



# SLOVENSKI STANDARD

## SIST EN 1779:2000

01-februar-2000

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**Neporušitveno preskušanje - Preskus tesnosti - Kriteriji za izbiro metode in postopka**

Non-destructive testing - Leak testing - Criteria for method and technique selection

Zerstörungsfreie Prüfung - Dichtheitsprüfung - Kriterien zur Auswahl von Prüfmethoden und -verfahren

Essais non destructifs - Contrôle d'étanchéité - Critères de choix de la méthode et de la technique

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**ICS:**

19.100      Neporušitveno preskušanje      Non-destructive testing

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EUROPEAN STANDARD  
NORME EUROPÉENNE  
EUROPÄISCHE NORM

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English version

Non-destructive testing - Leak testing - Criteria for method and  
technique selection

Essais non destructifs - Contrôle d'étanchéité - Critères de  
choix de la méthode et de la technique

Zerstörungsfreie Prüfung - Dichtheitsprüfung - Kriterien zur  
Auswahl von Prüfmethoden und -verfahren

This European Standard was approved by CEN on 10 July 1999.

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 Central Secretariat 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 Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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

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AGENCIJA REPUBLIKE SLOVENIJE  
ZA VARNOST IN ZDRAVJE  
PRI VARNOSTI IN ZDRAVJU  
.....  
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2000-01-01

## Foreword

This European Standard has been prepared by 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 February 2000, and conflicting national standards shall be withdrawn at the latest by February 2000.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this standard.

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

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## 1 Scope

This European Standard describes criteria for the selection of the most suitable method and technique for the assessment of leak tightness by indication or measurement of a gas leakage. Annex A, normative, allows a comparison of standard test methods. Leak detection using hydrostatic tests, ultrasonic or electromagnetic methods is not included in this document.

This standard can be used for equipment which can be evacuated or pressurized.

## 2 Normative references

This standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this standard only when incorporated in it by amendment or revision. For undated references the latest edition of the reference applies.

EN 473	Qualification and certification of NDT personnel - General principles
EN 1330-8	Non-destructive testing - Terminology - Part 8: Terms used in leak tightness testing

## 3 Definitions

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For the purposes of this standard, the definitions given in EN 1330-8 apply.

## 4 Personnel qualification

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It is assumed that leak testing is performed by qualified and capable personnel. In order to prove this qualification, it is recommended to certify the personnel in accordance with EN 473.

## 5 Units

The leakage rate is defined as the pV-throughput of a specific fluid which passes through a leak under specific conditions and is expressed in Pascals cubic metre per second.

In the past, the leakage rate was expressed in various units, these are given in informative annex B.

## 6 Tightness requirements

The leak tightness of an object is usually determined by measurement of its gas leakage rate.

Leak tightness is commonly described as the flow rate of fluid into or from the test object. For a gas, leak tightness may be conveniently indicated by the variation of pressure with time under specified conditions.

For testing, however, i.e. when drafting specifications and procedures, the leak tightness shall be expressed as leakage rate in units of gas throughput ( $\text{Pa}\cdot\text{m}^3/\text{s}$ ) for a specific gas at specified temperature and at specified pressure conditions.

Zero leakage rate shall not be specified. The required leak tightness shall be related to the function of the object under consideration.

NOTE 1 : Examples of relationship between leakage rate and the object :

- leakage rates in the order of  $5 \times 10^{-4} \text{ Pa.m}^3/\text{s}$  can be acceptable for compressed air cylinders (this corresponds to a pressure variation of 5000 Pa in a 10 l volume in 24 hours or 0,5 l loss measured at atmospheric pressure);
- a leakage rate of  $10^{-10} \text{ Pa.m}^3/\text{s}$  is typical for cardiac pacemakers (this corresponds to a loss of  $1 \text{ cm}^3$  every 30 years approximately).

The total tightness of a system can be considered in terms of tightness for all components of that system. To meet requirements the sum of the leakage rates for each component plus the sum of the leakage rates at each connecting point shall be less than the overall allowable leakage rate of the system.

The tightness of component or system shall be specified under normal operating conditions.

NOTE 2 : The following factors have the most significant influence on tightness:

- the nature and pressure of the gas;
- the operating temperature.

The suitability of the system for a given task is indicated by the functional tightness.

NOTE 3 : To take into account factors that are unquantifiable, it may be advisable to adopt leak tightness values lower than this by a factor from three to ten.

## 7 Leak testing

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The actual gas flow through the leaks of the test object, which has been determined in a leak test, shall be converted to the leakage rate with that under operating conditions.

