# SLOVENSKI STANDARD
# SIST EN 45544-4:2002

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**Workplace atmospheres - Electrical apparatus used for the direct detection and direct concentration measurement of toxic gases and vapours - Part 4: Guide for selection, installation, use and maintenance**

Workplace atmospheres - Electrical apparatus used for the direct detection and direct concentration measurement of toxic gases and vapours -- Part 4: Guide for selection, installation, use and maintenance



Arbeitsplatzatmosphäre - Elektrische Geräte für die direkte Detektion und direkte Konzentrationsmessung toxischer Gase und Dämpfe -- Teil 4: Leitfaden für Auswahl, Installation, Einsatz und Instandhaltung



Athmosphères des lieux de travail - Appareillage électrique utilisé pour la détection directe des vapeurs et gaz toxiques et le mesurage direct de leur concentration -- Partie 4: Guide de sélection, d'installation, d'utilisation et d'entretien

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| 13.040.30 | Kakovost zraka na delovnem mestu | Workplace atmospheres |
| 13.320 | Alarmni in opozorilni sistemi | Alarm and warning systems |

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EUROPEAN STANDARD

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# Workplace atmospheres - Electrical apparatus used for the direct detection and direct concentration measurement of toxic gases and vapours - Part 4: Guide for selection, installation, use and maintenance

Atmosphères des lieux de travail - Appareillage électrique utilisé pour la détection directe des vapeurs et gaz toxiques et le mesurage direct de leur concentration - Partie 4: Guide de sélection, d'installation, d'utilisation et d'entretien

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This European Standard was approved by CEN on 5 September 1999 and by CENELEC on 15 November 1999.

CEN/CENELEC 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/CENELEC 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/CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.



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## Contents

## Foreword

This European Standard has been prepared by Technical Committee CEN/CLC/WG CMI, Continuous measuring instruments, the Secretariat of which is held by DIN.

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 May 2000, and conflicting national standards shall be withdrawn at the latest by May 2000.

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.

## Introduction

This European Standard specifies general requirements and test methods for the determination of the performance characteristics of electrical apparatus used for the direct detection and concentration measurement of toxic[1)] gases and vapours in workplace atmospheres. It also provides guidance on the selection, installation, use and maintenance of such instruments.

This European Standard includes the following parts:

*Workplace atmospheres - Electrical apparatus used for the direct detection and direct concentration measurement of toxic gases and vapours –*

*Part 1: General requirements and test methods.*

*Part 2: Performance requirements for apparatus used for measuring concentrations in the region of limit values.*

*Part 3: Performance requirements for apparatus used for measuring concentrations well above limit values.*

*Part 4: Guide for selection, installation, use and maintenance.*

This European Standard is based on EN 482 which specifies general performance requirements for procedures for determining the concentration of chemical agents in workplace atmospheres. These performance requirements include maximum values for overall uncertainty (a combination of precision and bias) that should be met under prescribed laboratory conditions and also in the environment representative of the workplace and other areas.

The advantages and disadvantages of measurements by direct reading apparatus compared to sampling followed by laboratory analysis are shown in the following table:



**Table 1: Advantages and disadvantages**

| Sampling followed by laboratory analysis | Direct reading apparatus |
|---|---|
| Results are time delayed. | Results are known immediately, on site. |
| Concentrations are time-averaged. | Concentration fluctuations in time and space of toxic gases and vapours can be monitored such as:<br>– intermittent emissions;<br>– concentrations exceeding short term exposure limit values. |
| Sample alteration or loss can occur during transportation and storing. | No sample handling, no storage. |
| Laboratory analysis can be time consuming for example in sample preparation and analysis. | On site analysis can save time. |
| High degree of selectivity. | Only some instruments have high selectivity. |



1) For the purposes of this standard, the word "toxic" should be taken to include "very toxic", "toxic", "harmful", "corrosive", "irritating", "sensitizing", "carcinogenic", "mutagenic", "teratogenic".

## 1 Scope

This European Standard gives guidelines for background information and gives guidance on the selection, installation, use and maintenance of electrical apparatus used for the direct detection and direct concentration measurement of toxic gases and vapours in workplace air. It is concerned with apparatus whose primary purpose is to indicate the presence and concentration of a toxic gas or vapour to provide a rapid indication or warning of the presence of a toxic hazard within a time of response as specified in accordance with EN 45544-2 and EN 45544-3. It applies to:

- personal, portable, transportable and fixed apparatus;
- apparatus where the presence of a gas or vapour causes an automatically generated electrical signal;
- apparatus intended to provide an indication, alarm and/or other output function, whose purpose is to give a warning of potential toxic hazard and in some cases to initiate automatic or manual protective actions.

