BS EN 12261:2024

BSI Standards Publication



# Gas meters — Turbine gas meters

bsi.

# National foreword

This British Standard is the UK implementation of EN 12261:2024. It supersedes BS EN 12261:2018, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GSE/25, Gas Meters.

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



**Contractual and legal considerations**

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided as is, and is to be used at the recipient's own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

This publication has been prepared under a mandate given to the European Standards Organizations by the European Commission and the European Free Trade Association. It is intended to support requirements of the EU legislation detailed in the European Foreword. A European Annex, usually Annex ZA or ZZ, describes how this publication relates to that EU legislation.

For the Great Britain market (England, Scotland and Wales), if UK Government has designated this publication for conformity with UKCA marking (or similar) legislation, it may contain an additional National Annex. Where such a National Annex exists, it shows the correlation between this publication and the relevant UK legislation. If there is no National Annex of this kind, the relevant Annex ZA or ZZ in the body of the European text will indicate the relationship to UK regulation applicable in Great Britain. References to EU legislation may need to be read in accordance with the UK designation and the applicable UK law. Further information on designated standards can be found at www.bsigroup.com/standardsandregulation.

For the Northern Ireland market, UK law will continue to implement relevant EU law subject to periodic confirmation. Therefore Annex ZA/ZZ in the European text, and references to EU legislation, are still valid for this market.

UK Government is responsible for legislation. For information on legislation and policies relating to that legislation, consult the relevant pages of www.gov.uk.


Published by BSI Standards Limited 2024

ISBN 978 0 539 14003 3

ICS 91.140.40



This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 March 2024.

**Amendments/corrigenda issued since publication**

| Date | Text affected |
|---|---|

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN 12261

March 2024

ICS 91.140.40

Supersedes EN 12261:2018



English Version

# Gas meters - Turbine gas meters

Compteurs de gaz - Compteurs de gaz à turbine

Gaszähler - Turbinenradgaszähler

This European Standard was approved by CEN on 1 January 2024.

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-CENELEC 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-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

**CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels**



Ref. No. EN 12261:2024 E

# Contents

Page

## European foreword

This document (EN 12261:2024) has been prepared by Technical Committee CEN/TC 237 “Gas meters”, the secretariat of which is held by BSI.

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 September 2024, and conflicting national standards shall be withdrawn at the latest by September 2024.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 12261:2018.

EN 12261:2024 includes the following significant technical changes with respect to EN 12261:2018:

— Harmonization with PED;

— Clause 6 reworked completely;

— Annex G added;

— Annex ZB added.

This document has been prepared under a standardization request addressed to CEN by the European Commission. The Standing Committee of the EFTA States subsequently approves these requests for its Member States.

For the relationship with EU Legislation, see informative Annex ZA and ZB, which is an integral part of this document.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

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

## Introduction

In the preparation of this document, the content of ISO 9951:1993, the content of OIML Publication, “International Recommendation 6” and “International Recommendation 32” and the content of member bodies' national standards on turbine meters have been taken into account.

The metrological aspects of this document might be subject to amendments to bring it into line with the Measuring Instruments Directive (MID).

Electronic Indexes are not specifically covered by this document, however, work to produce a standard covering these devices is in progress under CEN/TC 237.

## 1 Scope

This document specifies the measuring conditions, requirements and tests for the construction, performance and safety of class 1,0 axial and radial turbine gas meters with mechanical indicating devices, hereinafter referred to as a meter(s), having in-line pipe connections for gas flow measurement.

This document applies to turbine gas meters used to measure the volume of fuel gases of the 1st and 2nd gas families, the composition of which is specified in EN 437:2021, at maximum operating pressures up to 420 bar, actual flow rates up to 25 000 $m^3/h$ over a gas temperature of a minimum −40 °C up to 70 °C, with a range of at least 40 K and for a climatic environmental temperature range of at least 50 K.

This document applies to meters that are installed in locations with vibration and shocks of low significance and in:

— closed locations (indoor or outdoor with protection as specified by the manufacturer) with condensing or with non-condensing humidity;

or, if specified by the manufacturer,

— open locations (outdoor without any covering) with condensing humidity or with non-condensing humidity;

and in locations with electromagnetic disturbances.

Unless otherwise specified in this document:

— all pressures used are gauge;

— all influence quantities, except the one under test, are kept relatively constant at their reference value.



## 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.

EN 437:2021, *Test gases - Test pressures - Appliance categories*

EN 1092-1:2018, *Flanges and their joints - Circular flanges for pipes, valves, fittings and accessories, PN designated - Part 1: Steel flanges*

EN 1092-2:2023, *Flanges and their joints - Circular flanges for pipes, valves, fittings and accessories, PN designated - Part 2: Cast iron flanges*

EN 1092-3:2003,[1] *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 1759-1:2004, *Flanges and their joint - Circular flanges for pipes, valves, fittings and accessories, Class designated - Part 1: Steel flanges, NPS 1/2 to 24*

[1] As impacted by corrigendum EN 1092-3:2003/AC:2007.

EN 1759-3:2003,[2] *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, Class designated — Part 3: Copper alloy flanges*

EN 1759-4:2003, *Flanges and their joint - Circular flanges for pipes, valves, fittings and accessories, Class designated - Part 4: Aluminium alloy flanges*

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

EN 15612:2020, *Railway applications - Braking - Brake pipe accelerator*

EN ISO 17663:2023, *Welding — Quality requirements for heat treatment in connection with welding and allied processes (ISO 17663:2023)*

EN 22768-1:1993, *General tolerances - Part 1: Tolerances for linear and angular dimensions without individual tolerance indications (ISO 2768-1:1989)*



EN IEC 60079-0:2018,[3] *Explosive atmospheres — Part 0: Equipment — General requirements (IEC 60079-0:2018)*

EN 60079-11:2012, *Explosive atmospheres - Part 11: Equipment protection by intrinsic safety "i"*

EN 60529:1991,[4] *Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989)*

EN 60947-5-6:2000, *Low-voltage switchgear and controlgear - Part 5-6: Control circuit devices and switching elements - DC interface for proximity sensors and switching amplifiers (NAMUR)*

EN 62246-1:2015, *Reed switches - Part 1: Generic specification*

EN ISO 5167-1:2022, *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 1: General principles and requirements (ISO 5167-1:2022)*

EN ISO 9606-1:2017, *Qualification testing of welders - Fusion welding - Part 1: Steels (ISO 9606-1:2012 including Cor 1:2012 and Cor 2:2013)*

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

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

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

EN ISO 9606-5:2000, *Approval testing of welders - Fusion welding - Part 5: Titanium and titanium alloys, zirconium and zirconium alloys (ISO 9606-5:2000)*

EN ISO 9712:2022, *Non-destructive testing - Qualification and certification of NDT personnel (ISO 9712:2021)*

---

[2] As impacted by corrigendum EN 1759-3:2003/AC:2004.
[3] As impacted by corrigendum EN 60079-0:2018/AC:2020-02.
[4] As impacted by EN 60529:1991/corrigendum May 1993, EN 60529:1991/AC:2016-12, EN 60529:1991/A1:2000, EN 60529:1991/A2:2013 and EN 60529:1991/A2:2013/AC:2019-02.

EN ISO 14732:2013, *Welding personnel - Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials (ISO 14732:2013)*

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

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 15614-1:2017,[5] *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 15614-1:2017, Corrected version 2017-10-01)*

EN ISO 15614-2:2005,[6] *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)*

EN ISO 15614-4:2005,[7] *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 4: Finishing welding of aluminium castings (ISO 15614-4:2005)*

EN ISO 15614-5:2004, *Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 5: Arc welding of titanium, zirconium and their alloys (ISO 15614-5:2004)*

EN ISO 15614-6:2006, *Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 6: Arc and gas welding of copper and its alloys (ISO 15614-6:2006)*

EN ISO 15614-7:2019, *Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 7: Overlay welding (ISO 15614-7:2016)*

EN ISO 15614-8:2016, *Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 8: Welding of tubes to tube-plate joints (ISO 15614-8:2016)*

EN ISO 15614-11:2002, *Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 11: Electron and laser beam welding (ISO 15614-11:2002)*

ISO 7005-1:2011, *Pipe flanges — Part 1: Steel flanges for industrial and general service piping systems*

ISO 7005-2:1988, *Metallic flanges — Part 2: Cast iron flanges*

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*



[5] As impacted by amendment EN ISO 15614-1:2017/A1:2019.
[6] As impacted by corrigendum EN ISO 15614-2:2005/AC:2009.
[7] As impacted by corrigendum EN ISO 15614-242005/AC:2007.

# 3 Terms, definitions and symbols

## 3.1 Terms and definitions

For the purposes of this document, the following terms and definitions 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**
**turbine gas meter**
measuring device in which the dynamic forces of the flowing gas cause a turbine wheel to rotate with a speed as a function of the volume flow rate

Note 1 to entry: The number of revolutions of the turbine wheel is the basis for the indication of the volume passed through the meter.

Note 2 to entry: It is designed to measure, memorize and display the volume of a fuel gas that has passed through it.

**3.1.2**
**measured quantity**
volume in cubic meters, at metering conditions

**3.1.3**
**volume flow rate**
volume at metering conditions divided by time

**3.1.4**
**rangeability**
ratio between $Q_{min}$ and $Q_{max}$, i.e. the minimum and maximum flow rate respectively for which the meter performs within the maximum permissible errors

**3.1.5**
**average velocity**
volume flow rate divided by the cross-sectional area of the meter connections

**3.1.6**
**casing**
pressure containing structure of the meter

### 3.1.7 Pressures and temperatures

**3.1.7.1**
**maximum allowable pressure (strength)**
*PS*
maximum allowable pressure *PS*′ means the maximum pressure for which the equipment is designed, as specified by the manufacturer, and defined at a location specified by him, being either the connection of protective and/or limiting devices, or the top of equipment or, if not appropriate, any point specified

**3.1.7.2**
**metering pressure**
$p_m$
absolute gas pressure to which the indicated volume of gas is related

**3.1.7.3**
**operating pressure**
gas pressure within the piping containing the meter

**3.1.7.4**
**operating pressure range**
permissible pressure range over which the meter is calibrated and operates within the metrological requirements, which has to be compatible with the design and construction calculations



**3.1.7.5**
**maximum/minimum allowable temperature (strength)**
*TS*
maximum/minimum allowable temperature *TS*' means the maximum/minimum temperatures for which the equipment is designed, as specified by the manufacturer

**3.1.7.6**
**operating temperature range**
range of metering temperatures over which the meter operates within the metrological requirements, which has to be compatible with the design and construction calculations

**3.1.8 Designation**

**3.1.8.1**
**DN-designation**
numerical designation of size for components of a pipework system, which is used for reference purposes

Note 1 to entry: It comprises the letters DN followed by a dimensionless whole number which is indirectly related to the physical size, in millimetres, of the bore or outside diameter of the end connections.

**3.1.8.2**
**PN-designation**
alphanumeric term used for reference purposes related to a combination of mechanical and dimensional characteristics of a component of a pipework system with regard to pressure

Note 1 to entry: It comprises the letters PN followed by a dimensionless whole number.

**3.1.9**
**metering conditions**
conditions of the gas prevailing at the point of the measurement

EXAMPLE Temperature and pressure of the measured gas in the meter.

**3.1.10**
**Reynolds number**
*Re*
number referring to the flow conditions:

$$Re = \frac{4Q_{\text{mass}}}{\pi \mu D} 10^3$$

where

$Re$ is the Reynolds number, dimensionless value;

$D$ is the pipe internal diameter, mm;

$\mu$ is the dynamic viscosity, kg/m·s;

$Q_{\text{mass}}$ is the mass flow rate, kg/s;

where the value of $D$ is given by the internal pipe diameter

Note 1 to entry: The parameters (variables) in the above equation and their units are defined in Table 1.

**3.1.11**
**error of indication**
indication of a turbine meter minus the reference value of the measurand

Note 1 to entry: Errors ($E$) are expressed as relative values (as a percentage) by the ratio of the difference between the indicated volume ( $V_i$ ) and a reference volume ( $V_c$ ) of the gas which has passed through the gas meter to this latter value:

$$E = \frac{V_i - V_c}{V_c} \cdot 100\left[\%\right]$$

or between the indicated flow rate ( $Q_i$ ) and the reference flow rate ( $Q_c$ )

$$E = \frac{Q_i - Q_c}{Q_c} \cdot 100\left[\%\right]$$

**3.1.12**
**pressure loss**
non-recoverable pressure drop caused by the presence of the turbine meter in the conduit

**3.1.13**
**pulse value**
number of pulses per cubic metre indicated

### 3.1.14 Gas families

**3.1.14.1**
**1st family**
gas having a Wobbe index between:

23,8 MJ · m$^{-3}$ and 31,4 MJ · m$^{-3}$

according to EN 437:2021 related on gross calorific value

**3.1.14.2**
**2nd family**
gas having a Wobbe index between:

41,3 MJ · m$^{-3}$ and 57,9 MJ · m$^{-3}$

according to EN 437:2021 related on gross calorific value



**3.1.15**
**class 1,0 meter**
meter which has an error of indication between −2 % and +2 % for flow rates $Q$ where $Q_{min} \leq Q < Q_t$, and between −1 % and +1 % for flow rates $Q$ where $Q_t \leq Q \leq Q_{max}$ and when the errors between $Q_t$ and $Q_{max}$ all have the same sign, they all shall not exceed 0,5 %

**3.1.16**
$Q_{min}$
lowest flowrate at which the gas meter provides indications that satisfy the requirements regarding maximum permissible error (MPE)

**3.1.17**
$Q_{max}$
highest flowrate at which the gas meter provides indications that satisfy the requirements regarding MPE

**3.1.18**
$Q_t$
transitional flowrate, the flowrate occurring between the maximum and minimum flowrates at which the flowrate range is divided into two zones, the ‘upper zone’ and the ‘lower zone’

Note 1 to entry: Each zone has a characteristic MPE.

**3.1.19**
$Q_r$
overload flowrate, the highest flowrate at which the meter operates for a short period of time without deteriorating

## 3.2 Symbols

The symbols and subscripts used hereafter in this document are specified in Table 1.

**Table 1 — Symbols**

| Symbols | Represented quantity | Unit |
|---|---|---|
| $c$ | Pressure loss coefficient depending on meter type | $mm^{-4}$ |
| $d$ | Relative density of the gas ($\rho_{gas}/\rho_{air}$) | — |
| $D$ | Inside diameter meter outlet/inlet | mm |
| $D_1$ | Inside diameter pipe | mm |
| $E$ | Error | % |
| $F$ | Force (bending moment) | N |
| $F'$ | Force (torsional moment) | N |
| $I$ | Current | A |
| $L$ | Length of the lever arm (bending moment) | mm |
| $L'$ | Length of the lever arm (torsional moment) | mm |
| $M$ | Torque | N·m |
| $p$ | Pressure | bar |
| $PS$ | Maximum allowable pressure (strength) | bar |
| $\Delta p$ | Pressure loss | mbar |
| $Q$ | Volume flow rate | $m^3/h$ |
| $Q_{mass}$ | Mass flow rate | kg/s |
| $q_s$ | specified volume flow | $m^3/h$ |
| Re | Reynolds number | — |
| $t$ | Temperature | °C |
| $TS$ | Maximum/minimum allowable temperature (strength) | K |
| $T$ | Absolute temperature | K |
| $U_B$ | Battery voltage | V |
| $V$ | Volume | $m^3$ |
| $v$ | Average velocity | m/s |
| $\mu$ | Dynamic viscosity | Pa·s |
| $\rho$ | Density of the gas | $kg \cdot m^{-3}$ |
| Subscripts: | | |
| i | Summation index | |
| m | Metering conditions of the gas | |
| max | Maximum value | |
| min | Minimum value | |
| s | Specified conditions | |
| t | Transitional | |

# 4 Meter classification

## 4.1 General

The maximum allowable operating pressure for flanges in accordance with the relevant parts of ISO 7005-1:2011 and ISO 7005-2:1988 shall not be less than maximum allowable pressure PS. Flanges shall be in accordance with following appropriate standards: EN 1092-1:2018; EN 1092-2:2023; EN 1092-3:2003; EN 1092-4:2002; EN 1759-1:2004; EN 1759-3:2003; EN 1759-4:2003.



## 4.2 Flange pressure ratings

Flanges shall be designed according to PN Designation or ANSI class rating (see Table 2).

**Table 2 — Flange pressure ratings**

| PN Designation | ANSI class rating |
|---|---|
| 10 | 125 |
| 16 | — |
| 20 | 150 |
| 25 | — |
| 40 | — |
| 50 | 300 |
| 64 | — |
| 100 | — |
| 110 | 600 |
| 150 | 900 |
| 250 | — |
| 260 | 1 500 |
| 420 | 2 500 |
| NOTE This table is based on EN 1333:2006 resp. ISO 7005-1:2011. | |

The use of the following pressure ratings is recommended:

10 – 16 – 20 – 25 – 40 – 50 – 100 – 150 – 250 – 420.

## 4.3 Gas meter sizes, rangeability and connection diameter sizes

Gas meters shall be classified as class 1,0 with the maximum and minimum flow rates and nominal diameters as shown in Table 3.

The maximum and minimum flow rates shall be specified for the gas density for which the meter will operate within the specifications of meter performance defined in Clause 5.

NOTE The maximum flow rate in cubic meters per hour ($m^3/h$) is a number in R 5 of the sets of preferred numbers listed in ISO 3:1973 (the value of 63 has been rounded to 65).

