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Gas welding equipment —

Part 1: Line pressure regulators and line pressure regulators with flow-metering devices for gas distribution pipelines up to 6 MPa (60 bar)

Matériel de soudage au gaz —

Partie 1: Détendeurs de canalisation et détendeurs de canalisation à débitmètre intégré pour les canalisations de distribution du gaz jusqu'à 6 MPa (60 bar)

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Foreword

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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 document 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).

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This document was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 8, *Equipment for gas welding, cutting and allied processes*.

A list of all parts in the ISO 22073 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. Official interpretations of ISO/TC 44 documents, where they exist, are available from this page: https://committee.iso.org/sites/tc44/home/interpretation.html.

Gas welding equipment —

Part 1: Line pressure regulators and line pressure regulators with flow-metering devices for gas distribution pipelines up to 6 MPa (60 bar)

1 Scope

This document specifies requirements for line pressure regulators and line pressure regulators with flow-metering devices to be connected to industrial gas distribution pipelines of:

— compressed gases and carbon dioxide up to 6 MPa (60 bar);

— acetylene up to 150 kPa (1,5 bar);

— liquefied petroleum gases (LPG);

— methylacetylene-propadiene mixtures (MPS);

for use in welding, cutting and allied processes.

This document does not apply to pressure regulators intended for direct use on cylinders or bundles, such regulators are addressed in ISO 2503 or ISO 7291, respectively.

NOTE Where there is no risk of ambiguity, both line pressure regulators and line pressure regulators with flow-metering devices are addressed with the collective term ‘pressure regulators’.

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 2503, Gas welding equipment — Pressure regulators and pressure regulators with flow-metering devices for gas cylinders used in welding, cutting and allied processes up to 300 bar (30 MPa)

ISO 5171, *Gas welding equipment — Pressure gauges used in welding, cutting and allied processes*

ISO 7291, *Gas welding equipment — Pressure regulators for manifold systems used in welding, cutting and allied processes up to 30 MPa (300 bar)*

ISO 9090, *Gas tightness of equipment for gas welding and allied processes*

ISO 9539, *Gas welding equipment — Materials for equipment used in gas welding, cutting and allied processes*

ISO 10225, *Gas welding equipment — Marking for equipment used for gas welding, cutting and allied processes*

ISO 11114-6, *Gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 6: Oxygen pressure surge testing*

ISO 15296, *Gas welding equipment — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15296 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
accuracy of a flow-metering device
classification based on the *permissible error of the flow indication* (3.5) of the device

3.2
line pressure regulator
device for regulating a generally stable inlet pressure of a pipeline gas distribution system to an outlet pressure that is as constant as possible

3.2.1
adjustable line pressure regulator
line pressure regulator that is provided with a means of operator adjustment of the outlet pressure

3.2.2
preset line pressure regulator
line pressure regulator that is not provided with a means of operator adjustment of the outlet pressure

3.3
flow-metering device
device that measures and indicates the flow of a specific gas or gas mixture

3.4
indicated flow(s)
flow(s) indicated on the measuring device of a *line pressure regulator with flow-metering devices* (3.7)

3.5
permissible error of the flow indication
difference between the *indicated flow* (3.4) and the true flow, as a percentage of the *indicated flow* (3.4)

3.6
pressure gauge
device that measures and indicates pressure

3.7
line pressure regulator with flow-metering devices
device for regulating a generally stable inlet pressure of a pipeline gas distribution system to an outlet pressure that is as constant as possible, ensuring in addition a selected gas flow

Note 1 to entry: The device is generally a pressure regulator equipped with flow-adjusting and measuring devices which are not intended to be separated from the regulating device by the operator.

3.8
true flow
flow measured with a calibrated measuring device

4 Symbols and abbreviated terms

The symbols used in this document are given in Table 1.

Table 1 — Symbols and definitions

Symbol	Definition
p_1	Maximum inlet pressure specified by the manufacturer
p_2	Nominal outlet pressure at the nominal discharge Q_n specified by the manufacturer
p_4	Closing outlet pressure measured 1 min after stopping the nominal discharge Q_n, at p_2 and p_1
q_f	Maximum allowable internal leakage
Q_n	Nominal discharge at p_2 and p_1, specified by the manufacturer
R	Coefficient of pressure increase upon closure defined by the Formula: $R = \frac{p_4 - p_2}{p_2}$

5 Design requirements

5.1 Materials

Materials for pressure regulators shall conform to the requirements of ISO 9539.