This European Standard is not intended, but can provide useful information, for the following:

- apparatus used for the measurement of oxygen deficiency which can affect human health;
- apparatus used for the measurement of combustible gases and vapours or oxygen related to the risk of explosion (see EN 50073);
- apparatus of laboratory or scientific type used only for analysis or measurement purposes;
- apparatus used only for process control applications;
- apparatus used for underground mining applications;
- apparatus used in the domestic environment;
- apparatus used for environmental air pollution monitoring;
- open path apparatus not used for point measurement.



## 2 Normative references

This European 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 European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 482:1994, *Workplace atmospheres - General requirements for the performance of procedures for the measurement of chemical agents*

EN 45544-1, *Workplace atmospheres - Electrical apparatus used for the direct detection and direct concentration measurement of toxic gases and vapours - Part 1: General requirements and test methods*

EN 45544-2, *Workplace atmospheres - Electrical apparatus used for the direct detection and direct concentration measurement of toxic gases and vapours - Part 2: Performance requirements for apparatus used for measuring concentrations in the region of limit values*

EN 45544-3, *Workplace atmospheres - Electrical apparatus used for the direct detection and direct concentration measurement of toxic gases and vapours - Part 3: Performance requirements for apparatus used for measuring concentrations well above limit values*

EN 689:1995, *Workplace atmospheres - Guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategy*

EN 50014, *Electrical apparatus for potentially explosive atmospheres - General requirements*

EN 50015, *Electrical apparatus for potentially explosive atmospheres - Oil immersion "o"*

EN 50016, *Electrical apparatus for potentially explosive atmospheres - Pressurized apparatus "p"*

EN 50017, *Electrical apparatus for potentially explosive atmospheres - Powder filling "q"*

EN 50018, *Electrical apparatus for explosive atmospheres - Flameproof enclosures "d"*

EN 50019, *Electrical apparatus for potentially explosive atmospheres - Increased safety "e"*

EN 50020, *Electrical apparatus for potentially explosive atmospheres - Intrinsic safety "i"*

EN 50028, *Electrical apparatus for potentially explosive atmospheres - Encapsulation "m"*

EN 50039, *Electrical apparatus for potentially explosive atmospheres - Intrinsic safety "i" Systems*

EN 50054, *Electrical apparatus for the detection and measurement of combustible gases - General requirements and test methods*

EN 50073, *Guide for selection, installation, use and maintenance of apparatus for the detection and measurement of combustible gases*

EN 50270, *Electromagnetic compatibility - Electrical apparatus for the detection and measurement of combustible gases, toxic gases or oxygen*

EN 60079-10:1996, *Electrical apparatus for explosive gas atmospheres - Part 10: Classification of hazardous areas* (IEC 60079-10:1995)

ISO 3534-1, *Statistics -Vocabulary and symbols - Part 1: Probability and general statistical terms*



ISO 6141:1984, *Gas analysis - Calibration gas mixtures - Certificate of mixture preparation*

ISO 6142:1981, *Gas analysis - Preparation of calibration gas mixtures - Weighing methods*

ISO 6143:1981, *Gas analysis - Determination of composition of calibration gas mixtures - Comparison methods*



ISO 6144:1981, *Gas analysis - Preparation of calibration gas mixtures - Static volumetric methods*

ISO 6145-1:1986, *Gas analysis - Preparation of calibration gas mixture - Dynamic volumetric methods - Part 1: Methods of calibration*

ISO 6145-3:1986, *Gas analysis - Preparation of calibration gas mixtures - Dynamic volumetric methods - Part 3: Periodic injections into a flowing gas stream*

ISO 6145-4:1986, *Gas analysis - Preparation of calibration gas mixtures - Dynamic volumetric methods - Part 4: Continuous injection method*

ISO 6145-6:1986, *Gas analysis - Preparation of calibration gas mixtures - Dynamic volumetric methods - Part 6: Sonic orifices*

ISO 6147:1979, *Gas analysis - Preparation of calibration gas mixtures - Saturation method*

ISO 6349:1995, *Gas analysis - Preparation of calibration gas mixtures - Permeation method*

ISO 6879:1996, *Air quality - Performance characteristics and related concepts for air quality measuring methods*

ISO 7504:1984, *Gas analysis - Vocabulary*

## 3 Definitions

For the purposes of this standard, the following definitions apply.

