INTERNATIONAL STANDARD

ISO 20486

First edition
2017-12

Non-destructive testing — Leak testing — Calibration of reference leaks for gases

Essais non destructifs — Contrôle d'étanchéité — Étalonnage des fuites de référence des gaz

Reference number
ISO 20486:2017(E)

Documents
Document Sharing Hub

© ISO 2017

Full document details: ISO 20486-2017

COPYRIGHT PROTECTED DOCUMENT

© ISO 2017, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

© ISO 2017 – All rights reserved

Documents
Document Sharing Hub

Full document details: ISO 20486-2017

Contents

Page

Foreword ..... **v**

1 Scope **1**

2 Normative references **2**

3 Terms and definitions **2**

4 Nominal leakage rates **3**

5 Classification of leaks **3**
5.1 Permeation leak 3
5.2 Conductance leaks 3
5.2.1 Capillary leak 3
5.2.2 Aperture leak (orifice) 4
5.2.3 Compressed powder leak 4

6 Calibration by comparison **4**
6.1 Methods A, A_S, B and B_S 4
6.2 Applicability of comparison methods 4
6.3 Preparation of leaks and apparatus 5
6.3.1 Leak detector 5
6.3.2 Connection to the leak detector 5
6.3.3 Temperature accommodation 7
6.4 Measurement 7
6.4.1 Set-up 7
6.4.2 General measurement sequence 7
6.5 Evaluation for methods A, A_S, B and B_S (Comparison) 8
6.5.1 Determination of leakage rate 8
6.5.2 Influence factors to measurement uncertainty 9

7 Volumetric calibration **10**
7.1 Direct flow (Method C) 10
7.1.1 General 10
7.1.2 Equipment 10
7.1.3 Preparation of leaks and apparatus 10
7.1.4 Measurement 11
7.1.5 Evaluation for Method C (direct flow measurement) 13
7.2 Leak measurement under water (Method D) 14
7.2.1 General 14
7.2.2 Equipment 14
7.2.3 Preparation of leaks and apparatus 14
7.2.4 Measurement 15
7.2.5 Evaluation for Method D 16
7.2.6 Influence factors to measurement uncertainty 17
7.3 Calibration by (volumetric) gas meter (Method E) 17
7.3.1 General 17
7.3.2 Equipment 18
7.3.3 Preparation of leaks and apparatus 18
7.3.4 Measurement 18
7.3.5 Evaluation for Method E (gas meter) 18
7.3.6 Influence factors to measurement uncertainty 19
7.4 Calibration by pressure change in a known volume (Method F) 19
7.4.1 General 19
7.4.2 Preparation of leaks and apparatus 20
7.4.3 Measurement 22
7.4.4 Special situation in vacuum chambers 23
7.4.5 Evaluation for Method F (pressure change) 25
7.4.6 Influence factors to measurement uncertainty 25

© ISO 2017 – All rights reserved

AVA Documents
Document Sharing Hub
Full document details: ISO 20486-2017

7.5 Calibration by volume change at constant pressure (Method G) 26
7.5.1 Equipment 26
7.5.2 Preparation of leaks and apparatus 26
7.5.3 Measurement 26
7.5.4 Evaluation for Method G (volume change at constant pressure) 27

8 General influences 28

9 Report 28

10 Labelling of reference leaks 29

11 Handling of reference leaks 29
11.1 General 29
11.2 Permeation leaks (normally with reservoir fitted the leak outlet) 29
11.3 Conductance leaks (normally without reservoir) 29

Annex A (informative) **Calculation of leakage rate decrease due to tracer gas depletion in the reservoir 30**

Bibliography 32

© ISO 2017 – All rights reserved

Documents
Document Sharing Hub
Full document details: ISO 20486-2017

Foreword

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

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation 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*.

