control valves — Part 4: Inspection and routine testing*

3 Terms and definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 23555-1 and the following apply.

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

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

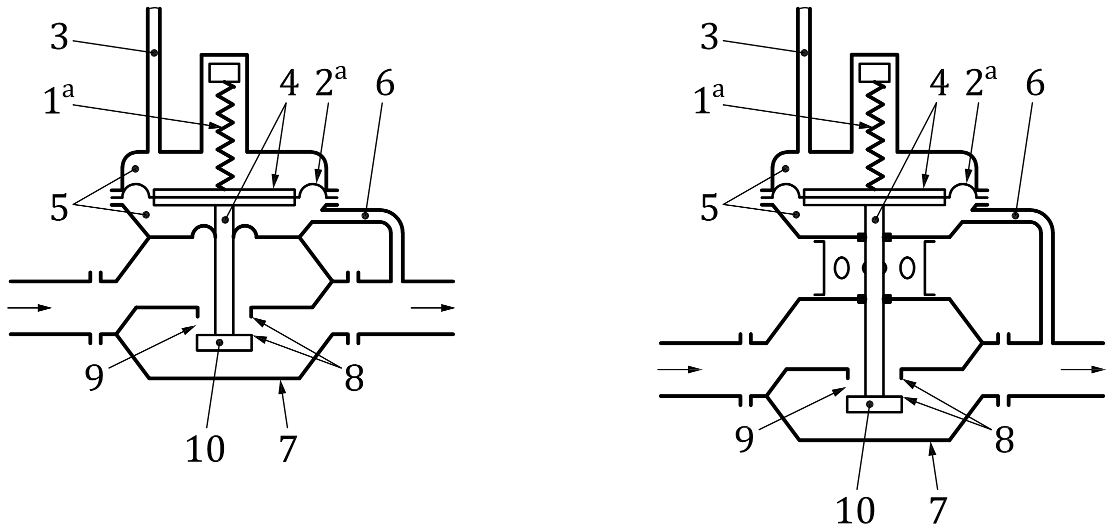
— IEC Electropedia: available at https://www.electropedia.org/

3.1.1 General terms

3.1.1.1
gas pressure regulator
device whose function is to maintain the value of the *controlled variable* (3.1.3.1) within its tolerance field irrespective of disturbance variables

3.1.1.2
direct acting gas pressure regulator
regulator in which the net force required to move the control member is supplied directly by the controlled variable

Note 1 to entry: See example in Figure 1.



a) Direct acting regulator - type integral strength

b) Direct acting regulator - type differential strength

Key

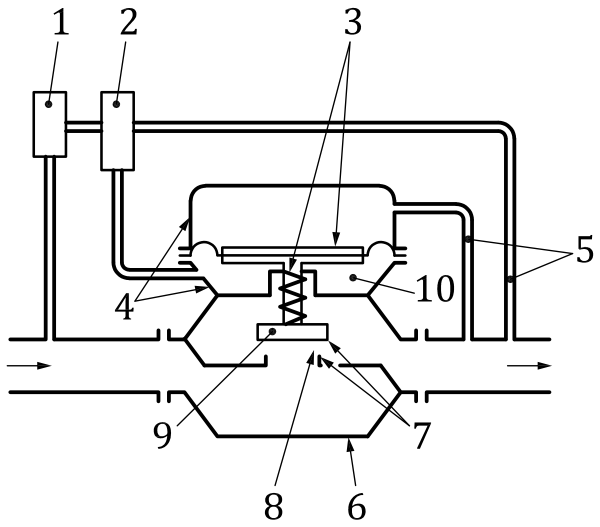
1 + 2 = Controller

1	setting element	6	sensing line
2	pressure detecting element	7	regulator body
3	breather/exhaust line	8	valve seats
4	actuator	9	seat ring
5	casing of actuator	10	control member

Figure 1 — Examples of a direct acting regulator

3.1.1.3
pilot-controlled gas pressure regulator
regulator in which the net force required to move the control member is supplied by a pilot

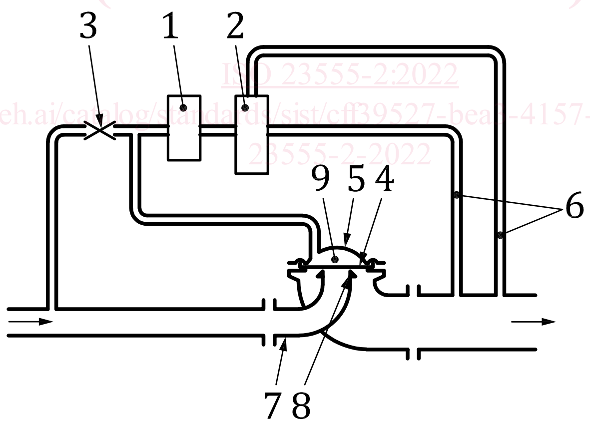
Note 1 to entry: See example in Figures 2 and 3.