**3.1**
**toxic gas or vapour**
general term for any gas or vapour that can be harmful to human health[2)].

**3.2**
**interferent gas or vapour**
any substance other than the substance to be detected, including water vapour, which affects the indication.

**3.3**
**clean air**
air which is free of gases and vapours to which the sensing element is sensitive or which influence the performance of the sensing element.

**3.4**
**standard test gas (STG)**
test gas with a composition specified for each apparatus and gas to be tested.

**3.5**
**volume ratio (V/V)**
ratio of the volume of a component to the volume of the gas mixture, under specified conditions of temperature and pressure. [ISO 7504]

**3.6**
**limit value (LV)**
a reference figure for the concentration of a gas or vapour in air. [EN 482]



**3.7**
**exposure (by inhalation)**
a situation in which a chemical agent is present in air which is inhaled by a person.



**3.8**
**short term exposure limit (STEL)**
the time weighted average concentration over a specified short period of time.

NOTE The period is specified in national regulations

**3.9**
**time weighted average (TWA) concentration**
the concentration of gas or vapour in air integrated over time and divided by the measuring period.

**3.10**
**fixed apparatus**
an apparatus which is intended to have all parts permanently installed.

**3.11**
**transportable apparatus**
an apparatus not intended to be portable, but which can readily be moved from one place to another.

**3.12**
**portable apparatus**
spot-reading or continuously sensing apparatus that has been designed to be readily carried from place to place and to be used while being carried. Portable apparatus is generally battery powered.

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2) For the purposes of this standard, the word "toxic" should be taken to include "very toxic", "toxic", "harmful", "corrosive", "irritating", "sensitizing", "carcinogenic", "mutagenic", "teratogenic".

**3.13**
**personal monitor**
a device, attached to a person, that monitors the atmosphere in their breathing zone so that their exposure to toxic gases or vapours can be determined.

**3.14**
**aspirated apparatus**
an apparatus which samples the atmosphere by drawing it to the sensor, for example by means of a hand operated or electric pump.

**3.15**
**spot reading apparatus**
an apparatus whose measuring event is triggered, intended to be used for short periods of time.

**3.16**
**alarm-only apparatus**
an apparatus having an alarm but not having a meter or other indicating device.

**3.17**
**sensing element:**
a device, the output of which will change in the presence of an analyte.

**3.18**
**sensor**
an assembly in which the sensing element is housed and which may contain associated circuit components.

**3.19**
**remote sensor**
a sensor which is not integral with the main body of the apparatus.



**3.20**
**alarm set point**
a fixed or adjustable setting of the apparatus that is intended to pre-set the level of concentration at which the apparatus will automatically initiate an indication, alarm or other output function.



**3.21**
**fault signal**
an audible, visible or other type of output permitting, directly or indirectly, a warning or indication that the apparatus is not working satisfactorily.

**3.22**
**sample line**
the pipe by means of which the gas or vapour being sampled is conveyed to the sensor.

**3.23**
**sampling probe**
device inserted into the gas to be sampled and to which is connected a sample line or a container for collecting the sample.

**3.24**
**field verification kit**
a means of testing the operation of the apparatus under field conditions.

**3.25**
**zero indication**
the indication given by a properly adjusted apparatus when exposed to clean air in normal operating conditions.

**3.26**
**specified measuring range**
the set of values of the concentration for which the overall uncertainty of a measuring procedure is intended to lie within specified limits. [EN 482]

**3.27**
**selectivity**
degree of independence from interferents.

**3.28**
**overall uncertainty (OU)**
quantity used to characterize as a whole the uncertainty of the result given by an apparatus or a measuring procedure. It is expressed, as a percentage, by a combination of bias and precision usually according to the formula:

$$OU = \frac{\left| \bar{x} - x_{ref} \right| + 2s}{x_{ref}} \times 100$$

where:

$\bar{x}$ is the mean value of results of n repeated measurements;

$x_{ref}$ is the true or accepted reference value of concentration;

$s$ is the standard deviation of measurements;

$$s = \sqrt{\sum \frac{(x - \bar{x})^2}{n - 1}}$$

$\bar{x}$ is the mean value of results of repeated measurements;

$n$ is the number of measured values.

NOTE In strict mathematical terms there is no way to combine precision (a variance) and bias (an absolute number). However by occupational hygiene precedent and time honoured convention they have been combined according to the above formula.