**Table 3 — Authorized values of maximum flow rates, corresponding minimum flow rates and nominal diameters**

| $Q_{max}$ ($m^3/h$) | | Rangeability | | | Nominal diameters DN | | |
|---|---|---|---|---|---|---|---|
| | | 1 : 20 | 1 : 30 | 1 : 50 | | | |
| | | $Q_{min}$ ($m^3/h$) | | | | | |
| | | | | | A | B | C |
| 40 | | 2 | 1,3 | 0,8 | 25 | | 50 |
| 65 | | 3 | 2 | 1,3 | | 50 | |
| 100 | | 5 | 3 | 2 | | 50 | 80 |
| 160 | | 8 | 5 | 3 | 50 | 80 | 100 |
| 250 | | 13 | 8 | 5 | | 80 | 100 |
| 400 | | 20 | 13 | 8 | 80 | 100 | 150 |
| 650 | | 32 | 20 | 13 | 100 | 150 | |
| 1 000 | | 50 | 32 | 20 | | 150 | 200 |
| 1 600 | | 80 | 50 | 32 | 150 | 200 | 250 |
| 2 500 | | 130 | 80 | 50 | 200 | 250 | 300 |
| 4 000 | | 200 | 130 | 80 | 250 | 300 | 400 |
| 6 500 | | 320 | 200 | 130 | 300 | 400 | |
| 10 000 | | 500 | 320 | 200 | 400 | 500 | |
| 16 000 | | 800 | 500 | 320 | 500 | 600 | |
| 25 000 | | 1 300 | 800 | 500 | 600 | 750 | |

A high speed version
B normal speed version (preferred)
C low speed version



## 4.4 Connections and dimensions

The inlet and outlet of the meter shall have the same nominal diameter and connection type.

The preferred overall length in millimetres of the meter between inlet and outlet connections is 3 DN. Tolerances are given in EN 22768-1:1993, “Designation c”.

The preferred length in millimetres of 3 DN for the meter shall not be exceeded. For shorter meters the manufacturer shall be able to provide a “make up spool piece” to bring their body lengths up to the preferred length, where requested.

The maximum overall distance in millimetres measured from the extremity of the protruding parts to the meter axis shall not exceed 150 plus 1,5 DN.

For flange connections refer to Table 2.

### 4.5 Temperature ranges

The gas and the ambient temperature ranges for which the meter is designed to perform within the standard performance specification shall be stated.

### 4.6 Climatic environment

The climatic environment ranges for which the meter is designed to perform within the standard performance specification shall be stated.



## 5 Metrological performance requirements

### 5.1 General

Each type of meter shall be subjected to the series of tests specified in 5.2 to establish the metrological performance of the type of meter. If the type of meter comprises a range of sizes of the same basic design and a range of metering conditions, the type test may be performed on a limited number of sample meters (1 to 6 samples irrespective of size) being representative for that range of meter sizes and metering conditions.

Each meter conforming to an approved type shall be tested individually according to Annex E. The results of the tests obtained in 5.2 and Annex E shall be available on request together with a statement of the conditions under which the test took place.

The meter shall be fitted with all components which may affect the metrological performance.

General requirements for the test facility to be used for the type test are given in Annex A.

Where the text refers to a gas for flow tests this means air or a gas from the 1st or 2nd gas family or any other gas provided it is yielding similar metrological results at a Reynolds number within ±5 % of the Reynolds number at the foreseen metering conditions.

The total uncertainty of the equipment used to measure the error of indication shall be calculated according to ISO/IEC Guide 98-3:2008.

### 5.2 Type testing

#### 5.2.1 Error of indication

##### 5.2.1.1 Requirements

The error of indication of the meter shall be in absolute values less than the maximum permissible errors specified in Table 4, taking account of Table 5.

**Table 4 — Maximum permissible errors**

| Flow rate $Q$ | Maximum permissible errors |
|---|---|
| $Q_{min} \leq Q < Q_t$ | ±2 % |
| $Q_t \leq Q \leq Q_{max}$ | ±1 % |

**Table 5 — Transitional flow rate $Q_t$**

| Rangeability | $Q_t$ |
|---|---|
| 1 : 20 | $0{,}20 \cdot Q_{max}$ |
| 1 : 30 | $0{,}15 \cdot Q_{max}$ |
| ≥ 1 : 50 | $0{,}10 \cdot Q_{max}$ |



In order to ensure that the gas meter does not exploit the MPEs or systematically favour any party, each meter shall be adjusted so that the weighted mean error (*WME*) is as close to zero as the adjustment and the maximum permissible errors will allow.

The *WME* shall have a value between −0,4 % and +0,4 %.

The *WME* is calculated as follows:

$$WME = \frac{\Sigma\left(Q_i \,/\, Q_{max}\right) \cdot E_i}{\Sigma\left(Q_i \,/\, Q_{max}\right)}$$

where

$Q_i/Q_{max}$ is a weighting factor;

$E_i$ is the error of indication at the flow rate $Q_i$ given as a percentage.

When $Q_i = Q_{max}$ a weighting factor of 0,4 instead of 1 shall be used.

If tests at more than one pressure are carried out, the difference between the results of the tests between $0{,}25 \cdot Q_{max}$ and $Q_{max}$ shall not exceed 0,5 % for meters with DN > 100 or 1,0 % for meters with DN ≤ 100.

If a meter has been certified for one operating pressure range it is deemed to be certified for any smaller operating pressure range.

If a meter is certified for one rangeability it is deemed to be certified for any lower rangeability.

**5.2.1.2 Test**

Before type testing, a meter shall undergo a run-in-period of 50 h at a flow rate of at least $0{,}5 \cdot Q_{max}$.

The test consists of determining the error of indication of the complete meter at the flow rates given in Table 6.

For a meter type specified for measurement in a pressure range below or equal to 4 the error of indication test shall be carried out with a gas at atmospheric conditions (±100 mbar).

For a meter type specified for measurement in a pressure range extended above 4 bar the error of indication test shall be carried out with a gas in the range of the specified metering conditions. The tests shall be carried out at least at the lowest and the highest operating pressure specified by the manufacturer. However, for specified maximum pressures above 50 bar a test at 50 bar is deemed acceptable.



**Table 6 — Test flow rates in % of $Q_{max}$**

| Rangeability | | |
|---|---|---|
| 1 : 20 | 1 : 30 | 1 : 50 |
| | | 2 |
| | | |
| 5 | 5 | 5 |
| 10 | 10 | 10 |
| 20 | 15 | |
| | | 25 |
| 40 | 40 | 40 |
| 70 | 70 | 70 |
| 100 | 100 | 100 |

NOTE The above test points include $Q_{min}$, $Q_t$ and $Q_{max}$ for each meter. If the test point is equal to $Q_t$, the tighter limit of the error of indication has to be applied.

### 5.2.2 Metrological stability

#### 5.2.2.1 Requirements

In the flow rate range from $0{,}25 \cdot Q_{max}$ to $Q_{max}$ the variation of the error of indication of the meter at each flow rate shall stay within a span of 0,2 %.

#### 5.2.2.2 Test

The error of indication of the meter shall be determined at various flow rates in the following order: $0{,}25 \cdot Q_{max}$, $0{,}70 \cdot Q_{max}$, $0{,}40 \cdot Q_{max}$, $Q_{max}$, where the change from $0{,}4 \cdot Q_{max}$ to $Q_{max}$ is done via $1{,}10 \cdot Q_{max}$, in order to approach $Q_{max}$ from a higher flow rate. At each flow rate the error shall be determined three times without changing the flow rate. The cycle shall be repeated three times. The test shall be carried out with a gas at atmospheric conditions (±100 mbar) or at the lowest pressure designated on the meter.

The nine resulting errors of indication at each flow rate shall be within a span of 0,2 %.

### 5.2.3 Linearity

#### 5.2.3.1 Requirements

For the test flow rates from $0{,}25\ Q_{max}$ to $Q_{max}$ at each test pressure the differences between the highest and the lowest error of indication shall not exceed the values specified in Table 7.

**Table 7 — Allowable differences between the highest and lowest error of indication at each test pressure**

| Size | Pressure | |
|---|---|---|
| | ≤ 4 bar | > 4 bar |
| ≤ DN 100 | 1,0 % | 0,5 % |
| > DN 100 | 1,0 % | 0,3 % |



#### 5.2.3.2 Test

In order to determine if the linearity requirement is fulfilled the value of the errors found at each flow rate according to 5.2.1.2 shall be taken.

### 5.2.4 Endurance

#### 5.2.4.1 Requirements

Meters shall retain the accuracy of their metrological characteristics, within defined limits, over their expected life. To prove this the meters shall undergo an endurance test.

The difference in error of indication between the start and end of the test shall be less than one third of the maximum permissible error given in Table 4.

After the test, the error of indication shall not exceed the maximum permissible error given in Table 4.

#### 5.2.4.2 Test

One to six sample meters of each type irrespective of size shall be used for the endurance test.

Meters shall be tested with their indicating devices fitted.

The duration of the test shall be such that each meter measures a volume corresponding to 1 000 h of operation of the meter at the maximum flow rate; the test shall be completed within 2 months.

For a meter type intended for operation in a pressure range below or equal to 4 bar the test shall be carried out with a gas at a pressure of 4 bar or its maximum operating pressure whichever is the lower. For a meter type intended for operation in a pressure range extended above 4 bar, the test shall be carried out with a gas at a minimum pressure of 8 bar or at its maximum operating operating pressure whichever is lower.

At the start of the test all meters shall conform to 5.2.1.1 and 5.2.2.1.

At the end of the test the error of indication of the meters shall be determined again under the same conditions and at the same test facility as at the start of the test.

### 5.2.5 Meter position

#### 5.2.5.1 Requirements

Unless it is specified on the meter that it is to be used only for certain mounting positions in the line, for each type of meter it shall be established whether the position of the meter influences the measuring behaviour of the meter. The following positions shall be considered: horizontal, vertical flow-up, vertical flow-down.

#### 5.2.5.2 Test

The test consists of 2 parts.

a) The meter shall be tested in each position to be considered according to the procedure in 5.2.1. The test shall take place at the lowest operating pressure of the meter. The difference in test results shall be less than one third of the maximum permissible error limits for the flow rates above and below $Q_t$.

b) A sample meter shall be subjected to the endurance test specified in 5.2.4 in each position.

Different sample meters may be used for each test position.

### 5.2.6 Temporary overload

#### 5.2.6.1 Requirements

The meter shall be designed to be capable of occasionally running 20 % above the maximum flow rate within the range of pressure and temperature for which it is rated without influence on the error of indication of the meter.

#### 5.2.6.2 Test

The meter shall run at a flow rate of $1{,}2 \cdot Q_{max}$ for a time period of 1 h. The test shall be carried out at the same pressures as the error of indication test in 5.2.1.

After this 1 h test, the error of indication in the flow rate range from $0{,}25 \cdot Q_{max}$ to $Q_{max}$ shall remain within the span specified for the stability test in 5.2.2.

### 5.2.7 Temperature range

#### 5.2.7.1 Requirements

The gas and the environmental (climatic) temperature ranges over which the meter is designed to perform within the standard performance specification shall be stated by the manufacturer. These shall be a minimum temperature range of 40 K for the gas temperature and 50 K for the environmental temperature.

The upper temperatures (gas and climatic) shall be either 40 °C, 55 °C or 70 °C. The lower temperatures (gas and climatic) shall be either –10 °C, –25 °C or –40 °C.

#### 5.2.7.2 Test

The test consists of three parts.

a) Materials

The manufacturer shall demonstrate that all materials of which the meter is designed are capable of withstanding the extreme temperatures of the specified temperature range.

b) Test on the indicating device

The indicating device, including as many parts of the gear train as possible from the design of the meter, shall be taken from the meter and placed in a temperature cabinet. It shall be connected to a drive unit capable of operating the indicating device.

The indicating device shall then be exposed to a 24 h cyclic temperature variation between the upper and lower temperature limit, maintaining the relative humidity above 95 % during the temperature change and low temperature phases, and at 93 % at the upper temperature phase.

NOTE Condensation will occur during the temperature rise.

The 24-h cycle consists of:

— temperature rise during 3 h;

— temperature maintained at the upper value until 12 h from the start of the cycle;

— temperature lowered to lower value within 3 h;

— temperature maintained at the lower value until 24 h cycle is completed.

During and after the temperature cycle the indicating device shall operate without problems.

c) Test of the complete meter

The error of indication of the meter shall be determined at the lowest and the highest temperature defined in 3.1.7.6. Care shall be taken that the meter temperature has been stabilized at this test temperature.

The test shall be carried out at the flow rates defined in the Table 6.

Two sample meters of each type, the size of which does not exceed DN 150, shall be used for the test.

The test shall be carried out at atmospheric conditions (±100 mbar).

### 5.2.8 Installation conditions

#### 5.2.8.1 Requirements

In order to assess the sensitivity of the meter performance to upstream installation conditions, each type of meter shall be subjected to the standard tests described in Annex B, Perturbation testing.

The errors of indication obtained during disturbed flow conditions downstream of the perturbation units shall not differ by more than one third of the maximum permissible error limits given in Table 4, from the error of indication obtained with an undisturbed upstream flow condition as obtained in 5.2.1.

Any additional pipe inlet lengths and/or flow conditioners necessary to meet this requirement shall be specified by the manufacturer. These components together with the meter constitute a “meter package”.

#### 5.2.8.2 Test

The test is specified in Annex B.

### 5.2.9 Maximum permissible pressure loss

#### 5.2.9.1 Requirements

Pressure loss data for the meter type and size or meter package, as appropriate, shall be provided by the manufacturer.

The pressure loss of a new turbine meter shall, with air at atmospheric conditions (±100 mbar) as test medium, and at flow rate $Q_{max}$ be less than the values specified in Table 8.

**Table 8 — Maximum pressure loss values across the meter at $Q_{max}$ with atmospheric air as test medium**

| Nominal diameters | Pressure loss (mbar) |
|---|---|
| according to C | 10 |
| according to B | 15 |
| according to A | 25 |
| NOTE Definitions A, B, C see Table 3. | |



**5.2.9.2 Test**

The pressure loss across the meter, including any additional components necessary to meet the requirements of 5.2.8.1, shall be measured between two points. These points shall be within distances of 1$D$ upstream and downstream of the inlet and outlet of the meter (and any additional components) on piping of the same nominal diameter as the meter. Care shall be taken on selection and manufacturing of the pressure tappings to ensure that flow pattern distortions do not affect the pressure readings. The test is carried out at $Q_{max}$.

The pressure loss at $Q_{max}$ across the meter, and any additional components necessary to satisfy the requirements of 5.2.8.1, shall be stated in the type test certificate.

**5.2.10 Output shaft (where fitted)**

**5.2.10.1 Requirements**

The retarding torque imposed on the meter by the output shaft shall have a limited influence on the metrological performance of the meter, so that when tested in accordance with 5.2.10.2, the meter error at $Q_{min}$ does not shift more than the values given in Table 9.

The maximum torque, specified by the manufacturer, shall be indicated in a permanent manner on the meter close to the output shaft.

**Table 9 — Maximum permissible shifts in the meter error due to loading of the output shaft**

| $Q_{min}$ | Maximum permissible shift of the meter error |
|---|---|
| $0{,}02 \cdot Q_{max}$ | 1,0 % |
| $0{,}03 \cdot Q_{max}$ | 1,0 % |
| $0{,}05 \cdot Q_{max}$ | 1,0 % |
| $0{,}10 \cdot Q_{max}$ | 0,5 % |

**5.2.10.2 Test**

Apply the maximum torque indicated on the turbine meter at atmospheric conditions (±100 mbar).

# 6 Design, material requirements and manufacturing

## 6.1 General

The gas meter shall be designed such that, when installed, any mechanical interference capable of affecting the measuring accuracy to the gas meter or to the verification or protection marks is made obvious.

A drawing showing the method of metrological sealing, including a method of sealing of all metrological relevant removable accessories shall be part of the documentation for type approval.

Meters shall be designed and manufacturing tolerances shall be set to allow interchangeability of components and meters of the same size and type.

All parts of the meter and all lubricants which come into contact with the fluid to be measured shall be manufactured of suitable materials and resistant against attack by the fluid and its constituents.

External surfaces shall be suitably protected against corrosion and the design shall be resistant to run-off water.

All parts of the meter shall be manufactured of materials whose characteristics do not alter significantly during their expected life span.

The meter casing and all other parts forming the pressure containing structure of the meter shall be made of materials free of defects and designed in accordance with good engineering practice and procedures suited to the pressure and temperatures for which the meter has been rated.

The design and materials shall also be such as to maintain performance when installed in accordance with the manufacturer's recommendations.

Internal bearings and the drive mechanism shall be protected from ingress of dirt or particles in the gas stream.

All internal components shall be made of dimensionally stable material and be protected against any direct or indirect corrosion caused by the gas.

The above requirements shall be assessed by visual inspection.

Materials and design shall comply with the pressure testing described in 6.2.

## 6.2 Robustness

### 6.2.1 General

Pressure testing by the manufacturer of each individual meter is mandatory.

### 6.2.2 Materials for pressurized parts

Pressure containing parts shall be constructed with materials suitable for the scheduled lifetime of the meter unless replacement is foreseen. Such materials shall meet the following requirements:

— materials shall comply with harmonized standards ; **or**

— materials shall be covered by a European approval of pressure equipment materials; **or**

— materials shall be subject of a particular material appraisal.

The meter manufacturer shall ensure all relevant material certificates are available in accordance with all specifications of the standards and codes of construction.

For a steel to be considered sufficiently ductile, when tested in a tensile test using a standard procedure the elongation after rupture shall be no less than 14 % and its bending rupture energy shall be no less

than 27 J when measured on an ISO V test-piece. The test shall be undertaken at a temperature not exceeding the lowest scheduled operating temperature, but with a maximum temperature of 20 °C. For other than steel materials, refer to relevant standards or construction codes.

### 6.2.3 Welded joint coefficient

There are three possible methods of determining the value of the welded joint coefficient for welded joints in pressure containing parts. In case of destructive and non-destructive tests (DT and NDT) where it has been proven that the whole series of joints showed no significant defects, the welded joint coefficient shall not exceed the value 1. Otherwise, in case of meters subject to random NDT this value is limited by 0.85 and for meters not subject to NDTs other than visual inspection 0.7.