Key

1 auxiliary device
2 pilot
3 actuator
4 casing of actuator
5 sensing/process line
6 regulator body
7 valve seats
8 seat ring
9 control member
10 motorization chamber

Figure 2 — Example of a pilot-controlled regulator



Key

1 auxiliary device
2 pilot
3 throttle
4 control member
5 casing of control member
6 sensing/process lines
7 regulator body
8 valve seat
9 motorization chamber

Figure 3 — Example of a pilot-controlled regulator with a diaphragm as control member

3.1.1.4
monitor
second regulator installed in series with an active regulator, normally upstream, which has the task of maintaining the controlled variable within allowable limits in the event of its value exceeds pre-established values (e.g. in the event of opening of the active regulator due to a failure, etc.)

3.1.1.5
fail close regulator
regulator whose control member automatically tends to close or close when failures occur

Note 1 to entry: This definition is based on typical control failure modes.

3.1.1.6
fail open regulator
regulator whose control member automatically tends to open or open when failures occur

Note 1 to entry: This definition is based on typical control failure modes.

3.1.1.7
regulator size
nominal size DN of the inlet connection

Note 1 to entry: The preferred DN values are specified in ISO 6708.

3.1.1.8
series of regulators
regulators with the same design concept but differing only in size

3.1.2 Terms related to flow

3.1.2.1
flow coefficient in critical conditions
Cg
characteristic value for the flow capacity of regulator in critical conditions

Note 1 to entry: Flow coefficient Cg is a non-SI regulator coefficient.

Note 2 to entry: Numerically, Cg is represented as the number of normal cubic feet per hour of air flowing through a regulator in critical conditions with inlet absolute pressure 1 psia and with a reference inlet temperature t_{ur} = 15 °C[1)]. The numerical value in SI units is equal to the number of m^3/h of air flowing through a regulator in critical conditions with inlet absolute pressure 243 kPa (2,43 bar) and inlet temperature of 15 °C.

Note 3 to entry: IEC 60534-2-1:2011, Clause 7 and Appendix B deals with this flow coefficient.

3.1.2.2
flow coefficient in normal conditions
KG
characteristic value for the flow capacity of a regulator in normal conditions

Note 1 to entry: The flow coefficient is equal to the volumetric flow rate at normal conditions through the regulator under the following reference conditions:

— reference natural gas at normal conditions with the relative density d_r = 0,64 (density ρ_r = 0,827 5 kg/m^3);

— fully opened control member (mechanical stop);

— reference inlet temperature of t_{ur} = 15 °C;

— reference absolute gas inlet pressure p_{ur} = 200 kPa (2 bar);

— reference absolute gas outlet pressure p_{dr} = 100 kPa (1 bar).

Note 2 to entry: The KG value is specified in (m^3/h)/bar.

1) The definition of this flow coefficient is based on IEC 60534-1.

3.1.3 Terms related to variables in the controlling process

3.1.3.1
controlled variable
variable which is monitored by the controlling process

Note 1 to entry: In this document, only the outlet pressure, p_d, is considered as the controlled variable.

3.1.3.2
disturbance variable
variable acting from outside on the controlling process

Note 1 to entry: In the case of regulators with outlet pressure as the controlled variable, the disturbance variables are essentially:

— changes in the inlet pressure;

— changes in the volumetric flow rate.

3.1.3.3
reference inlet temperature
t_{ur}
temperature at the inlet of control in the assessment of its functional performance

Note 1 to entry: This document considers as reference temperature 15 °C.

Note 2 to entry: The use of reference inlet temperature is necessary to obtain homogeneous set of test results when comparing the functional performances of different type of control.

3.1.4 Terms related to the controlled process

3.1.4.1
set point
p_{ds}
nominal value of the controlled variable under specified conditions

Note 1 to entry: The set point is not directly measurable but determined as shown in Figure 6.