**3.29**
**bias**
consistent deviation of the measured value from the value of the air quality characteristic itself, or the accepted reference value.



NOTE Bias is often called "systematic error" [ISO 6879:1995]

**3.30**
**precision**
the closeness of agreement between independent test results obtained under stipulated conditions. [ISO 3534-1]

NOTE The precision is defined in this standard as twice the standard deviation of the repeated measurements expressed as a percentage of the test gas concentration.

**3.31**
**zero variation (ZV)**
quantity used to characterize the uncertainty of a measurement result given by an apparatus when the concentration of the gas to be measured is zero. It is expressed on an absolute basis by a combination of bias and precision according to the formula:

$$ZV = |\bar{x}| + 2s$$

where:

$\bar{x}$ is the mean value of results of a number (n) of repeated measurements;

$s$ is the sample standard deviation of measurements.

**3.32**
**averaging time**
a period of time for which the measuring procedure yields an averaged value.

NOTE 1 For direct reading instruments the averaging time is related to the internal electrical time constant and the time constant of the sensor. For other procedures it is normally equal to the sampling time.

NOTE 2 The averaging time cannot be lower than the electrical time constant.

**3.33**
**drift**
the variation in apparatus indication with time under constant environmental conditions.

**3.34**
**recovery time**
the time interval, with the apparatus in a warmed-up condition, between the time when an instantaneous decrease in volume ratio is produced at the sensor input and the time when the response reaches a stated indication of (*x*) % of the initial indication. For alarm only apparatus the stated indication may be represented by the de-activation of the alarm set at a stated value.

**3.35**
**time of response ($T_x$)**
the time interval, with the apparatus operating in an warmed-up condition, between the time when an instantaneous increase in volume ratio is produced at the sensor input and time the when the response reaches a stated indication of (*x*) % of the final indication. For alarm only apparatus the stated indication may be represented by the activation of the alarm set at a stated value.

**3.36**
**retention time (of a constituent)**
the time between the beginning of the injection of a sample and the moment when there is emergence of the peak maximum of a stated component. [3.3.4.1 of ISO 7504:1984]

**3.37**
**warm-up time**
the time interval, with the apparatus in a stated atmosphere, between the time when the apparatus is switched on and the time when the indication reaches and remains within the stated tolerances (see Figure 1).



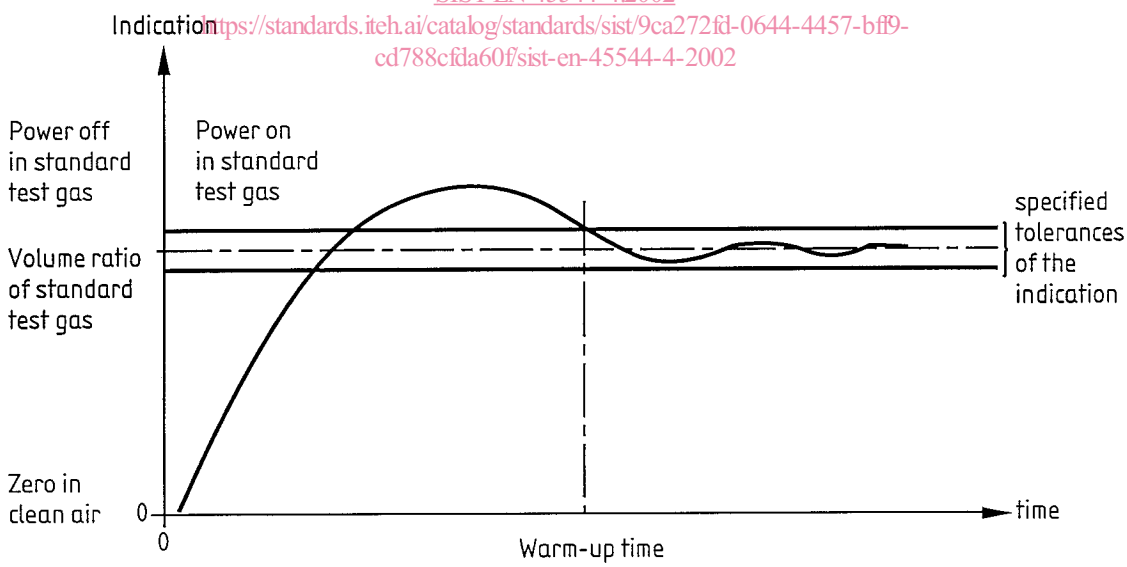


**Figure 1 - Warm-up time in standard test gas**