© ISO 2017 – All rights reserved

Documents
Document Sharing Hub
Full document details: ISO 20486-2017

Documents
Document Sharing Hub

Full document details: ISO 20486-2017

Non-destructive testing — Leak testing — Calibration of reference leaks for gases

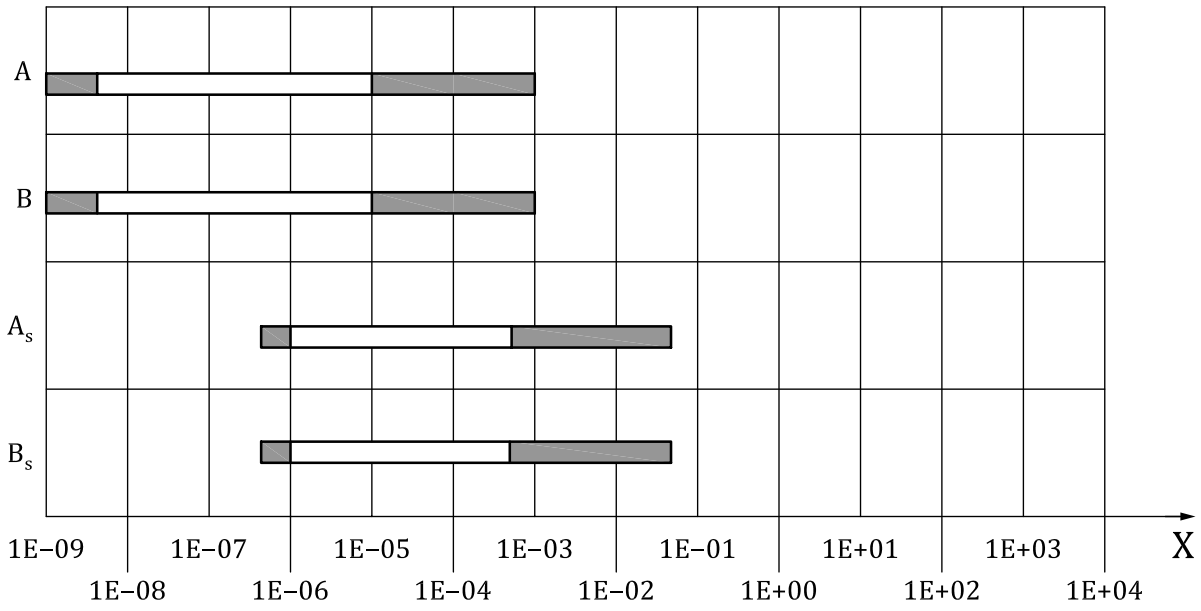
1 Scope

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·m^3/s.

