

Gas pressure regulators for inlet pressures up to 100 bar

ICS 23.060.40

National foreword

This British Standard is the UK implementation of EN 334:2005+A1:2009. It supersedes BS EN 334:2005 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by A1.

The UK participation in its preparation was entrusted to Technical Committee GSE/32, Gas governors.

A list of organizations represented on this committee can be obtained on request to its secretary.

Warning

The responsible BSI technical committee GSE/32 ‘Gas governors’ wishes to bring to the attention of users of this British Standard the following essential information. The UK as a member of CEN, is obliged to publish EN 334:2005 as a British Standard. However, attention is drawn to the fact that during the development of this European Standard, the UK voted against its approval as a European Standard. The reason for this disapproval was that pressure regulators commonly used in the UK had been excluded from the harmonized part of the standard.

As a result, the UK has applied for an extension of the date of withdrawal of the existing BS EN 334:1999. This has been accepted. Hence BS EN 334:1999 will continue in existence in parallel with the 2005 version until March 2008.

It is the intention of the BSI technical committee to have amendments to the harmonized standards approved by 2007 so that all devices are included in the harmonized part of the standard.

At the present time gas pressure regulators are used in accordance with the UK national guidelines for pressure regulating stations up to 100 bar, issued by the Institute of Gas Engineers and Managers document, IGE/TD/13.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 23 February 2006

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English Version

Gas pressure regulators for inlet pressures up to 100 bar

Appareils de régulation de pression de gaz (régulateurs)
pour des pressions amont jusqu'à 100 bar

Gas-Druckregelgeräte für Eingangsdrücke bis 100 bar

This European Standard was approved by CEN on 23 December 2004 and includes Amendment 1 approved by CEN on 8 December 2008.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

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Foreword

This document (EN 334:2005+A1:2009) has been prepared by Technical Committee CEN/TC 235 "Gas pressure regulators and associated safety devices for use in gas transmission and distribution", the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2009, and conflicting national standards shall be withdrawn at the latest by July 2009.

This document includes Amendment 1, approved by CEN on 2008-12-08.

This document supersedes A1 EN 334:2005 A1.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1 A1.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 97/23/EC.

For relationship with EU Directive 97/23/EC, see informative Annex ZA, which is an integral part of this document.

Gas pressure regulators dealt with in this document are standard gas pressure regulators and, when used in pressure regulating stations complying with EN 12186 or EN 12279, they are considered as standard pressure equipment in accordance with Clause 3.1 of Art. 1 of Pressure Equipment Directive 97/23/EC (PED).

For standard gas pressure regulators used in pressure regulating stations complying with EN 12186 or EN 12279, Table ZA.1 given in Annex ZA includes all applicable Essential Requirements given in Annex I of PED, A1 except the external corrosion resistance in case of environmental conditions where corrosion is likely to occur A1.

The normative Annex H of this document lists some suitable materials for pressure containing parts, inner metallic partition walls, fasteners and connectors. Other materials may be used when complying with the restrictions given in Table 5.

A1 *deleted text* A1

A1 Continued A1 integrity of gas pressure regulators is assured by periodic functional checks. For periodic functional checks it is common to refer to national regulations/standards where existing or users/manufacturers practices.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

A1 This document specifies constructional, functional, testing and marking requirements, sizing and documentation of gas pressure regulators used in the pressure regulating stations in accordance with EN 12186 or EN 12279: **A1**

- for inlet pressures up to 100 bar and nominal diameters up to DN 400;
- for an operating temperature range from -20 °C to +60 °C,

which operate with fuel gases of the 1st and 2nd family in accordance with EN 437 in transmission and distribution networks and also in commercial and industrial installations.

"Gas pressure regulators" hereafter will be called "regulators" except in the titles.

A1 For standard regulators when used in pressure regulating stations complying with EN 12186 or EN 12279, Annex ZA lists all applicable Essential Requirements except the external corrosion resistance in case of environmental conditions where corrosion is likely to occur. **A1**

A1 This document considers the following classes/types of regulators: **A1**

- class 1: operating temperature range from -10 °C to 60 °C;
- class 2: operating temperature range from -20 °C to 60 °C;

A1

- type IS: (integral strength type);
- type DS: (differential strength type). **A1**

This document applies to regulators which use the pipeline gas as a source of control energy unassisted by any external power source.

The regulator may incorporate a creep (venting) relief device, complying with the requirements in Annex F.

The regulators complying with the requirements of this document may be declared as "in compliance with EN 334" and bear the marking "EN 334".

This document does not apply to:

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

A1

- regulators incorporated into pressure-regulating devices used in service lines¹ with volumetric flow rate ≤ 200 m³/h at normal conditions and inlet pressure ≤ 5 bar; **A1**
- regulators for which a specific document exists (e.g. EN 88, etc.);
- industrial process control valves in accordance with EN 1349.

¹⁾ **A1** The services lines are those defined in EN 12279. **A1**

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including amendments) applies.

 deleted text 

 EN 287-1, *Qualification test of welders – Fusion welding – Part 1: Steel*

 EN 473:2000 , *Non destructive testing – Qualification and certification of NDT personnel – General principles*

 deleted text 

 EN 970:1997 , *Non-destructive examination of fusion welds – Visual examination*

 deleted text 

 EN 1092-1:2007, *Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated – Part 1: Steel flanges*

EN 1092-2:1997, *Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated – Part 2: Cast iron flanges*

EN 1092-3:2003, *Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated – Part 3: Copper alloy flanges*

EN 1092-4:2002, *Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated – Part 4: Aluminium alloy flanges* 

EN 1349, *Industrial process control valves*

 EN 1418:1997 , *Welding personnel – Approval testing of welding operators for fusion welding and resistance weld setters for fully mechanised and automatic welding of metallic materials*

 deleted text 

 EN 1759-1, *Flanges and their joint – Circular flanges for pipes, valves, fittings and accessories, Class designated – Part 1: Steel flanges, NPS ½ to 24*

EN 1759-3, *Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, Class designated – Part 3: Copper alloy flanges*

EN 1759-4, *Flanges and their joint – Circular flanges for pipes, valves, fittings and accessories, class designated – Part 4: Aluminium alloy flanges* 

EN 10045-1, *Metallic materials – Charpy impact test – Part 1: Test method*

 EN 10204:2004 , *Metallic products – Types of inspection documents*

 EN 10226-1, *Pipe threads where pressure tight joints are made on the threads – Part 1: Taper external threads and parallel internal threads – Dimensions, tolerances and designation*

