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**Zrak na delovnem mestu - Črpalke za vzorčenje kemičnih agensov z volumenskim pretokom nad 5 l/min - Zahteve in preskusne metode**

Workplace atmospheres - Pumps for the sampling of chemical agents with a volume flow rate of over 5 l/min - Requirements and test methods

Arbeitsplatzatmosphäre - Pumpen für die Probenahme von chemischen Stoffen mit einem Volumendurchfluß über 5 l/min - Anforderungen und Prüfverfahren

Atmospheres des lieux de travail - Pompes pour l'échantillonnage individuel des agents chimiques d'un débit volumique supérieur 5 l/min - Exigences et méthodes d'essai

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English version

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### CEN

European Committee for Standardization  
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**Foreword**

This European Standard has been prepared by Technical Committee CEN/TC 137, Assessment of workplace exposure, 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of an identical text or by endorsement, at the latest by February 2000, and conflicting national standards shall be withdrawn at the latest by February 2000.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.

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## Introduction

Many different methods are used to determine the concentration of chemical agents in the workplace atmosphere. In some of these methods the air, charged with the chemical agent, is aspirated by means of a pump and the chemical agents are collected by a sample medium (e.g. a filter). The sample is then transported to the laboratory and analysed.

Such pumps need to meet special requirements. The flow rate in particular needs to remain constant during sampling, as its value is used in the calculation of the concentration of the agent together with the duration of sampling and the analysed mass of the agent.

Requirements and test procedures for pumps which are attached to a person during the period of sampling and which have a volume flow rate in the region of 5 ml/min to 5 l/min are laid down in EN 1232. This standard deals with pumps with a volume flow rate above 5 l/min.

Pumps with a volume flow rate above 5 l/min are mainly used in a stationary position to evaluate the effectiveness of engineering controls or for troubleshooting. They can also be used for personal sampling.

## 1 Scope

This European Standard specifies the performance requirements for pumps used within the scope of measuring methods for the determination of the concentration of chemical agents in the workplace atmosphere. The pumps considered in this standard are mainly used for aerosol sampling. This standard is valid for pumps with a nominal volumetric flow rate within the range 5 l/min to 400 l/min.

This standard applies to electrically driven pumps and also to air movers, which induce air flow with the aid of another mechanism, such as pressure drop across a critical nozzle.

The standard applies to pumps which:

- are attached to a person and connected to the sampler by means of tubing during sampling;
- are stationary and connected to the sampler by means of tubing during sampling;
- are built into sampling apparatus which is either attached to a person or is operated in a stationary position.

This standard applies to pumps whose nominal volumetric flow rate can be kept constant by an automatic controller if the flow resistance changes during sampling. The control range shall be specified by the manufacturer.

This standard also applies to pumps which are operated at a constant nominal volumetric flow rate, since they work at a constant flow resistance pressure drop during sampling (e.g. pumps with rotating cups).

For pumps which are attached to a person during sampling, ergonomic requirements like maximum mass should be taken into account. These requirements are not specified in this standard in detail, but should be considered by the manufacturer when constructing a pump.

## 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 141:1990, *Respiratory protective devices — Gas filters and combined filters — Requirements, testing, marking.*

EN 1232, *Workplace atmospheres — Pumps for personal sampling of chemical agents — Requirements and test methods.*

EN 45001:1989, *General criteria for the operation of testing laboratories.*

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

EN 50081-1, *Electromagnetic compatibility — Generic emission standard — Part 1: Residential, commercial and light industry.*

EN 50082-1, *Electromagnetic compatibility — Generic immunity standard — Part 1: Residential, commercial and light industry.*

EN 60068-2-31:1993, *Basic environmental test procedures — Part 2: Tests — Test Ec: Drop and topple, primarily for equipment-type specimens.* (IEC 60068-2-31:1969 + A1:1982)

## 3 Definitions

For the purposes of this standard, the definitions of EN 1232, as well as the following definitions, apply.

