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

Part 4: General requirements

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

Partie 4: Exigences générales

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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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 44, *Welding and allied processes*, Subcommittee SC 9, *Health and safety*.

ISO 15012 consists of the following parts, under the general title *Health and safety in welding and allied processes — Equipment for capture and separation of welding fume*:

— *Part 1: Requirements for testing and marking of separation efficiency*

— *Part 2: Determination of the minimum air volume flow rate of captor hoods and nozzles*

— *Part 3: Determination of the capture efficiency of on-gun welding fume extraction devices*

— *Part 4: General requirements*

Requests for official interpretations of any aspect of this International Standard should be directed to the Secretariat of ISO/TC 44/SC 9 via your national standards body. A complete listing of these bodies can be found at www.iso.org.

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 could result in high exposure and can be detrimental to workers' health. It is important therefore that it adheres to defined manufacturing, materials and design requirements and gives warning of malfunction.

This part of ISO 15012 defines the general requirements that are necessary for ventilation equipment to maintain exposure to fumes at acceptable levels.

This part of ISO 15012 is a type-B standard as stated in ISO 12100.

This part of ISO 15012 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 organizations, market surveillance, etc.).

Others can be affected by the level of machinery safety achieved with the means of this part of ISO 15012 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 part of ISO 15012.

In addition, this part of ISO 15012 is intended for standardization bodies elaborating type-C standards.

The requirements of this part of ISO 15012 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 4: General requirements

1 Scope

This part of ISO 15012 defines the general requirements for ventilation equipment used to control exposure to fumes generated by welding and allied processes. It applies to the design and manufacture of all parts of the equipment including hoods, 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 part of ISO 15012 is applicable to the following:

— local exhaust ventilation systems (LEV);

— mobile and stationary equipment.

This part of ISO 15012 is not applicable to the following:

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

— air conditioning systems;

— separation of gases generated by or used by welding and allied processes;

— LEV used for welding and allied processes that generate reactive potentially explosive particles and atmospheres;

— grinding dust.

This part of ISO 15012 applies to systems designed and manufactured after its publication.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 15012-1:2013, *Health and safety in welding and allied processes — Equipment for capture and separation of welding fume — Part 1: Requirements for testing and marking of separation efficiency*

ISO 15012-2, *Health and safety in welding and allied processes — Requirements, testing and marking of equipment for air filtration — Part 2: Determination of the minimum air volume flow rate of captor hoods and nozzles*

ISO 15012-3, *Health and safety in welding and allied processes — Requirements, testing and marking of equipment for air filtration — Part 3: Determination of the capture efficiency of on-gun welding fume extraction*

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

IEC 60335-2-69, *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, *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 and the following apply.

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 air

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

3.3
on-line filter cleaning system
filter cleaning system operating while welding fume separation equipment is working

3.4
off-line filter cleaning system
filter cleaning system 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 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
emission rate
mass of the particles emitted by the welding fume source per time

Note 1 to entry: Emission rate is expressed in milligrams per second.

3.7
local exhaust ventilation
LEV
use of extraction to remove contaminated air at or near to its source

3.8
spark arrestor
device, normally positioned at the intake of welding fume separation equipment, used to prevent the damaging impact of sparks and large particles on filter media

Note 1 to entry: Examples of spark arrestors are cyclones, spin separators, baffles or sieves. A spark arrestor may be designed to also protect against flame damage.

3.9 Extraction device

3.9.1
captor hood
equipment (movable or fixed) that generates sufficient air velocity at the source to capture and draw in the contaminated air

3.9.2
receiving hood
passive equipment (movable or fixed), normally positioned above a hot process, where the contaminated air is propelled into it by process-induced air movement

3.9.3
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

3.10
welding fume
airborne particles generated during welding

4 Significant hazards

Exposure to 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 of alloyed materials 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

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 for relevant but not significant hazards which are not dealt with by this part of ISO 15012.

5.2 Welding fume separation equipment

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.

5.3 Extraction devices

5.3.1 General

Non-metallic hoods shall be made of materials of low flammability. Verification shall be performed by examining compliance with the glow-wire end product test GWEPT: 550 according to IEC 60695-2-12 (glow-wire test temperature of 550 °C).

5.3.2 Captor hoods

Captor hoods shall comply with the requirements of ISO 15012-2.

5.3.3 Receiving hoods

An air volume flow rate sufficient to remove all the 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 fume source and hood, and the dimensions of the receiving hood.

Verification that no 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.

5.3.4 Enclosures (chambers)

During 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 fumes to the external environment.

Verification that no 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.

5.3.5 On-gun extraction devices

On-gun extraction devices shall comply with ISO 15012-3.