### 6.2.4 Resistance to internal pressure

#### 6.2.4.1 Requirements

The meter case shall be designed to withstand the internal pressure using an appropriate safety factor for the case material at *PS*. The safety factor shall be chosen according to the selected design method according to 6.2.4.2, Option 1. Alternatively, it shall be tested in accordance with 6.2.4.2, Option 2 to ensure it has sufficient strength to operate safely.

Each meter casing and all other parts forming the pressure containing structure of the meter shall be subjected to the individual strength test specified in 6.2.4.3. A certificate shall be delivered by the manufacturer with each meter certifying conformity with this clause according to EN 10204:2004.

#### 6.2.4.2 Validation method

Option 1:

Records of all design calculations shall be available for inspection to ensure that the materials and design of the meter casing comply with a harmonized standard (e.g. EN 13445-2). Other non-harmonized standards may be used with additional proof of compliance against the essential safety requirements of the European legislation for pressure equipment. The design calculation shall fulfil the strength requirements at a minimum temperature of –10 °C or lower and at a maximum temperature of +40 °C or higher.

Option 2:

For meter casings operating at a maximum pressure in the following conditions:

— the product of the maximum allowable pressure *PS* and the volume *V* is less than 6000 bar ·L

or

— the product *PS*·DN is less than 3000 bar,

a hydrostatic test shall be performed at a pressure of at least five times the maximum stated operating pressure or 2 bar, whichever is the greater.

In this test the pressure shall be maintained continuously for 30 min without the casing yielding. The test shall be performed at a temperature of (20 ± 5) °C and the procedures and results shall be recorded and available. For each nominal diameter one sample meter shall be tested.

#### 6.2.4.3 Individual test

The test equipment shall not subject the meter to externally applied stress which may significantly affect the results of these tests.

At the discretion of the test facility the tests can be carried out with water, kerosene or any other suitable liquid, having a viscosity of not greater than that of water, or with gas (air or any other suitable gas).

The meter shall be free of entrapped air when testing with a liquid.

The test shall be performed on a meter without external painting or coating at a minimum internal pressure of 1,5 times the maximum allowable pressure *PS* with a minimum of 2 bar.

The test shall be performed by applying pressure inside the assembled meter casing with the connections closed.

Detectable leakage through the casing is not acceptable. Test duration shall be 3 min.

If pressure tests in the presence of a representative of the purchaser are specified, painted meters from stock may be retested without removal of paint.



### 6.2.5 External leak tightness

#### 6.2.5.1 Requirements

When tested as specified in 6.2.4.2 and 6.2.4.3, the meter shall not leak.

The assembled meters shall be tested for leakage prior to the application of any external coating or painting capable of sealing against such a leakage. Parts shall be free of deposits, oxides, welding slag, etc. Chemical corrosion protection treatments and internal linings are permitted.

Meters with a direct coupling that penetrates from the body of the meter to the index mechanism shall be tested without the index mechanism fitted, leaving only the index housing.

#### 6.2.5.2 Type test

The type test for leakage shall be identical to that given in 6.2.4.3 except that the duration of the test shall be a minimum of 15 min.

#### 6.2.5.3 Individual test

Test equipment shall not subject the meter to externally applied stress which may significantly affect the results of the tests.

The test shall be carried out with a suitable gas, e.g. air or nitrogen. The gas shall be free of oil, grease and moisture.

The test method to be used shall provide the level of sensitivity suitable for detecting a level of leakage of $0{,}1 \cdot DN \cdot mm^3 \cdot s^{-1}$ at ambient pressure and temperature conditions.

If the leakage test is run after the hydrostatic test (see 6.2.4.3) water could become trapped and seal potential leaks, therefore the meter shall be dried before assembling the mechanism and the leak test is carried out.

The completely assembled gas containing parts shall be pneumatically tested for external leakage at a minimum internal pressure of 1,1 times of the maximum operating pressure with a minimum of 0,5 bar. The pressure shall be increased slowly up to the test pressure. The rate of pressure increase shall not exceed 350 $mbar \cdot s^{-1}$ unless specified otherwise by the manufacturer.

The test pressure shall be maintained for a minimum of 3 min.

The manufacturer of the meter may carry out an additional test at a pressure close to that at which the meter is designated to operate.

After the test the pressure shall be released at a rate not greater than that during pressurization.

### 6.2.6 Bending and torsional moment

#### 6.2.6.1 Requirements

The manufacturer's installation instructions shall specify the level of protection required with regard to bending and torsional moment.

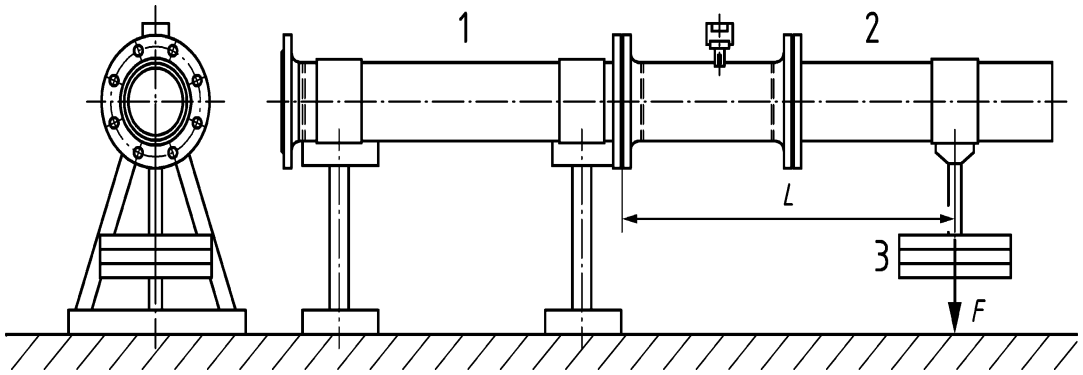
When tested as specified in 6.2.6.2, the performance of the meter shall not be significantly affected, and the meter shall remain leak tight in accordance with 6.2.5.

#### 6.2.6.2 Type test

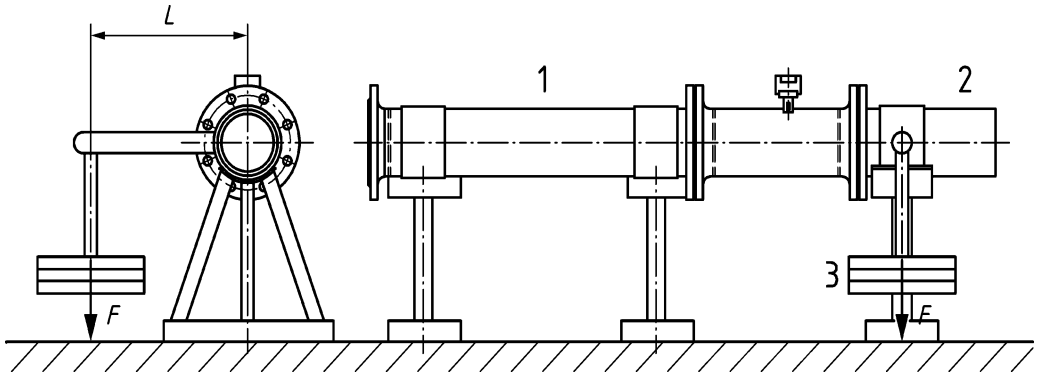
Tests for determining the strength of the meter shall be performed with a device according to Figure 1. It consists of a lever arm of predetermined length to which a force in addition to the weight of the meter can be applied in a perpendicular plane for performing torsional and bending moment tests. The moment may be applied to the inlet or the outlet flange of the meter. The opposite end of the meter shall be supported as shown in Figure 1.



NOTE Figure 1 does not show the reference meter rig, or instruments for checking leakage.




**Bending Test**




**Torsional Test**

**Key**

1 inlet pipe
2 outlet pipe
3 load

**Figure 1 — Arrangement for bending and torsional testing**

Bending and torsional moment shall be applied to the inlet or outlet flange according to the values given in Table 10. The duration of the test shall be such as to enable the low flow calibration and leakage test to be performed with the moment applied, however, this shall not be less than 1 min.

**Table 10 — Torsional and bending moment for meter applied to the inlet or outlet flange**

| **Pipe size** (DN) | **Moment** (N · m) |
|---|---|
| 50 | 440 |
| 80 | 760 |
| 100 | 1 220 |
| 150 | 2 710 |
| 200 | 4 470 |
| ≥ 250 | 7 050 |



The low flow calibration and leakage test shall be carried out prior to, during and after the bending and torsional tests.

The low flow calibration test shall be performed with the meter at atmospheric pressure (±100 mbar), the error of indication shall be checked at the two lowest flows given in the relevant column of Table 6.

The errors of indication obtained during and after applying the moment shall not differ by more than one third of the maximum permissible error, from the values obtained prior to applying the moment.

For the purpose of this bending and torsional test, the meter shall be subjected to the leakage test detailed in 6.2.5. This shall be carried out either, at the maximum operating pressure, or at 7 bar, whichever is the lower.

The meter shall meet the leakage requirements given in 6.2.5.

### 6.2.7 Resistance to impact

#### 6.2.7.1 Requirements

The indicating device and indicating device window shall resist impact without damage or affecting the visual reading of the indicating device numerals. The indicating device is deemed to meet this requirement if it complies with 6.2.7.2.

#### 6.2.7.2 Type test

The indicating device window fitted in the meter as in operation and at a temperature of (−5 ± 1) °C shall withstand the impact of a 25 mm diameter solid steel ball dropped three times from a height of 350 mm striking the centre of the window and falling normal to its plane.

### 6.2.8 Transportation and storage

#### 6.2.8.1 Requirements

The meter connections shall be fitted with suitable covers to prevent the entry of foreign matter during transportation and storage.

The meter packing shall be prepared in such a way as to minimize the possibility of damage to the meter during transportation. For meters with DN 100 connections and above, provision shall be made to secure the meter in a stable position during transportation.

The meter shall withstand the handling required during its transport and installation. After the test as given in 6.2.7.2 it shall still comply with the following requirements:

a) the error shall be within the stability limits (see 5.2.2)

b) the external leak tightness shall be in accordance with 6.2.5.

#### 6.2.8.2 Type test

The meter, in its normal packaging, shall be dropped vertically, from rest, on to a flat hard, horizontal floor from a height of 0,2 m. The dropping positions are selected to prevent damage to external accessories of the meter.



## 6.3 Manufacturing

The general requirements for the manufacturing of a gas meter are given in Annex F.

The manufacturer shall state the selected materials standards in the relevant documentation (see Clause 9).

Fabrication welds in any of the pressure containing parts shall be made using qualified welding procedures by qualified welders or welding operators according to EN ISO 9606-1:2017, EN ISO 9606-2:2004, EN ISO 9606-3:1999, EN ISO 9606-4:1999 EN ISO 9606-5:2000, EN ISO 15614-1:2017, EN ISO 15614-2:2005, EN ISO 15614-4:2005, EN ISO 15614-5:2004, EN ISO 15614-6:2006, EN ISO 15614-7:2019, EN ISO 15614-8:2016, EN ISO 15614-11:2002, EN ISO 15613:2004, EN ISO 14732:2013, EN ISO 15611:2003 and EN 15612:2020 respectively.

Quality of heat treatments of welds shall be in accordance with EN ISO 17663:2023.

The revalidation routes 9.3.c) according to EN ISO 9606-1 and 5.3.c) according to EN ISO 14732 are not permitted for meters in the categories II, III and IV.

Forming and machining e.g. chamfering and any of the form of preparation of components shall not result in cracking, defects, or changes in the mechanical characteristics of the component that may be crucial to safety of the meter. In addition, for fabrication welds to make the meter body only full penetration welds shall be used.

This additional requirement is not applicable to seal welding.

For all pressure containing parts, the meter manufacturer shall establish and maintain suitable procedures to identify the material throughout the production from the receipt up to the final manufacturer's test by markings or labelling or other equivalent methods.

Where non-destructive testing is required, the test shall be carried out by qualified personnel in accordance with EN ISO 9712:2022.

## 6.4 Resistance to environmental conditions

### 6.4.1 General

The meter case, indicating device, name plates and external parts shall be made of or protected by materials that are resistant to attack by weather (sunlight, humidity and temperature changes) and common meter cleaning agents over the expected life of the meter.

### 6.4.2 Resistance to ultraviolet radiation

#### 6.4.2.1 Requirements

Unless it is clear from the construction or from the indication on the meter that the indicating devices and data plates are not subject to direct radiation of the sun, those indicating devices and data plates shall undergo the test in 6.4.2.2.

After completion of the following test, the indicating device as well as the name plate shall still be legible.

#### 6.4.2.2 Type test

The window of the indicating device and the name plate shall be exposed to the effects of ultraviolet radiation for five periods, each of 8 h duration, using a suspended sun lamp which has been used not more than 400 h. The light source shall have the same radiation spectrum as a Xenon lamp with a low transmission below 290 nm.

The test equipment shall provide an energy of at least 765 $W \cdot m^2$ over the entire surface of the tested items.

The surrounding air shall not be confined, shall be free to circulate and be regulated at (43 ± 3) °C.

After each exposure except the last, the items shall be immersed completely in distilled water for 16 h and then cleaned and dried with cotton wool.

### 6.4.3 Resistance to external corrosion

#### 6.4.3.1 General

All parts of the meter shall be able to resist any corrosive substances contained in the internal and external atmosphere with which they may be in contact during normal conditions of use.

Meters shall be protected from corrosion. The protection shall meet the requirements of 6.4.3.2.1 and 6.4.3.3.1.

#### 6.4.3.2 Penetration resistance

#### 6.4.3.2.1 Requirements

After the test described in 6.4.3.2.2 the base metal shall not be exposed.

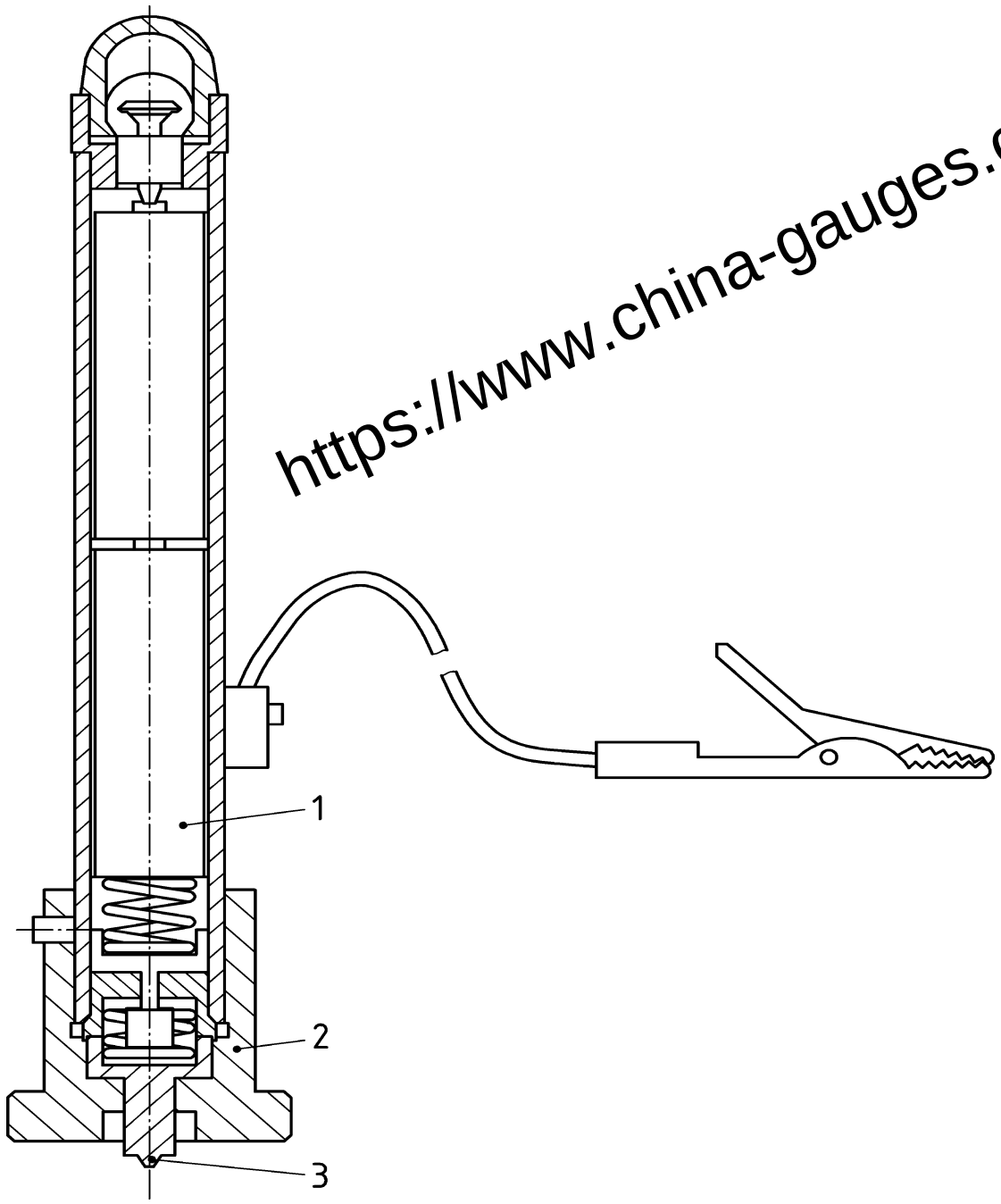
#### 6.4.3.2.2 Type test

The penetration resistance of the protective coating is assessed using the apparatus described in Figure 2 with a spring loading of 29,4 N. The scratching element of the apparatus shall be a 1 mm diameter steel ball.