5.2 Design and construction

5.2.1 Oxygen pressure regulators

All components and accessories used on pressure regulators for oxygen shall be thoroughly cleaned and degreased before assembly.

The materials which come in contact with oxygen in normal condition shall be resistant to corrosion and compatible with oxygen.

If lubricants are used, they shall be compatible with oxygen. They shall be resistant to ignition up to the pressure they are intended to be exposed to under operating condition.

Pressure regulators for oxygen with a maximum inlet pressure equal or greater than 3 MPa (30 bar) shall not ignite or show evidence of burning when submitted to the ignition test in 9.7.4.

5.2.2 Acetylene pressure regulators

If any of the connections' internal diameter is greater than 25 mm, an acetylene pressure regulator shall withstand a decomposition test according to 9.7.5.

5.2.3 Connections

5.2.3.1 Inlet connection

The inlet connection shall be different from the ones used for cylinder regulators.

5.2.3.2 Outlet connection

In the absence of applicable national or regional regulations, it is recommended that the connection conform with ISO/TR 28821.

5.2.4 Filter

A particle filter shall be fitted upstream of the pressure-regulator valve either inside or outside the pressure regulator.

The filter shall retain particles greater or equal to 150 µm.

5.2.5 Pressure-adjusting device

This device shall be designed in such a way that it is not possible for the pressure-regulator valve to be held in the open position, for example, as a consequence of the spring being compressed fully (to its solid length).

If prevention of the spring becoming fully compressed depends on the dimensions of the pressure-adjusting screw, then the screw shall be not removable.

5.2.6 Flow-control valve

A pressure regulator with flow-metering devices may be fitted with a flow-control valve. The flow-control knob and the valve spindle shall be captive such that they cannot be dismantled without the use of a tool.

5.2.7 Pressure gauges

If pressure gauges with a Bourdon-tube are used, they shall conform to ISO 5171.

5.2.8 Pressure relief valve

If a pressure relief valve is fitted, it shall conform to ISO 2503.

NOTE A pressure relief valve is intended to protect the line pressure regulator itself and not the downstream pipeline.

5.2.9 Leakage

5.2.9.1 External leakage

Pressure regulators and pressure regulators with flow-metering devices shall be externally gas tight at p_1 and p_2. Regulators shall not have a leakage rate greater than 170 Pa · l/min (10 cm^3/h).

This requirement is given in ISO 9090, together with suitable test methods.

5.2.9.2 Internal leakage

The test for internal leakage shall be performed according to 9.7.3.2. The maximum leakage rate allowed q_f is 200 Pa · l/min (12 cm^3/h) for test 9.7.3.2 a) Q_n up to 50 m^3/h. For higher Q_n expressed in m^3/h, the maximum permissible internal leakage expressed in cm^3/h is specified by Formula (1).

$$q_f = 0{,}24 \times Q_n \quad (1)$$

5.2.10 Mechanical resistance

5.2.10.1 Resistance to internal pressure

Pressure regulators and pressure regulators with flow-metering devices shall be designed and constructed in such a way that the application of a pressure equal to 2,25 × p_1 or 6 MPa (60 bar) whichever is greater for 5 min in the high-pressure and low-pressure side chambers does not lead to permanent deformation.

Pressure regulators and pressure regulators with flow-metering devices shall comply with the test in 9.7.2.1.

5.2.10.2 Pressure retention of the low-pressure side of the pressure regulator

Pressure regulators shall be designed and constructed so that, if the low-pressure chamber of the pressure regulator is in direct communication with the pipeline upstream pressure, for example, if the regulator pressure valve is held in the open position and the outlet connection is closed by an attached stop valve or a blind plug, the high-pressure gas shall either be safely retained or vented to a safe location.

Pressure regulators and pressure regulators with flow-metering devices shall comply with the test in 9.7.2.2.

6 Operating characteristics

6.1 Operating-temperature range

The pressure regulators shall be capable of operating normally in the temperature range –20 °C to +60 °C.

