



BSI Standards Publication

Non-destructive testing - Leak testing - Calibration of reference leaks for gases (ISO 20486:2017)

National foreword

This British Standard is the UK implementation of EN ISO 20486:2018. It is identical to ISO 20486:2017. It supersedes BS EN 13192:2002, which is withdrawn.

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

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d'étanchéité - Étalonnage des fuites de
référence des gaz (ISO 20486:2017)

Zerstörungsfreie Prüfung - Dichtheitsprüfung
- Kalibrieren von Referenzlecks
für Gase (ISO 20486:2017)

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European foreword

This document (EN ISO 20486:2018) has been prepared by Technical Committee ISO/TC 135 "Non-destructive testing" in collaboration with Technical Committee CEN/TC 138 "Non-destructive testing", the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by August 2018, and conflicting national standards shall be withdrawn at the latest by August 2018.

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Endorsement notice

The text of ISO 20486:2017 has been approved by CEN as EN ISO 20486:2018 without any modification.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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

This document was prepared by Technical Committee ISO/TC 135, *Non-destructive testing*, Subcommittee SC 6, *Leak testing*.

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Non-destructive testing - Leak testing - Calibration of reference leaks for gases (ISO 20486:2017)

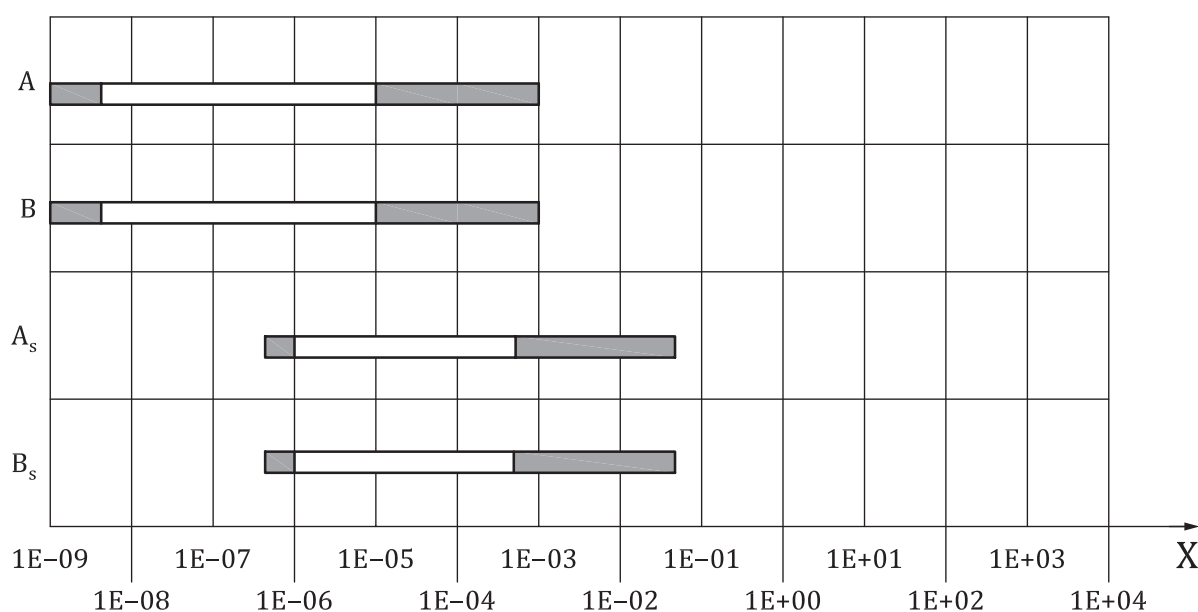
1 Scope

This document specifies the calibration of those leaks that are used for the adjustment of leak detectors for the determination of leakage rate in everyday use. One type of calibration method is a comparison with a reference leak. In this way, the leaks used for routine use become traceable to a primary standard. In other calibration methods, the value of vapour pressure was measured directly or calculated over a known volume.