### 3.1

#### chemical agent

any chemical element or compound, on its own or admixed, as it occurs in the natural state or as produced, including release as waste, by any work activity, whether or not produced intentionally and whether or not placed on the market

### 3.2

#### nominal back pressure range

the range of back pressure specified by the manufacturer within which, at a preset flow rate adjustment, the pump can be operated with a constant flow rate

**3.3****personal sampler**

a device attached to a person that samples air in the breathing zone

**3.4****stationary sampler**

a device, not carried by a person, that samples air so that the concentration of chemical agents in a particular location can be determined

**3.5****personal pump**

pump which is carried by a person during use

**3.6****stationary pump**

a pump which is not carried by a person during use

**3.7****response time**

when a step function is applied to a measuring device, time between start of the application and a response of the device of 90 % of the stabilized value

**4 Requirements****4.1 General**

The corresponding test methods are given in clause 6.

The requirements concerning air volume or air volumetric flow rate are applicable under the environmental conditions (temperature, pressure, humidity) at which the pump will be operated.

In cases where systems operate using a critical orifice as a flow rate control device, the term "pumps" applies to the actual pump plus the critical nozzle.

For pumps which are built into a sampling apparatus, different requirements apply compared to the requirements for personal pumps.

It can be unpractical to carry out tests to assess compliance with the requirements in 4.3, 4.6 and 4.13 for some built-in pumps. In this case the manufacturer shall supply an adequate justification for omitting the relevant tests.

If the pump is built into a sampling apparatus, requirements concerning mechanical and electrical safety shall be taken from the standard for that sampling apparatus.

**4.2 Features**

The pump shall have as a minimum the following features:

- personal pumps: means to secure the pump on a person (integrated or available as an accessory);
- an automatic control which keeps the volumetric flow rate constant;

— either a malfunction indicator which, during sampling or following completion of sampling, indicates that the air flow has been reduced or interrupted during sampling, or an automatic cut-out which stops the pump if the flow rate is reduced or interrupted;

— for battery- and accumulator-powered pumps, a fuse or current-limiting switch which interrupts or limits the current in the electrical circuit of the pump in case of a short circuit;

— the facility for the adjustment of flow rate shall be such that it can only be actuated with the aid of a tool (e.g. screwdriver) or requires special knowledge for operation (e.g. via software) so that inadvertent readjustment of the flow rate is precluded during use.

NOTE The use of an integral timer, automatically resettable by operating the on/off switch of the pump, is not mandatory; however, this feature is highly desirable.

**4.3 Mechanical strength****4.3.1 Personal pumps**

After shock treatment, the flow rate measured shall not deviate by more than 5 % from the initial value.

The general function of the pump shall not be impaired by the shock treatment. No mechanical or electrical defects shall occur.

**4.3.2 Stationary pumps**

After the treatment described in 3.2.3 of EN 60068-2-31:1993, the flow rate shall not deviate by more than 5 % from the initial value.

**4.4 Design safety (not for built-in pumps)**

The outer case of the pump shall be so designed that there are no sharp corners or other uncomfortable protruding parts.

**4.5 Pulsation of air flow**

The pulsation shall not exceed 10 % of the flow rate.

**4.6 Flow rate stability under increasing back pressure**

The flow rate adjusted within the nominal range shall not vary from the original value by more than  $\pm 5\%$  upon changing the back pressure within a range which shall be specified in the manufacturer's technical manual. This applies to any measured flow rate/back pressure plot.

If several flow rates can be set within a nominal flow rate range, the technical requirements of the first paragraph shall apply for each adjustable nominal flow rate.

**4.7 Nominal volume flow rate**

For pumps whose volume flow rate is not adjustable by the user, the volume flow rate shall not deviate by more than 5 % from the nominal volume flow rate which is to be specified in the instructions for use (see 4.14e).