6.2 Coefficient of pressure increase upon closure *R* (applicable for line pressure regulators without flow-metering devices)

For nominal discharge Q_n, the coefficient R of pressure increase upon closure shall be less than 0,3.

6.3 Accuracy classification (applicable for line pressure regulators with flow-metering devices)

The error in the flow indication shall remain within the limits defined by the classification indicated in Table 2 or ±1 l/min, whichever is greater.

Table 2 — Accuracy classification

Accuracy class	10	20
Maximum error of the flow indication	±10 %	±20 %

For any indicated flow between 30 % of Q_n and Q_n or for the flows indicated on any fixed orifice of a flow measuring system, the error in flow indication shall not exceed that of the respective accuracy class in Table 2.

EXAMPLE 1 For a pressure regulator with flow-metering devices of class 10 and Q_n = 40 l/min, the allowed true flow at Q_n is (40 ± 4) l/min:

— at Q = 12 l/min (30 % of Q_n), the allowed true flow is (12 ± 1,2) l/min;

— at Q = 26 l/min (65 % of Q_n), the allowed true flow is (26 ± 2,6) l/min.

EXAMPLE 2 For a pressure regulator with flow-metering devices with fixed orifices of class 10 and flows of 10 l/min, 20 l/min, 30 l/min and 40 l/min, the allowed true flows are respectively (10,00 ± 1) l/min, (20,00 ± 2) l/min, (30,00 ± 3) l/min and (40,00 ± 4) l/min.

7 Marking

7.1 Line pressure regulators without flow-metering devices

The following information shall be clearly and permanently marked in accordance with 9.8 on the pressure regulator body or cover or on a label permanently fixed to the pressure regulator:

— the number of this document; i.e. ISO 22073-1:2024;

— the name or trademark of the manufacturer and/or distributor;

— the designation of the line pressure regulator model;

— p_1, p_2 and Q_n of the pressure-regulator;

— the gas intended for use: when the full name of the gas cannot be imprinted, a letter code according to ISO 10225 shall be used;

— Inlet and outlet connections or the intended direction of the gas flow shall be clearly and permanently identified according to 5.2.3. The function of any other connection should also be identified in the same way.

7.2 Line pressure regulators with flow-metering devices

The following information shall be clearly and permanently marked in accordance with 9.8 on the pressure regulator body or cover or on a label permanently fixed to the pressure regulator:

— the number of this document; i.e. ISO 22073-1:2024;

— the name or trademark of the manufacturer and/or distributor;

— the designation of the line pressure regulator model;

— the accuracy class according to 6.3;

— the maximum inlet pressure, p_1, and Q_n of the pressure-regulator;

— the gas intended for use: when the full name of the gas cannot be imprinted, a letter code according to ISO 10225 shall be used;

— Inlet and outlet connections or the intended direction of the gas flow shall be clearly and permanently identified according to 5.2.3. The function of any other connection should also be identified in the same way.

8 Instructions for use

The manufacturer, supplier or distributor shall supply instructions for use with each pressure regulator, and with each pressure regulator with flow-metering devices, covering at least:

a) the field of application of the pressure regulator; or

b) the field of application of the pressure regulator with flow-metering devices; in particular the range of specific gravity of the gases or gas mixtures for which it can be used;

c) a description of the pressure regulator, or of the pressure regulator with flow-metering devices and the meaning of the marking;

d) the safe and correct installation of the pressure regulator, or of the pressure regulator with flow-metering devices;

e) the commissioning tests that are necessary to prove safe and correct installation prior to service. To protect the pipeline system downstream of a line pressure regulator, a safety valve according to ISO 4126-1 should be considered by the installer;

f) the use and maintenance of the pressure regulator, or of the pressure regulator with flow-metering devices (intended for the operator);

g) hazards and safety precautions for the intended gas e.g. in the case of oxygen.

9 Type-test procedure

9.1 General

Checking conformity to this document of a pressure regulator, or a pressure regulator with flow-metering devices of a given type, consists of:

— tests, and

— checking of documents.

NOTE These are type tests applicable to pressure regulators only for verifying conformity with this document and are not intended as a program for production testing of all pressure regulators.

9.2 Test samples and necessary documents

The number of samples is given in Table 3. For the tests, the following documents shall be available:

— two sets of drawings with material lists;

— two sets of detail drawings;

— if necessary, a declaration from the manufacturer giving the material specifications.