EN 10226-2, *Pipe threads where pressure tight joints are made on the threads – Part 2: Taper external threads and taper internal threads – Dimensions, tolerances and designation* 

EN 12186, *Gas supply systems – Gas pressure regulating stations for transmission and distribution – Functional requirements*

EN 12279, *Gas supply systems – Gas pressure regulating installations on service lines – Functional requirements*

 *deleted text* 

 EN 12516-1:2005, *Industrial valves – Shell design strength – Part 1: Tabulation method for steel valves shells*

EN 12516-2:2004, *Industrial valves – Shell design strength – Part 2: Calculation method for steel valve shells*

EN 12516-4:2008, *Industrial valves – Shell design strength – Part 4: Calculation method for valve shells in metallic materials other than steel* 

EN 12627, *Industrial valves – Butt welding ends for steel valves*

EN 13445-4, *Unfired pressure vessels – Part 4: Fabrication*

 EN 14382:2005 , *Safety devices for gas pressure regulating stations and installations – Gas safety shut-off devices for inlet pressures up to 100 bar*

EN 60534-1:1993, *Industrial-process control valves – Part 1: Control valve terminology and general considerations (IEC 60534-1:1987)*

EN 60534-2-1, *Industrial-process control valves – Part 2-1: Flow capacity – Sizing equations for fluid flow under installed conditions (IEC 60534-2-1:1998)*

EN 60534-2-3, *Industrial-process control valves – Part 2-3: Flow capacity – Test procedures (IEC 60534-2-3:1997)*

 EN 60534-8-3, *Industrial-process control valves – Part 8-3: Noise considerations – Control valve aerodynamic noise prediction method (IEC 60534-8-3:2000)* 

EN ISO 175:2000, *Plastics – Methods of test for the determination of the effects of immersion in liquid chemicals (ISO 175:1999)*

 *deleted text* 

 EN ISO 9606-2, *Qualification test of welders – Fusion welding – Part 2: Aluminium and aluminium alloys (ISO 9606-2:2004)*

EN ISO 9606-3, *Qualification test of welders – Fusion welding – Part 3: Copper and copper alloys (ISO 9606-3:1999)*

EN ISO 9606-4, *Qualification test of welders – Fusion welding – Part 4: Nickel and nickel alloys (ISO 9606-4:1999)*

EN ISO 15607:2003, *Specification and qualification of welding procedures for metallic materials – General rules (ISO 15607:2003)*

EN ISO 15609-1:2005, *Specification and qualification of welding procedures for metallic materials – Welding procedure specification – Part 1: Arc welding (ISO 15609-1:2004)*

EN ISO 15610:2003, *Specification and qualification of welding procedures for metallic materials – Qualification based on tested welding consumables (ISO 15610:2003)*

EN ISO 15611:2003, *Specification and qualification of welding procedures for metallic materials – Qualification based on previous welding experience (ISO 15611:2003)*

EN ISO 15612:2004, *Specification and qualification of welding procedures for metallic materials – Qualification by adoption of a standard welding procedure (ISO 15612:2004)*

EN ISO 15613:2004, *Specification and qualification of welding procedures for metallic materials – Qualification based on pre-production welding test (ISO 15613:2004)*

EN ISO 15614-1:2004, *Specification and qualification of welding procedures for metallic materials – Welding procedure test – Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1:2004)*

EN ISO 15614-2:2005, *Specification and qualification of welding procedures for metallic materials – Welding procedure test – Part 2: Arc welding of aluminium and its alloys (ISO 15614-2:2005)* ^{A1}

EN ISO/IEC 17025:2000, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025:1999)*

^{A1} deleted text ^{A1}

ISO 1817, *Rubber, vulcanized – Determination of the effect of liquids*

ISO 3419, *Non-alloy and alloy steel butt-welding fittings*

ISO 5752, *Metal valves for use in flanged pipe systems – Face-to-face and centre-to-face dimensions*

ISO 7005(all parts), *Metallic flanges*

^{A1} deleted text ^{A1}

MSS SP 55:1985, *Quality standard for steel castings for valves, flanges and fittings and other piping components (Visual method)*

3 Terms, definitions and symbols

^{A1} For the purposes of this document, the following terms, definitions and symbols apply.

NOTE Annex I list all terms in alphabetic order for English language, the relevant translation in French and German language and the relevant sub-clause of this clause. ^{A1}

3.1 ^{A1} General terms and definitions of types of gas pressure regulators ^{A1}

^{A1} deleted text ^{A1}

3.1.1

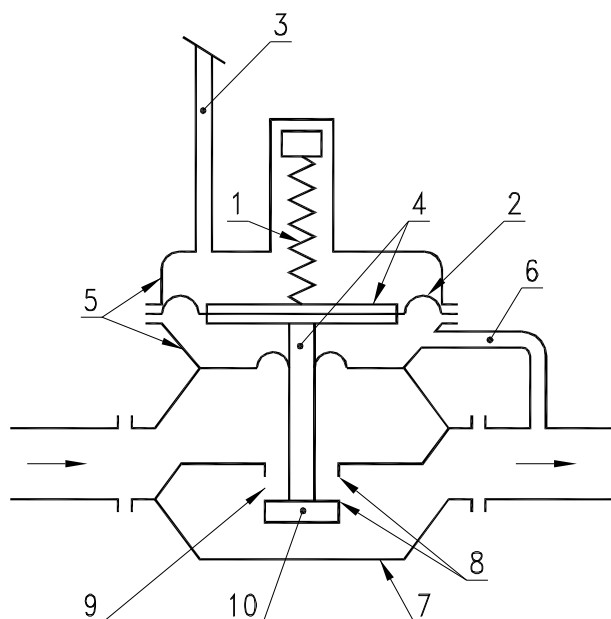
gas pressure regulator

device whose function is to maintain the value of the controlled variable ^{A1} (see 3.3.4.1) ^{A1} within its tolerance field irrespective of disturbance variables

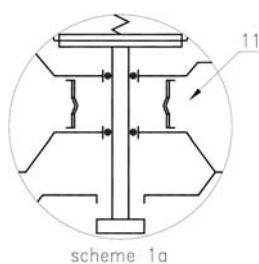
3.1.2

direct acting gas pressure regulator

regulator in which the net force required to move the control member is supplied directly by the controlled variable (see example in Figure 1)