The 1 mm diameter steel ball shall be mounted by soft soldering in a spring loaded housing. The crocodile clip shall be attached to the meter connection and the test apparatus shall be drawn easily over the surface under test at a speed of 30 $mm \cdot s^{-1}$ to 40 $mm \cdot s^{-1}$ keeping the apparatus upright and pressed to the surface throughout the movement.

Where a metallic protective coating is applied directly onto a metal surface the indicator lamp will light without any penetration of the surface. In this case the surface shall be visually inspected for penetration.

The ball shall be cleaned after each test and inspected to ensure that it complies with the specification. Check periodically that the spring loading complies with the specification.






**Key**

1 two batteries each of 1,5 V nominal voltage
2 spring loading
3 scratching point (1mm diameter steel ball)

**Figure 2 — Penetration resistance test apparatus**

### 6.4.3.3 Adhesion of the protective coating

#### 6.4.3.3.1 Requirements

There shall be no detachment of the coating when tested in accordance with the method given in 6.4.3.3.2.

#### 6.4.3.3.2 Type test

The coated surface is scored through at 1 mm intervals in a series of lines at 90 degrees. A surface cross-scored with 100 squares each of 1 mm side length is produced.

Adhesive tape is stuck to the cross-scored surface and is then removed with a sharp pull.

#### 6.4.3.4 Resistance to external corrosive atmosphere

#### 6.4.3.4.1 Requirements

External surfaces of the meter shall be protected as necessary against corrosion caused by an external corrosive atmosphere.

#### 6.4.3.4.2 Type test

A sample, representative of the meter assembly exposed to corrosion, shall be placed in a cabinet for 1 000 h at a test temperature of (25 ± 5) °C and exposed to a continuous salt mist produced by spraying the salt solution, which shall be composed as follows:

| | |
|---|---|
| Sodium chloride as NaCl | 26,50 g |
| Magnesium chloride as $MgCl_2$ | 2,40 g |
| Magnesium sulphate as $MgSO_4$ | 3,30 g |
| Potassium chloride as KCl | 0,73 g |
| Sodium hydrogencarbonate as $NaHCO_3$ | 0,20 g |
| Sodium bromide as NaBr | 0,28 g |
| Calcium chloride as $CaCl_2$ (to be added last) | 1,10 g |
| Water to | 1 000 ml |

The salt solution drained from the test sample is collected in a tray and emptied at regular intervals to prevent recirculation or contact with the test sample.

### 6.5 Removable meter mechanisms

#### 6.5.1 Integrity

#### 6.5.1.1 Requirements

The design and integrity of a meter with a removable mechanism or cartridge shall not be affected by the removal or replacement of the measuring element or cartridge. A meter will be deemed to meet this requirement if it remains leak tight, as specified in 6.2.5, when subjected to the test given in 6.5.2.

#### 6.5.1.2 Type test

The meter is tested for leak tightness as specified in 6.2.5. The cartridge will then be completely removed from the meter body and then re-inserted and retested for leak tightness.

#### 6.5.2 Performance

#### 6.5.2.1 Requirements

Removable meter mechanisms (cartridge) shall maintain their original performance following repeated removal and installation of cartridges in different meter bodies of the same type and size. Meters of this type are deemed to comply with this requirement if the errors in each meter body are within the stability limits given in 5.2.2.1.

The removable meter mechanism or cartridge shall have a unique serial number clearly marked on the outside surface and be capable of being sealed to the main pressure containing body of the meter to prevent unauthorized interference.

#### 6.5.2.2 Type test

Two meters “A” and “B” with removable mechanisms or cartridges are tested as specified in 5.2.1.

The cartridges are then removed and the cartridge from meter “A” fitted into the body of meter “B” and cartridge “B” fitted into the body of meter “A”. The two meters are tested as specified above.

The cartridges are then returned into their original bodies and tested again.



## 6.6 Indicating devices and accessories

### 6.6.1 General

Indicating devices and accessories shall be of sound and reliable design. When indicating devices are mounted on the turbine meter they are required to operate reliably and remain readable over the specified temperature range.

A mechanical indicating device shall be easily removable if such a removal is necessary for verification. The transmission system through the meter case, which connects the measuring element to the indicating device can be either direct or via a magnetic coupling.

If a magnetic coupling is used it shall comply with the requirements of 6.6.2.

It is only admissible to use direct transmission on meters with gas pressurized indicating devices when

a) the meter’s nominal diameter DN ≤ 50 and

b) the maximum allowable pressure *PS* ≤ 4 bar and

c) the indicating device contains no mechanical output shafts.

Indicating devices which are isolated from the gas flow shall be protected against the consequences of possible gas leakage.

Provisions shall be made in the design for sealing the indicating device from unauthorized interference and from being rotated more than 359 degrees in any direction.

The indicating device shall be designed to be impermeable to run-off water and foreign matter, and be resistant to shock when tested in accordance with IP 65 of EN 60529:1991.

### 6.6.2 Magnetic drive units

#### 6.6.2.1 Requirements

The torque transmission of any magnetic drive unit shall be equal to at least three times that to which the drive can be subjected including all indicating devices, output shafts and accessories designed for collective operation by the magnetic drive unit as stated by the manufacturer.

#### 6.6.2.2 Type test

The magnetic drive unit shall be fitted with all the devices designed for collective operation and subjected to the maximum stated torques where applicable (i.e. output shafts). The magnetic drive unit shall then be operated to record an equivalent volume of gas to that passing through the meter during the endurance test.

Where employed, mechanical indicating devices shall now be set so that all the drums are reading 9´s.

The maximum torque required to operate the devices and simultaneously rotate the drums of the indicating devices, where fitted, to all the 0´s shall now be measured and compared against the available torque of the magnetic drive unit.

## 6.7 Pressure and temperature tappings

### 6.7.1 Pressure tappings

#### 6.7.1.1 General

All pressure tappings shall be provided with means of plugging and sealing against unauthorized interference. The tapping design shall ensure that the connection does not protrude into the gas flow.

#### 6.7.1.2 Metering pressure tappings

##### 6.7.1.2.1 Requirements

At least one metering pressure tapping shall be provided to enable measurement of the static pressure that equals the static pressure at the turbine wheel of the meter at metering conditions.

This tapping shall be identified as "$p_m$". If more than one tapping marked with "$p_m$" is provided it shall conform to the requirements of 6.7.1.2.2.

##### 6.7.1.2.2 Individual test

The allowable difference in readings between metering pressure tappings shall not exceed 0.5mbar when the meter is tested at maximum flow rate with air at atmospheric conditions (±100 mbar).

#### 6.7.1.3 Dimensions

##### 6.7.1.3.1 Requirements

Circular tappings shall have a bore diameter of not less than 3 mm and not greater than 10 mm. The length of the bore shall be a minimum of one bore diameter.

Slit shaped tappings shall have a minimum dimension of 2 mm in the direction of flow and a minimum cross-sectional area of 10 $mm^2$. The cross-sectional area shall not exceed 80 $mm^2$. The length of the tapping shall be a minimum of one times the slit dimension in the flow direction.

##### 6.7.1.3.2 Type test

Confirmation that the pressure tappings meet the dimensional requirements of 6.7.1.3.1 shall be achieved using the engineering drawings and by visual inspection. If doubt exists confirmation will be obtained from metrological measurements.

### 6.7.2 Temperature tappings

#### 6.7.2.1 Requirements

Where temperature pockets, thermowells or sensors are provided within the meter, they are considered to be part of the meter. They shall be provided with means for sealing them against unauthorized interference or removal. They shall already be installed when the meter is calibrated. Where a thermometer pocket is provided in the meter, this shall be clearly marked with $t_m$.

#### 6.7.2.2 Tests

##### 6.7.2.2.1 Type test

Confirmation that the requirements for temperature tappings are met are achieved by visual inspection of the drawings.

#### 6.7.2.2.2 Individual test

If a thermometer pocket marked with $t_m$ is provided in the meter this shall be used during the individual meter testing (see Annex E) for the determination of the measuring temperature and the error calculation. If no pocket is provided, the measuring temperature shall be measured downstream of the meter for the individual meter testing. The place (distance) of the used temperature tapping shall be mentioned in the meter report (see D.2).



### 6.8 Lubrication

#### 6.8.1 Requirements

The design and construction of the meter shall be such that any lubrication necessary for satisfactory operation shall be either internally sealed, permanent and maintenance free or shall be in the form of an external applicator.

Where external lubricators are supplied they shall provide reliable means of applying the correct amount and type of lubricant during operation of that meter.

When applied correctly, lubrication shall not affect permanently the operation or performance characteristics of the meter whether applied automatically or manually.

The correct grade of lubricant shall be marked on the meter, close to the injection point or any other special operating conditions advised by the manufacturer.

The lubricant pump shall be able to overcome the maximum pressure for which the meter is rated and deliver the proper amount of lubricant when operated with external force of less than 100 N.

The lubrication system shall be designed to ensure that water ingress is not possible under normal operating conditions.

#### 6.8.2 Type test

With the lubricant pump fitted and filled with the correct grade of lubricant, the meter shall be run up to $Q_{min}$ and the error of registration shall be noted. The lubricant pump shall then be operated in accordance with the manufacturer's instructions and the error of registration of the meter shall be noted again. A negative shift in error of up to 2 % indicates that the lubricant has reached the bearings. The meter shall then be run at $Q_{max}$ for a duration of 1 h at the end of which the error shift at $Q_{min}$ shall be less than 1 %.

The lubricating system is assessed for protection against water ingress by reviewing the design drawings supplied by the manufacturer.

## 7 Meter output

### 7.1 General

The output of the turbine meter consists of a mechanical indicating device integrating the volume flow through the meter. The indicating device is an integral part of the meter. In addition, an electrical pulse signal or one or several rotating shafts may be present as outputs for the meter.

The indicating device shall operate satisfactorily and shall remain legible for the normal life of the meter under normal conditions of use and shall be visually inspected to ensure that it complies with the appropriate clauses of 7.2 to 7.5.

If turbine meters have been fitted with pulse generators these devices are regarded as an integral part of the gas meter.

## 7.2 Indicating device

### 7.2.1 General

A turbine meter shall be equipped with a non-resettable and non-volatile indicating device directly indicating the volume of gas measured at metering conditions and expressed in cubic metres.

### 7.2.2 Capacity

The number of numerals in an indicating device shall be such that the device can show a throughput equal to at least 8 000 h of operation at the maximum flow rate without passing twice to the same indication.

### 7.2.3 Unit of indication

The unit of indication shall be clearly and unambiguously stated on the indicating device (i.e. $m^3$).

Where the indicating device includes numerals showing decimal submultiples of the cubic metre, these numerals shall be separated by a clear decimal sign from those showing cubic metres. The numerals after the decimal sign shall be clearly distinguished from those in front of the decimal sign, e.g. shall be surrounded by a red visor.

In cases in which the last numeral indicates in decimal multiples of a cubic metre the face plate shall bear:

a) either one or more fixed zeros, as appropriate, after the last numeral, or

b) the marking: x10, x100, etc.

in such a way that the reading is always made in cubic metres.

### 7.2.4 Readability

The indicating device shall be easily readable without the use of tools.

The minimum height of the numerals shall be 4 mm and the minimum width shall be 2,4 mm.

It shall be possible to read the indicating device clearly and correctly within an angle of 15° from normal to the window or display.

An indicating device shall have drums, the diameter of which shall be at least 16 mm.

A complete revolution of a drum shall, during the last tenth of its travel, i.e. from 9 to 0, cause the advance of the next higher drum by one unit.

### 7.2.5 Adjustment

It shall be possible to adjust the transmission ratio between the metering mechanism and the indicating device in graduations of a maximum of 0,3 % to minimize the error of indication.

## 7.3 Pulse generator

### 7.3.1 General

A meter may be equipped with a device capable of generating electrical pulses. These devices are called pulse generators for the purpose of this document and are usually in the form of:

— voltage free contacts;

— proximity switches, etc.

All impulse generators shall be provided with the means of sealing against unauthorized interference.

Pulse generators shall be in accordance with EN 60947-5-6:2000 to fulfil the electromagnetic compatibility requirement for the level indicated by the manufacturer.

If pulse generators are operated magnetically provision shall be made to prevent or detect tampering or interference by external magnetic fields.

The pulse value shall be calculated with at least six significant digits from the transmission ratio between the indication of the gas meter and the location where the pulses are generated.

The manufacturer shall provide documentation by which the calculation of the pulse value can be checked.

The turbine meter shall be designed in such a way that, prior to initial error of indication check taking place, the calculated pulse value as specified can be compared with the indicating device with an uncertainty not greater than 0,05 %.

A meter can be fitted with a pulse generator. When fitted, this pulse generator shall provide pulses per $10^n$ $m^3$ ($n$ being a positive or negative integer number or zero) with a maximum frequency of 1 Hz at $Q_{max}$.



### 7.3.2 Electrical specifications for pulse generators

#### 7.3.2.1 General

The use of a pulse generator shall allow appropriate intrinsic safe operation according to EN IEC 60079-0:2018 and EN 60079-11:2012.

#### 7.3.2.2 Electrical specifications for high frequency pulse generators

When the meter is fitted with a high frequency output the high frequency signal at $Q_{max}$ shall be in the range of 0,3 kHz to 4 kHz.

Pulse generators shall be in accordance with EN 60947-5-6:2000.

#### 7.3.2.3 Electrical specifications for voltage free contacts

##### 7.3.2.3.1 Requirements

Voltage free contacts shall comply with EN 62246-1:2015. At any flow passing through the meter, the open and close time shall be greater than 200 ms. Voltage free contacts shall operate satisfactorily over a period of at least one year at maximum flow condition.

##### 7.3.2.3.2 Type tests

The voltage free contact is connected to a generator providing the following electric conditions:

— Voltage at open position (10 ± 0,5) V;

— Current at close position (10 ± 0,5) mA;

— Resistive load.

The test shall be carried out with the actual configuration (e.g. magnet, position) with a frequency of operations < 10 Hz.

The test shall be carried out during a number of operations equivalent to a period of at least one year at maximum flow condition.

After completion of the above tests, 5 sets of operations of the sensor (actuator) are performed at a voltage of 1 V using a source with a resistance of 1 000 Ω. The actuator resistance shall vary from above 1 000 Ω with one operation of the device to below 10 Ω.

### 7.3.3 Electrical connections

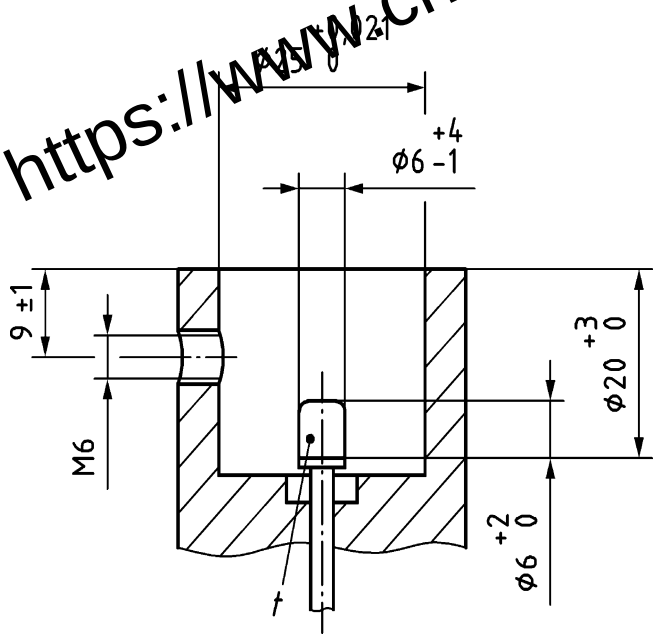
All connections shall be fitted with a protection cap which cannot be detached from the meter. Meters shall be capable of being fitted with electrical shielded wiring. Connections shall have a minimum protection class of IP 65 (EN 60529:1991).



## 7.4 Output shaft

A turbine meter may be fitted with output shafts to drive removable accessories.

Mechanical drive couplings on the output shaft shall comply with the dimensions given in Figure 3.




**Key**

1 $t$ = thickness

**Figure 3 — Output shaft coupling**

The output shaft of the meter shall rotate in a clock-wise direction when looking at the shaft.

## 7.5 Test element

### 7.5.1 General provisions

A meter shall be designed in such a way that its metrological performance can be tested with sufficient accuracy in a reasonably short time. For this purpose the meter shall be designed either with a built-in test element or with arrangements permitting the use of an external test unit. This test unit shall not affect the metrological performance of the meter.

### 7.5.2 Test element in case of mechanical indicating device

The built-in test element may consist of the least significant element of the indicating device in the form of a continuously moving drum bearing a scale.

The scale spacing shall not be less than 1 mm and shall be constant throughout the entire scale.

The scale interval shall be in the form $1 \times 10^n$, $2 \times 10^n$ or $5 \times 10^n$ $m^3$ ($n$ being a positive or negative integer number or zero).

The scale marks shall be fine and uniformly drawn.

In the case where the scale interval is in the form $1 \times 10^n$ or $2 \times 10^n$ $m^3$ all the lines representing multiples of 5, and where the scale interval is in the form of $5 \times 10^n$ $m^3$ all the lines representing multiples of 2, shall be distinguished by being longer than the other lines.

The test element may be provided with a mark of sufficient size and contrast to allow automatic photoelectric scanning. Where the test element is in the form of the least significant moving drum the scale mark shall not obscure the graduation and its presence shall not be detrimental to the accuracy of reading.



#### 7.5.3 Pulse generator used as test element

An add-on pulse generator may be used as a test element if it complies with the requirements of 7.3.

## 8 Marking

### 8.1 General

The following marks and inscriptions shall be affixed to the meter distinctly grouped together. These markings shall be directly visible, easily legible and indelible under normal conditions of use of the meter. The meter shall have adequate facilities for the affixing of the CE marking of conformity and/or inscriptions. These shall be such that it is impossible to remove the mark and inscriptions without damaging them and that the mark and inscriptions are visible when the meter is in its regular working position.

