INTERNATIONAL STANDARD

ISO 13137

Second edition
2022-08

Workplace atmospheres — Pumps for personal sampling of chemical and biological agents — Requirements and test methods

Air des lieux de travail — Pompes pour le prélèvement individuel des agents chimiques et biologiques — Exigences et méthodes d'essai

Reference number
ISO 13137:2022(E)

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Published in Switzerland

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Foreword

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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 of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 146, *Air quality*, Subcommittee SC 2, *Workplace atmospheres*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 137, *Assessment of workplace exposure to chemical and biological agents*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 13137:2013), which has been technically revised.

The main changes are as follows:

— definitions that appear in ISO 18158 have been removed from this document, with ISO 18158 being added as a reference (replacing references to EN 1540);

— references to EN 482 have been replaced with ISO 20581;

— the text has been editorially updated.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Many different methods are used to determine the concentration of chemical and biological agents in workplace air. Many of these methods involve the use of a pump and sampler connected by a flexible tube. Air is drawn through the sampler and chemical and biological agents are trapped, e.g. on a filter, sorbent tube or long-term detector tube, or in a gas washing bottle. In personal sampling, the pump and sampler are attached to the worker to collect chemical and biological agents in the breathing zone.

The volume of air drawn by the pump during the sampling period is one of the quantities in the calculation of the concentration of the chemical and biological agents in air. Therefore, the volume of air sampled should be determined accurately and, in order to facilitate this, the flow rate should be maintained within acceptable limits throughout the sampling period. For particle size selective sampling, the short-term fluctuation of the flow rate should also be maintained within acceptable limits in order to ensure that the sampler exhibits the required collection characteristics.

ISO 20581[1] specifies general performance criteria for methods for measuring the concentration of chemical and biological agents in workplace air. These performance criteria include maximum values of expanded uncertainty that are not to be exceeded under prescribed laboratory conditions. In addition, the performance criteria should also be met under a wider variety of environmental influences, representative of workplace conditions. The contribution of the sampling pump to measurement uncertainty should be kept to a minimum.

This document is intended to enable manufacturers and users of personal sampling pumps to adopt a consistent approach to, and provide a framework for, the assessment of the specified performance criteria. Manufacturers are urged to ensure that pumps meet the requirements laid down in this document, including environmental influences which can be expected to affect performance.

Workplace atmospheres — Pumps for personal sampling of chemical and biological agents — Requirements and test methods

1 Scope

This document specifies performance requirements for battery powered pumps used for personal sampling of chemical and biological agents in workplace air. It also specifies test methods in order to determine the performance characteristics of such pumps under prescribed laboratory conditions.

This document is applicable to battery powered pumps having a nominal volumetric flow rate above 10 ml · min^{-1}, as used with combinations of sampler and collection substrate for sampling of gases, vapours, dusts, fumes, mists and fibres.

This document is primarily intended for flow-controlled pumps.

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 18158, *Workplace air — Terminology*

IEC 60079-0, *Explosive atmospheres — Part 0: Equipment — General requirements*

IEC 61000-6-1, *Electromagnetic compatibility (EMC) — Part 6-1: Generic standards — Immunity standard for residential, commercial and light-industrial environments*

IEC 61000-6-3, *Electromagnetic compatibility (EMC) — Part 6-3: Generic standards — Emission standard for residential, commercial and light-industrial environments*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 18158 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
flow rate
volumetric flow rate
amount of air volume per time, drawn by a pump through a test set-up, at the ambient conditions

3.2
nominal flow rate range
range of volumetric flow rate values, adjustable at the pump, at which the manufacturer claims that the pump can operate at a constant flow rate up to the maximum value of the required pressure drop range for the operating time

3.3
pulsation
short-term relative variation of volumetric flow rate at a given flow rate

4 Type of pump

Sampling pumps are classified according to their intended use as follows:

— type P: pumps for personal sampling of airborne particles;

— type G: pumps for personal sampling of gases and vapours.

NOTE 1 Type P pumps can be used for personal sampling of gases and vapours as long as they conform with the type G pump requirements.

NOTE 2 For types of pump mechanism and control system. See Annex A.

5 Requirements

5.1 Features

The pump shall have the following features:

a) an automatic control which keeps the volumetric flow rate nominally constant;

b) a means to reduce the likelihood of unintentional or unauthorized adjustment of any pump control, such that it is concealed beneath a cover, can only be actuated with the aid of a tool, or requires specialized knowledge for operation;

c) either a malfunction indicator which, 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 deviates by more than 5 % or is interrupted;

d) a fuse or resettable breaker which interrupts the current in the electrical circuit of the pump in the case of excessive current drain;

e) a filter which prevents particles from being drawn into the mechanism of the pump;

f) a means to secure the pump on a person (integrated or available as an accessory).