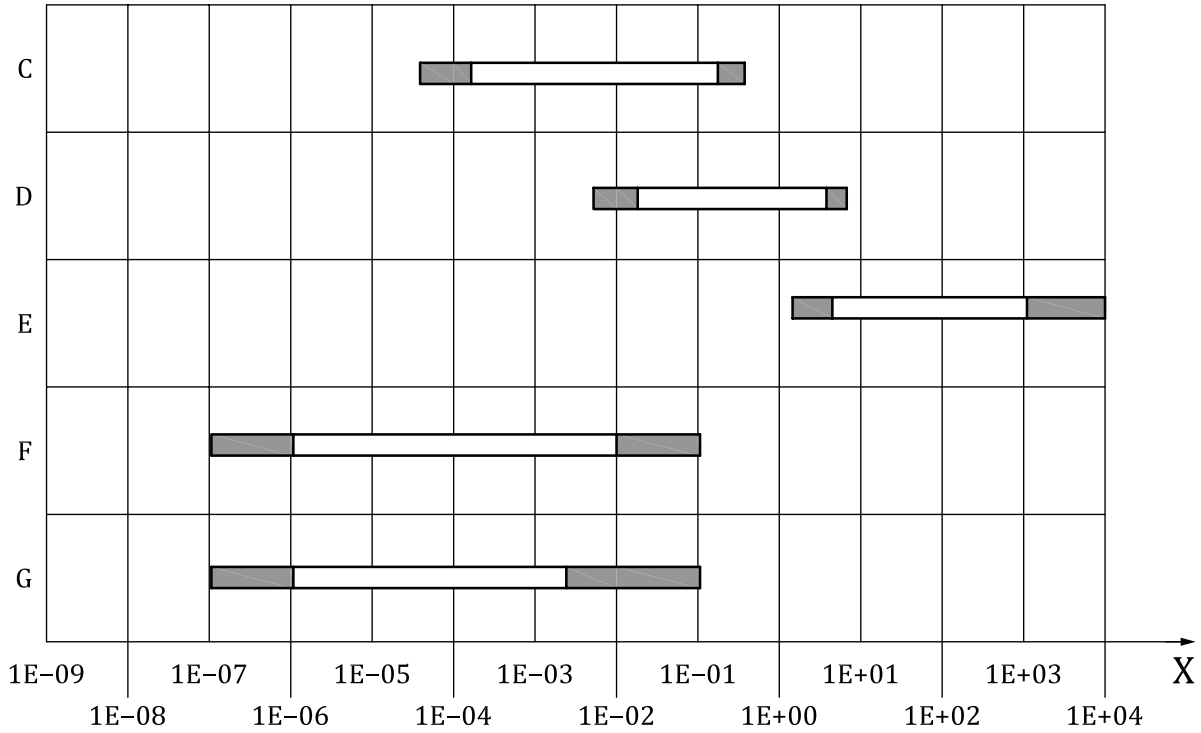
Figure 1 gives an overview of the different recommended calibration methods.



a) Calibration by comparison

© ISO 2017 – All rights reserved

Documents
Document Sharing Hub
Full document details: ISO 20486-2017



b) Calibration by direct measurement

Key

X	leakage rate in Pa·m^3/s	C	Method C
A	Method A	D	Method D
B	Method B	E	Method E
A_S	Method A_S	F	Method F
B_S	Method B_S	G	Method G
▭	normal range	▬	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/

© ISO 2017 – All rights reserved
Documents
Document Sharing Hub
Full document details: ISO 20486-2017

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 (Pa·m^3/s, mbar l/s, Std cm^3/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} Pa·m^3/s to 10^{-4} Pa·m^3/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} Pa·m^3/s.

© ISO 2017 – All rights reserved

Documents
Document Sharing Hub
Full document details: ISO 20486-2017

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.

© ISO 2017 – All rights reserved
Documents
Document Sharing Hub
Full document details: ISO 20486-2017

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.

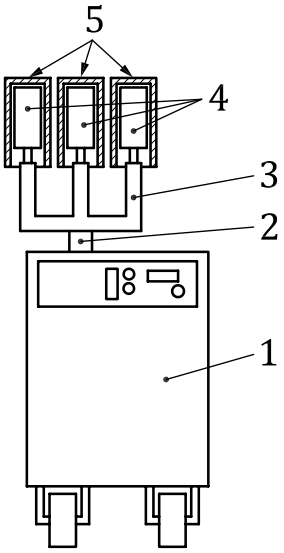
6.3.2 Connection to the leak detector

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.

© ISO 2017 – All rights reserved

Documents
Document Sharing Hub
Full document details: ISO 20486-2017



Key

1 transfer device (leak detector)

2 test port

3 rig

4 leaks to be calibrated and reference leak

5 hoods for thermal stability

Figure 2 — Coupling of leaks to the leak detector

In the case of sniffer leaks, the connection to the leak detector sniffing tip is made by an adapter which makes a tight connection to the leak outlet and enables atmospheric air to be continuously sucked across the leak exhaust via an air inlet (see Key item 3 in Figure 2), so that the whole leak gas flow is taken up by the sniffer tip. The air inlet opening shall not throttle the free flow of air to maintain atmospheric pressure in front of the sniffer tip. See Figure 3.

© ISO 2017 – All rights reserved
Documents
Document Sharing Hub
Full document details: ISO 20486-2017