### 8.2 Data plate

Each meter shall bear, in a group, on a data plate, at least the following information:

a) the CE type approval mark and number(s), if appropriate;

b) manufacturer's trade mark and/or trade name;

c) the serial number of the meter and its year of manufacture;

d) the maximum allowable pressure: $PS$ = … bar;

e) The design temperature range: $TS$ = … to … °C;

f) the maximum flow rate: $Q_{max}$ = ...$m^3$/h;

g) the minimum flow rate: $Q_{min}$ = ...$m^3$/h;

h) the operating temperature range $t$ = ... – ... °C;

i) the working/operating pressure range: $p$ = ... – ...bar;

j) nominal diameter: DN

k) nominal pressure: PN

l) the number of this document, EN 12261:2024;

m) accuracy class.

### 8.3 Direction of flow

The direction of flow shall be shown on the meter by means of an indelible arrow.

### 8.4 Working position

The meter shall be marked with the permissible mounting/working positions using the nomenclature shown in Table 11.

**Table 11 — Nomenclature for mounting/working positions**

| Nomenclature | Permissible mounting/working positions |
|---|---|
| VD | Flow vertically down |
| VU | Flow vertically up |
| H | Flow horizontally |
| HV | Flow horizontally or vertically up or down |



### 8.5 Other connections

#### 8.5.1 General

Drive shaft, electrical pulse generator, pressure and temperature tappings shall be clearly and indelibly marked.

#### 8.5.2 Pressure tappings

The metering pressure tapping shall be marked "$p_m$". Where additional tappings, other than $p_m$ tappings are provided, these shall be clearly marked "*p"*.

#### 8.5.3 Pulse generators

If the turbine meter is fitted with an electrical pulse generator the number of pulses per cubic metre shall be indicated on the meter or on the indicating device.

Each pulse generator has to be labelled. It shall contain at least the type of generator, the pulse value given and the wiring diagram.

The pulse value shall comprise at least six significant figures.

If the pulse value is an exact multiple of 10, the decimal zeroes may be omitted.

#### 8.5.4 Output shafts

If the meter is fitted with an output shaft, the value per revolution is expressed as:

1 tr = …$m^3$, the maximum permissible torque in the form of: $M_{max}$ = …N·m and an arrow indicating the direction of rotation shall all be marked on or adjacent to the shaft.

## 9 Documentation

### 9.1 General

The following information shall be provided with each meter or group of meters used in the same location.

### 9.2 Documentation related to the manufacturer's tests

Inspection certificate and/or material certificate shall be in accordance with EN 10204.

### 9.3 Declaration of conformity

The manufacturer shall provide a declaration of conformity to this harmonized Standard and all relevant Directives.

### 9.4 Instruction manual

The operating instructions shall be available in written form or electronic format and shall identify the name and address of the manufacturer and the date of issue.

Each meter, or group of meters, shall be delivered with installation, operation and maintenance manuals, in a language acceptable by the user and easily understandable, giving appropriate information on:

— safe use;

— gas family;

— rated operating conditions;

— mounting;

— possible installation positions;

— mechanical and electromagnetic environment classes;

— safety requirements concerning commissioning and de-commissioning procedures;

— safety requirements on filling/discharge of gas of/from the meter;

— statement if a maintenance is possible and a relevant instruction;

— hazards arising from misuse and particular features of the design when appropriate;

— way of controlling the proper installation and functioning;

— conditions for compatibility with interfaces;

— provisions, if any, for transport and handling;

— how to trace the right spare parts;

— storage requirements for spare parts if relevant.

# Annex A
(normative)

# Test facility specifications



## A.1 Test medium

The test medium shall be clean and free from dust and oil.

If air at atmospheric conditions (±100 mbar) is used as a test medium, the relative humidity shall be such that condensation is avoided at all times.

If natural gas is used as test medium, no condensates or other liquids shall be present in the gas.

## A.2 Leakage

Periodically the test facility shall be tested extensively for external and internal leakage. These leakage tests shall be performed with the minimum or maximum operating pressure of the test facility whichever is applicable. The test facility is deemed to be leaktight if the rate of leakage is less than 0,1 % of the minimum flow rate for which it is intended to be used.

## A.3 Installation conditions

The performance of the meter shall not be influenced by the installation conditions at the test facility. This means that the test shall be carried out with an undisturbed axis-symmetric, swirl free flow profile.

If meters are to be tested in series there shall be no interaction between the meters.

## A.4 Reference standards

The test facility shall be equipped with reference standards that are suitable for the calibration of meters. The rangeability of the reference standards shall match that of the meters to be calibrated.

The reference standards and all secondary instruments used to measure parameters that enter into the calculation of the meter error shall have calibration certificates traceable to the international standards of mass, length, time and temperature. The certificates shall cover the range for which the instruments are used and shall report their calibration uncertainty.

The test facility shall be able at all times to specify the uncertainty in the determination of the meter error. The uncertainty shall be calculated according to ISO/IEC Guide 98-3:2008. The overall uncertainty of the testing shall be less than one third of the maximum permissible error provided in Table 4.

The uncertainty of the test facility shall be taken into account explicitly when assessing the metrological performance of the meter. For determining the error of indication (5.2.1 and E.3) the full uncertainty shall be used. For other tests, determining influences on the meter performance, using the reproducibility is sufficient.

# Annex B
(normative)

# Perturbation testing



## B.1 General

If the gas at the meter inlet has significant swirl the turbine wheel speed can be influenced. A swirl at the turbine wheel in the direction of the rotation can increase the turbine wheel speed, whereas a swirl in the opposite direction may decrease the turbine speed. For high accuracy flow measurement such a swirl effect shall be reduced to an insignificant level by proper installation of the meter.

The gas turbine meter is designed for and calibrated under a condition which approaches uniform velocity profile at the meter inlet. In the case of a significant deviation from this, the turbine wheel speed at a given flow rate can be affected by the actual velocity profile at the turbine wheel. For a given average flow rate, generally, a non-uniform velocity profile results in a higher turbine wheel speed than a uniform velocity profile. For high accuracy flow measurement, the velocity profile at the turbine wheel shall be made essentially uniform by proper installation of the meter.

The following provides standardized tests to assess the effects of disturbed flow profiles on the meter.

## B.2 Terms and definitions

For the purposes of this normative annex, the following terms and definitions apply.

**B.2.1**

**low level perturbation**

perturbation caused by piping elements such as bends, tees, convergent and divergent sections

**B.2.2**

**high level perturbation**

perturbation caused by regulators or other throttling devices

## B.3 Requirements

### B.3.1 Low level perturbation

The influence of perturbations is determined by measuring the error of indication in non-perturbed conditions, in accordance with 5.2.1, and in perturbed conditions as described in B.4.1.1, both at atmospheric conditions (±100 mbar). The difference between the errors of indication in both situations (non-perturbed and perturbed), the so-called error shift, shall be less than one third of the maximum permissible error of Table 4.

If this requirement is met, the installation will require no additional lengths of upstream pipe, if only low level perturbations occur at a distance of 2 D or more upstream of the meter inlet. However, if this requirement is not met, the test described in B.4.1.2 shall be carried out. The test has to be continued until the above mentioned requirement for error shift is met.

The piping configuration and/or elements required to meet this requirement shall be noted and specified by the manufacturer. They are part of the “meter package” to be installed at a distance of 2 *D* downstream of the low level perturbation.

### B.3.2 High level perturbation

When tested in perturbed conditions, as described in B.4.2.1, the error shift, as specified in B.3.1, shall be less than one third of the maximum permissible error (of Table 4). If this requirement is met, the installation will require no additional lengths of upstream pipe, if only high level perturbations occur at a distance of 2 *D* or more upstream of the meter inlet. If this requirement is not met, the test described in B.4.2.2 shall be carried out in the same manner as described in B.3.1.

The piping configuration and/or elements required to meet this requirement shall be noted and specified by the manufacturer. They are part of the "meter package" to be installed at a distance of 2 *D* downstream of the high level perturbation.

Because the high level perturbation flow profiles are not representative of all flow situations downstream of pressure regulators, great care is needed when drawing conclusions from the test B.4.2.2 in respect to pipework configurations downstream of regulators. Special consideration shall be given to dampening high velocity noise and swirl.



## B.4 Tests

### B.4.1 Low level perturbations

#### B.4.1.1 Piping elements installed 2 *D* upstream of the meter inlet

Fit the meter with one of the two piping configurations illustrated in Figure B.1A and Figure B.1B. These configurations consist of a pipe with nominal diameter $DN_1$ and length of 5 $D_1$, two elbows with radius equal to $D_1$ not in the same plane, and a concentric expander from $DN_1$ to DN and a length between 1 *D* and 1,5 *D*. This length shall result in an opening angle of between 4,5 degrees to 6 degrees for the expander of all sizes $DN_1$/DN.

The configuration chosen Is installed 2 *D* upstream of the meter inlet (Figure B.1C).

The values of $DN_1$ are listed in Table B.1.

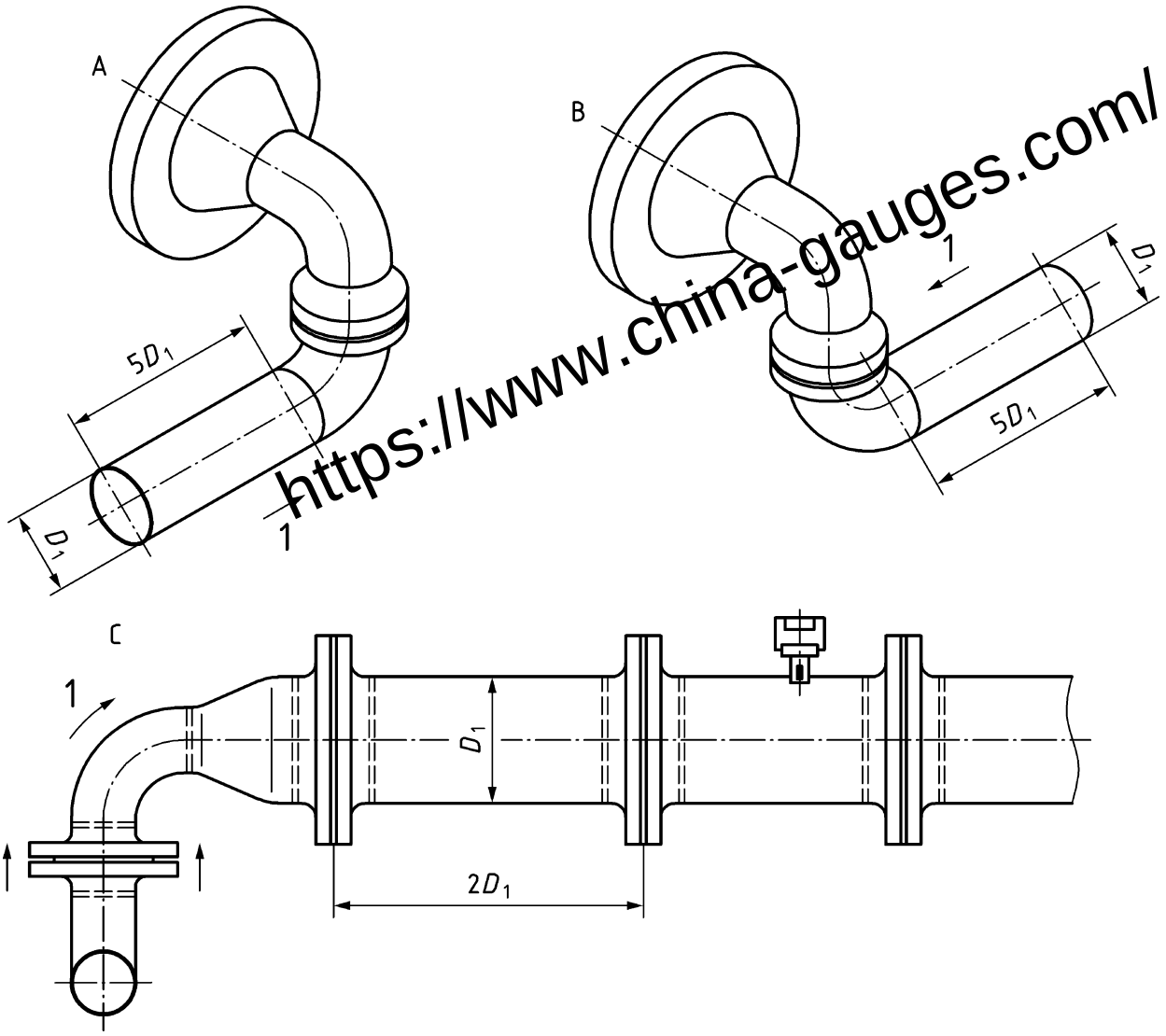
The test is carried out with air at atmospheric conditions (±100 mbar) at air flow rates of

$0{,}25 \cdot Q_{max}$, $0{,}4 \cdot Q_{max}$ and $Q_{max}$.

The above test is repeated using the second configuration, Figure B.1A or Figure B.1B.

**Table B.1 — The relations between $DN_1$ and DN**

| **DN**<br>**meter** | **$DN_1$**<br>**pipe** |
|---|---|
| 50 | 40 |
| 80 | 50 |
| 100 | 80 |
| 150 | 100 |
| 200 | 150 |
| 250 | 200 |
| 300 | 250 |
| 400 | 300 |
| 500 | 400 |
| 600 | 500 |
| 750 | 600 |
| 1 000 | 750 |






**Key**

1 flow

**Figure B.1 — Piping configurations for low level perturbation tests**

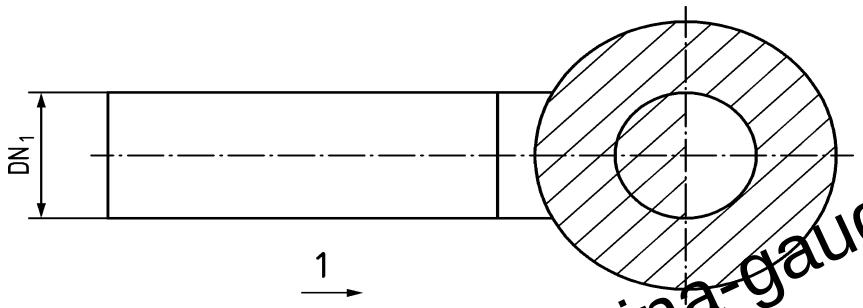
#### B.4.1.2 Piping elements installed greater than 2 *D* upstream of the meter inlet

If the error shift requirement specified in B.3.1 is not met, the tests shall be continued with the meter by incorporating a longer upstream straight pipe and/or flow conditioner, preferably of the types specified in EN ISO 5167-1:2022

### B.4.2 High level perturbations

#### B.4.2.1 Piping elements installed 2 *D* upstream of the meter inlet

Test the meter in accordance with B.4.1.1, but with a half-pipe area plate, as shown in Figure B.2, installed between the two elbows, with the opening toward the outside radius of the first bend.




**Key**
1 flow

**Figure B.2 — Location of half area opening for high level perturbation tests**



#### B.4.2.2 Piping elements installed greater than 2 *D* upstream of the meter inlet

If the error shift requirement specified in B.3.2 is not met, the tests shall be continued with the meter incorporating a longer upstream straight pipe and/or flow conditioner.

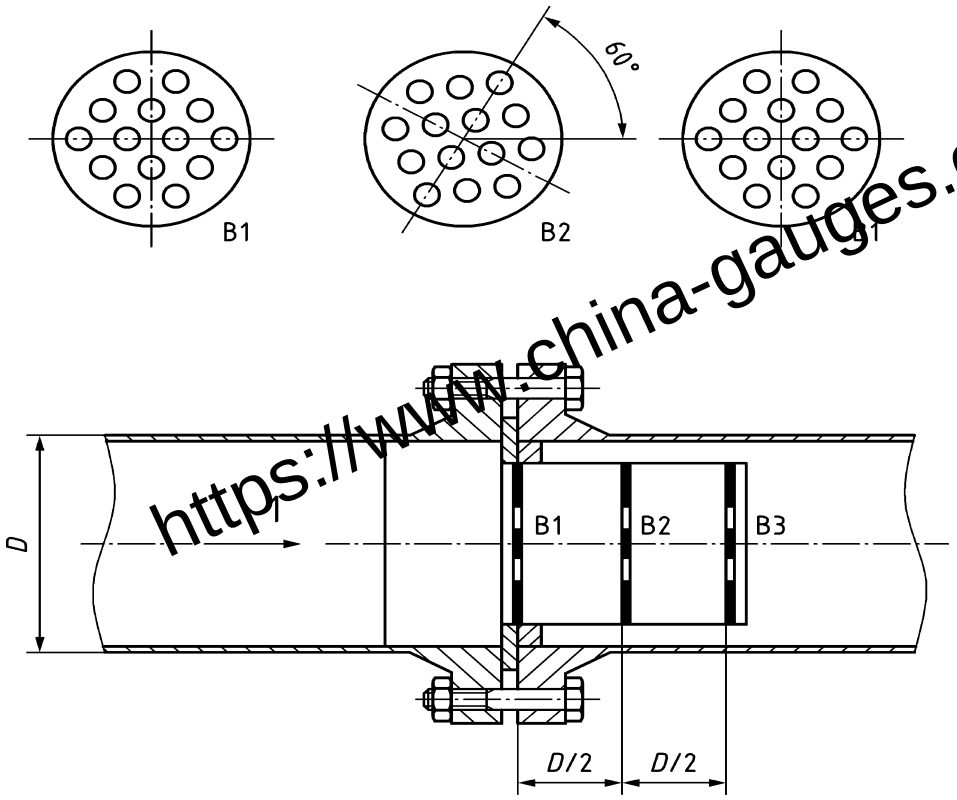
## B.5 Similarity

If similarity of design exists in the meter inlet section for various sized meters, a minimum of two meter sizes shall be tested, and if the results are similar, it can be assumed other meter sizes would produce the same results. Similarity can be assumed to exist if the design principle and the dimensions relevant to aerodynamic similarity remain constant over the range of meter sizes. The use of other materials will require additional tests.

