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Health and safety in welding and allied processes — Equipment for capture and separation of welding fume —

Part 1: General requirements

Hygiène et sécurité en soudage et techniques connexes — Equipements de captage et de filtration des fumées —

Partie 1: Exigences générales

Reference number
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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 44, *Welding and allied processes*, Subcommittee SC 9, *Health and safety*.

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.

A list of all parts in the ISO 21904 series can be found on the ISO website.

This first edition cancels and replaces ISO 15012-4.

Introduction

Welding and allied processes generate fumes and gases which, if inhaled, can be harmful to human health. Therefore, control of the fumes and gases generated is to be exercised to minimize worker exposure.

The most effective method of control is to capture the fumes and gases close to their source before they enter a worker's breathing zone or the general workplace environment.

Ventilation equipment used to capture the fumes and gases is to be fit for purpose because inefficient capture can result in high exposure and can be detrimental to workers' health. Therefore, it is important that it adheres to defined manufacturing, materials and design requirements and gives warning of malfunction.

This document is a type-C standard as stated in ISO 12100.

This document is of relevance, in particular, for the following stakeholder groups representing the market players with regard to machinery safety:

— machine manufacturers (small, medium and large enterprises);

— health and safety bodies (regulators, accident prevention organisations, market surveillance etc.);

Others can be affected by the level of machinery safety achieved with the means of the document by the above-mentioned stakeholder groups:

— machine users/employers (small, medium and large enterprises);

— machine users/employees (e.g. trade unions, organizations for people with special needs);

— service providers, e. g. for maintenance (small, medium and large enterprises);

— consumers (in case of machinery intended for use by consumers).

The above-mentioned stakeholder groups have been given the possibility to participate at the drafting process of this document.

In addition, this document is intended for standardization bodies elaborating type-C standards.

The requirements of this document can be supplemented or modified by a type-C standard.

For machines which are covered by the scope of a type-C standard and which have been designed and built according to the requirements of that standard, the requirements of that type-C standard take precedence.

Health and safety in welding and allied processes — Equipment for capture and separation of welding fume —

Part 1: General requirements

1 Scope

This document defines the general requirements for ventilation equipment used to capture and separate fumes generated by welding and allied processes, e.g. arc welding and thermal cutting.

This document also specifies the test data to be marked on the capture devices.

It applies to the design and manufacture of parts of the equipment including hoods for welding, ducting, filter units, air movers, systems that inform of unsafe operation and workplace practices to ensure safe working with regard to exposure.

Significant hazards are listed in Clause 4. It does not cover electrical, mechanical and pneumatic hazards.

This document is applicable to:

— local exhaust ventilation systems (LEV) excluding draught tables;

— mobile and stationary equipment;

— separation equipment used for welding and allied processes;

This document is not applicable to:

— general ventilation, air make up or air movement systems;

— air conditioning systems;

— grinding dust.

This document applies to systems designed and manufactured after its publication.

NOTE Specific safety requirements for thermal cutting machines are defined in ISO 17916.

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 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

ISO 13849-1:2015, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*

ISO 21904-2:2020, *Health and safety in welding and allied processes — Equipment for capture and separation of welding fume — Part 2: Requirements for testing and marking of separation efficiency*

ISO 21904-4:2020, *Health and safety in welding and allied processes — Requirements, testing and marking of equipment for air filtration — Part 4: Determination of the minimum air volume flow rate of captor hoods and nozzles*

IEC 60204-1:2005, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 60335-2-69:2012, *Household and similar electrical appliances — Safety — Part 2-69: Particular requirements for wet and dry vacuum cleaners, including power brush, for commercial use*

IEC 60695-2-12:2010+A1:2014, *Fire hazard testing — Part 2-12: Glowing/hot-wire based test methods — Glow-wire flammability index (GWFI) test method for materials*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100:2010 and the following apply.

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

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

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

3.1
welding fume separation equipment
air filtration equipment, the purpose of which is to separate particles generated by welding and allied processes from workplace atmosphere

Note 1 to entry: Some separation equipment is designed to also remove gases generated by welding, but the ISO 21904 series does not address the efficiency of gas separation.