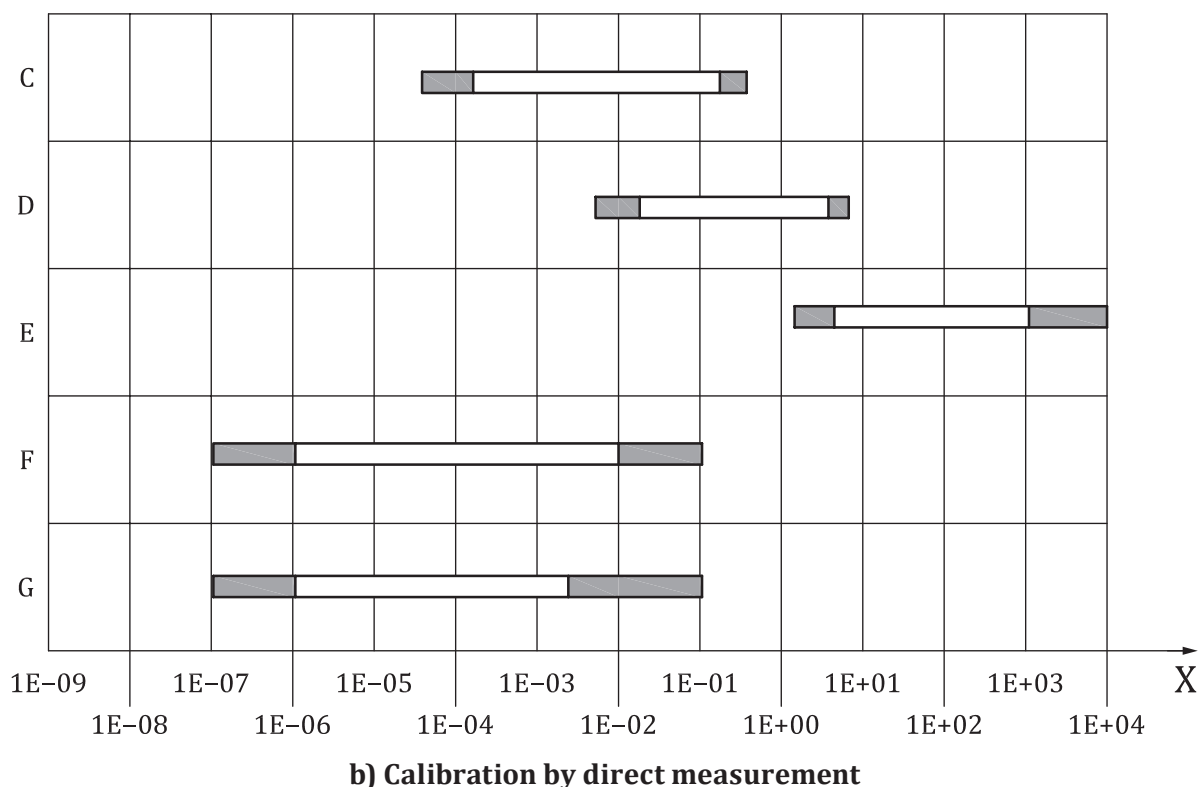
The comparison procedures are preferably applicable to helium leaks, because this test gas can be selectively measured by a mass spectrometer leak detector (MSLD) (the definition of MSLD is given in ISO 20484).

Calibration by comparison (see methods A, A_s, B and B_s below) with known reference leaks is easily possible for leaks with reservoir and leakage rates below 10^{-7} Pa·m³/s.

[Figure 1](#) gives an overview of the different recommended calibration methods.



a) Calibration by comparison



Key

X leakage rate in Pa·m³/s

A Method A

B Method B

A_s Method A_s

B_s Method B_s

□ normal range

C Method C

D Method D

E Method E

F Method F

G Method G

■ possible range

Figure 1 — Calibration ranges

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 20484, *Non-destructive testing — Leak testing — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20484 and the following apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1

unknown leak

leak having a stable and repeatable leakage rate of known order of magnitude that can be determined by calibration

3.2

reference leak

calibrated leak which may be used to calibrate another leak

Note 1 to entry: The uncertainty of the reference leak is lower than the required uncertainty of the leak to be calibrated.

3.3

calibration

set of operations which establish, under specified conditions, the relationship between leakage rate values represented by an unknown leak and the corresponding known values of the leakage rate

Note 1 to entry: In the case of calibration by comparison, the known values of the leakage rate are represented by a reference leak.

Note 2 to entry: Normally, the result of a calibration is given as the leakage rate value for the reference leak with a standard uncertainty.

3.4

nominal leakage rate

leakage rate of a leak calculated for specified reference conditions

Note 1 to entry: In leak detection, leakage rates are commonly given in units of pV-throughput ($\text{Pa}\cdot\text{m}^3/\text{s}$, mbar l/s , $\text{Std cm}^3/\text{min}$). These are only a precise measure of gas flow if the temperature is given and kept constant. Flow units such as mass flow (g/y) or molar flow (mol/s) are sometimes used to overcome this problem.

4 Nominal leakage rates

Calibrated leaks are only comparable under the same reference conditions. Nominal leakage rates shall be used for comparison. Recommended reference conditions are:

- Ambient temperature: 20 °C
- Atmospheric exhaust pressure: 1 000 mbar
- Vacuum exhaust pressure: < 100 mbar

The reference inlet pressure is given by the leak reservoir pressure or the application requirement.