## B.6 Flow conditioner

For piping systems having an unknown potential influence on meter performance, it is recommended that a flow conditioner is installed. This could be of a type as shown in Figure B.3 installed with a minimum distance of 4 *D* between the conditioner outlet and the meter inlet. A flow conditioner of this type causes a relatively large pressure loss. In those cases where the pressure loss across the flow conditioner in Figure B.3 cannot be tolerated, other types of flow conditioner e.g. as described in EN ISO 5167-1:2022 and as shown in Figure B.4 may also be used.

Free area = 20 % of pipe area. For this area ratio the pressure loss at $Q_{max}$ is approximately 0,07 times the static pressure for a nominal pipe diameter DN and for a relative density of the gas of 0,64. The hole pattern will be such that the holes on adjacent plates do not form a straight through path for the flowing fluid. The plates are attached to a sleeve so all fluid has to pass through the perforated plates.

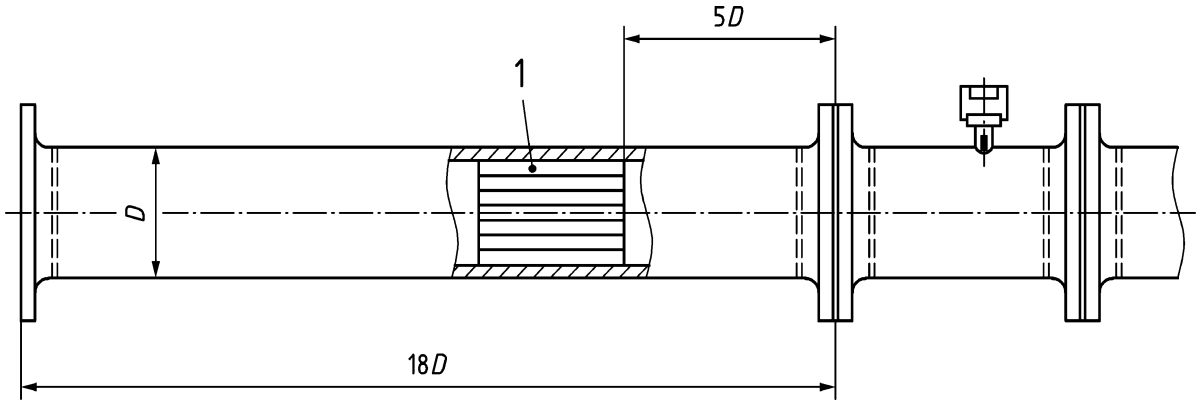





**Key**

1 flow

**Figure B.3 — Flow conditioner to damp out high level perturbation**




**Key**

1 flow conditioner

The straight lengths specified are minimum values.

**Figure B.4 — Alternative flow conditioner configuration to damp out high level perturbation**

# Annex C
(informative)

# Recommendations for use



## C.1 Pressure loss

The pressure loss of a meter is determined by the energy required for driving the meter mechanism, the losses due to the internal passage friction and changes in flow velocity and direction.

The pressure loss approximately follows the turbulent flow loss relationship (except at very low flow rates).

$$\Delta p_{\mathrm{m}} = c \cdot \rho_{\mathrm{m}} \cdot Q_{\mathrm{m}}^2$$

where

$\Delta p_{\mathrm{m}}$ is the pressure loss, in mbar;

$c$ is the pressure loss coefficient depending on meter type;

$\rho_{\mathrm{m}}$ is the density at the metering conditions, in kg/m³;

$Q_{\mathrm{m}}$ is the volume flow rate at metering conditions, in m³/h.

From the pressure loss at specified conditions and from the equation of state of a real gas, it follows:

$$\Delta p_{\mathrm{m}} = \Delta p_{\mathrm{s}} \frac{\rho_{\mathrm{m}} \cdot Q_{\mathrm{m}}^2}{\rho_{\mathrm{s}} \cdot Q_{\mathrm{s}}^2}$$

where

$\rho_{\mathrm{s}}$ is the density at specified conditions, kg/m³;

$Q_{\mathrm{s}}$ is the volume flow rate at specified conditions, m³/h.

## C.2 Spin test

The spin test determines the relative level of the mechanical friction present in the meter. If the mechanical friction has not significantly changed, the meter area is clean and the internal portions of the meter show no damage, the meter shall display no change in accuracy. If the mechanical friction has increased significantly, this indicates the accuracy characteristics of the meter at low flow rates have deteriorated. Upon request, typical spin times for meters are provided by the manufacturer.

The spin test is conducted in a draught-free area with the measuring mechanism in its normal working position. The turbine wheel is rotated at a reasonable speed with a minimum speed of approximately 1/20 of the rated speed corresponding to that at $Q_{\mathrm{max}}$ and is timed from initial motion until the turbine wheel stops. Spin tests shall be repeated at least three times and the mean average time taken. The usual cause for a decrease in spin time is increased turbine wheel shaft bearing friction. It shall be noted, however, that there are other causes of mechanical friction which affect spin time such As heavily lubricated bearings, low ambient temperature, draughts and attached accessories.

NOTE Other methods of conducting a spin test are possible as long as the method is specified.

## C.3 Locations of temperature measuring devices

Temperature measuring devices in the adjacent pipework should preferably be located downstream of the meter at a distance so that they do not affect the performance of the meter.

# Annex D
(normative)

# Individual factory testing



## D.1 General

Each meter shall be checked during manufacture, according to the Manufacturer's Quality Assurance System.

Individual meter testing, prior to dispatch, shall be carried out according to the checklist in Table D.1.

**Table D.1 — Checklist for the individual meter**

| Subject | Clause |
|---|---|
| Error of indication | E.3 |
| Linearity | E.4 |
| Pressure range | E.2 |
| Calculation of *WME* | E.5 |
| Adjustment | E.5.3 |
| Check on adjustment | E.5.3.2 |
| Strength test | 6.2.4.3 |
| Leakage test | 6.2.5.3 |
| Pressure tappings | 6.7.1.2.2 |
| Temperature tappings | 6.7.2.2.2 |
| Marking | 8 |

## D.2 Meter report

A meter report shall be issued by the manufacturer for each meter, in which all results according to Table D.1 are stated.

# Annex E
(normative)

# Metrological requirements and tests for each meter prior to dispatch (Individual meter testing)



## E.1 Information required from the purchaser (user)

The foreseen operating conditions, i.e. user's specified operating pressure (or range) and type of gas used, shall be made available.

## E.2 Determination of number of tests

### E.2.1 Criteria

a) For meters specified by the purchaser to be operating at pressures lower than or equal to 4 bar, a single test is required at atmospheric conditions (±100 mbar). Meters meeting the requirements E.3.1, E.4.1 and E.5.1, are deemed to perform within their metrological characteristics for the operating pressure range 0 bar to 4 bar.

b) For meters specified by the purchaser to be operating at pressures exceeding 4 bar, one or more tests are required.

   1) If the upper limit of the user's specified operating pressure range is less than or equal to four times that of the lower limit of the user's operating pressure range, only one test at $p_{test}$ is required. Meters meeting the requirements E.3.1, E.4.1 and E.5.1, are deemed to perform within their metrological characteristics for the operating pressure range 0,5 $p_{test}$ to 2,0 $p_{test}$.

      Where:

      $p_{test}$ = the metering pressure during individual meter testing, expressed as gauge pressure.

      EXAMPLE 1: (only one test is required)

      If the purchaser specifies an operating pressure of 5 bar, the meter is tested at $p_{test}$ = 5 bar . The meter is then suitable for a operating pressure range of 2,5 bar to 10 bar.

      EXAMPLE 2: (only one test is required)

      If the purchaser specifies an operating pressure in the range of 15 bar to 35 bar , the meter is tested at $p_{test}$ = 20 bar. The meter is then suitable for a operating pressure range of 10 bar to 40 bar.

   2) If the upper limit of the user's specified operating pressure range is greater than four times that of the lower limit of the user's operating pressure range, two tests at $p_{test,min}$ and $p_{test,\ max}$ are required. Meters meeting the requirements E.3.1, E.4.1 and E.5.1 are deemed to perform within their metrological characteristics for the operating pressure range 0,5 · $p_{test,min}$ to 2,0 · $p_{test,\ max}$.

      Where:

      $p_{test,\ min}$ resp. $p_{test,\ max}$ = the metering pressures during individual meter testing expressed as gauge pressure

EXAMPLE 3: (two tests are required)

If the purchaser specifies an operating pressure in the range of 3 bar to 15 bar bar, two tests are required. However, there is more than one way of satisfying these conditions. If the meter is tested at $p_{test,min}$ = 4 bar and $p_{test,\ max}$ = 8 bar, the meter is then suitable for a operating pressure range of 2 bar to 16 bar. If the purchaser specifies an operating pressure in the range of 3 bar to 15 bar, but advises that the meter will normally be operating at 10 bar, one of the tests shall be carried out at $p_{test,min}$ = 4 bar and the other at $p_{test,max}$ = 10 bar. The meter is then suitable for a operating pressure range of 2 bar to 21 bar.

Further tests shall be performed if specified by the purchaser.



## E.3 Error of indication

### E.3.1 Requirements

The error of indication of the meter shall be at least within the maximum permissible errors specified in Table 4, taking account of Table 5.

In order to ensure that the gas meter does not exploit the MPEs or systematically favour any party, each meter shall be adjusted so that the *WME* is as close to zero as the adjustment and the maximum permissible errors will allow.

The *WME* shall have a value between −0,4 % and +0,4 %.

The *WME* is calculated as follows:

$$WME = \frac{\sum \left( Q_i \ / \ Q_{\max} \right) \cdot E_i}{\sum Q_i \ / \ Q_{\max}}$$

where

$Q_i/Q_{max}$ is a weighting factor;

$E_i$ is the error of indication at the flow rate $Q_i$ given as a percentage.

When $Q_i = Q_{max}$ a weighting factor of 0,4 instead of 1 shall be used.

If tests at more than one pressure are carried out (see E.3.2), the difference between the results of the tests between $0{,}25 \cdot Q_{max}$ and $Q_{max}$ shall not exceed 0,5 % for meters with DN > 100 or 1,0 % for meters with DN ≤ 100.

### E.3.2 Test

The test shall be carried out with the meter in a permissible mounting position, as determined by the type test. The test is carried out after a sufficient long run-in period. This period is specified by the manufacturer.

The test consists of determining the error of indication of the meter at the flow rates given in Table 6. This test shall be carried out in a suitably accredited test facility (see Annex A).

For a meter specified for measurement at a pressure lower than or equal to 4 bar, only one error of indication test is required with a gas at atmospheric conditions (±100 mbar).

For a meter specified for measurement in a pressure range extended above 4 bar, at least one error of indication test is carried out with a gas at a pressure as close as possible to the foreseen operating pressure. This pressure shall be specified by the purchaser and shall be within the user's specified operating pressure range, as defined in E.2.1 b). It shall also be within the operating pressure range of the meter.

In case of two errors of indication tests (see b.2) of E.2.1 both metering pressures and corresponding user's operating pressure range shall be within the operating pressure range of the meter.

For specified maximum operating pressures above 50 bar, the test may be carried out at a minimum pressure of 50 bar.



## E.4 Linearity

### E.4.1 Requirements

For the test flow rates from 0,25 · $Q_{max}$ to $Q_{max}$ at each test pressure the differences between the highest and the lowest error of indication shall not exceed the values specified in Table 7.

### E.4.2 Test

In order to assess if the linearity requirement is fulfilled the values of the errors found at each flow rate according to E.3.2 are taken.

## E.5 *WME*

### E.5.1 Requirement

The *WME* for each $p_{test}$ shall have a value between −0,4 % and +0,4 %.

### E.5.2 Test

The error figures for the calculation of *WME* shall be the ones obtained in E.3.2, taken into account separately for each $p_{test}$.

The *WME* is calculated as follows:

$$WME = \frac{SUM\left(Q_i \,/\, Q_{max}\right) \cdot E_i}{SUM\left(Q_i \,/\, Q_{max}\right)}$$

where

$Q_i/Q_{max}$ is a weighting factor;

$E_i$ is the error of indication at the flow rate $Q_i$ given as a percentage.

When $Q_i = Q_{max}$ a weighting factor of 0,4 instead of 1 shall be used.

### E.5.3 Adjustment

#### E.5.3.1 Requirement

For meters that only required one test, the meter shall be adjusted so that the *WME* is as close to zero as the adjustment steps and the maximum permissible error allow.

When the meter has been tested at different pressures, the error figures used for the calculation of *WME* for the purpose of adjustment, shall be those obtained at the pressure closest to the specified operating pressure. In the case of no preferred operating pressure specified, two *WME* values are required. Using the values from E.3.2, an error of indication curve shall be plotted over the Reynolds Number range. The approximation of zero shall be fulfilled by displacing the curve with the arithmetic mean of the two *WME* values.

#### E.5.3.2 Test

The adjustment shall be checked by repeating the test under E.3.2 at one flow rate. The other new $E_i$ values can be calculated from the previously measured $E_i$ values under E.3.2.

## E.6 Data plate specification

In case of meeting the requirements E.3.1, E.4.1 and E.5.1 the operating pressure range shall be specified on the data plate as:

a) for a meter specified for measurement in a pressure range lower than or equal to 4 bar: 0 bar to 4 bar;

b) for a meter specified for measurement in a pressure range extended above 4 bar:

   — if only one test is performed on the meter: $0{,}5 \cdot p_{test}$ to $2{,}0 \cdot p_{test}$, or

   — if two tests are performed on the meter: $0{,}5 \cdot p_{test,\,min}$ to $2{,}0 \cdot p_{test,\,max}$.



## E.7 Test certificate

A test certificate shall be issued. The test certificate shall include the following information:

— the name and location of the test facility;

— the method of testing (bell prover, sonic nozzle, other meters, ...);

— the serial number of the meter;

— the error of indication figures;

— the estimated uncertainty of the method;

— the nature and conditions (pressure, temperature, density) of the test gas;

— the mounting position of the meter during the test;

— adjustment gear wheels, pulse values.

# Annex F
(normative)

# Compliance evaluation for gas meters



## F.1General

Manufacturers shall have procedures to ensure the final product when placed on the market is fit for purpose and will perform satisfactorily over its life.

## F.2Quality Management System

### F.2.1 General

An organization producing meters to comply with this document shall operate a Quality Management System.

For meters certified in compliance with this document, a compliance evaluation shall be undertaken in accordance with F.2.2.

### F.2.2 Compliance evaluation

Individual production meters shall be subjected to final assessment, which shall include a visual examination of the meter and accompanying documents to ensure compliance with this document, e.g. appropriate test certificates.

For each series of meters the manufacturer shall carry out:

— the tests as detailed in Annex D;

— a permanent internal control of production using a quality management system.

Furthermore, the manufacturer shall retain and file which includes:

— the material certificates for all pressure containing parts;

— the NDT reports and the inspection certificate

for a period of at least 10 years from the delivery of the meter.

A copy of these certificates shall be made available to the purchaser if requested in the order specification.

### F.2.3 Issue of the certificate of compliance

If the series of meters complies with this document a “certificate of compliance” shall be issued.

# Annex G
(informative)

# Materials for pressurized parts



The steel materials listed in Table G.1 with the restrictions listed in the last 3 columns of the same table, are suitable for the design of pressure containing parts of meters complying with this European Standard.