3.2
filter cleaning system
system designed to clean the filter of *welding fume separation equipment* (3.1) in order to restore the air flow rate through the filter when it is reduced by an accumulation of *welding fume* (3.13) particles

3.3
on-line filter cleaning system
filter cleaning system, either automatically or manually initiated, operating while *welding fume separation equipment* (3.1) is running

3.4
off-line filter cleaning system
filter cleaning system, either automatically or manually initiated, operating after the air mover of the filtration equipment is switched off

3.5
separation efficiency by mass
ratio of the mass of particles retained by *welding fume separation equipment* (3.1) to the mass of particles entering the equipment during a given period

Note 1 to entry: General information on test methods for determination of separation efficiency is described in EN 1093-6 and EN 1093-7.

3.6
local exhaust ventilation
LEV
use of extraction to remove contaminated air at or near to its source

3.7
filter protector
device normally positioned at the intake of the *welding fume separation equipment* (3.1), used to minimize the possibility of damaging impacts of sparks or large particles on filter media

Note 1 to entry: Filter media can also be protected against sparks and large particles by the internal design of the welding fume separation equipment.

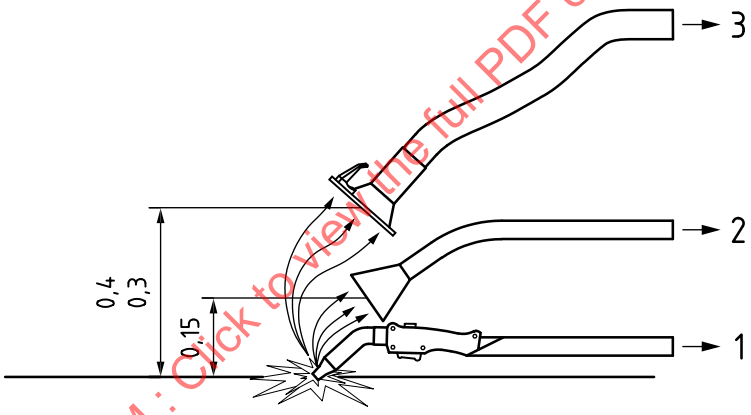
Note 2 to entry: Examples of filter protectors are cyclones, spin separators, baffles or sieves. A filter protector may be designed to also protect against flame damage.

3.8
on-torch extraction device
on-gun extraction device
equipment, integrated or attached, on torch used for capturing *welding fume* (3.13), when connected to an extraction source

Note 1 to entry: Due to the state of the art, on-torch extraction devices for TIG welding are not covered by this definition.

Note 2 to entry: For an overview of the different extraction devices, see Figure 1.

Dimensions in metres



Key

1 on-torch extraction (3.8), 50 m^3/h to 100 m^3/h, 5 kPa to 18 kPa
2 high vacuum extraction (3.9), 100 m^3/h to 150 m^3/h, 5 kPa to 10 kPa
3 low vacuum extraction (3.9), 700 m^3/h to 1500 m^3/h, 800 Pa to 2 000 Pa

Figure 1 — Overview of extraction devices and common air volume flow rates and pressure

3.9
captor hood
captor nozzle
equipment, movable or static, used for capturing *welding fume* (3.13), when connected to an extraction source

Note 1 to entry: For an overview of the different extraction devices, see Figure 1.

3.10
receiving hood
canopy
equipment, movable or static, normally positioned above a hot process, where the contaminated air is propelled into it by process-induced air movement

3.11
enclosure
chamber
fully or partially enclosed space where the process takes place, designed to contain and prevent the escape of hazardous substances into the workshop air

3.12
suction equipment
unit with air mover and with or without a filter

3.13
welding fume
airborne particles typically with diameter smaller than 1 µm generated by welding and allied processes

3.14
minimum air volume flow rate
air volume flow rate required for acceptable capture of *welding fume* (3.13)

Note 1 to entry: The minimum air volume flow rate depends on the type and the geometric dimensions of the capture device and the test positions selected to demonstrate the extent of the capture zone (see 7.3).

3.15
suction field
volume around a capture device, in which the air velocity required to capture *welding fume* (3.13) is exceeded

4 Significant hazards

Exposure to welding fumes and gases generated by welding and allied processes can be detrimental to health. Control of exposure can usually be achieved using ventilation equipment but any failure of this equipment, such as poor design and the use of parts made of unsuitable materials, can result in reduced extraction efficiency and hence over exposure and ill health.