The tests shall be carried out with pressure regulators, and with pressure regulators with flow-metering devices, which are in accordance with the drawings.

Table 3 — Number of samples

Test sequence	Test and relevant subclause for test procedure	Condition of test sample	Numbering of test samples	For pressure regulators without flow-metering devices	For pressure regulators with flow-metering devices
0	Design requirements (5)	As received	—	x	x
1	Resistance to internal pressure (9.7.2.1)	As received	1	x	x
2	Pressure retention test of the low-pressure side (9.7.2.2)	As received	2	x	x
3	Leakage tests (9.7.3)	As received	3 to 5	x	x
4	Nominal discharge Q_n (9.5.2)	From test 3	3 to 5	x	—
5	Coefficient of pressure increase upon closure, R (9.5.3)	From test 4	3 to 5	x	—
6	Test for accuracy classification of pressure regulators with flow-metering devices (9.6.)	From test 5	3 to 5	—	x
7	Oxygen pressure surge test (9.7.4) (Only for oxygen regulators)	As received	6 to 8	x	x
8	Acetylene decomposition test (9.7.5) (only for acetylene regulators with inner diameter > 25 mm)	As received	9 to 14	x	—
9	Test for durability of markings (9.8)	From test 6	3	x	x
10	Instructions for use (8)	—	—	x	x

9.3 Test conditions

9.3.1 General characteristics of the test installation

All the pipelines of the test installation, together with the valve controlling the flow, shall have a flow capacity greater than that of the pressure regulator or pressure regulator with flow metering devices to be tested.

9.3.2 Test gas

Tests shall be carried out with air or nitrogen, free from oil and grease, except for test in 9.7.4 and 9.7.5.

In all cases, tests shall be carried out with a gas with a maximum moisture content of 50 µg/g corresponding to a dew-point of −40 °C.

9.3.3 Accuracy of a flow-metering device

The accuracy of the flow-metering instruments shall be within ±3 % of the measured value.

9.3.4 Pressure measurement

The accuracy of the pressure-measuring instruments shall be within ±1 % of the measured value.

9.4 Units

9.4.1 Pressure

The pressures measured are gauge pressures and are expressed in MPa (bar).

9.4.2 Flow

Flow rates are measured in cubic metres per hour (m^3/h) or in litres per minute (l/min) under normal conditions taking into account the relevant conversion coefficient for the gas used (see Table 4).

NOTE Normal conditions are 0 °C and 101,3 kPa (1,013 bar) (in accordance with IUPAC).

Table 4 — Conversion coefficient, *U*

Test gas	Conversion coefficient								
	Air	Oxygen	Nitrogen	Argon	Hydrogen	Helium	Acetylene	LPG, e.g. propane	CO_2
Air	1	0,950	1,02	0,851	3,81	2,695	1,05	0,800	0,808
Nitrogen	0,983	0,930	1	0,837	3,75	2,65	1,03	0,784	0,792

The conversion coefficient, U, is based on Formula (2):

$$U = \sqrt{\frac{\gamma_0}{\gamma_1}} \tag{2}$$

where

γ_0 is the specific gravity of the test gas;

γ_1 is the specific gravity of the gas used.