The following considerations shall be applied to all methods by which leakage rates are determined. A review of the methods and techniques is given in table 1.

**Table 1: Leak testing - Criteria for method and technique selection**

Flow direction	Extent of test	Applicability	Techniques
gas flow out of object	local area	location	B.1, B.2.2, B.4, C.3
		measurement	B.2.1, B.3, D.3
	total area	location	C.1, C.2
		measurement	B.3, B.5, D.1, C.1, B.6, D.3, D.4
gas flow into object	local area	location	A.3
		measurement	A.2, D.3
	total area	location	
		measurement	A.1, D.2, D.3, D.4

Utilisation of the table:

- 1) choose the appropriate flow direction for test;
- 2) define the extent of the investigation: total or local area;
- 3) define the aim of test: location or measurement;
- 4) choose the appropriate method (A to D, from the normative annex A);
- 5) check any practical difficulties associated with the test.

**NOTE:** Some techniques used for location can also give an estimate of the leakage size, but they are not allowed to demonstrate the compliance with the specifications.

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## 7.1 Techniques for leak location and techniques for measurement

It is usually not possible to establish in one step the total leakage of a component (or a system) and the location of the leaks. Two techniques shall, therefore, be considered: measurement of the overall leakage rate or location of leaks for possible elimination.

Examples of total (or integral) techniques include the measurement of the pressure variation with time within the object and the accumulation of gas escaping from the object over a period of time.

One technique for leak location involves probing the object with a suitable tracer gas or sniffing the surface of an object filled with tracer gas.

NOTE : In the selection of an appropriate technique for leak assessment, the conditions of the test (pressure, vacuum, type of gas, etc.) should be carefully considered. Some guidance is given in clause 8.

## 7.2 Time dependence (in tracer gas techniques)

The measuring device shall be placed on the opposite side of the boundary to that probed with tracer gas. The tracer gas can be detected only when it has crossed the boundary. Time shall be allowed, therefore, for stabilization. The time taken by the gas to cross the boundary depends on the nature of gas, the pressure difference and the geometry of the leak path. It also depends on the temperature, the cleanliness of the object, etc.

NOTE : Small leaks can require a long stabilization time. If the flow through the leak is impeded by successive obstacles, such as multiple seals or double weld beads, the test time can be very long.



### 7.3 Influence of flow conditions

The usual laws governing gas flow shall be used to calculate variation in leakage rate, as a function of pressure, temperature and type of gas.

NOTE : In quantitative leak detection two different flow regimes are normally considered. These are the regimes of viscous laminar or molecular flow.

The boundaries between these regimes are not precisely defined. Care shall be taken therefore in the selection of any of the formulas given in 7.3.1, 7.3.2 and 7.3.3.

For practical purposes it is generally accepted that for helium leakage rates less than or equal  $10^{-7}$  Pa.m<sup>3</sup>/s, conditions for molecular flow apply. For helium leakage rates greater than  $10^{-5}$  Pa.m<sup>3</sup>/s, conditions for viscous laminar flow apply in the case of a single capillary leak.

For the different flow regimes the dependence of leakage rate on pressure, temperature and type of gas is different.

#### 7.3.1 Influence of pressure

For a given leak, the dimensions of which are unchanged by the applied pressure, the following expressions shall be used to take into account the effect of pressure change on flow rate:

- Molecular flow

$$q_2 = q_1 \frac{\Delta p_2}{\Delta p_1}$$

with pressure differences

$$\Delta p_2 = p_{B_2} - p_{A_2}$$

$$\Delta p_1 = p_{B_1} - p_{A_1}$$

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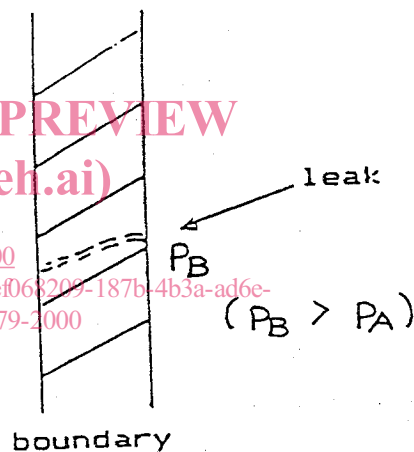


Figure 1: Leak

- Viscous laminar flow

$$q_2 = q_1 \frac{(p_{B_2}^2 - p_{A_2}^2)}{(p_{B_1}^2 - p_{A_1}^2)} = q_1 \frac{\Delta p_2}{\Delta p_1} \frac{\bar{p}_2}{\bar{p}_1}$$

with pressure averages

$$\bar{p}_1 = \frac{(p_{B_1} + p_{A_1})}{2}$$

$$\bar{p}_2 = \frac{(p_{B_2} + p_{A_2})}{2}$$

where

$p_{A_1}$  and  $p_{A_2}$  are different downstream pressures in Pascals;

$p_{B_1}$  and  $p_{B_2}$  are different upstream pressures in Pascals;

$q_1$  and  $q_2$  are the leakage rates in  $\text{Pa}\cdot\text{m}^3/\text{s}$  associated with the two pressure differences.