Common health effects include respiratory disease, but exposure to carcinogenic substances during the welding can occur and shall be considered.

The requirements of the ventilation equipment are dependent on the level of control necessary.

5 Requirements and verifications

5.1 General

The general requirements and corresponding verifications are given in Table 1.

Table 1 — General requirements and verifications

	Requirement	Verification
1.1 Requirements for all equipment	Machinery shall comply with the safety requirements and/or protective/risk reduction measures in Clause 5. In addition, the machine shall be designed according to the principles of ISO 12100:2010 for relevant but not significant hazards which are not dealt with by this document.	
	All parts and materials used in the manufacture of welding fume ventilation equipment shall withstand the conditions (thermal, mechanical, UV radiation) present in the environment in which they are intended to be used.	Verification shall be performed by examining the manufacturer's datasheets, the instruction manual, and by referring to the manufacturer's long-term experience with respective devices.
	Equipment used for capturing of welding fume shall be fitted with indicators and control units showing correct operation or malfunction of the device, as malfunctions can cause hazardous operation conditions for the user. Malfunction of equipment shall be indicated by a clear visual or acoustic warning signal. Two types of malfunctions are possible and are shown in Annex A together with their most common causes. Visual warning signals shall work with a pulse frequency between 2 Hz and 0,2 Hz, emitting yellow or yellow-orange light. Visible warning signals shall be installed inside or nearby the working area of welders in order to be recognized when the light is on. NOTE EN 842 provides additional guidance for visual danger signals. This document can also be part of national legislation.	Conformity shall be checked by visual and/or audible inspection.
	If an acoustic warning device is installed, it shall work within an audio-frequency between 500 Hz and 3 000 Hz and have a pulse time between 0,5 s and 5 s. The A-weighted sound pressure level shall be between 8 dB and 20 dB higher than the 1 m-surface sound pressure level of the welding fume separation equipment. Signals/indicators for normal operation — For LEV: Proper operation of a LEV shall be indicated by a control lamp emitting green light. — For dampers on devices for capturing: Capture equipment fitted with a manual shut off damper, the handle shall be aligned with the damper position. For automatic dampers, the position shall be indicated clearly visible to the user as open or closed. Warning signals for malfunction	Conformity shall be checked by simulating a malfunction in order to test the function of the warning signal.

Table 1 *(continued)*

	Requirement	Verification
	— Separation equipment shall be fitted with a device that indicates that the filter needs service (either cleaning or replacement). When any malfunction exists, the control lamp shall not emit green light and the warning signals shall be active. NOTE There is currently no reliable system for monitoring the filter efficiency. It is therefore excluded.	
1.2 Additional requirements for equipment used for separation of carcinogenic substances	Carcinogenic substances require checking of airflow rate in the extraction duct at each individual work place. NOTE The airflow rate is measured indirectly, usually by measuring the duct pressure except for on-torch extraction devices where a direct measurement of airflow at the nozzle is required. The required Performance Level, PL_r, according to ISO 13849-1:2015 is level a. Warning signal for malfunction: if the airflow rate in the extraction duct is insufficient, it shall be indicated by a clear visual or acoustic warning signal.	Conformity shall be checked by simulating a malfunction in order to test the function of the warning signal.
1.3 Flammability	Non-metallic parts (especially hoods, hoses and ducting properties) shall be made of materials of low flammability.	Verification shall be performed by examining compliance with the following: a) For hoods and hoses: GWIT: 550 according to IEC 60695-2-12:2010+A1:2014 (glow-wire test temperature of 550 °C) b) For ducting properties: GWIT: 960 according to IEC 60695-2-12:2010+A1:2014 (glow-wire test temperature of 960 °C) NOTE The use of materials of higher flammability can result in damage to the hose leading to reduced airflow at the extraction point and hence poor extraction efficiency.

5.2 Extraction devices

The requirements and corresponding verifications for extraction devices are given in Table 2.