5 Classification of leaks

5.1 Permeation leak

This type of leak is normally made with a tracer gas reservoir. It has the best long-term stability but an appreciable temperature coefficient (approximately 3,5 %/K). Typical leakage rates are in the range from $10^{-10} \text{ Pa}\cdot\text{m}^3/\text{s}$ to $10^{-4} \text{ Pa}\cdot\text{m}^3/\text{s}$.

5.2 Conductance leaks

5.2.1 Capillary leak

This type of leak is available with or without a tracer gas reservoir. It has a low temperature coefficient (approximately 0,3 %/K) but easily blocks if not handled with care. Typical leakage rates are greater than $10^{-7} \text{ Pa}\cdot\text{m}^3/\text{s}$.

5.2.2 Aperture leak (orifice)

Orifices are seldom used as reference leaks in practice, as they are difficult to manufacture and even more prone to blocking than capillaries.

NOTE Critical flow orifices are a form of aperture leak that is commonly found in industry, but are out of the scope of this document.

5.2.3 Compressed powder leak

This type of leak uses metal powder compressed into a tube. They are usually offered without reservoir. They are used for routine check of the sensitivity of leak detectors but they are not stable enough to be used as calibrated leaks. Their suitability depends on how well controlled the storage and operating conditions are, and on the required uncertainty.

6 Calibration by comparison

6.1 Methods A, A_s, B and B_s

There are two ways of calibrating leaks by comparison with known reference leaks. Both methods require the knowledge of the order of magnitude of the leakage rate to be measured. The methods differ in using one or two reference leaks, resulting in different uncertainties of measurement. In the following, the two methods are designated as A and B:

- Method A: Comparison to one reference leak normally with a leakage rate of the same order of magnitude, calibration with vacuum method.
- Method A_s: Comparison to one reference leak normally with a leakage rate of the same order of magnitude, calibration with sniffing method.
- Method B: Comparison to two reference leaks with leakage rates normally lying on either side of the unknown leakage rate, calibration with vacuum method.
- Method B_s: Comparison to two reference leaks with leakage rates normally lying on either side of the unknown leakage rate. Calibration with sniffing method.

Method A is most suitable for use on site as only one reference leak is used. It is generally applicable but is most reliable when the leakage rate of the unknown is close to that of the reference leak. This is because the measurement uncertainty is directly dependent on the linearity of the leak detector in use. As the linearity error cannot be measured independently, it needs to be estimated. To keep the linearity error small, the operating characteristics of leak detector should not change during calibration (e.g. automatic ranging should be disabled).

For more precise calibrations, where a more reliable measure of uncertainty is required or if a reference leak with a leakage rate close to the unknown is not available Method B should be used. By the use of two reference leaks, the non-linearity of the leak detector is accounted for.

6.2 Applicability of comparison methods

Since comparison of leaks is not a fundamental measurement method, it relies on the stability of the transfer device and cleanliness of the ambient gas atmosphere. Moreover, the temperature dependence of the reference and unknown leaks shall be taken into account.

The most stable and clean conditions are achieved for leaks with exhaust into vacuum and a mass spectrometer leak detector as transfer device measuring the partial pressure generated by the leaks in vacuum. Under these conditions, all interfering background gases are reduced to a minimum so that the zero point of the transfer device is defined and stable.

For leaks with exhaust into the atmosphere and measurement by sniffing gas, more conditions shall be controlled. These are:

- the background level of tracer gas shall be as low as possible and as stable as possible;
- the total gas flow rate of the sniffer shall be high enough to take up the total tracer gas flow out of the leak;
- the aspiration of the sniffer (the coupling to the leak exhaust) shall be of suitable geometry to make sure that the atmospheric gas flow across the leak exhaust takes up the whole tracer gas flow from the leak opening.

As a consequence, the measurement uncertainty is appreciably higher for sniffer leaks than for vacuum leaks.

Methods by comparison are therefore applicable but not preferable for the calibration of sniffer leaks (with exhaust to atmosphere).

6.3 Preparation of leaks and apparatus

6.3.1 Leak detector

The leak detector (LD) used as a transfer device shall be set up according to the manufacturer's manual. The warm-up time shall be at least 2 h.

6.3.2 Connection to the leak detector

The reference and unknown leaks are connected to the leak detector used as the transfer instrument. The connection shall be kept continuously until the measurement is completed. This includes thermal accommodation^[1].

In the case of vacuum leaks, they are connected to the inlet flange and pumped with their valves (if any) open for at least 30 min to remove any tracer gas that can have accumulated in seals or valves. For the calibration of more than one leak, a separate pumping system and set of valves is useful to keep all the leaks pumped until they are measured.