A1



scheme 1a

A1

Key

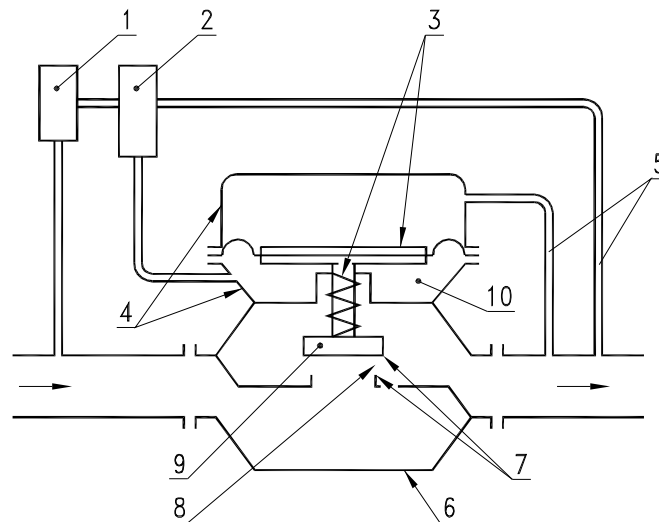
- | | |
|-----------------------------------|--------------------|
| 1 Setting element | 6 Sensing line |
| A1 2 pressure detector element A1 | 7 Regulator body |
| 3 Breather/exhaust line | 8 Valve seats |
| 4 Actuator | 9 Seat ring |
| 5 Casing of actuator | 10 Control member |
| 1 + 2 = Controller | A1 11 scheme 1a A1 |

Figure 1 — Example of a direct acting regulator

3.1.3

pilot controlled gas pressure regulator (indirect acting)

regulator in which the net force required to move the control member is supplied by a pilot (see example in Figure 2)



Key

1 Fixture	6 Regulator body
2 Pilot	7 Valve seats
3 Actuator	8 Seat ring
4 Casing of actuator	9 Control member
5 Sensing/process line	10 Motorization chamber

Figure 2 — Example of a pilot controlled regulator

3.1.4 monitor

$\square_{A1}$ second regulator installed in series with an active regulator, normally upstream, which has the task of maintaining the $\square_{A1}$ controlled variable within allowable limits in the event of its value exceeds a pre-established value (e.g. in the event of opening of the active regulator due to a failure, etc.)

$\square_{A1}$ deleted text $\square_{A1}$

3.1.5 fail open regulator

regulator whose control member automatically tends to open when the main diaphragm fails or when the energy required to move the control member fails

NOTE The definition in this clause is based on typical control failure modes.

3.1.6 fail close regulator

regulator whose control member automatically tends to close when the main diaphragm fails or when the energy required to move the control member fails

NOTE The definition in this clause is based on typical control failure modes.

$\square_{A1}$ deleted text $\square_{A1}$

3.1.7 regulator size

$\square_{A1}$ deleted text $\square_{A1}$

nominal size DN of the inlet connection in accordance with EN ISO 6708

A1 3.1.8

series of regulators

regulators with the same design concept but differing only in size **A1**

A1 *deleted text* **A1**

3.2 A1 Terms and definitions of components of gas pressure regulators A1

3.2.1

main components

parts including normally: control member, regulator body, actuator, casing of actuator, controller, pilot (only in pilot controlled regulators)

NOTE The regulator might include additional devices such as a shut-off device, a monitor, a relief valve and other fixtures. The Figures 1 and 2 serve as examples.

3.2.1.1

control member

movable part of the regulator which is positioned in the flow path to restrict the flow through the regulator

NOTE A control member may be a plug, ball, disk, vane, gate, diaphragm, etc.

3.2.1.2

body

main pressure containing envelope which provides the fluid flow passageway and the pipe end connections

3.2.1.3

valve seats

corresponding sealing surfaces within a regulator which make full contact only when the control member is in the closed position

3.2.1.4

seat ring

part assembled in a component of the regulator to provide a replaceable seat

3.2.1.5

actuator

device or mechanism which changes the signal from the controller into a corresponding movement controlling the position of the control member

3.2.1.6

casing of actuator

housing of the actuator (which may consist of two chambers under pressure)

NOTE When the pressure in each chamber is different from atmospheric pressure, the chamber at the higher pressure is termed the "motorization chamber".

3.2.1.7

controller

device which normally includes:

- a setting element, normally a spring, to obtain the set value of the controlled variable;
- **A1** a pressure detector element, normally a diaphragm, for the controlled variable **A1**

3.2.1.8

pilot

device which includes:

- a setting element to obtain the set value of the controlled variable;

Ⓐ

- a pressure detector element, normally a diaphragm, for the controlled variable Ⓐ;
- a unit which compares the set value of the controlled variable with its feedback value;
- a system which provides the motorization energy for the actuator

3.2.1.9

main diaphragm

diaphragm, the function of which is to detect the feedback of the controlled variable and/or the diaphragm which provides the thrust to move the control member

3.2.2

pressure containing parts

Ⓐ parts whose failure to function would result in a release of the retained fuel gas to the atmosphere

NOTE These include bodies, control member, bonnets, the casing of the actuator, blind flanges and pipes for process and sensing lines but exclude compression fittings, diaphragms, bolts and other fasteners. Ⓐ

3.2.3

inner metallic partition wall

metallic wall that separates a chamber into two individual pressure-containing chambers at different pressures under normal operating conditions

Ⓐ *deleted text* Ⓐ

3.2.4

process and sensing lines

lines which connect impulse points to the regulator

NOTE Sensing and process lines may be integrated into the regulator or external to the regulator. Those lines with no internal flow are termed "sensing lines"; those with internal flow are termed "process lines".

3.2.5

breather line

Ⓐ line connecting the atmosphere side of the pressure detector element to atmosphere

NOTE In the event of a fault in the pressure detector element this line may become an exhaust line. Ⓐ

3.2.6

exhaust line

Ⓐ line connecting the regulator or its fixtures to atmosphere for the safe exhausting of gas in the event of failure of any part Ⓐ

3.2.7

fixtures

functional devices connected to the main components of the regulator Ⓐ (see 3.2.1) Ⓐ

3.3 Terms, symbols and definitions of components of functional performance

 deleted text 

3.3.1

pressure

all pressures specified in this document are static gauge pressures

NOTE Pressure is expressed in bar²⁾.