Table 2 — Requirements and verifications for extraction devices

<table>
<tr><th></th><th>Requirement</th><th>Verification</th></tr>
<tr><td colspan="3">1 Extraction devices to be used close to the welding fume source (distance up to 0,4 m)</td></tr>
<tr><td>1.1 On-torch extraction devices</td><td>— The extraction device integrated to the torch shall be able to induce a sufficient velocity, see Table below. These induced velocities shall be obtained with a limited depression at the connector.
<table>
<tr><th>Designed current
A</th><th>Induced velocity, v_i
m/s</th><th>Needed depression at connector, Δp_c
kPa</th></tr>
<tr><td>≤200</td><td>≥0,25</td><td rowspan="2">≤18</td></tr>
<tr><td>>200</td><td>≥0,35</td></tr>
</table></td><td>Verification shall be performed by measuring the air flow rate and depression according to ISO 21904-4:2020.</td></tr>
<tr><td></td><td>NOTE 1 Torch designed for maximum operating current (60 % duty cycle for air-cooled torches and 100 % for liquid-cooled torches with shielding gas Ar-CO_2).

— The manufacturer of the torch shall use the results of the test according to ISO 21904-4:2020 to specify the air flow rate and the depression at the connector to achieve the required induced velocity.

— In order to guarantee the efficiency on field, the design of the torch should not allow operation if parts ensuring the capture are not assembled, e.g. the nozzle (this provision means to prevent the dismantling of parts which the welder does not deem necessary).

NOTE 2 Reaching 100 % efficiency is not possible because that would extract the shielding gas and each single spark spattering away, has its own wisp of smoke. It can be necessary to use additional equipment like ventilation or personal protection to reduce the hazardous substances.</td><td></td></tr>
<tr><td>1.2 Captor hoods and nozzles extraction devices</td><td>The extension of the suction field shall be determined in a measurement plane according ISO 21904-4:2020.

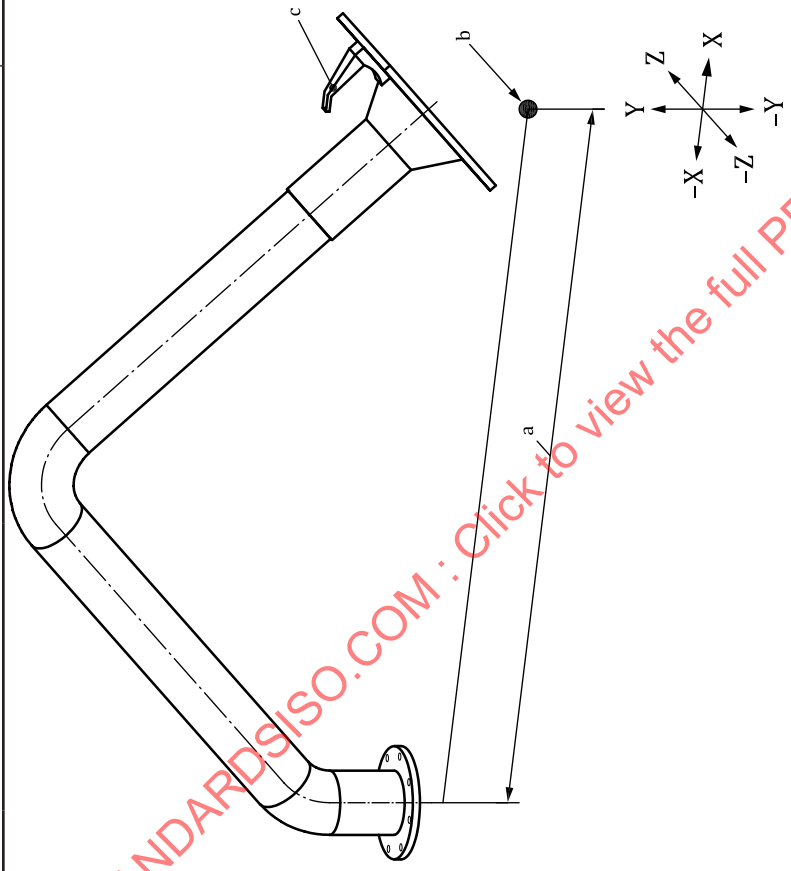
The suction field shall have an extension of at least 1,5 times the diameter of the attached duct in one direction and at least one duct diameter in the orthogonal direction.</td><td>Verification shall be performed by measuring the suction field according to ISO 21904-4:2020.