#### 4.8 Operating time (for battery-operated pumps)

The manufacturer shall specify in the instructions for use the operating time for the following flow rates for temperatures from  $(5 \pm 2)^\circ\text{C}$  and  $20^\circ\text{C}$  to  $25^\circ\text{C}$ :

- a) minimum value of nominal flow rate range;
- b) maximum value of nominal flow rate range.

The operating time shall be at least 2 h and should preferably be 8 h. This applies to the complete nominal flow rate range against a specified back pressure at temperatures of:

- $(5 \pm 2)^\circ\text{C}$ ;
- $20^\circ\text{C}$  to  $25^\circ\text{C}$ .

During the operating time, the flow rate shall not deviate by more than 5 % from the initial value.

#### 4.9 Start-up and long-term performance

During operation of the pump, the flow rate shall not deviate by more than 5 % from the value measured at the start of the determination of the long-term performance.

This requirement applies at room temperature  $20^\circ\text{C}$  to  $25^\circ\text{C}$  and at an ambient temperature of  $(5 \pm 2)^\circ\text{C}$ .

This requirement applies to battery- and accumulator-operated pumps during the operating time specified by the manufacturer, and to mains-operated pumps for a duration of 8 h.

#### 4.10 Short-term interruption of air flow

When the air flow is fully blocked for 2 min, the pump shall cut out or the malfunction indicator shall activate. The pump shall not restart automatically at the end of the blocking time or the malfunction indicator shall remain activated. The indicator shall not be reset until the malfunction has been cleared.

#### 4.11 Temperature dependence

Within the range of ambient temperature from  $5^\circ\text{C}$  to  $40^\circ\text{C}$ , the flow rate measured under operating conditions shall not deviate by more than 5 % from the flow rate at  $20^\circ\text{C}$ .

If a wider temperature range is claimed by the manufacturer, the requirement applies in the claimed range.

#### 4.12 Orientation (personal pumps)

When the pump is tilted backwards, forwards, to the right and to the left by  $90^\circ$  from its normal upright position, the flow rate shall not deviate by more than 5 % from the value measured in the upright position.

#### 4.13 Timer accuracy

If the pump is supplied with an internal timer, after 8 h the indicated time shall not deviate by more than 5 min from that of the reference timer.

#### 4.14 Instructions for use

The instructions for use supplied with the pump shall be in the language(s) of the countries where the pump is marketed. They shall contain at least the following information:

- a) manufacturer's name;
- b) type designation;
- c) reference to this European Standard;
- d) intended use (especially information on sampling equipment to be used with the pump or which is part of it);
- e) nominal flow rate or nominal range of flow rates (if applicable);
- f) nominal range of back pressure for each nominal flow rate;
- g) operating time;
- h) temperature range for operation;
- i) type designation of charger to be used for charging the batteries or accumulators;
- j) notes and recommendations for operation and calibration of the pump, including frequency of calibration;
- k) information with respect to maintenance and troubleshooting;
- l) information with respect to special safety requirements; if the pump can be used in an area subject to explosion hazard, the certificate number provided by the appropriate certification body;
- m) information concerning the adjustment of the flow rate (if adjustable by the user);
- n) information with respect to the calculation of the sampled volume under operating conditions.

#### 4.15 Electromagnetic compatibility

The pump shall meet the requirements for electromagnetic compatibility according to EN 50081-1 and EN 50082-1.

NOTE For some industries, e.g. mining, there can be additional requirements.

#### 4.16 Explosion hazard

If the pump is claimed by the manufacturer to be suitable for use in areas subject to explosion hazard, it shall fulfil the requirements of EN 50014.

### 5 General test conditions

The pump shall be operated in accordance with the instructions for use.

#### 5.1 Number of test objects

At least one pump shall be tested in accordance with test conditions for a type test. Apart from that in 6.15 and 6.16, the test candidate(s) shall be selected randomly from a production batch.

## 5.2 Test instruments

Only calibrated meters shall be used for the test.