3.3.1.1

inlet pressure

p_u

gas pressure at the inlet of the regulator

3.3.1.2

outlet pressure

p_d

gas pressure at the outlet of the regulator

3.3.1.3

differential pressure

Δp

difference between two values of pressure at two different points

3.3.1.4

motorization pressure

p_m

gas pressure in the motorization chamber

3.3.1.5

pilot feeding pressure

p_{up}

gas pressure at the inlet of the pilot

 deleted text 

3.3.2 Terms, symbols and definitions related to flow

3.3.2.1

normal conditions

absolute pressure p_n of 1,013 bar and temperature T_n of 0 °C (273,15 K)

NOTE For calculation purposes a value of 273 K is used in this document.

3.3.2.1.1

gas volume

volume of gas at normal conditions

NOTE Gas volume is expressed in m³.

²⁾ 1 bar = 1 000 mbar = 10⁵ N/m² = 10⁵ Pa = 10⁻¹ MPa.

3.3.2.1.2 volumetric flow rate

Q

A1 volume of gas which flows through the regulator per unit of time, at normal conditions A1

NOTE Volumetric flow rate is expressed in m^3/h .

3.3.3 sound pressure level

L_{pA}

sound pressure frequency weightings A in accordance with EN 61672-1

3.3.4 Variables in the controlling process

3.3.4.1 controlled variable

X

variable which is monitored by the controlling process

NOTE In this document, only the outlet pressure " p_d " is considered as the controlled variable.

3.3.4.2 disturbance variable

Z

A1 variables acting from outside on the controlling process.

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

- changes in the inlet pressure;
- changes in the volumetric flow rate A1

3.3.5 A1 Terms and definitions related to possible values of all variables A1

3.3.5.1 actual value

instantaneous value of any variable at any instant. It is specified by the index "i" added to the symbol of the variable

3.3.5.2 maximum value

highest value, which is specified by the subscript "max" added to the symbol of the variable:

- to which any variable can be adjusted or to which it is limited;
- any variable may reach during a series of measurements or during a certain time period

3.3.5.3 minimum value

lowest value, which is specified by the index "min" added to the symbol of the variable:

- to which any variable can be adjusted or to which it is limited;
- any variable may reach during a series of measurements or during a certain time period

3.3.6 Terms, symbols and definitions related to the controlled process

3.3.6.1 set point

p_{ds}

 nominal value of the controlled variable under specified conditions 

NOTE The set point is not directly measurable but determined as shown in Figure 5.

3.3.6.2 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)

3.3.6.3 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

 *deleted text* 

3.3.6.4 regulation change

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

3.3.7 Terms, symbols and definitions of functional performance

3.3.7.1 stable conditions

conditions when the controlled variable settles to a stable value after a disturbance has occurred

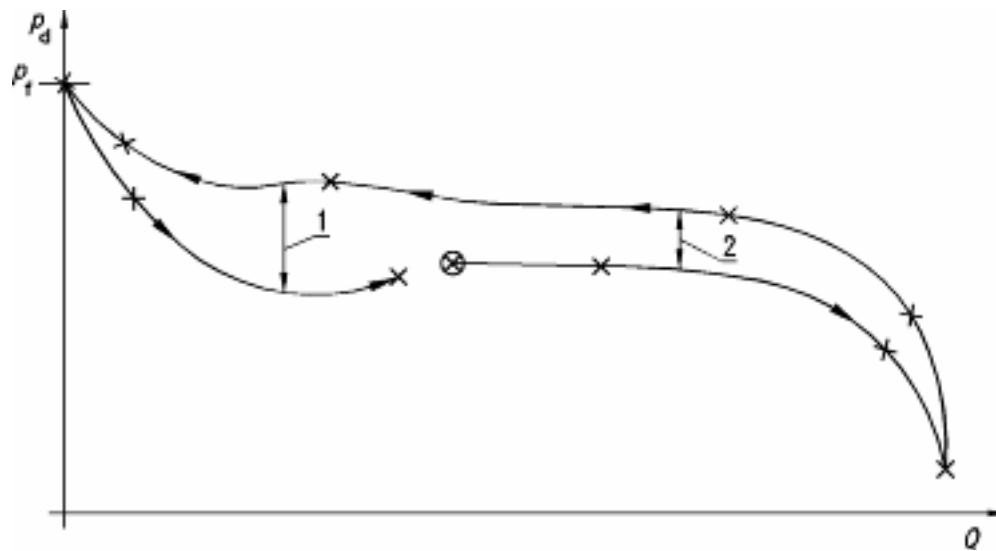
3.3.7.2 performance curve

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

NOTE This curve is determined by increasing and then decreasing the volumetric flow rate with constant inlet pressure and set point (see Figure 3).

3.3.7.3 hysteresis band

difference between the two values of outlet pressure for a given volumetric flow rate (see Figure 3)



Key

- 1 Max hysteresis band
- 2 Hysteresis band
- ⊗ Start setting
- × Measured values

Figure 3 — Performance curve (p_{ds} constant, p_u constant)

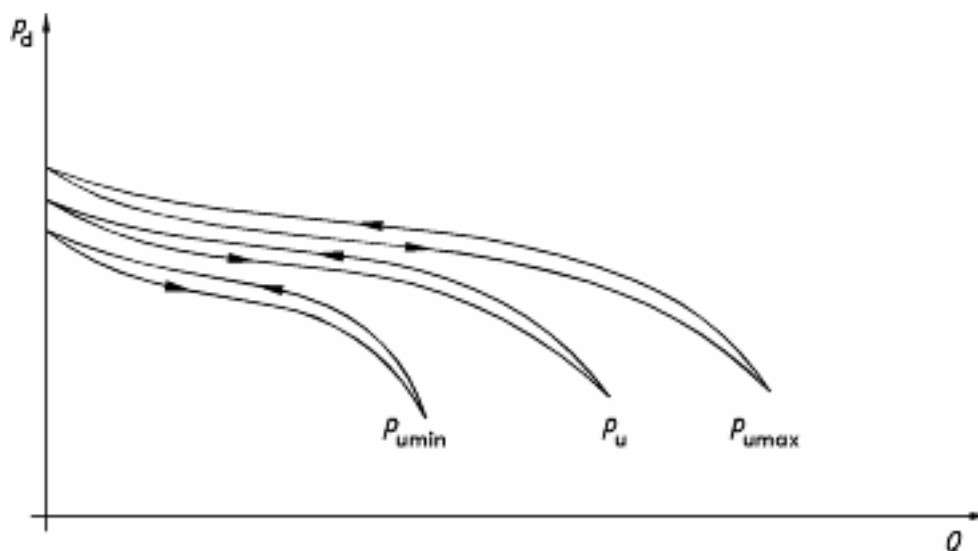


Figure 4 — Family of performance curves (p_{ds} constant)