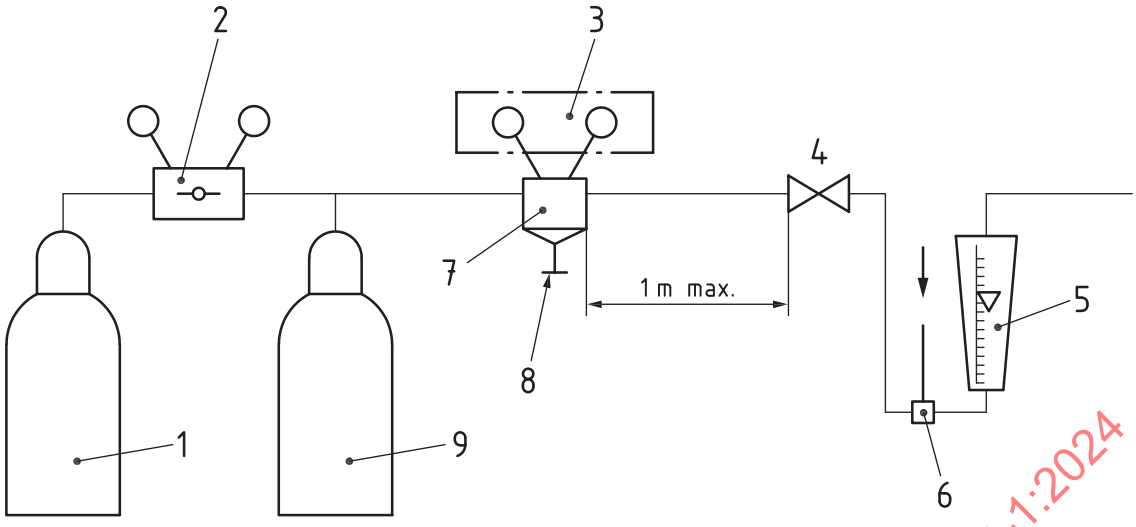
9.4.3 Temperature

Temperatures are measured in degrees Celsius.

9.5 Test for performance and operating characteristics of pressure regulators without flow-metering devices

9.5.1 General

An example of the test apparatus used for the measurement of performance and operating characteristics is shown in Figure 1. The pressure regulator may, for example, be supplied by a buffer cylinder. The upstream pressure p_1 is kept constant by means of an auxiliary pressure regulator or any equivalent device.



Key

1 gas supply
2 auxiliary pressure regulator
3 calibrated gauges
4 control valve for regulation
5 flow meter
6 thermometer for measurement of gas temperature
7 pressure regulator (test sample)
8 adjusting screw
9 buffer cylinder

Figure 1 — Example for the measurement of performance and operating characteristics

9.5.2 Nominal discharge Q_n

The nominal discharge, Q_n, shall be obtained by adjusting the screw of the pressure-regulator sample under test and the valve for regulation shall be set to achieve an outlet pressure, p_2, and Q_n at an inlet pressure p_1.

9.5.3 Coefficient of pressure increase upon closure, R

With the pressure regulator set to nominal discharge conditions (Q_n, p_2, p_1), proceed as follows:

— stop the flow by using the valve for regulation;

— after 1 min, record the stabilization pressure p_4;

— determine the value of R (see Table 1).

9.6 Test for accuracy classification of pressure regulators with flow-metering devices

Connect the outlet of the pressure regulator with flow-metering devices to be tested to the flow-measuring apparatus.

With an inlet pressure of p_1, set the initial flow at Q_n or, for multiple calibrated orifices, select the orifice with the highest flow and record both the indicated flow of the measuring device of the pressure regulator with flow-metering devices and the true flow. The difference between the indicated flow and the true flow, as a percentage of the indicated flow, shall be recorded.

Repeat the above-mentioned test for 30 % of Q_n and 65 % of Q_n. Perform the above tests for all other fixed orifices.

9.7 Tests for mechanical resistance of pressure regulators or pressure regulators with flow-metering devices

9.7.1 General

WARNING — Precautions shall be taken to protect test personnel.

9.7.2 Test for mechanical resistance to internal pressure

9.7.2.1 Resistance test to internal pressure

For this test (see 5.2.10.1), the relief valve, diaphragm, pressure gauges and flow-metering devices shall be replaced by blind plugs. The low and high-pressure chambers shall be hydraulically pressurized for 5 min. After the test, check that there is no visible permanent deformation.

9.7.2.2 Pressure retention test of the low-pressure side of the pressure regulator

For this test (see 5.2.10.2), the pressure-regulator valve shall be held permanently open. This may be realized by removing the internal regulator valve before the test or kept permanently open during the test. The outlet connection shall be blanked off.

A pneumatic pressure p_1 shall be applied to the pressure-regulator inlet, through a valve which is manually opened quickly.

If no rupture occurs, the test is satisfactory.

If rupture occurs, no pieces shall be ejected. Venting of gas through pressure-relief devices, if fitted, is allowed.

9.7.3 Leakage tests

9.7.3.1 External leakage

Gas tightness to the atmosphere shall be tested with the pressure p_1 at the inlet side and p_2 at the outlet side in accordance with ISO 9090. An example of the test apparatus used for the external leakage test is shown in Figure 2.