Insufficient performance of the hood can be compensated by increasing the volume flow rate. The size of the suction field shall be verified by performing a new measurement with the new flow rate.</td></tr>
</table>

Table 2 *(continued)*

	Requirement	Verification
	The necessary flow rate shall be assured by the manufacturer. The manufacturer of a hood or nozzle shall use the results of the tests according to ISO 21904-4:2020 to specify and mark the device with the minimum air volume flow rate required to achieve an air velocity of 0,3 m/s in the measurement plane, the distance of the measurement plane from the entry plane and the position of the measurement points selected to demonstrate the extent of the capture zone of the device. The measurement points shall be identified by their (x, y)-co-ordinates projected from the entry plane. NOTE A hood or nozzle is expected to achieve effective capture of welding fume if it is operated with an air volume flow rate greater than or equal to the determined minimum air volume flow rate, and if it is positioned at a distance less than or equal to the distance between the measurement plane and the entry plane of the device.	
1.2.1 Extraction devices with flexible arms	It shall be possible (see Figure 2) to move a flexible arm in any direction using a force not exceeding 60 N at the handhold of the hood: a) with the arm at 70 % of its maximum range; b) at a point c, 1 300 mm ± 100 mm above ground level; c) in the directions shown in Figure 2, over a range that is 10 % of the maximum range. The movement in the Z-direction may follow an arc with radius, r. NOTE 1 If flexible arms do not fulfil the requirements, the risk of incorrect use or non-use increases because of ergonomic reasons. NOTE 2 The handhold is the point on the hood intended to be touched for movement. The arm shall retain their position over the entire operating range after the force has been removed.	Verification that the arm is easily movable shall be achieved by measurement of forces and that it retains its position by visual inspection.
1.2.2 Extraction devices with fixed arms	No specific requirements	

Table 2 *(continued)*

	Requirement	Verification
		

Key

a 70 % of the maximum range.

b Starting point of movement.

c Point of force measurement.

Figure 2 — Example for a moving force test setup

Table 2 *(continued)*

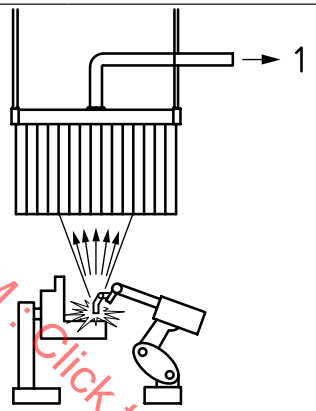
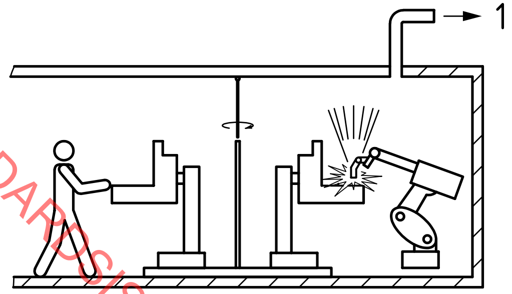
	Requirement	Verification
2 Extraction devices to be used in the vicinity of the welding fume source (distance up to 1,5 m)		
	 **Key** 1 common airflow and pressure, 2 000 m^3/h to 4 000 m^3/h, 100 Pa to 500 Pa **Figure 3 — Receiving hood with curtains**	
2.1 Receiving hoods	Figure 3 shows a receiving hood with curtains. An air volume flow rate sufficient to remove all the welding fumes received shall be employed. NOTE 1 The air volume flow rate required depends on the thermal flow generated by the welding process, the vertical distance between welding fume source and hood, and the dimensions of the receiving hood.	Verification that no welding fume escapes shall be performed qualitatively by visual inspection using a welding fume source (see also Annex A). NOTE 2 A possible method for visual inspection is using a dust lamp (Tyndall effect) under worst-case welding conditions.
2.2 Enclosures (chambers)	During welding fume generation and for a pre-determined clearance period afterwards, there shall be an inflow of air through all openings sufficient to prevent any escape of welding fumes to the external environment. For an example of an enclosure see Figure 4.	Verification that no welding fume escapes shall be performed qualitatively by visual inspection with the welding process operating. The required flow rate shall be recorded. See also Annex A. NOTE 1 The flow rate can be different for different welding parameter/material combinations. NOTE 2 A possible method for visual inspection is using a dust lamp (Tyndall effect) under worst-case welding conditions.