3.3.7.4

family of performance curves

set of the performance curves for each value of inlet pressure determined for a given set point (see Figure 4)

3.3.8 Feature related to accuracy

3.3.8.1

accuracy

 maximum absolute value of regulation change under specified operating range 

3.3.8.2

accuracy class

AC

 maximum permissible value of the accuracy under specified operating range 

3.3.8.3

inlet pressure range

b_{pu}

range of the inlet pressure for which the regulator ensures a given accuracy class

NOTE The inlet pressure range is characterized by its limit values p_{umax} and p_{umin} .

3.3.8.4

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 5) $Q_{max,pumin}$
- at the highest inlet pressure (see Figure 5) $Q_{max,pumax}$
- at an intermediate inlet pressure between p_{umax} and p_{umin} (see Figure 5) $Q_{max,pu}$

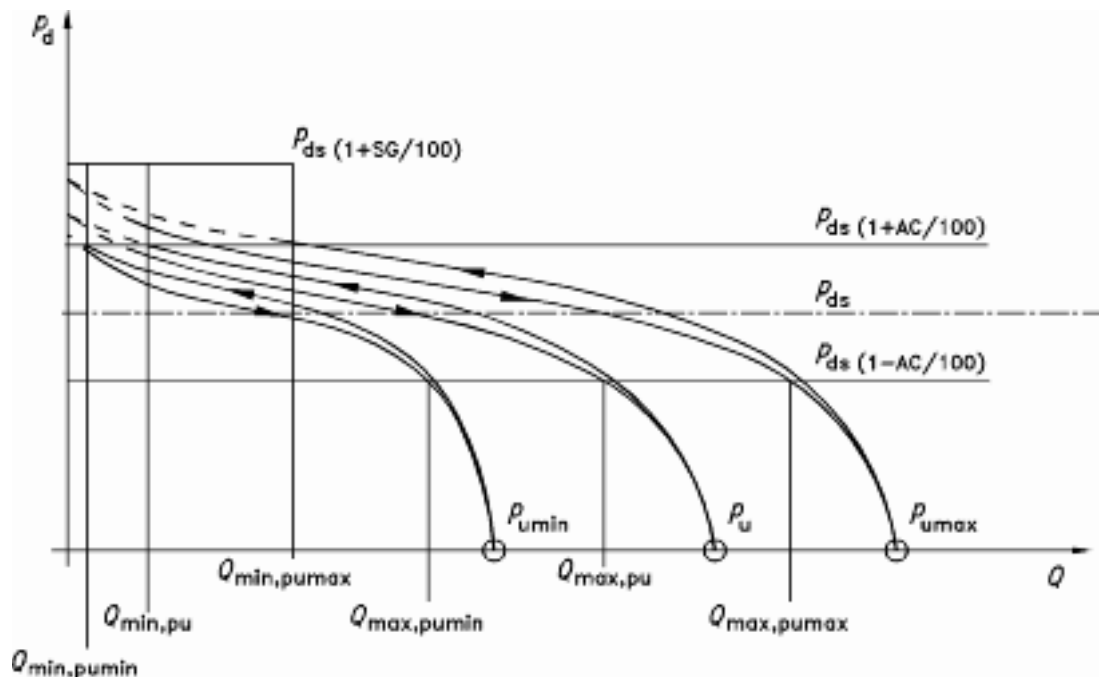
3.3.9 Terms, symbols and definitions related to lock-up behaviour

3.3.9.1

lock-up time

t_f

time taken for the control member to move from an open position to the closed position



○ = $Q_{\max}$ with the control member at the limit imposed by the mechanical stop

Figure 5 — Family of performance curves indicating maximum accuracy flow rates and minimum flow rates (p_{ds} constant, stable conditions)

3.3.9.2

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 The lock-up pressure corresponds to the outlet pressure at the volumetric flow rate $Q = 0$ in the performance curve (see Figure 3). 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.

3.3.9.3

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 e.g.

$$SG = \frac{P_f - P_{ds}}{P_{ds}} \times 100 \quad (1)$$

3.3.9.4

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 as per 5.3.3 are obtained:

— at the lowest inlet pressure (see Figure 5)

$Q_{\min,pumin}$

— at the highest inlet pressure (see Figure 5)

$Q_{\min,pumax}$

— at an intermediate inlet pressure between $p_{u\max}$ and $p_{u\min}$ (see Figure 5) $Q_{\min,pu}$

3.3.9.5

lock-up pressure zone

zone between the volumetric flow rate $Q = 0$ and the minimum flow rate $Q_{\min,pu}$ for each corresponding inlet pressure and set point (see Figure 6)

3.3.9.6

class of lock-up pressure zone

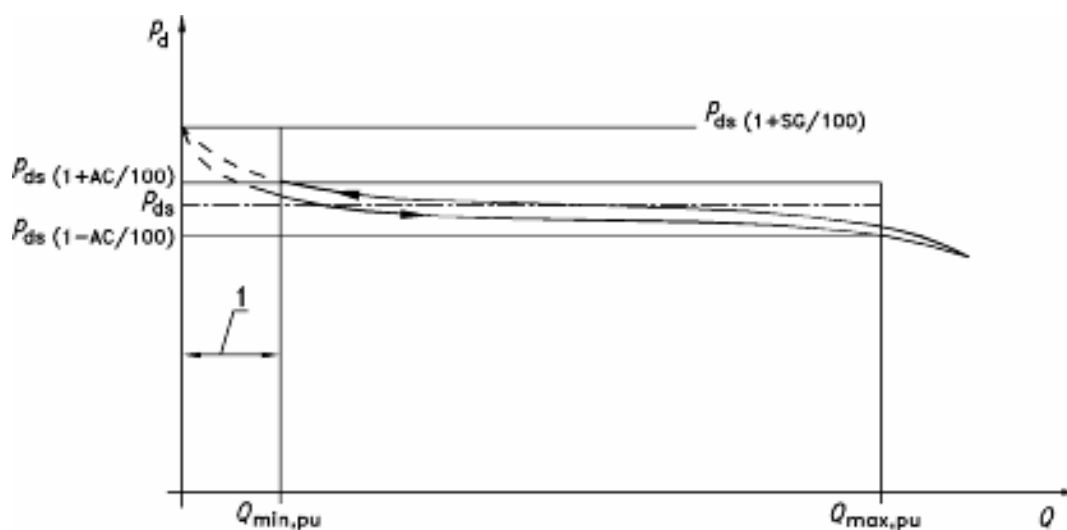
SZ

maximum permissible lock-up pressure zone for specified:

