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Health and safety in welding and allied processes — Sampling of airborne particles and gases in the operator's breathing zone —

Part 1: Sampling of airborne particles

Hygiène et sécurité en soudage et techniques connexes — Échantillonnage des particules en suspension et des gaz dans la zone respiratoire des opérateurs —

Partie 1: Échantillonnage des particules en suspension

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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 document 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).

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This document was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 9, *Health and safety*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 121, *Welding and allied processes*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 10882-1:2011), which has been technically revised.

The main changes are as follows:

— references to other documents have been updated;

— in 8.2 and 9.3.1.1, alternative personal sampling position(s) for air-fed welder's helmets and sampling methods with more than one collection device have been added.

A list of all parts in the ISO 10882 series can be found on the ISO website.

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. Official interpretations of ISO/TC 44 documents, where they exist, are available from this page: https://committee.iso.org/sites/tc44/home/interpretation.html.

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Introduction

The health of workers in many industries is at risk through exposure by inhalation to airborne particles generated by welding and allied processes (welding fumes) and other airborne particles generated by welding-related operations, such as grinding. Industrial hygienists and other public health professionals need to determine the effectiveness of measures taken to control workers' exposure to these harmful substances and this is generally achieved by making personal exposure measurements.

This document is intended to be of benefit to agencies concerned with health and safety at work, industrial hygienists and other public health professionals, industrial users of welding and allied processes and their workers, and analytical laboratories.

It has been assumed in the drafting of this document that the execution of its provisions, and the interpretation of the results obtained, is entrusted to appropriately qualified and experienced people.

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Health and safety in welding and allied processes — Sampling of airborne particles and gases in the operator's breathing zone —

Part 1: Sampling of airborne particles

1 Scope

This document specifies a procedure for sampling airborne particles in the breathing zone of a person who performs welding and allied processes (the operator). It also provides details of relevant standards that specify required characteristics, performance requirements and test methods for workplace air measurement, and augments guidance provided in EN 689 on assessment strategy and measurement strategy.

This document also specifies a procedure for making gravimetric measurements of personal exposure to airborne particles generated by welding and allied processes (welding fumes) and other airborne particles generated by welding-related operations.

Additionally, it provides references to suitable methods of chemical analysis specified in other standards to determine personal exposure to specific chemical agents present in welding fumes and other airborne particles generated by welding-related operations.

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 7708:1995, *Air quality — Particle size fraction definitions for health-related sampling*

ISO 15767, *Workplace atmospheres — Controlling and characterizing uncertainty in weighing collected aerosols*

ISO 18158:2016, *Workplace air — Terminology*

EN 482, *Workplace exposure — General requirements for the performance of procedures for the measurement of chemical agents*

EN 13205-1, *Workplace exposure — Assessment of sampler performance for measurement of airborne particle concentrations — Part 1: General requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7708 and 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/

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3.1 General definitions

3.1.1
chemical agent
chemical element or compound, on its own or admixed, as it occurs in the natural state or as produced, used or released, including release as waste, by any work activity, whether or not produced intentionally and whether or not placed on the market

[SOURCE: Council Directive 98/24/EC, Art. 2 a)]

3.1.2
breathing zone
space around the nose and mouth from which breath is taken

Note 1 to entry: Technically, the breathing zone corresponds to a hemisphere (generally accepted to be 30 cm in radius) extending in front of the human face, centred on the midpoint of a line joining the ears. The base of the hemisphere is a plane through this line, the top of the head and the larynx. This technical description is not applicable when respiratory protective equipment is used.

[SOURCE: ISO 18158:2016, 2.1.5.5]

3.1.3
exposure
<inhalation> situation in which a *chemical agent* (3.1.1) or biological agent is present in the air that is inhaled by a person

[SOURCE: ISO 18158:2016, 2.1.5.1]

3.1.4
occupational exposure limit value
OELV
limit of the time-weighted average of the concentration of a *chemical agent* (3.1.1) in the air within the *breathing zone* (3.1.2) of a worker in relation to a specified reference period

Note 1 to entry: Limit values are mostly set for reference periods of 8 h, but can also be set for shorter periods or concentration excursions. Limit values for gases and vapours are stated in terms independent of temperature and air pressure variables in millilitres per cubic metre, and in terms dependent on those variables in milligrams per cubic metre, for a temperature of 20 °C and a pressure of 101,3 kPa. Limit values for airborne particles, as well as mixtures of particles and vapours, are given in milligrams per cubic metre or multiples of that unit for actual environmental conditions (temperature, pressure) at the workplace. Limit values of fibres are given in number of fibres per cubic metre or number of fibres per cubic centimetre for actual environmental conditions (temperature, pressure) at the workplace.