**Table G.1 — List of materials for pressure containing parts and relevant standards**

| Materials | | | Restrictions | | |
|---|---|---|---|---|---|
| | | | Meter body | | |
| Group | Type | Relevant standard | Operating temperature | | *PS* max |
| | | | −10 °C to 60 °C | −25 °C to 70 C | bar |
| **Pressure containing parts** | | | | | |
| Rolled and forged steel | P235GH / 1.0345, P265GH / 1.0425, P295GH / 1.0481, P355GH / 1.0473 all with thickness ≤ 150 mm | EN 10028-2:2017 | x | | 100 |
| | P275NH / 1.0487, P355NH / 1.0565 with thickness ≤ 150 mm, P355NL1 / 1.0566 with thickness ≤ 150 mm | EN 10028-3:2017 | | x | |
| | P355QH1 | EN 10028-3:2017 | | x | |
| | All types | EN 10028-4:2017 E N 10028-5:2017 | | x | |
| | All grades from P355 to P50 with thickness ≤ 150 mm | EN 10028-6:2017 | | x | |
| | All steel designation with $A_{min}$ ≥ 16 % | EN 10028-7:2016 | | x | |
| | All steel designations with $A_{min}$ ≥ 16 % and at −20 °C KV 27 J av. of three and 20 J min | EN 10222-1:2017 | | | |
| | 1) 355NH −20 °C KV 47 J<br>2) S355J2+N −20 °C and −50 °C 27 J | EN 10222-1:2017 | | | |
| | All steel designations martensitic type | EN 10222-5:2017 | x | | |
| | All steel designations austenitic type | | | x | |
| | All steel designations with $A_{min}$ ≥ 16 %, and at −20 °C | EN 10272:2016 | | x | |

| Materials | | | Restrictions | | |
|---|---|---|---|---|---|
| Group | Type | Relevant standard | Meter body | | |
| | | | Operating temperature | | PS max |
| | | | −10 °C to 60 °C | −25 °C to 70 °C | bar |
| | KV 27 J av. of three and 20 J min | | | | |
| Cast Steel | All steel designations | EN 10213:2007+A1:2016 | | x | 100 |
| | S235JR / 1.0037 with thickness ≤ 40 mm, S275JR / 1.0044 with thickness ≥ 1,5 mm, S355JR / 1.0045 with thickness ≥ 1,5 mm | EN 10025-2:2019<br>EN 10025-3:2019<br>EN 10025-4:2019+A1:2022<br>EN 10025-5:2019<br>EN 10025-6:2019+A1:2022 | | | 20 |
| | S235J2G3 / 1.0116 and S235J2G4 / 1.0117 both with nominal thickness ≤ 150 mm, S275J2G3 / 1.0144 and S275J2G4 / 1.0145 and S355J2G3 / 1.0570 all with 1,5 mm < nominal thickness ≤ 150 mm | EN 10025-2:2019<br>EN 10025-3:2019<br>EN 10025-4:2019+A1:2022<br>EN 10025-5:2019<br>EN 10025-6:2019+A1:2022 | | x | 20 |
| | S355J2+N<br>−20 °C KV 27 J<br>−50 °C KV 27 J | EN 10025-2:2019<br>EN 10025-3:2019<br>EN 10025-4:2019+A1:2022<br>EN 10025-5:2019<br>EN 10025-6:2019+A1:2022 | | x | 100 |
| | S275JO / 1.0143 and S355JO / 1.0553 both with 1,5 mm < nominal thickness ≤ 250 mm and at −20 °C KV 27 J av. of three and 20 J min | EN 10025-2:2019<br>EN 10025-3:2019<br>EN 10025-4:2019+A1:2022<br>EN 10025-5:2019<br>EN 10025-6:2019+A1:2022 | | x | 20 |
| Rolled and forged steel | 25CrMo4 / 1.7218 and 25CrMoS4 / 1.7213 both with 100 mm < $d$ ≤ 160 mm or 60 mm < $t$ ≤ 100 mm, 36CrNiMo4 / 1.6511 with $A_{min}$ = 16 %. All types shall be quenched and tempered (+QT) and with cast analysis $C$ ≤ 0,25 % or, when 0,25 % < $C$ ≤ 0,40, Ni ≥ 1 %. | EN ISO 683-1:2018<br>EN ISO 683-2:2018 | x | | 20 |

| Materials | | | Restrictions | | |
|---|---|---|---|---|---|
| Group | Type | Relevant standard | Meter body | | |
| | | | Operating temperature | | *PS* max. |
| | | | −10 °C to 60 °C | −25 °C to 70 °C | bar |
| | 36CrNiMo4 / 1.6511 quenched and tempered (+QT) with $A_{min}$ = 16 % and KV 27 J av. of three and 20 J min. at −20 °C. | | | x | |
| | All steel designations quenched and tempered (+QT) with $A_{min}$ ≥ 16 % and with cast analysis $C \leq 0{,}25$ %. | EN ISO 683-1:2018<br>EN ISO 683-2:2018 | x | | |
| | 11SMn30 / 1.0715,<br>11SMn37 / 1.0736,<br>11SMnPb30 / 1.0718,<br>11SMnPb37 / 1.0737 all with 16 ≤ $d$ ≤ 100 and $A_{min}$ = 16 % | EN 10277:2018 | x | | |
| | As above and types 35S20 / 1.0726, 35SPb20 / 1.0756, 36SMn14 / 1.0764, 36SMnPb14 / 1.0765, 38SMn28 / 1.0760, 38SMnPb28 / 10761, 44SMn28 / 1.0762, 44SMnPb28 / 1.0763, 46SPb20 / 1.0757 with KV 27 J av. of three and 20 J min at −20 °C | | | x | |
| | All austenitic steel designations with longitudinal $A_{min}$ ≥ 16 % and other steel designations with longitudinal $A_{min}$ ≥ 16 % and KV 27 J av. of three and 20 J min. at −20 °C | EN 10088-3:2023 | | x | |
| | DD11 / 1.0332,<br>DD12 / 1.0398,<br>DD13 / 1.0335 | EN 10111:2008 | x | | |
| | All steel designations used for skin- pass | EN 10130:2006 | x | | |
| | All steel designations with $A_{min}$ ≥ 16 % and at −20 °C KV 27 J av. of three and 20 J min | EN 10250-1:2022 | | x | |

| Materials | | | Restrictions | | |
|---|---|---|---|---|---|
| | | | Meter body | | |
| Group | Type | Relevant standard | Operating temperature | | PS max |
| | | | −10 °C to 60 °C | −25 °C to 70 °C | bar |
| | All steel designations with cast analysis $C \leq 0{,}25$ % and with longitudinal $A_{min} \geq 16$ % | EN 10250-2:2022 | x | | |
| | S235J2G3 / 1.0116, S355J2G3 / 1.0570 with $t_R \leq 500$ mm | | | x | |
| | All steel designations with $A_{min} \geq 16$ % except X30Cr13 / 1.4028 | EN 10250-4:2021 | x | | |
| | All austenitic grades | | | x | |
| Spheroidal graphite cast iron | EN-GJS400–18 / EN-JS1020, EN-GJS400–18-LT / EN-JS1025, EN-GJS400–15 / EN-JS1030, EN-GJS400–18U-LT / EN-JS1049 | EN 1563:2018 | | x | 20 |
| | A 395M | ASTM A 395/A 395M:1999 | | x | |
| | A 536 Grades 60–40–18 and 65–45–12 | ASTM 536:2019 | | x | |
| | A 874M | ASTM A 874/ A 874M:2018 | | x | |
| | 400–18, 500–7 | ISO 1083:2018 | | x | |
| | EN-GJS400–18-LT / EN-JS1025, EN-GJS-400–18U-LT / EN-JS1049 with wall thickness ≤ 60 mm | EN 1563:2018 | | x | |
| | EN-GJS400–15 / EN-JS1030, EN-GJS-400–18U-RT / EN-JS1059 with wall thickness ≤ 60 mm | | x | | |
| | 400–18L | ISO 1083:2018 | | x | |
| | 400–18 | | x | | |
| | A 395M | ASTM A 395/A 395M:1999 | x | | |
| | A 536 Grade 60–40–18 | ASTM A 536:2019 | x | | |

| Materials | | | Restrictions | | |
|---|---|---|---|---|---|
| Group | Type | Relevant standard | Meter body | | |
| | | | Operating temperature | | *PS* max. |
| | | | −10 °C to 60 °C | −25 °C to 70 °C | bar |
| Copper-zinc wrought alloys | All material designations with $A \geq 15$ % | EN 1652:1997 | | x | 20 |
| | All material designations with $A \geq 15$ % | EN 12164:2016 | | x | |
| | All material designations with $A \geq 15$ % | EN 12165:2016 | | x | |
| Copper-tin and copper-zinc cast alloys | Cu Sn5Zn5Pb5-B (CB491K) and CuSn5Zn5Pb5-C (CC491K) | EN 1982:2017 | | x | 20 |
| Aluminium wrought alloys | All metallurgic state and thickness for which $A_{min} \geq 4$ % | EN 485-2:2016+A1:2018 | | x | 20 |
| | All metallurgic state and dimensions for which $A_{min} \geq 4$ % | EN 586-2:1994 | | x | |
| | | EN 754-2:2016 | | x | |
| | All metallurgic state and thickness for which $A_{min} \geq 4$ % | EN 755-2:2016 | | x | |
| Aluminium wrought alloys | All metallurgic state and thickness for which $A_{min} \geq 7$ % | EN 485-2:2016+A1:2018 | | x | 20 |
| | All metallurgic state and dimensions for which $A_{min} \geq 7$ % | EN 586-2:1994 | | x | |
| | | EN 754-2:2016 | | x | |
| | All metallurgic state and thickness for which $A_{min} \geq 7$ % | EN 755-2:2016 | | x | |
| | All metallurgic state and thickness for which $A_{min} \geq 7$ % | EN 485-2:2016+A1:2018 | | x | |
| | All metallurgic state and dimensions for which $A_{min} \geq 7$ % | EN 586-2:1994 | | x | |
| | | EN 754-2:2016 | | x | |
| | All metallurgic state and dimensions for which $A_{min} \geq 7$ % | EN 755-2:2016 | | x | |

| Materials | | | Restrictions | | |
|---|---|---|---|---|---|
| Group | Type | Relevant standard | Meter body | | |
| | | | Operating temperature | | PS max |
| | | | −10 °C to 60 °C | −25 °C to 70 °C | bar |
| Aluminium cast alloys | All alloy designations with elongation ≥ 1,5 % | EN 1706:2020+A1:2021 | | x | 10 |
| | All alloy designations with elongation ≥ 1,5 | ASTM B 85/ B 85M:2018 | | x | |
| | All alloy designations with elongation ≥ 2 % | EN 1706:2020+A1:2021 | | x | 20 |
| | All alloy designations with elongation ≥ 4 % | EN 1706:2020+A1:2021 | | x | 20 |
| | All alloy designations with elongation ≥ 4 % | ASTM B 85/ B 85M:2018 | | x | |
| Pipes | Cu 999 | EN 1057:2006+A1:2010 | | x | 20 |
| | X6CrNiMoTi17–12–2 / 1.4571 | EN 10088-1:2023 | | x | 100 |
| | All grades | ASTM A 106/ A 106M:2019 | | x | |
| | TP 304, TP 304L, TP 316, TP 316L | ASTM A 213/ A 213M:2023 | | x | |
| | TP 304, TP 304L, TP 316, TP 316L | ASTM A 269:2022 | | x | |
| | TP 304 | ASTM A 312/ A 312M:2022 | | x | |
| | Grade 6 | ASTM A 333/ A 333M:2018 | | x | |
| Compression fittings | All steel designations in Table 5, 11SMn30 / 1.0715 with $A_{min}$ 8 % and $10 \leq d \leq 16$, 11SMnPb30 / 1.0718 and 11SMnPb37 / 1.0737 both with Amin 8 % and $5 \leq d \leq 100$ | EN ISO 683-4:2018 | | x | 100 |
| | All steel designations | EN 10088-3:2023 | | x | |
| | All steel designations | EN ISO 8434-1:2018 ISO 8434-2:2007 | | x | |
| | All grades | ASTM A 420/ A 420M:2022 | | x | |

| Materials | | | Restrictions | | |
|---|---|---|---|---|---|
| | | | Meter body | | |
| Group | Type | Relevant standard | Operating temperature | | *PS* max. |
| | | | −10 °C to 60 °C | −25 °C to 70 °C | bar |
| **Fasteners** | | | | | |
| Bolts, screws, studs and nuts | Class 10.9 | EN ISO 898-1:2013 | | x | 100 |
| | Class 10 | EN ISO 898-2:2022 | | x | |
| | All alloy groups and types with $A_{min}$ ≥ 9 % for bolts, screws and studs | ASTM F 593:2022 | | x | |
| | Class 4.6, 5.6, 8.8 | EN ISO 898-1:2013 | | x | 100 |
| | Grade A2ss, A4ss | EN ISO 3506-1:2020<br>EN ISO 3506-2:2020 | | x | |
| | Classes. 5, 8, 9 for nuts | EN ISO 898-2:2022 | | x | |
| | All grades | ASTM A 193/<br>A 193M:2023 | | x | |
| | All grades for nuts | ASTM A 194/<br>A 194M:2023 | | x | |
| | All classes and grades | ASTM A 320/<br>A 320M:2022 | | x | |
| | All alloy groups and types with $A_{min}$ ≥ 12 % for bolts, screws and studs | ASTM F 593:2022 | | x | |
| | All alloy groups | ASTM F 594:2022 | | x | |
| Rolled and forged steel | A 105M with chemical composition $C$ ≤ 0,25 %, A 105N (normalized) with hardness between 137HB to 187HB (supplementary requirements S1 and S2.4) | ASTM A 105/<br>A 105M:2023 | x | | 20 |
| | A 106 grade A 106 grade B with $C$ ≤ 0,25 % or hardness ≤ 187 HB | ASTM A 106/<br>A 106M:2019 | x | | |
| | F304/F316/F5a/F6a class 2 | ASTM A 182/<br>A 182M:2023 | | x | |
| | A 234M grades WPB, WPC and WP1 with chemical composition $C$ ≤ 0,25 % and all remaining grades | ASTM A 234/<br>A 234M:2023 | x | | |
| | All austenitic types | ASTM A 240/<br>A 240M:2023 | | x | |
| | All martensitic and ferritic types with KV 27 J av. of three and 20 J min. at −20 °C | | | x | |
| | A 266 grade 4 with chemical composition $C$ ≤ 0,25 % | ASTM A 266A/<br>A 266M:2021 | x | | |

| Materials | | | Restrictions | | |
|---|---|---|---|---|---|
| Group | Type | Relevant standard | Meter body | | |
| | | | Operating temperature | | PS max |
| | | | −10 °C to 60 °C | −25 °C to 70 °C | bar |
| | A 276 all austenitic grades | ASTM A 276:2017 | | x | |
| | A 333M all grades | ASTM A 333/ A 333M:2018 | | x | |
| | A 350M LF2 class 1, LF3, LF5 classes 1 and 2, LF6 classes 1 and 2, LF9, LF787 classes 2 and 3 | ASTM A 350/ A 350M:2023 | | x | 100 |
| | A 420M all grades | ASTM A 420/ A 420M:2022 | | x | |
| | A 513 all grades with $A_{min}$ 16 % and with chemical composition $C \leq 0{,}25$ % | ASTM A 513/ A 513M:2020 | x | | |
| | A 513 all grades normalized with $A_{min}$ 16 % and at −20 °C KV 27 J av. of three and 20 J min. | | | x | |
| | A 516 all grades with KV 27 J av. of three and 20 J min. at −20 °C | ASTM A 516/ A 516M:2017 | | x | |
| | A 564 T630 H1150 with KV 27 J av. of three and 20 J min. at −20 °C, | ASTM A 564/ A 564M:2019 | | x | |
| | A 694 all grades | ASTM A 694/ A 694M:2022 | x | | |
| | A 694 Gr F60 with KV 27 J av. of three and 20 J min at −20 °C | | | x | |
| | A 707M all grades from L2 to L8 and all classes | ASTM A 707/ A 707M:2019 | | x | |

# Annex ZA
(informative)

## Relationship between this European Standard and the essential requirements of Directive 2014/32/EU Measuring Instruments Directive aimed to be covered



This European Standard has been prepared under a Commission's standardization request M/541 to provide one voluntary means of conforming to essential requirements of Directive 2014/32/EU Measuring Instruments Directive.

Once this standard is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

**Table ZA.1 — Correspondence between this European Standard and Directive 2014/32/EU Measuring Instruments Directive**

| Essential Requirements (ERs) of Directive 2014/32/EU | | | Clause(s)/sub-clause(s) of this EN | Remarks/Notes |
|---|---|---|---|---|
| ANNEX 1 | | | | |
| 1 | | Allowable errors under rated operating conditions | | |
| | 1.1 | Within MPE – no disturbance | 5.1 (Annex E), 5.2.1, 5.2.5, 5.2.7 | Covered for class 1.0 |
| | 1.2 | Within MPE – disturbance | 5.2.8 (Annex B), 5.2.6, 5.2.10 | Covered for class 1.0 |
| | 1.3 | Specify climatic, mechanical and EM environment | Clause 9 | |
| | 1.3.1 | Climatic environments | Clause 1, 5.2.7 | Covered for class 1.0 |
| | 1.3.2 | Mechanical environments | Clause 1, 6.2.7.2 | Covered<br>Only M1 |
| | 1.3.3 | Electromagnetic environments | Clause 1, 7.3.1 | Covered<br>Only E1 and E2 |
| | 1.3.4 | Other influence quantities | 5.1 (Annex E), 6.2.5, 6.6.2, 6.8 | Covered<br>Because any such quantities are not seen |
| | 1.4.1 | Basic rules | Whole standard | Covered |
| | 1.4.2 | Ambient humidity | 6.4.3.4, 6.6.1 | Covered |
| 2 | | Reproducibility | N/A | Covered<br>Because these meters are permanently installed in one location |
| 3 | | Repeatability | 5.2.2 | Covered |

| Essential Requirements (ERs) of Directive 2014/32/EU | | | Clause(s)/sub-clause(s) of this EN | Remarks/Notes |
|---|---|---|---|---|
| 4 | | Discrimination and sensitivity appropriate for measurement task | 5.2.1 | Covered |
| 5 | | Sufficient durability for intended task | | Covered |
| 6 | | Reliability | Whole standard | Covered |
| 7 | | Suitability | | |
| | 7.1 | Design discourages fraudulent use and minimizes unintentional misuse | 5.2.1.1, 6.1, 6.6.1, Clause 8 | Covered |
| | 7.2 | Design to be suitable for its intended use and working conditions. User friendly. | 5.2.9, 6.2.4, 6.2.5, 6.2.6, 6.2.7, 6.4, 6.6, 6.8, Clause 7 | Covered |
| | 7.3 | The errors of a utility measuring instrument at flows or currents outside the controlled range shall not be unduly biased | N/A | Covered<br>Because N/A |
| | 7.4 | Where a measuring instrument is designed for the measurement of values of the measured that are constant over time, the measuring instrument shall be insensitive to small fluctuations of the value of the measurand, or shall take appropriate action | N/A | Covered<br>Because these meters are not used for measurand which are constant over time |
| | 7.5 | Robust and materials suitable for intended use | 6.1, 6.2, 6.4 | Covered |
| | 7.6 | A measuring instrument shall be designed so as to allow the control of the measuring tasks after the instrument has been placed on the market and put into use | 6.6, 7.5, 9.3 | Covered |
| 8 | | Protection against corruption | | |
| | 8.1 | Measurement cannot be affected by feature of instrument, connection of external or communicating device | 5.2.10, 6.5, 6.6, 6.7, 6.8, 7.3 | Covered |
| | 8.2 | Critical hardware components secure or tampering is evident | 6.1 | Covered |