3.1.4.2
set range
W_d
whole range of set points which can be obtained from a regulator by adjustment and/or the replacement of some components (i.e. replacement of the valve seat or setting element, e.g. spring)

3.1.4.3
specific set range
W_{ds}
whole range of set points which can be obtained from a regulator by adjustment and with no replacement of its components

3.1.4.4
regulation change
difference between the actual value of the controlled variable and the set point expressed as a percentage of the set point

3.1.5 Terms related to functional performance

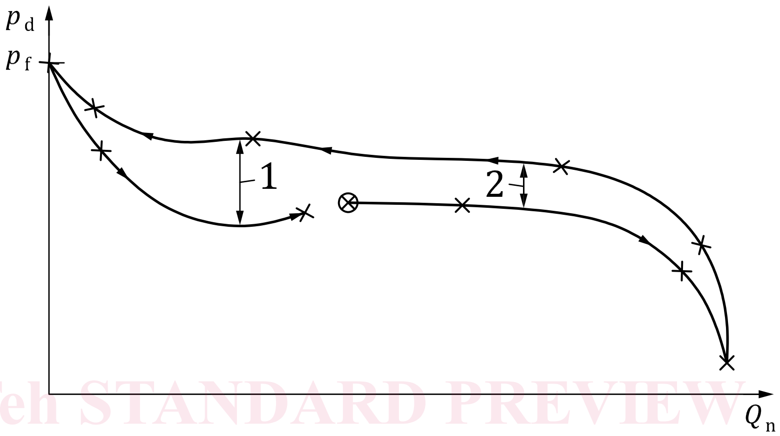
3.1.5.1
stable
condition where the controlled variable settles to a stable value after a disturbance has occurred

3.1.5.2
performance curve
graphic representation of the controlled variable as a function of the volumetric flow rate

Note 1 to entry: This curve is determined by increasing and then decreasing the volumetric flow rate with constant inlet pressure and set point (see Figure 4).

3.1.5.3
hysteresis band
difference between the two values of outlet pressure for a given volumetric flow rate

Note 1 to entry: See Figure 4.



Key

⊗	start setting	1	max hysteresis band
×	measured values	2	hysteresis band

Figure 4 — Performance curve (p_{ds} constant, p_u constant)

3.1.5.4
family
<of performance curves> set of the performance curves for each value of inlet pressure determined for a given set point

Note 1 to entry: See Figure 5.

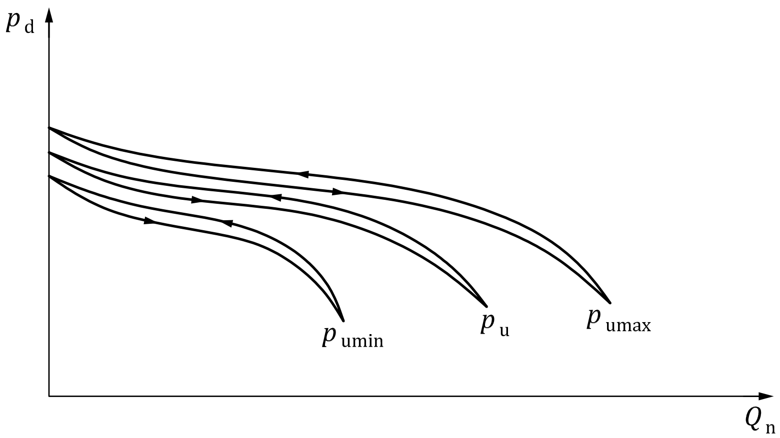


Figure 5 — Family of performance curves (p_{ds} constant)

3.1.6 Feature related to accuracy

3.1.6.1
accuracy
maximum absolute value of regulation change under specified operating range

3.1.6.2
accuracy class
AC
maximum permissible value of the accuracy under specified operating range

3.1.6.3
inlet pressure range
$\boldsymbol{b}_{\mathbf{pu}}$
range of the inlet pressure for which the regulator ensures a given accuracy class

Note 1 to entry: The inlet pressure range is characterized by its limit values p_{umax} and p_{umin}.