[SOURCE: Council Directive 98/24/EC, Art. 2 d), modified — Note 1 to entry added.]

3.1.5
reference period
specified period of time for which the *occupational exposure limit value* (3.1.4) of a *chemical agent* (3.1.1) or biological agent applies

Note 1 to entry: The reference period is usually 8 h for long-term measurements and 15 min for short-term measurements.

[SOURCE: ISO 18158:2016, 2.1.5.7]

3.1.6
time-weighted average concentration
TWA concentration
concentration of a *chemical agent* (3.1.1) in the atmosphere, averaged over a reference period

[SOURCE: ISO 25901-2:2022, 3.3.10, modified — "<occupational health>" deleted as the domain for the definition.]

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3.1.7
total airborne particles
all particles surrounded by air in a given volume of air

Note 1 to entry: Because all measuring instruments are size selective to some extent, it is often impossible to measure the total airborne particle concentration.

[SOURCE: ISO 7708:1995, 2.13]

3.1.8
workplace
designated area or areas in which the work activities are carried out

[SOURCE: ISO 18158:2016, 2.1.6.2]

3.2 Sampling definitions

3.2.1
sample
air sample
product of the process of (air) *sampling* (3.2.2)

Note 1 to entry: An air sample is frequently considered to include the collection substrate(s) as well as the collected *chemical agents* (3.1.1) and/or biological agents; or sometimes it is considered to be the fractional part of a larger volume of air.

[SOURCE: ISO 18158:2016, 2.2.1.1, modified — "<workplace air quality>" deleted as the domain for the definition.]

3.2.2
sampling
air sampling
process consisting of the separation of *chemical agents* (3.1.1) and/or biological agents from air or the withdrawal or isolation of a fractional part of a larger volume of air

[SOURCE: ISO 18158:2016, 2.2.3.1, modified — "<workplace air quality>" deleted as the domain for the definition.]

3.2.3
collection substrate
sampling substrate
collection medium
sampling medium
medium on which airborne *chemical agents* (3.1.1) and/or biological agents are collected for subsequent analysis

Note 1 to entry: Filters, polyurethane foams and sampling cassettes are examples of collection substrates for airborne particles.

[SOURCE: ISO 18158:2016, 2.2.3.7, modified — Note 2 and Note 3 to entry were deleted]

3.2.4
inhalable fraction
mass fraction of *total airborne particles* (3.1.7) which are capable of being inhaled through the nose and mouth

Note 1 to entry: The inhalable fraction depends on the speed and direction of the air movement, the rate of breathing and other factors.

[SOURCE: ISO 7708:1995, 2.3, modified — Definition revised.]

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3.2.5
inhalable sampler
aerosol sampler that is used to collect the *inhalable fraction* (3.2.4) of airborne particles from the surrounding air

[SOURCE: ISO 18158:2016, 2.2.2.1.6.1]

3.2.6
key component of welding fume
component of *welding fume* (3.3.9) that has the greatest occupational hygienic significance and therefore requires the most stringent control measures to ensure that a welder is not exposed to an excessive level of the substance concerned, i.e. it is the component whose limit value is exceeded at the lowest *welding fume* (3.3.9) concentration

[SOURCE: ISO 15011-4:2017, 3.3]

3.2.7
personal sample
product of the process of using a *sampler* (3.2.12), attached to a person, to collect gases, vapours and/or airborne particles in the breathing zone for the purpose of measuring exposure to *chemical agents* (3.1.1) and/or biological agents

[SOURCE: ISO 18158:2016, 2.2.1.3]

3.2.8
personal sampler
sampler (3.2.12), attached to a person, that collects gases, vapours or airborne particles in the *breathing zone* (3.1.2) for the purpose of measuring exposure to *chemical agents* (3.1.1) and/or biological agents

[SOURCE: ISO 18158:2016, 2.2.2.2]

3.2.9
personal sampling
process of using a *sampler* (3.2.12), attached to a person, to collect gases, vapours or airborne particles in the *breathing zone* (3.1.2) for the purpose of measuring exposure to *chemical agents* (3.1.1) and/or biological agents, representative of the exposure being evaluated

[SOURCE: ISO 18158:2016, 2.2.3.3, modified — Definition revised.]

3.2.10
respirable fraction
mass fraction of inhaled particles capable of penetration to the unciliated airways

[SOURCE: ISO 7708:1995, 2.11, modified — Definition revised.]

3.2.11
respirable sampler
aerosol sampler that is used to collect the respirable fraction of airborne particles from the surrounding air

[SOURCE: ISO 18158:2016, 2.2.2.1.6.3]

3.2.12
sampler
air sampler
device for separating and/or collecting *chemical agents* (3.1.1) and/or biological agents from the surrounding air

Note 1 to entry: (Air) samplers are generally designed for a particular purpose, for example for sampling gases and vapours or for sampling airborne particles.