| Essential Requirements (ERs) of Directive 2014/32/EU | | | Clause(s)/sub-clause(s) of this EN | Remarks/Notes |
|---|---|---|---|---|
| | 8.3 | Critical software shall be identified and secure.<br>Identification readily available. Tampering evidenced for "reasonable" time | N/A | Covered |
| | 8.4 | Data and critical parameters protected against corruption | N/A | Covered |
| | 8.5 | Display cannot be reset during use | 7.3 | Covered |
| 9 | | Information of/accompanying | | |
| | 9.1 | Shall bear manufacturer's mark or name and information in respect of its accuracy. Where applicable data on conditions of use, identity marking, number of type examination certificate | 5.2, 8.2 | Covered |
| | 9.2 | If too small, information placed on packaging | N/A | Covered<br>Because all relevant information is marked on the meter |
| | 9.3 | Accompanied by information on rated operating conditions, climatic, mechanical and EM environment classes, instruction operation and maintenance, etc. | Clause 9 | Covered |
| | 9.4 | Utility meters do not require individual instruction manuals | Clause 9 | Covered |
| | 9.5 | Decimal scale interval | 7.2 | Covered |
| | 9.6 | Material measure | N/A | Not covered<br>Because the instrument is not a material measure |
| | 9.7 | Units of measurement | 7.2 | Covered |
| | 9.8 | Durability of marking | 6.4.2, 7.1, 8.1 | Covered |
| 10 | | Indication of result | | |
| | 10.1 | Display | 7.2 | Covered |
| | 10.2 | Clear indication | 7.1, 7.2, 7.3 | Covered |
| | 10.3 | Hard copy | N/A | Not covered<br>Because these meters are not designed for a hard copy |

| Essential Requirements (ERs) of Directive 2014/32/EU | | | Clause(s)/sub-clause(s) of this EN | Remarks/Notes |
|---|---|---|---|---|
| | 10.4 | Direct trading | N/A | Not covered<br>Because these meters are not used for direct trading |
| | 10.5 | Indicator required | 7.1, 7.2 | Covered |
| 11 | | Further processing of data | | |
| | 11.1 | Durable record | N/A | Not covered<br>Because it is a Utility meter |
| | 11.2 | Durable proof | N/A | Not covered<br>Because it is a Utility meter |
| 12 | | Conformity evaluation | Whole standard | Covered |
| | | Annex IV (MI-002) | | |
| Part 1 | | Specific requirements gas meters | | |
| 1 | | Rated operating conditions | Clause 4, 9.3 | |
| | 1.1 | Flow-rate | Clause 1, 5.2.1, 5.2.6 | Covered<br>But only for class 1,0 |
| | 1.2 | T > 40 gas | Clause 1, 5.2.7 | Covered |
| | 1.3 | Gas family/MOP | Clause 1, 3.1.14, 5.1 (Annex E), 8.2 | Covered |
| | 1.4 | T > 50 climatic | Clause 1, 5.2.7 | Covered |
| | 1.5 | Limits of dc supply | N/A | Not covered<br>Because no external power supply required |
| 2 | | Maximum permissible errors | | |
| | 2.1 | MPE | 5.1 (Annex E), 5.2.1, 6.2.5, 6.2.7 | Covered |
| | 2.2 | MPE TC | N/A | Covered |
| 3 | | Permissible effects of disturbances | | |
| | 3.1 | EMC | Clause 1 | Covered |
| | 3.2 | Flow disturbances | 5.2.8 (Annex B) | Covered |
| 4 | | Durability | | |
| | 4.1 | Durability – Class 1,5 m | N/A | Not covered<br>Because the standard does not address Class 1,5 m |
| | 4.2 | Durability – Class 1,0 m | 5.2.4 | Covered |

| Essential Requirements (ERs) of Directive 2014/32/EU | | | Clause(s)/sub-clause(s) of this EN | Remarks/Notes |
|---|---|---|---|---|
| 5 | | Suitability | | |
| | 5.1 | Mains power | N/A | Not covered<br>Because no external power supply required |
| | 5.2 | Battery power | N/A | Not covered<br>Because no power supply required |
| | 5.3 | 8 000 h | 7.4 | Covered |
| | 5.4 | Any position | 5.2.5 | Covered |
| | 5.5 | Test element | 7.5 | Covered |
| | 5.6 | Flow direction marked | 8.3 | Covered |
| 6 | | Units | 7.2 | Covered |
| Part II | | Specific requirements – Volume conversion devices | N/A | Not covered<br>Because Part II applies to a volume conversion device as sub- assembly |
| 7 | | Base conditions for converted quantities | N/A | Not covered<br>Because Part II applies to a volume conversion device as sub- assembly |
| 8 | | Maximum permissible error | N/A | Not covered<br>Because Part II applies to a volume conversion device as sub- assembly |
| 9 | | Suitability | N/A | Not covered<br>Because Part II applies to a volume conversion device as sub- assembly |
| Part III | | Putting into use and conformity assessment | | |
| | 10 (a) (b) (c) | Putting into use | N/A | Not covered<br>Because it is Member States responsibility |
| | | Conformity assessment | N/A | Not covered<br>Because it is Member States responsibility |



**WARNING 1** — Presumption of conformity stays valid only as long as a reference to this European Standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

**WARNING 2** — Other Union legislation may be applicable to the product(s) falling within the scope of this standard.

# Annex ZB
(informative)

## Relationship between this European Standard and the essential requirements of Directive 2014/68/EU aimed to be covered



This European Standard has been prepared under a Commission's standardization request M/601 to provide one voluntary means of conforming to essential requirements of the New Approach Directive 2014/68/EU (PED).

Once this standard is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of this standard given in Table ZB.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

**Table ZB.1 — Correspondence between this European Standard and Annex I of Directive 2014/68/EU (PED)**

| Essential Requirements of Directive 2014/68/EU | Clause(s)/sub-clause(s) of this EN | Remarks/Notes |
|---|---|---|
| 2.2.1 | 6.2.4.1, 6.2.6 | Design loading, internal pressure, bending and torsional moments |
| 2.2.2 | 6.2.4.1, 6.2.4.2 | Design for adequate strength |
| 2.2.4 | 6.2.4.2, Option 2 | Experimental design method |
| 2.6 | 6.4.3 | Corrosion and other chemical attack |
| 3.1.2, paragraphs 3, 4 and 5 | 6.3, paragraph 3 | Permanent joining<br>For meters in the categories II, III and IV, the examiner/examining body is a competent third party<br>S |
| 3.1.3 | 6.3, last paragraph | Non-destructive testing<br>For meters in the categories III and IV, the certification body is a recognized third party organization |
| 3.1.4 | 6.3, paragraph 4 | Heat treatment |
| 3.1.5 | 6.3, paragraph 8, Annex F 2.2, par.3 | Traceability |
| 3.2.1 | F.2.2, paragraph 1 | Final inspection |
| 3.2.2 | 6.2.1,6.2.4.3 | Proof test |
| 3.3 | 8.1 to 8.4 | Marking and labelling |
| 3.4 | 9.4 | Instruction manual |
| 4.1.a, 4.2 b) | 6.2.2, paragraph 1 | Materials for pressurized parts |
| 4.3, paragraph 1 | 6.2.2, paragraph 2 | Materials conformity to required specifications |

| Essential Requirements of Directive 2014/68/EU | Clause(s)/sub-clause(s) of this EN | Remarks/Notes |
|---|---|---|
| 7.2 | 6.2.3 | Joint coefficients |
| 7.4 | 6.2.4.3 | Hydrostatic test pressure |
| 7.5 | 6.2.2, paragraph 3 | Material characteristic |

**WARNING 1** — Presumption of conformity stays valid only as long as a reference to this European Standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

**WARNING 2** — Other Union legislation may be applicable to the product(s) falling within the scope of this standard.

# Bibliography



EN 334:2019, *Gas pressure regulators for inlet pressure up to 10 MPa (100 bar)*

EN 1333:2006, *Flanges and their joints - Pipework components - Definition and selection of PN*

EN 12405-1:2021, *Gas meters - Conversion devices - Part 1: Volume conversion*

EN 13134:2000, *Brazing - Procedure approval*

EN 60068-2-30:2005, *Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

EN 60730-1:2016, *Automatic electrical controls - Part 1: General requirements*

EN ISO 6708:1995, *Pipework components - Definition and selection of DN (nominal size) (ISO 6708:1995)*

EN ISO 9001:2015, *Quality management systems - Requirements (ISO 9001:2015)*

ISO 3:1973, *Preferred numbers — Series of preferred numbers*

ISO 5168:2005, *Measurement of fluid flow — Procedures for the evaluation of uncertainties*

ISO 9951:1993, *Measurement of gas flow in closed conduits — Turbine meters*

OIML D 11, General requirements for electronic measuring instruments — Environmental conditions

OIML R 6, General provisions for gas volume meters

OIML R 32, Rotary piston gas meters and turbine gas meters

OIML R 137, Gas meters

EN ISO 15607:2019, *Specification and qualification of welding procedures for metallic materials - General rules (ISO 15607:2019)*

EN ISO 15609-1:2019, *Specification and qualification of welding procedures for metallic materials - Welding procedure specification - Part 1: Arc welding (ISO 15609-1:2019)*

ASTM A 395/A 395M:1999, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*

ASTM 536:2019, *Standard Specification for Nickel-Iron-Chromium-Silicon Alloys Plate, Sheet, and Strip*

ASTM A 874/A 874M:2018, *Standard Specification for Ferritic Ductile Iron Castings Suitable for Low-Temperature Service*

ASTM B 85/B 85M:2018, *Standard Specification for Aluminum-Alloy Die Castings*

ASTM A 106/A 106M:2019, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service*

ASTM A 213/A 213M:2023, *Standard Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes*

ASTM A 269:2022, *Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service*

ASTM A 312/A 312M:2022, *Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes*

ASTM A 333/A 333M:2018, *Standard Specification for Seamless and Welded Steel Pipe for Low-Temperature Service and Other Applications with Required Notch Toughness*

ASTM A 420/A 420M:2022, *Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service*

ASTM F 593:2022, *Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs*

ASTM A 193/A 193M:2023, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications*

ASTM A 194/A 194M:2023, *Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both*

ASTM A 320/A 320M:2022, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service*

ASTM F 594:2022, *Standard Specification for Stainless Steel Nuts*

ASTM A 105/A 105M:2023, *Standard Specification for Carbon Steel Forgings for Piping Applications*

ASTM A 182/A 182M:2023, *Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service*

ASTM A 234/A 234M:2023, *Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service*

ASTM A 240/A 240M:2023, *Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications*

ASTM A 266A/A 266M:2021, *Standard Specification for Carbon Steel Forgings for Pressure Vessel Components*

ASTM A 276:2017, *Standard Specification for Stainless Steel Bars and Shapes*

ASTM A 350/A 350M:2023, *Standard Specification for Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components*

ASTM A 420/A 420M:2020, *Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service*

ASTM A 513/A 513M:2020, *Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing*

ASTM A 516/A 516M:2017, *Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service*

ASTM A 564/A 564M:2019, *Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes*

ASTM A 694/A 694M:2022, *Standard Specification for Carbon and Alloy Steel Forgings for Pipe Flanges, Fittings, Valves, and Parts for High-Pressure Transmission Service*

ASTM A 707/A 707M:2019, *Standard Specification for Forged Carbon and Alloy Steel Flanges for Low-Temperature Service*

EN 10028-2:2017, *Flat products made of steels for pressure purposes - Part 2: Non-alloy and alloy steels with specified elevated temperature properties*

EN 10028-3:2017, *Flat products made of steels for pressure purposes - Part 3: Weldable fine grain steels, normalized*

EN 10028-4:2017, *Flat products made of steels for pressure purposes - Part 4: Nickel alloy steels with specified low temperature properties*

EN 10028-5:2017, *Flat products made of steels for pressure purposes - Part 5: Weldable fine grain steels, thermomechanically rolled*

EN 10028-6:2017, *Flat products made of steels for pressure purposes - Part 6: Weldable fine grain steels, quenched and tempered*

EN 10028-7:2016, *Flat products made of steels for pressure purposes - Part 7: Stainless steels*

EN 10222-1:2017, *Steel forgings for pressure purposes - Part 1: General requirements for open die forgings*

EN 10222-5:2017, *Steel forgings for pressure purposes - Part 5: Martensitic, austenitic and austenitic-ferritic stainless steels*

EN 10272:2016, *Stainless steel bars for pressure purposes*

EN 10213:2007+A1:2016, *Steel castings for pressure purposes*

EN 10025-2:2019, *Hot rolled products of structural steels - Part 2: Technical delivery conditions for non-alloy structural steels*

EN 10025-3:2019, *Hot rolled products of structural steels - Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels*

EN 10025-4:2019+A1:2022, *Hot rolled products of structural steels - Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels*

EN 10025-5:2019, *Hot rolled products of structural steels - Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance*

EN 10025-6:2019+A1:2022, *Hot rolled products of structural steels - Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition*

EN 10277:2018, *Bright steel products - Technical delivery conditions*

EN 10088-3:2023, *Stainless steels - Part 3: Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes*

EN 10111:2008, *Continuously hot rolled low carbon steel sheet and strip for cold forming - Technical delivery conditions*

EN 10130:2006, *Cold rolled low carbon steel flat products for cold forming - Technical delivery conditions*

EN 10250-1:2022, *Open die steel forgings for general engineering purposes - Part 1: General requirements*

EN 10250-2:2022, *Open die steel forgings for general engineering purposes - Part 2: Non-alloy quality and special steels*

EN 10250-4:2021, *Open die steel forgings for general engineering purposes - Part 4: Stainless steels*

EN 1563:2018, *Founding - Spheroidal graphite cast irons*

EN 1652:1997, *Copper and copper alloys - Plate, sheet, strip and circles for general purposes*

EN 12164:2016, *Copper and copper alloys - Rod for free machining purposes*

EN 12165:2016, *Copper and copper alloys - Wrought and unwrought forging stock*

EN 1982:2017, *Copper and copper alloys - Ingots and castings*

EN 485-2:2016+A1:2018, *Aluminium and aluminium alloys - Sheet, strip and plate - Part 2: Mechanical properties*

EN 586-2:1994, *Aluminium and aluminium alloys - Forgings - Part 2: Mechanical properties and additional property requirements*

EN 754-2:2016, *Aluminium and aluminium alloys - Cold drawn rod/bar and tube - Part 2: Mechanical properties*

EN 755-2:2016, *Aluminium and aluminium alloys - Extruded rod/bar, tube and profiles - Part 2: Mechanical properties*

EN 1706:2020+A1:2021, *Aluminium and aluminium alloys - Castings - Chemical composition and mechanical properties*

EN 1057:2006+A1:2010, *Copper and copper alloys - Seamless, round copper tubes for water and gas in sanitary and heating applications*

EN 10088-1:2023, *Stainless steels - Part 1: List of stainless steels*

EN 13445-2, *Unfired pressure vessels - Part 2: Materials*

EN ISO 683-1:2018, *Heat-treatable steels, alloy steels and free-cutting steels - Part 1: Non-alloy steels for quenching and tempering (ISO 683-1:2016)*

EN ISO 683-2:2018, *Heat-treatable steels, alloy steels and free-cutting steels - Part 2: Alloy steels for quenching and tempering (ISO 683-2:2016)*

EN ISO 683-4:2018, *Heat-treatable steels, alloy steels and free-cutting steels - Part 4: Free-cutting steels (ISO 683-4:2016)*

EN ISO 8434-1:2018, *Metallic tube connections for fluid power and general use - Part 1: 24° cone connectors (ISO 8434-1:2018, Corrected version 2018-10)*

EN ISO 898-2:2022, *Fasteners - Mechanical properties of fasteners made of carbon steel and alloy steel - Part 2: Nuts with specified property classes (ISO 898-2:2022)*

EN ISO 898-1:2013, *Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs with specified property classes - Coarse thread and fine pitch thread (ISO 898-1:2013)*

EN ISO 3506-1:2020, *Fasteners - Mechanical properties of corrosion-resistant stainless steel fasteners - Part 1: Bolts, screws and studs with specified grades and property classes (ISO 3506-1:2020)*

EN ISO 3506-2:2020, *Fasteners - Mechanical properties of corrosion-resistant stainless steel fasteners - Part 2: Nuts with specified grades and property classes (ISO 3506-2:2020)*

ISO 1083:2018, *Spheroidal graphite cast irons — Classification*

ISO 8434-2:2007, *Metallic tube connections for fluid power and general use — Part 2: 37 degree flared connectors*

# British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.



## About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

## Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

## Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

## Copyright in BSI publications

All the content in BSI publications, including British Standards, is the property of and copyrighted by BSI or some person or entity that owns copyright in the information used (such as the international standardization bodies) and has formally licensed such information to BSI for commercial publication and use.

Save for the provisions below, you may not transfer, share or disseminate any portion of the standard to any other person. You may not adapt, distribute, commercially exploit or publicly display the standard or any portion thereof in any manner whatsoever without BSI's prior written consent.

## Storing and using standards

Standards purchased in soft copy format:

- A British Standard purchased in soft copy format is licensed to a sole named user for personal or internal company use only.
- The standard may be stored on more than one device provided that it is accessible by the sole named user only and that only one copy is accessed at any one time.
- A single paper copy may be printed for personal or internal company use only.

Standards purchased in hard copy format:

- A British Standard purchased in hard copy format is for personal or internal company use only.
- It may not be further reproduced – in any format – to create an additional copy. This includes scanning of the document.

If you need more than one copy of the document, or if you wish to share the document on an internal network, you can save money by choosing a subscription product (see 'Subscriptions').

## Reproducing extracts

For permission to reproduce content from BSI publications contact the BSI Copyright and Licensing team.

## Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member.**

**PLUS** is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email cservices@bsigroup.com.

## Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

## Useful Contacts

**Customer Services**
**Tel:** +44 345 086 9001
**Email:** cservices@bsigroup.com

**Subscriptions**
**Tel:** +44 345 086 9001
**Email:** subscriptions@bsigroup.com

**Knowledge Centre**
**Tel:** +44 20 8996 7004
**Email:** knowledgecentre@bsigroup.com

**Copyright & Licensing**
**Tel:** +44 20 8996 7070
**Email:** copyright@bsigroup.com

## BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

bsi.