Table 2 *(continued)*

	Requirement	Verification
	 **Key** 1 common airflow and pressure, 2 000 m^3/h to 4 000 m^3/h, 100 Pa to 500 Pa **Figure 4 — Enclosure**	

5.3 Ducting properties

The requirements and corresponding verifications are given in Table 3.

Table 3 — Requirements and verifications for ducting properties

Component	Requirements	Verification
Ducting	The ducting shall a) allow access for inspection and maintenance (e.g. hatches), b) be sized, by calculation, to achieve a sufficient air velocity to minimize sedimentation NOTE 1 For welding and allied processes, an air velocity of at least 10 m/s in the duct is considered to be sufficient. Higher air velocities will result in higher power consumption. Proper aerodynamic design of ducting, junctions, bends, joints, etc., helps to minimize sedimentation, pressure drop and noise. A rounded, rather than right angled, cross-section is preferred. NOTE 2 Modern central systems often have automatic dampers for each workplace and maybe a frequency converter for the filter system. Normally, such a system is designed for a specific number of places to be used at the same time. If that number of places is active, the air velocity is expected to reach the design velocity. If fewer places are used, the air velocity will be lower. This is considered to be acceptable because the settling speed of welding fume is very low and so there is not too much sedimentation in the ducting system.	Verification shall be performed by visual inspection and measurement of the air velocity, e.g. by hot wire or Pitot static tube according to ISO 3966.

5.4 Filters, related components and handling

The requirements and corresponding verifications are given in Table 4.

Table 4 — Requirements and verifications for welding fume separation equipment

1 Efficiency of welding fume separation equipment		
Component	Requirements	Verification
1.1 General	The separation efficiency required is determined by the intended use of the unit. Possible modes of operation are: exhaust air (1.2), recirculated air (1.3) and a combination of recirculated and exhaust air. NOTE In some countries, regulations define the quality requirements for exhaust air and recirculated air. In some countries, recirculation of air is prohibited.	Verification according to ISO 21904-2:2020.
1.2 Exhaust air (airflow discharged to the outdoor environment)	Separation equipment that is used exclusively for exhaust air shall have filters that comply at least to dust class L as given in IEC 60335-2-69:2012 or comparable quality.	
1.3 Recirculated air (extract air that is returned to the workplace atmosphere)	The separation efficiency of the welding fume separation equipment shall be tested according to ISO 21904-2:2020 and shall be at least 99 %. In that case, it may be marked W3.	
2 Filter related components		
2.1 Air mover	Air movers shall be attached in a way that minimizes the risk of welding fume emissions. If an air mover is installed in front of the filter, it should be ensured that no leaks in the duct between the air mover and filter exist by which welding fume can be emitted. NOTE For LEV, it is state-of-the-art to install the air mover behind (regarding the direction of flow) the filter. For air movers powered by three-phase electric motors, it shall be possible to determine and adjust, if necessary, correct direction of rotation in order to reach a sufficient air flow.	Conformity shall be checked by visual inspection.
	The equipment shall be designed in a way that an unintentional reversal of air flow is prevented.	Conformity shall be checked by reversing the motor rotation, a reverse of air flow shall not occur.

Table 4 *(continued)*

2.2 Filter protector	If the separation efficiency can be compromised by sparks or large, hot or abrasive particles damaging the filter media, the filter media shall be protected either by a filter protector or by the welding fume separation equipment design. NOTE The hazard of damaging the filter by sparks depends on a large number of parameters. These need to be considered to determine the need for spark arrestors. Listed below are some of these parameters: — The welding process: MIG/MAG welding generates sparks. Their number is increasing with the welding amperage. Other processes like cutting or grinding also generate sparks. The amount depends on the thickness of the cut material or the amount of stripped material. — The material: Coatings on the basic material increase the generation of sparks. — The ducting: The longer the ducting and the more turns are installed, the lower the risk of living sparks at the filter will be.	If a filter protector shall be fitted, establish that the filter protector is present by visual inspection. NOTE Currently, there is no test method available to measure the efficiency of filter protectors against sparks.
2.3 Filter cleaning system	Filter cleaning systems shall restore the air volume flow rate greater than the minimum air volume flow rate for efficient capture. During cleaning, the emission of airborne particles into the workplace shall be minimized. Filter cleaning shall not create a reverse flow that causes the emission of particles from the extraction entry point or from the body of the welding fume separation equipment. In case of off-line filter cleaning systems, a damper can be necessary to prevent a return of airflow. NOTE Off-line filter cleaning systems are operating after the air mover of the filtration equipment is switched off. On-line filter cleaning systems are operating while welding fume separation equipment is running.	Conformity shall be checked by visual inspection
3 Airflow and exhaust air		
3.1 Airflow capacity for intended use	Built for the intended airflow For stand-alone units with combined extraction device the airflow measured during the test according to ISO 21904-2:2020 shall not go under the minimum air volume flow rate determined according to ISO 21904-4:2020.	