The accuracy of the test instruments shall be sufficient that it does not need to be taken into consideration when the measurement results are compared with the requirements.

NOTE A list of typical instruments is included in annex A.

## 5.3 Preconditioning of test objects

Prior to the technical tests (see clause 6), the pump shall be subjected to preconditioning, as follows.

### 5.3.1 Battery-powered pumps

20 charging and operating cycles are carried out. In each cycle fully charge the battery and run the pump for its operating time. In each cycle the pump is run at its maximum nominal flow rate and 80 % of the maximum back pressure.

After preconditioning, the pump is examined to demonstrate that its general function is not impaired.

### 5.3.2 Mains-operated pumps

The pump is operated 20 times for 8 h periods. The operation is carried out at maximum nominal flow rate and 80 % of the maximum back pressure.

After preconditioning, the pump is examined to demonstrate that its general function is not impaired.

## 5.4 Sequence of tests

After preconditioning, the tests 6.8, 6.9 and 6.10 are carried out. Subsequently tests shall be performed in the sequence of the clauses of this standard. For pumps whose volume flow rate is not adjustable by the user, after preconditioning, the test described in 6.7 is carried out first.

NOTE If the general function of the pump is impaired after the preconditioning described in 5.3 or if the mechanical strength test (see 6.3 and 6.4) fails, the procedure may be abandoned. For pumps whose volume flow rate is not adjustable by the user, the procedure may be abandoned if the requirement 4.7 is not fulfilled.

## 5.5 Adjustment of the volumetric flow rate

### 5.5.1 Pumps operated with a variable flow resistance

If it is intended that the flow rate of the pump can be modified by the user, the pump shall be adjusted prior to individual tests to the flow rate specified in each of the subclauses of clause 6 within a maximum deviation of  $\pm 5\%$ . Adjustment shall be effected in the basic set-up given in 5.6, using a flow resistor connected to the inlet of the pump. Unless otherwise stated, the flow resistor shall remain during the test in the test set-up. The value stated in clause 6 is selected as the flow resistance for each individual test.

If it is not intended that the flow rate of the pump can be modified by the user, the tests shall be carried out with the flow rate set by the manufacturer.

### 5.5.2 Pumps operated with a constant flow resistance

The volumetric flow rate is constant during operation. However, this flow rate is dependent on the sampling head which is used and has to be properly adjusted to the nominal values given by the manufacturer for each sampling head.

NOTE The selection of the appropriate sampling head depends on the particle size fraction to be sampled.

Adjustment shall be effected with the set-up given in 5.6 (see Figure 2), using a flow rate of externally supplied air matching exactly the nominal flow rate and measured by the flow meter. The pump flow rate is properly adjusted when the pressure gauge indicates zero.

## 5.6 Test set-up and performance

### 5.6.1 General

The testing of battery- and accumulator-powered pumps shall be performed with fully charged batteries.

Unless otherwise specified, the tests shall be performed at a temperature of 20 °C to 25 °C and this temperature shall be measured and recorded in the test report.

All connections shall be leaktight. The total length of tubing used should be as short as possible, with a maximum length of about 80 cm.