NOTE Some pumps use internal sensors to provide atmospheric pressure and air flow data. Information on the use of these sensors is given in Annex B.

5.2 Mass

The mass of the pump, including batteries and integral holders, shall not exceed 1,2 kg for sampling pumps with a flow rate of less or equal than 5 $l \cdot min^{-1}$ and 2,5 kg for sampling pumps with a flow rate above 5 $l \cdot min^{-1}$.

5.3 Design safety

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

5.4 Operating time

The operating time shall be at least 1 h and should preferably be greater than 8 h. This applies to the complete nominal flow rate range against the pressure drops as specified in Table 4 at (5 ± 2) °C. The

manufacturer shall report, in the instructions for use, the operating time at the specified pressure drop according to 5.10 for the flow rates given in Table 1 at (5 ± 2) °C.

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

Table 1 — Flow rates for reporting the operating time by the manufacturer

Pump type	Nominal flow rate range	Flow rate setting
	$ml \cdot min^{-1}$	$ml \cdot min^{-1}$
P	≤ 5 000	2 000
		Maximum value of the nominal flow rate range of the pump
	> 5 000	Minimum value of the nominal flow rate range of the pump
		Maximum value of the nominal flow rate range of the pump
G	≤ 300	50
		Maximum value of the nominal flow rate range of the pump
	> 300	300
		Maximum value of the nominal flow rate range of the pump

NOTE Annex C describes regular tests that users can perform to maintain pumps and flow meters. These tests are not required for conformance with this document.

5.5 Start-up and long-term performance

During operation of the pump at (5 ± 2) °C and in the range from 20 °C to 25 °C, 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.

5.6 Short-term interruption of air flow

When the air flow is fully blocked, the pump shall cut out or the malfunction indicator activate. The pump may try to restart automatically after the airflow is blocked. If the air flow is blocked for more than (120 ± 10) s, the pump shall not restart automatically or the malfunction indicator shall remain activated until reset.

NOTE Some sampling pumps are designed to restart automatically for a number of times after being blocked. In this case, it is acceptable to restart automatically provided that the total time does not exceed 120 ± 10 s.

5.7 Temperature dependence

When the flow rate is set within the temperature range from 20 °C to 25 °C in accordance with 7.8, it shall not deviate by more than 5 % after cooling down the sampling train to (5 ± 2) °C within about 2 h and running for a period of (60 ± 1) min when the temperature is changed to the next (fixed) value within the range from 5 °C to 40 °C as stated in 7.8.3.

5.8 Mechanical strength

The general function of the pump shall not be impaired by shock treatment (see 7.9). No mechanical damage or electrical defect shall occur.

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

5.9 Pulsation of flow rate (for type P pumps only)

For type P pumps, the pulsation shall not exceed 11 % of the mean volumetric flow rate. This is the critical maximum value shown by experiment on several different designs of pumps to not alter the size-separation performance of several different designs of cyclones (see References [3], [4] and [5]).

By recording the time curve of the volumetric flow rate the pulsation P is given as a percentage of the mean volumetric flow rate by Formula (1):

$$P = \frac{\sqrt{\frac{1}{T}\int_0^T \left[f(t) - \bar{f}\right]^2 \, \mathrm{d}t}}{\bar{f}} \times 100 \tag{1}$$

where

$f(t)$ is the volumetric flow rate with respect to time t, in litre per minute ($l \cdot min^{-1}$), calculated from the measurement of velocity;

$\bar{f}$ is the mean volumetric flow rate over time T, calculated in litre per minute ($l \cdot min^{-1}$), from the measurement of velocity;

t is the time, in seconds (s);

T is the time period of pulsation, in seconds (s).

The quantity $f(t)$ is not necessarily the volumetric flow rate but shall have a direct linear relationship to the volumetric flow rate.

NOTE P can be measured in several ways. See 7.10 for examples.

5.10 Flow rate stability under increasing pressure drop

5.10.1 Pumps with a nominal flow rate range less or equal than 5 000 ml · min^{-1}

When set within the nominal flow rate range of the pump, the flow rate shall not deviate by more than ±5 % from the initial value on changing the pressure drop within the range specified in Table 2.