- inlet pressure p_u or inlet pressure range b_{pu} ;
- set point p_{ds} or specific set range W_{ds} or set range W_d ;

which is expressed as the percentage of $Q_{\min,pu}$ to $Q_{\max,pu}$, i.e.

$$SZ = \frac{Q_{\min,pu}}{Q_{\max,pu}} \times 100 \quad (2)$$



Key

1 Lock-up pressure zone

Figure 6 — Performance curve indicating lock-up pressure zone (stable condition)

3.4 A1 Terms, symbols and definitions related to design and tests A1

A1 deleted text A1

3.4.1

component operating pressure

p

gas pressure occurring in any part of a regulator during operation

3.4.2

maximum component operating pressure

$p_{\max}$

highest operating pressure at which a component of a regulator will continuously operate within specified conditions

3.4.3

maximum allowable pressure

PS

A1 maximum pressure for which the body, its inner metallic partition walls and some other pressure containing parts are designed in accordance with the strength requirements in this document A1

A1 3.4.4

specific maximum allowable pressure

PSD

pressure for which some pressure containing parts of differential strength regulators are designed where $\text{PSD} < \text{PS}$ A1

3.4.5

test pressure

pressure applied to a section of the regulator for a limited period of time in order to prove certain characteristics

3.4.6

limit pressure

p_l

pressure at which yielding becomes apparent in any component of the regulator or its fixtures

3.4.7

safety factor

A1 ratio of the limit pressure p_l to the maximum allowable pressure PS or to the specific maximum allowable pressure PSD applied to:

- the regulator body: S_b (only PS);
- the other pressure containing parts of the regulator: S (PS or PSD) A1

3.4.8

maximum inlet pressure

p_{umax}

highest inlet pressure at which the regulator can continuously operate within specified conditions

3.4.9

permissible outlet pressure

p_{dmax}

highest outlet pressure at which the regulator can continuously operate within specified conditions

3.4.10

minimum operating differential pressure

$\Delta p_{\min}$

minimum operating differential pressure between the inlet and outlet pressures below which the regulator will no longer function correctly within specified conditions

3.4.11

nominal pressure

numerical designation relating to pressure, which is a convenient round number for reference purposes in accordance with the relevant parts of ISO 7005 (some parts of these documents can be replaced by the equivalent documents when they are available. At the time of writing, this subject is dealt with in EN 1092-1, EN 1092-2, EN 1092-3, EN 1092-4, EN 1759-3, EN 1759-4 and EN 1759-1)

NOTE 1 For the specific purpose of this document this term applies to flanges.

EXAMPLE PN 16.

NOTE 2 For strength of envelope see A1 3.4.3 A1.

3.4.12

operating temperature range

temperature range at which the regulator components and fixtures are capable of operating continuously

4 Construction requirements

4.1 Basic requirements

4.1.1 General

The main function of a regulator is to maintain the value of the controlled variable within its tolerance field irrespective of the disturbance variables.

Regulators shall not have any continuous discharge of gas into the atmosphere, however, temporary discharges from fixtures may occur.

A1 Regulators shall be so designed that the external tightness and internal sealing meet the requirements of 5.2. If in the event of failure of the regulator (e.g. failure of a diaphragm) leakage to atmosphere is possible, the breather shall be provided with a threaded connection of at least DN 10 to enable an exhaust line to be connected³. This connection may be used for a specific device (e.g. a dumping device). A1

Pressure containing parts including measuring and test points, which may be dismantled for servicing, adjustment or conversion shall be made pressure tight by mechanical means (e.g. metal to metal joints, o-rings, gaskets, etc.). Jointing compounds, such as liquids and pastes, shall not be used.

Jointing compounds, however, may be used for permanent assemblies and shall remain effective under normal operating conditions.

Pressure containing parts not intended to be dismantled during servicing, adjustment or conversion shall be sealed by means which will show evidence of interference (e.g. lacquer).

A1 *deleted text* A1

When external protrusions or other external parts need special care to cover the hazards during transport and handling, the manual shall include the provisions to cover these risks.

The motorization energy in a pilot controlled regulator shall be provided by the gas upstream of the regulator.

³⁾ A1 For proper operation of the regulator any exhaust line should be designed in such a way to prevent the ingress of foreign materials. A1

Ⓐ¹ A regulator used as stand-by monitor should be fitted with an external visual device, which indicates whether the control member is in the closed or in fully open position. Ⓐ¹

4.1.2 Ⓐ¹ Gas pressure regulators with associated safety devices

4.1.2.1 Gas pressure regulators with integrated safety devices

Additional integrated (same body) safety devices i.e. gas safety shut-off devices (SSD)⁴ and/or a monitor shall be functionally independent from the regulator.

This requirement is met if:

- a) the function of the regulator is not affected in the event of the failure and/or loss of functionality of one or more of the following safety shut-off device / monitor components:

- closure / control member;
- seat ring;
- actuator;
- casing of actuator;
- controller;
- pilot (in case of pilot-controlled monitor type);
- sensing and process lines;

and if:

- b) the function of the safety shut-off device / monitor is not affected in the event of the failure and/or loss of functionality of one or more of the following regulator components:

- control member;
- seat ring;
- actuator;
- casing of actuator;
- controller;
- pilot (in case of pilot-controlled regulator type);
- sensing and process lines.

When the regulator incorporates more than one safety devices (e.g. a monitor and a SSD or two SSDs), the functional independence shall be met by each device from the other ones in similar way as detailed above.

⁴) Ⓐ¹ For this subject see EN 14382. Ⓐ¹

Further, when the integrated safety device utilizes pipeline gas as a source of energy for its operation, this shall be taken upstream of the regulator.

When the integrated safety device is a slam shut device or a cut-off device or a monitor, the motorization energy for the regulator, when it is a pilot-controlled type, shall be provided by the gas downstream of the safety device.