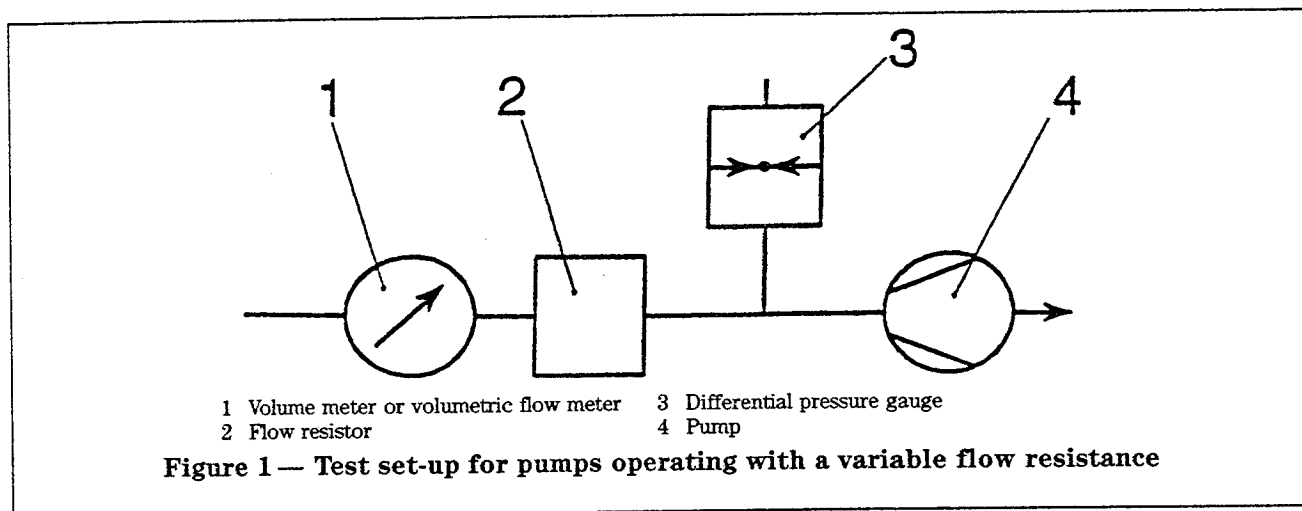
### 5.6.2 Pumps operated with a variable flow resistance

The test set-up for the technical tests for pumps operating with a variable flow resistance shall be as shown in Figure 1.

Air is drawn in through a volume meter or a volumetric flow meter. The flow resistor is selected depending on the test to be performed (see clause 6) and is connected to the outlet of the meter. The back pressure relative to ambient pressure is measured using a differential pressure gauge. The pump inlet is connected to the flow resistor and the differential pressure gauge. The basic test set-up shall be modified for individual tests. In tests where the flow resistance does not have to be measured, the pressure gauge may be omitted. For tests affected by the pulsation of the pump under test, a pulse damper of low flow resistance is inserted downstream of the flow resistor. The pulse damper is used whenever necessary, but will not be referred to in the description of individual tests. A pulse damper is not used for the pulsation test (see 6.5). For the pulsation test in 6.5, there are special requirements for the tubing and test set-up.

For pumps which are built-in into a sampling apparatus, a test set-up as specified in Figure 1 cannot be applicable. In this case the test set-up can be modified accordingly.





### 5.6.3 Pumps operated with a constant flow resistance

For pumps working at constant pressure, like pumps with rotating cups, the set-up shall be of compensated flow resistance type, shown in Figure 2.

A small airtight chamber is mounted over the aspiration slot of the sampling head. It is equipped with an air inlet and a manometer connection for measuring the static pressure inside the chamber. The air inlet is fed by an external pulsation-free compressed air supply. The flow rate is read on a precision flow meter the range of which includes the nominal flow rate of the pump, with a minimum resolution of 0,1 l/min. The flow meter shall be calibrated and used with its proper corrections. A precision relative pressure gauge with a range extending from 0 Pa to 150 Pa with a resolution of 1 Pa allows the relative pressure inside the chamber to be measured. When the external air supply is properly adjusted, the relative pressure shall be zero. Then the flow rate can be measured by means of the flow meter.

## 6 Test methods

### 6.1 General

Air volume and volumetric flow rate shall always be determined under the environmental conditions (temperature, pressure, humidity) under which the pump will be operated.

When testing using the test set-up according to Figure 1, the lowest achievable flow resistance can be higher than the lower limit of the nominal back pressure range of the pump under test. In these cases the tests at the lower limit of the nominal back pressure range shall be performed at the lowest achievable flow resistance. The flow resistance shall be in the lower quarter of the nominal back pressure range.

### 6.2 Features

Visual inspection based on the specifications in the user's instruction manual shall be performed.