The choice of pump is driven by the capability of the pump to pull air across the pressure drop. Annex D lists measured pressure drops across typical collection substrates, supporting the selection of pump type for a particular sampler. It is not necessary for a P-type or G-type pump to meet every flow rate or pressure drop listed in Table 2. However, the requirement shall be met for the nominal flow rate range specified by the manufacturer.

Table 2 — Required pressure drop range

Pump type	Adjusted flow rate	Required pressure drop range
	ml · min^{-1}	kPa
P	1 000	0,2 to 4,0
	2 000	0,3 to 4,0
	3 000	0,4 to 4,5
	4 000	0,6 to 5,5
	5 000	0,7 to 5,0

NOTE The upper and lower values specified for the required pressure drop range for type P pumps are typical for an unloaded and heavily loaded filter. The values specified for required pressure drop for type G pumps are typical for one sorbent tube with low flow resistance up to two sorbent tubes in line. See Annex D.

Table 2 *(continued)*

Pump type	Adjusted flow rate ml · min^{-1}	Required pressure drop range kPa
G	10	0,02 to 0,2
	30	0,2 to 1,0
	50	0,2 to 2,0
	100	0,2 to 2,6
	200	0,5 to 6,0
	300	1,0 to 10,0
	500	2,0 to 10,0

NOTE The upper and lower values specified for the required pressure drop range for type P pumps are typical for an unloaded and heavily loaded filter. The values specified for required pressure drop for type G pumps are typical for one sorbent tube with low flow resistance up to two sorbent tubes in line. See Annex D.

5.10.2 Pumps with a nominal flow rate range above 5 000 ml · min^{-1}

When set within the nominal flow rate range of the pump, the flow rate shall not deviate by more than ±5 % from the initial value on changing the pressure drop within the nominal pressure drop range specified by the pump manufacturer.

5.11 Timer accuracy

If the pump has an internal timer, the indicated time shall not deviate by more than ±0,5 % from that of a calibrated device to measure time (e.g. stopwatch).

5.12 Electromagnetic compatibility

The pump shall meet the requirements for electromagnetic compatibility according to IEC 61000-6-1 and IEC 61000-6-3.

5.13 Explosion hazard

If the pump is claimed to be suitable for use in areas subject to explosion hazard, the pump shall conform with the requirements of IEC 60079-0.

6 Test conditions

6.1 Number of test objects

The tests given in Clause 7 may be carried out with one pump only unless otherwise stated in the specific test clause.

6.2 Test instruments

The uncertainty of the test instruments shall be in accordance with Table 3.

Table 3 — Maximum uncertainty of test instruments used

Test instrument	Maximum uncertainty
Volumetric flow meter	2 %
Volumetric meter	2 %
Pressure gauge	3 %
Timer	0,1 %
Thermometer	1 °C

For a rapidly responding flow meter, such as a hot-wire anemometer, the response time shall be 4,5 ms or less from t_{10} to t_{90}.

NOTE 1 Times t_{10} and t_{90} are those at which 10 % and 90 % of the final reading of the anemometer signal is reached when a step signal is applied.

The temperature stability of the climatic chamber used shall be at least ±2 °C.

All test instruments listed in Table 3 shall have calibrations that are traceable to national standards.

NOTE 2 Annex E lists typical test instruments.

6.3 Preconditioning and sequence of tests

Prior to the technical tests (see Clause 7), precondition the pump by performing at least three charging and operating cycles (see Clause 10 for charger).

Fully charge the battery in accordance with the manufacturer's instructions and run the pump until it automatically shuts down due to low battery status.

To reduce the cycle time, the pump should run at its maximum nominal flow rate and at 80 % of the maximum of the required pressure drop range as in 5.10.

Following completion of the charging and operating cycles, perform tests in the order given in Clause 7.

6.4 Adjustment of volumetric flow rate and pressure drop

Flow rates shall be adjusted within a maximum deviation of ±5 % of the required value.

Pressure drops shall be adjusted within a maximum deviation of ±5 % of the required value.

If an internal flow meter is incorporated in the pump this shall not be used to adjust the flow rate.

The technical tests (see Clause 7) require the pump to be adjusted to specific flow rates and the flow resistor to be adjusted to give specific pressure drops at the inlet of the pump. The required flow rates and pressure drops are specified in the individual test clauses.

NOTE The pressure drop settings for the technical tests include the flow resistance of the connected volumetric flow meter or volumetric meter (see Figure 1, label 1).

6.5 Test set-up and performance

The basic test set-up for the technical tests shall be as depicted in Figure 1.