Table 4 *(continued)*

3.2 Exhaust air	Welding fume separation equipment shall be designed and manufactured in a way that the exhaust and the cooling air of the motor can be directed away from any persons working in the vicinity of the equipment. Further exhaust and cooling air shall not disperse dust settled on the floor and/or on walls. The velocities of the exhaust and of the cooling air shall not exceed 1 m/s at a distance of 1,5 m around the welding fume separator, between a lower measurement plane at a height of 50 mm above the floor level and an upper measurement plane at a height of 2 m above the floor level. NOTE In some countries, recirculation of air to the work place atmosphere is discouraged or prohibited. Channelling of the exhaust air can be necessary.	Conformity shall be checked by visual inspection and measuring the air velocity.
4 Handling		
4.1 Filter changing	Welding fume separation equipment shall be designed so that filters can be changed from the outside of the filter housing or from the clean air side. NOTE There is a high risk of exposure to suspended welding fume, if the equipment is not designed in that way.	Conformity shall be checked by visual inspection.
4.2 Waste handling	It shall be possible to replace any containers or bags while minimizing suspension of collected welding fume. The containers or bags shall be able to withstand the stresses of transportation, even when filled to their maximum capacity, and it shall be possible to seal them tightly to eliminate the risk of suspension of collected welding fume. Filter waste boxes or bags used for collection of particles shall not be reused. Such boxes or bags shall be labelled for one-time use.	Conformity shall be checked by visual inspection.

6 Instructions for use

6.1 General

The manufacturer shall provide information regarding the optimum use of extraction devices in an instruction manual.

The manufacturer of a component such as the capture device or suction equipment shall give technical data at the interface to connect components intended to be used. Technical data include, for example, characteristic curves for flow rate and depression as well as dimensions.

The manufacturer shall state that any additional hoses or ducts can add pressure drop and shall be considered by the installation designer or the user.

The manufacturer shall provide information regarding the inspection of hoses for damages affecting the extraction efficiency.

The manufacturer shall inform the user if and how channelling of the exhaust air can be done.

NOTE 1 In some countries, recirculation of air to the work place atmosphere is discouraged or prohibited. Channelling of the exhaust air can be necessary.

The instructions for use shall cover every life phase of the equipment (from assembling to placing out of operation).

a) the instructions for use of welding fume separation equipment, which shall include the following information:

   1) the intended use of the equipment;

   2) usability for welding fumes containing CMR (carcinogenic mutagenic reprotoxic) substances, e.g. generated by welding high alloyed steels or welding consumables with more than 5 % (Cr, Ni);

   3) usability only for welding fumes not containing CMR substances, e.g. TIG-welding of aluminium;

b) the meaning of indicators and warning signals;

c) the maintenance procedures, e.g. cleaning and changing of the filter, waste handling, changing of expendable parts;

d) the temperature and atmosphere conditions for operation and storage.

In case of unavoidable residual risks, there shall be information in the manual with advice on how to handle it, particularly regarding the handling of hazardous substances.

NOTE 2 There can be different requirements in national legislation for carcinogenic substances in the exhaust air (e.g. in some countries, it is not allowed to bring back the cleaned air into the workshop, other countries allow to bring back the cleaned air if the welding fume separation equipment is tested according to ISO 21904-2:2020 and marked W3).

NOTE 3 Reaching 100 % efficiency is not possible because that would extract the shielding gas and each single spark spattering away, has its own wisp of smoke. It may be necessary to use additional equipment like ventilation or personal protection to reduce the hazardous substances.

Conformity shall be checked by visual inspection.

6.2 Extraction devices

6.2.1 Captor hoods and nozzles

Effective operation of a captor hood depends primarily on its positioning towards the source/the process where welding fume is emitted, and its capture zone depending on the air velocity and the