### 7.3.2 Influence of temperature

For a given leak, the dimensions of which are not altered by the temperature change, the following expressions shall be used to take into account the effect of temperature on flow rate:

- Molecular flow

$$q_{T_2} = q_{T_1} \times \sqrt{\frac{T_2}{T_1}}$$

- Viscous laminar flow

$$q_{T_2} = q_{T_1} \times \frac{\eta_{T_1}}{\eta_{T_2}}$$

or approximately

$$q_{T_2} = q_{T_1} \times \sqrt{\frac{T_1}{T_2}}$$

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where

$T_1$  and  $T_2$  are the different temperatures, in Kelvins;

$q_{T_2}$  and  $q_{T_1}$  are the leakage rates in  $\text{Pa}\cdot\text{m}^3/\text{s}$  associated with  $T_2$  and  $T_1$ ;

$\eta_{T_2}$  and  $\eta_{T_1}$  are the different dynamic viscosities in  $\text{Pa}\cdot\text{s}$  associated with  $T_1$  and  $T_2$

### 7.3.3 Nature of gas

For a given leak, the leakage rate for two different gases is given by the following expressions:

- Molecular flow

$$q_{G_2} = q_{G_1} \times \sqrt{\frac{M_{G_1}}{M_{G_2}}}$$

- Viscous laminar flow

$$q_{G_2} = q_{G_1} \times \frac{\eta_{G_1}}{\eta_{G_2}}$$

where

$q_{G_2}$  and  $q_{G_1}$  are the leakage rates in  $\text{Pa}\cdot\text{m}^3/\text{s}$  associated with gases  $G_1$  and  $G_2$ ;

$M_{G_1}$  and  $M_{G_2}$  are the molar masses, in kilograms per mole of the gases  $G_1$  and  $G_2$ ;

$\eta_{G_1}$  and  $\eta_{G_2}$  are the dynamic viscosities in  $\text{Pa}\cdot\text{s}$  associated with gases  $G_1$  and  $G_2$ .

#### 7.4 Influence of other factors

In addition to the above, it should be noted that the dimension of a leak path can be changed by temperature and pressure variations. Further the direction of flow can have a significant effect on the measured leakage rate and care shall be taken if the pressure gradient has to be reversed.

The object to be tested shall, whenever possible, be cleaned, degreased and dried. Typical sources of contamination are swarf, dirt, oil and grease, flux residues from welding, paint marks, surface corrosion and fingerprints. It is obvious that any cleaning method used to remove contamination shall not damage the object or leave any unacceptable deposit.

To minimize the effects of such unquantifiable factors, the leak test shall be carried out, under the operating conditions. If it is not possible, the deviations from the operating conditions shall be stated in the test report.

In some industrial conditions the accuracy of the measurements, which depends on the technique employed, may be in the order of  $\pm 50\%$ .

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### 8 General principles of method and technique selection

In the selection of a test technique (see normative annex A) the following points shall be considered:

- range of allowable leakage rates (see 8.1);
- test type: leak location, measurement of the integral leakage rate (total or partial) (see 8.2);
- item design, e.g. dimensions, openings and surface accessibility, pressure and vacuum design limits, materials (walls, gaskets,...), surface finish (see 8.3);
- operating and test conditions, e.g. tracer fluids, temperature, driving force (pressure difference, magnitude and direction); tests during manufacture or in-service test (see 8.4);
- safety and environmental factors (see 8.5).

#### 8.1 Range of leakage rates

The maximum allowable leakage rate determines the technique selected.

NOTE :Some of the techniques may not have the sensitivity to measure the required leakage rate, nor do they cover the whole range. Some highly sensitive techniques however can be uneconomic or not suitable for the detection of large leakage rates.

#### 8.2 Test type

If a measure of the total leakage rate is needed, only a quantitative technique, with appropriate calibration, shall be used.

NOTE : Many techniques are only applicable for the location of a leak, and may give a very approximate indication of the leakage rate. Moreover, some of these techniques can only be used to investigate a part of the object.