3.1.6.4
maximum accuracy flow rate
lowest value of the maximum volumetric flow rate up to which, for a given set point and within the ambient temperature range specified, a given accuracy class is ensured:

— at the lowest inlet pressure (see Figure 6) $Q_{\text{n,max,}p\text{umin}}$;

— at the highest inlet pressure (see Figure 6) $Q_{\text{n,max,}p\text{umax}}$;

— at an intermediate inlet pressure between p_{umax} and p_{umin} (see Figure 6) $Q_{\text{n,max,}p\text{u}}$

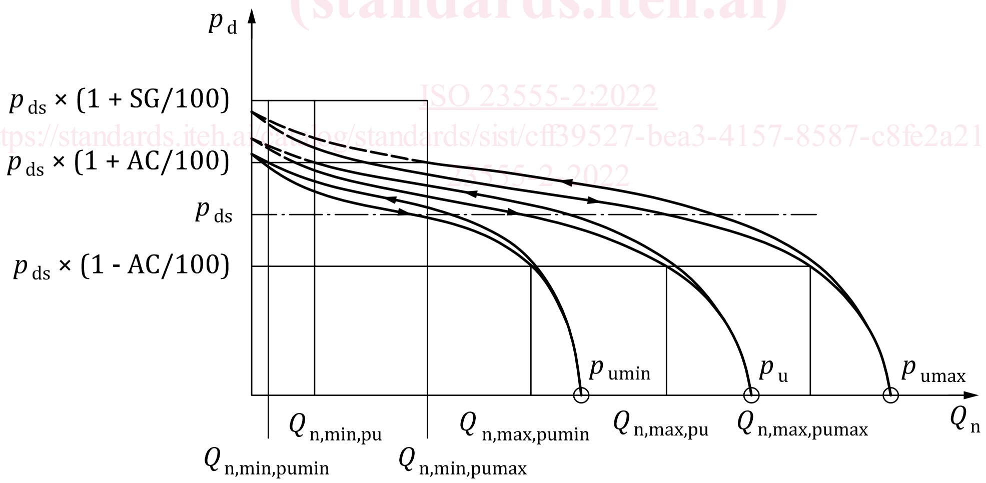


Figure 6 — Family of performance curves indicating maximum accuracy flow rates and minimum flow rates (p_{ds} constant, stable conditions)

3.1.7 Terms related to lock-up behaviour

3.1.7.1
lock-up time
$\boldsymbol{t}_{\mathbf{f}}$
time taken for the control member to move from an open position to the closed position

3.1.7.2
lock-up pressure
p_f
pressure that occurs at the measuring point of the controlled variable when the control member is in the closed position

Note 1 to entry: The lock-up pressure corresponds to the outlet pressure at the volumetric flow rate $Q = 0$ in the performance curve (see Figure 4). It results when the time taken for a change in volumetric flow rate from Q to zero is greater than the lock- up time of the regulator.

3.1.7.3
lock-up pressure class
SG
maximum permissible positive difference between the actual lock-up pressure and the set point expressed as a percentage of the set point [see Formula (1)]:

$$\mathrm{SG} = \frac{p_\mathrm{f} - p_\mathrm{ds}}{p_\mathrm{ds}} \bullet 100 \qquad (1)$$

Note 1 to entry: For better understanding of $(p_\mathrm{f} - p_\mathrm{ds})_\mathrm{max}$, see Figure 6.

3.1.7.4
minimum flow rate
largest value of the minimum volumetric flow rate down to which, for a given set point and within the ambient temperature range specified, stable conditions are obtained:

— at the lowest inlet pressure (see Figure 6) $Q_{\mathrm{nmin},p\mathrm{umin}}$;

— at the highest inlet pressure (see Figure 6) $Q_{\mathrm{nmin},p\mathrm{umax}}$;

— at an intermediate inlet pressure between p_umax and p_umin (see Figure 6) $Q_{\mathrm{nmin},p\mathrm{u}}$.

Note 1 to entry: Stable conditions are given in 7.2.8.3.

3.1.7.5
lock-up pressure zone
zone between the volumetric flow rate $Q_\mathrm{n} = 0$ and the minimum flow rate $Q_{\mathrm{nmin},p\mathrm{u}}$ for each corresponding inlet pressure and set point (see Figure 7)

3.1.7.6
class of lock-up pressure zone
SZ
maximum permissible lock-up pressure zone for specified:

— inlet pressure p_u ;

— set point p_ds;

which is expressed as the percentage of $Q_{\mathrm{nmin},p\mathrm{u}}$ to $Q_{\mathrm{nmax},p\mathrm{u}}$ [see Formula (2)]:

$$SZ = \frac{Q_\mathrm{nminpu}}{Q_\mathrm{nmaxpu}} \bullet 100 \qquad (2)$$

3.1.7.7
computational fluid dynamics
CFD
set of numerical methods and algorithms to solve and analyse problems that involve fluid flows