4.1.2.2 Gas pressure regulators with in-line monitor

The system includes a regulator with the function of active regulator and a second (in series) regulator with the function of monitor. The monitor shall be installed directly upstream of the active regulator and both equipment shall control the pressure at the same location.

The associated in-line monitor shall be functionally independent from the active regulator.

This requirement is met if:

- a) the function of the regulator is not affected in the event of the failure and/or loss of functionality of one or more of the following monitor components:
 - pilot (in case of pilot-controlled monitor type);
 - sensing and process lines;

and if:

- b) the function of the monitor is not affected in the event of the failure and/or loss of functionality of one or more of the following regulator components:
 - pilot (in case of pilot-controlled regulator type);
 - sensing and process lines.

The motorization energy for active regulator in case of pilot-controlled type shall be taken downstream of the monitor.

For in-line monitor stand-by type (in full open position in normal operating conditions), it is necessary to adopt appropriate design measures to avoid sticking actions that may occur between movable and fixed parts.

4.1.2.3 Gas pressure regulator with in-line safety shut off device

The system includes a regulator with the function of active regulator and an in-line SSD (in series).

The SSD shall be installed directly upstream of active regulator and both devices shall control the pressure at the same location.

The associated in-line SSD shall be functionally independent from the active regulator.

The requirement is met if:

- a) the function of active regulator is not affected in the event of the failure and/or loss of functionality of one or more of the following SSD components:
 - controller;
 - sensing and process lines;

and if:

- b) the function of SSD is not affected in the event of the failure and/or loss of functionality of one or more of the following active regulator components:
- pilot (in case of pilot-controlled regulator type);
 - sensing and process lines.

The motorization energy for active regulator, in case of pilot-controlled type, shall be taken downstream of the SSD. A_1

4.1.3 End connections

End connections may be one of the following:

- flanged connections in accordance with the applicable parts of ISO 7005 (some parts of these documents can be replaced by the equivalent documents when they are available. At the time of writing, this subject is dealt with in EN 1092-1, EN 1092-2, EN 1092-3, EN 1092-4, EN 1759-3, 1759-4 and EN 1759-1;
- flangeless type (e.g. wafer body);

A_1

- threaded connections in accordance with EN 10226-1 or EN 10226-2 for:
 - $\text{DN} \leq 50$;
 - $\text{DN} \leq 80$ and $\text{PS} \leq 16$ bar; A_1
- compression fittings for $\text{DN} \leq 50$;
- butt weld connections in accordance with EN 12627.

4.1.4 Flange ratings

The PN ratings for flanges shall be selected from the following designations:

6 - 10 - 16 - 20 - 25 - 40 - 50 - 110⁵⁾

A_1 according to the relevant parts of ISO 7005 (some parts of these documents can be replaced by the equivalent documents when they are available). Flange ratings shall be in accordance with EN 1092-1, EN 1092-2, EN 1092-3, EN 1092-4, EN 1759-3, EN 1759-4 and EN 1759-1. A_1

The underlined designations are preferred.

4.1.5 Nominal sizes and face-to-face dimensions

Regulators with flange connections should have the same nominal size at inlet and outlet.

The nominal sizes and the face-to-face dimensions given in Table 1 are recommended.

Alternatively, the nominal sizes and the face-to-face dimensions may be taken from Table 2.

⁵⁾ The nominal pressure designations PN 20, PN 50 and PN 110 are equivalent to class ratings 150, 300 and 600 respectively.

Flangeless regulators (regulators that have no line flanges but are intended to be installed by clamping between pipes flanges) are permitted as an alternative. In this case regulators should have the same nominal size at inlet and outlet and face-to-face dimensions should be taken from Tables 3 or 4.

The following regulators are permitted:



- flanged types with different nominal inlet and outlet sizes; 
- those with face-to-face dimensions differing from those given in Tables 1 and 2;
- angle pattern bodies in accordance with ISO 5752.

Table 1 — Recommended face-to face dimensions for flanged regulators

Nominal size DN	Nominal pressure			Limit deviations for face-to-face dimensions in mm
	PN 10/16/20 ^a	PN 25/40/50	PN 110	
	Face-to-face dimensions in mm			
25	184	197	210	± 2
40	222	235	251	
50	254	267	286	
65	276 ^b	292 ^b	311 ^b	
80	298	317	337	
100	352	368	394	
150	451	473	508	
200	543	568	610	
250	673	708	752	
300	737	775	819	± 3
350	889	927	972	
400	1016	1057	1108	

Source: Tables 1 and 2 of EN 60534-3-1:2000 (nominal pressure in accordance with the relevant parts of ISO 7005 – some parts of these documents can be replaced by the equivalent documents when they are available. At the time of writing, this subject is dealt with in EN 1092-1, EN 1092-2, EN 1092-3, EN 1092-4, EN 1759-3, EN 1759-4 and EN 1759-1).

^a In some countries the group PN 10/16/20 includes also PN 6.

^b Face-to-face dimensions according to Table 1 of IEC 60534-3.

Table 2 — Alternative face-to-face dimensions for flanged regulators

Nominal size DN	Nominal pressure		Limit deviations for face-to-face dimensions in mm
	PN 10/16/25/40/50 ^a	PN 110	
	Face-to-face dimensions in mm		
25	160	230	± 2
40	200	260	
50	230	300	
65	290 ^b	340 ^b	
80	310	380	
100	350	430	
150	480	550	
200	600	650	
250	730	775	
300	850	900	± 3
400	1 100	1 150	

Source: Table 2 of EN 60534-3-1:2000 with the addition of PN 50 and the replacement of PN 100 by PN 110 (nominal pressure in accordance with the relevant parts of ISO 7005 – some parts of these documents can be replaced by the equivalent documents when they are available. At the time of writing, this subject is dealt with in EN 1092-1, EN 1092-2, EN 1092-3, EN 1092-4, EN 1759-3, EN 1759-4 and EN 1759-1).

^a In some countries the group PN 10/16/25/40/50 includes also PN 6.

^b Face-to-face dimensions according to Table 2 of IEC 60534-3.

Table 3 — Face-to-face dimensions for flangeless regulators

Nominal size DN	Face-to-face dimensions in mm	Limit deviations for face-to-face dimensions in mm
25	102	± 2
40	114	± 2
50	124	± 2
80	165	± 2
100	194	± 2
150	229	± 2
200	243	± 2
250	297	± 2
300	338	± 3
400	400	± 3

NOTE 1 Nominal pressures: PN 10/16/20/25/40/50/110. In some countries this group includes also PN 6.