[SOURCE: ISO 18158:2016, 2.2.2.1, modified — “<workplace air quality>” deleted as domain.]

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3.2.13
screening measurements of time-weighted average concentration
measurements performed to obtain basic information on the exposure level in order to decide whether an exposure problem exists and, if so, to further investigate it

Note 1 to entry: Screening measurements of time-weighted average concentration can also be used to determine if exposure is well below or well above the limit value. For more information see EN 482.

3.2.14
worst-case measurements
screening measurements of time-weighted average concentration made to identify work activity during which highest exposure occurs

3.3 Welding terms

3.3.1
filler material
welding consumable added during welding to form the weld

EXAMPLE Welding rods, wire, stick electrodes.

[SOURCE: ISO/TR 25901-1:2016, 2.1.10.4, modified — Example added.]

3.3.2
harness
assembly that provides a means of maintaining a *welder's face shield* (3.3.6) in position on the head

[SOURCE: EN 175:1997, 3.7]

3.3.3
headband
part of the *harness* (3.3.2) to which the *welder's face shield* (3.3.6) is fixed and which surrounds the head, or that part of the *welder's goggles* (3.3.7) or welder's spectacles which secures the goggles or spectacles onto the head

[SOURCE: EN 175:1997, 3.8, modified — Definition revised.]

3.3.4
operator
welder
person who performs *welding and allied processes* (3.3.8)

3.3.5
operator's breathing zone
restricted *breathing zone* (3.1.2)

Note 1 to entry: It is essential to sample as near as possible to the operator's nose and mouth when measuring exposure to *welding fumes* (3.3.9) because of the very steep concentration gradients that occur in the immediate vicinity of the plume.

3.3.6
welder's face shield
welder's shield worn on the head and in front of the face, usually secured in position by a *harness* (3.3.2) to give protection to the eyes and face when fitted with the appropriate filter(s)

[SOURCE: EN 175:1997, 3.2]

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3.3.7
welder's goggles
device, held in position usually by a *headband* (3.3.3), enclosing the orbital cavity, into which radiation arising from *welding and allied processes* (3.3.8) can penetrate only through filter(s) and, where provided, filter cover(s)

[SOURCE: EN 175:1997, 3.5]

3.3.8
welding and allied processes
surfacing or joining process, producing a continuity in the nature of the workpiece material(s) by means of heat or pressure or both, and with or without the use of *filler material* (3.3.1)

Note 1 to entry: Low-temperature processes such as soldering are excluded.

[SOURCE: ISO/TR 25901-1:2016, 2.1.1.1, modified — Term and definition revised, note 1 to entry replaced.]

3.3.9
welding fume
airborne particles generated during *welding and allied processes* (3.3.8)

[SOURCE: ISO 25901-2:2022, 3.1.8, modified — Definition revised and note to entry removed.]

3.3.10
welding-related operations
operations other than *welding and allied processes* (3.3.8) carried out by the operator

3.4 Statistical terms

3.4.1
measurand
quantity intended to be measured

[SOURCE: ISO/IEC Guide 99:2007, 2.3, modified — Notes to entry and examples deleted.]

3.4.2
measurement uncertainty
uncertainty of measurement
uncertainty
non-negative parameter characterizing the dispersion of the quantity values being attributed to a *measurand* (3.4.1), based on the information used

Note 1 to entry: The parameter can be, for example, a standard deviation called standard measurement uncertainty (or a specified multiple of it), or the half-width of an interval, having a stated coverage probability.

Note 2 to entry: Measurement uncertainty comprises, in general, many components. Some of these can be evaluated by Type A evaluation of measurement uncertainty from the statistical distribution of the quantity values from series of measurements and can be characterized by standard deviations. The other components, which can be evaluated by Type B evaluation of measurement uncertainty, can also be characterized by standard deviations, evaluated from probability density functions based on experience or other information.

[SOURCE: ISO/IEC Guide 99:2007, 2.26, modified — Notes 1 and 4 to entry deleted.]

4 Principle

Airborne particles are collected by drawing a known volume of air through a collection substrate, for example a filter, mounted in a sampler designed to collect the appropriate fraction of airborne particles. For personal sampling, the sampler is positioned in the operator's breathing zone. In such instances, it is necessary to use a mounting arrangement that enables the sampler to be maintained in position in the operator's breathing zone throughout the sampling period without impeding normal work activity. Exposure to airborne particles from welding and allied processes (welding fume) and airborne particles from welding-

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