NOTE 2 Face-to-face dimensions do not include any allowances for gaskets to seal the joints between the regulator ends and the pipeline flanges.

Source: EN 60534-3-2 (nominal pressure in accordance with the relevant parts of ISO 7005 – some parts of these documents can be replaced by the equivalent documents when they are available. At the time of writing, this subject is dealt with in EN 1092-1, EN 1092-2, EN 1092-3, EN 1092-4, EN 1759-3, EN 1759-4 and EN 1759-1).

Table 4 — Face-to-face dimensions for flangeless regulators

Nominal size DN	Face-to-face dimensions in mm		Limit deviations for face-to-face dimensions in mm
	PN 10/16/20/25/40/50 ^a	PN 110	
25	77	86,5	± 1,5
40	77	86,5	± 1,5
50	77	86,5	± 1,5
80	94	104	± 1,5
100	114	133	± 1,5
150	140	175	± 1,5
200	171	205	± 1,5
250	203	240	± 2,5
300	240	280	± 2,5
400	320	350	± 2,5

NOTE 1 Face-to-face dimensions do not include any allowances for gaskets to seal the joints between the regulator ends and the pipeline flanges.

NOTE 2 Nominal pressure in accordance with the relevant parts of ISO 7005 (some parts of these documents can be replaced by the equivalent documents when they are available. At the time of writing, this subject is dealt with in EN 1092-1, EN 1092-2, EN 1092-3, EN 1092-4 and EN 1759-1).

^a In some countries the group PN 10/16/20/25/40/50 includes also PN 6.

4.1.6 Sealing of the adjusting device

A means for sealing the adjusting device shall be provided. If requested in the order specification the adjusting device shall be sealed.

4.1.7 Springs

Springs shall not be overstressed under any operating condition and there shall be sufficient free movement of the spring to allow satisfactory operation.

The spring shall be designed such that buckling does not occur, in accordance to EN 13906-1 and EN 13906-2.

4.1.8 Replaceable parts that may be affected by erosion or abrasion

The seat ring shall be replaceable where erosion or abrasion may occur. 

4.2 Materials

4.2.1 Requirements for metallic materials

4.2.1.1 Pressure containing parts and inner metallic partition walls

The pressure containing parts, including those that become pressure containing parts in the event of diaphragm or differential pressure seal failure, and the inner metallic partition walls can be constructed of:

- materials complying with the restrictions given in Table 5 and an established national or an international standard;
- or materials given in Annex H.

The internal components of regulators not subjected to differential pressure, may be constructed of either the materials given in Annex H or materials complying with the requirements given in Table 5, without taking into account the restrictions for pressures and nominal sizes, or of different materials provided they comply with the requirements of this document.

4.2.1.2 Material inspection documents of pressure containing parts and inner metallic partition walls

 This sub-clause specifies the different types of material inspection documents supplied to the purchaser, in accordance with the requirements of the order, for the delivery of components used for regulators. 

Pressure containing parts and inner metallic partition walls:

- bodies used in the regulators category II, III and IV according to Annex II of PED, shall be accompanied by a material  inspection certificate  type 3.2 in accordance with EN 10204.
For these bodies when the material manufacturer has an appropriate quality-assurance system, certified by a competent body established within the EC and having undergone a specific assessment for materials, an  inspection certificate  type 3.1 in accordance with EN 10204 may be used;
- bodies used in the regulators category I according to Annex II of PED, shall be accompanied by  a material test report at least  type 2.2 in accordance with EN 10204.

Pressure containing parts and inner metallic partition walls of other components used for regulators with:



- $PS \leq 25$ bar can be accompanied by a material test report at least type 2.2 in accordance with EN 10204;
- $PS > 25$ bar shall be accompanied by a material inspection certificate at least type 3.1 in accordance with EN 10204.

4.2.1.3 Fasteners, integral process and sensing lines and connectors

Fasteners, integral process and sensing lines and connectors can be made of:

- materials complying with the restrictions given in Table 5 and with a national or an international established standard;
- or materials given in Annex H.

4.2.1.4 Material inspection documents of fasteners and compression fittings

This sub-clause specifies the different types of material inspection documents supplied to the purchaser, in accordance with the requirements of the order, for the delivery of components used for regulators.

Bolts, screws, studs, nuts and compression fittings used in the pressure containing parts of the regulators shall bear the marking in accordance with the relevant document and they shall be accompanied by a material test report type 2.2 in accordance with EN 10204.

Table 5 — Materials

Restrictions				
Material		Regulator		
Group	Properties			
	$A_{\min}^a$ %	$PS_{\max}$ bar	$(PS \cdot DN^b)_{\max}$ bar · mm	$DN^b_{\max}$ mm
Pressure containing parts and inner metallic partition walls				
Rolled and forged steel ^c	16	100	-	-
Cast steel ^c	15	100	-	-
Spheroidal graphite cast iron ^d	7	20	1 500	1 000
	15	50	5 000	300
Malleable cast iron	6	20	1 000	100
Copper-zinc wrought alloys	15	100	-	25
Copper-tin and copper-zinc cast alloys	5	20	1 000	100
	15	100	-	25
Aluminium wrought alloys	4	20	-	50
	7	50	-	50
		100	-	25
Aluminium cast alloys	1,5	10	250	150
	4	20	1 600	1 000
Integral process and sensing lines				
Copper	-	25	-	-
Steel	-	100	-	-
Connectors				
Steel	8	-	-	-
Fasteners				
Steel for bolts, screws, studs	9	50	-	-
	12	100	-	-

NOTE For castings the specified mechanical characteristics are those measured on machined test piece prepared from separately cast test samples in accordance with the relevant document for the selected materials.

^a A = percentage elongation after fracture (according to the applicable document relevant to the chosen material).

^b For the bodies of pilots or fixtures this term shall refer to their inlet connections.

^c Bending rupture energy measured in accordance with EN 10045-1 shall be not less than 27 J as average of three test pieces with minimum individual of 20 J at minimum operating temperature (-10 °C or -20 °C). 

^d Bending rupture energy measured in accordance with EN 10045-1 shall be not less than 12 J as an average of three test pieces and no less than 9 J as a minimum individual value at a temperature of -20 °C for PS > 25 bar when used in regulator class 2.