5.4 Flexible arms, hoses and hoods

5.4.1 Movement of flexible arms

It shall be possible (see Figure 1) 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;

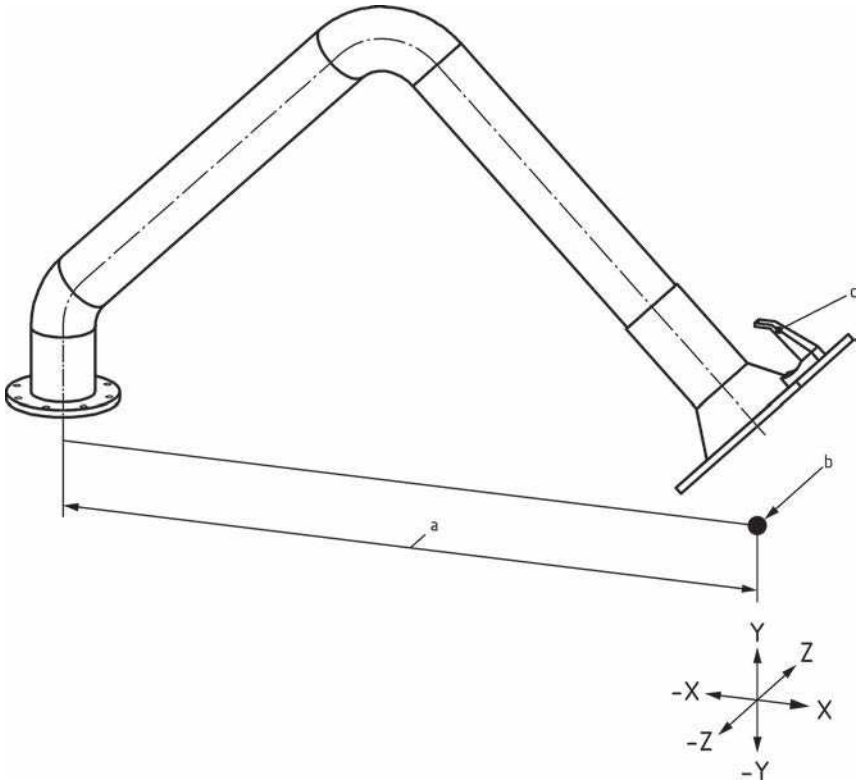
c) in the directions shown in Figure 1, over a range that is 10 % of the maximum range. The movement in the Z-direction may follow an arc with radius a.

NOTE 1 If flexible arms do not fulfil the requirements, risk of incorrect use or non-use will increase 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.



Key

a 70 % of the maximum range.

b Starting point of movement.

c Point of force measurement.

Figure 1 — Example of a moving force test setup

5.4.2 Hoses

Non-metallic parts shall be made of materials of low flammability.

Verification shall be performed by examining compliance with GWEPT: 550 according to IEC 60695-2-12 (glow-wire test temperature of 550 °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.

5.5 Ducting properties

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, and

c) be made of metal or of materials of low flammability.

NOTE 1 For welding and allied processes, an air velocity between 10 m/s and 15 m/s in the duct is usually considered to be sufficient. 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 will be not too much sedimentation in the ducting system.

Verification that the ducting complies with the above requirements shall be performed by visual inspection and measurement of the air velocity, e.g. according to ISO 3966 or ISO 16911.

Verification of low flammability shall be performed by examining compliance with GWEPT: 960 according to IEC 60695-2-12 (glow-wire test temperature of 960 °C).

5.6 Spark arrestor

If the separation efficiency could be compromised by sparks or large, hot or abrasive particles reaching the filter media, the welding fume separation equipment shall be fitted with a spark arrestor.

Verification shall establish whether separation efficiency can be compromised and, therefore, whether a spark arrestor is to be fitted. If so, establish that the spark arrestor is present by visual inspection.

5.7 Separation efficiency

5.7.1 General

The separation efficiency required is determined by the intended use of the unit. Possible modes of operation are: exhaust air (5.7.2), recirculated air (5.7.3) and a combination of recirculated and exhaust air.

NOTE In some countries, national regulations define the quality requirements for exhaust air and recirculated air and recirculation of air is prohibited.

5.7.2 Exhaust air (airflow discharged to the atmosphere)

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.

5.7.3 Recirculated air (extract air that is returned to the workplace)

5.7.3.1 Equipment for fumes not containing carcinogenic, mutagenic and/or substances toxic to reproduction (CMR)

Separation equipment that is exclusively used for fumes not containing CMR substances shall be either of the following.

a) Equipped with filter media complying to at least dust class M given in IEC 60335-2-69.

   The air shall not be able to bypass the filter element as shown by visual inspection using e.g. limestone or plaster.

   NOTE The test could be carried out by sucking in plaster or limestone dust into the extraction system and visual inspection of the clean air side for traces of plaster or limestone.

b) The whole unit shall have a separation efficiency of >95 %, tested according to the test procedure described in ISO 15012-1:2013, Clause 7.

5.7.3.2 Equipment for fumes where CMR substances are expected

For separation equipment used when CMR substances are expected (welding of high alloyed steels), the separation efficiency shall comply with ISO 15012-1, i.e. have a separation efficiency of the total unit of at least 99 %.

NOTE ISO 15012-1 specifies a method for testing equipment for the separation of welding fume generated by a defined welding process in order to determine whether its separation efficiency meets the specified requirements. It refers to the whole separation unit not only to filter elements.

5.8 Filter cleaning system

If welding fume separation equipment is fitted with a filter cleaning system in order to restore air volume flow rate, it shall be designed so that emissions of airborne particles into the workplace atmosphere are minimized during filter cleaning. Cleaning of the filter shall not cause emissions of welding fume discharged from the intake by a reverse of air flow or from leakages on the body of the welding fume separation equipment.

Conformity shall be checked by visual inspection.

5.9 Filter changing

Welding fume separation equipment shall be designed so that filters can be changed from outside of the filter housing or from its clean air side.

Conformity shall be checked by visual inspection.

NOTE There is a high risk of exposure to suspended welding fume, if the equipment is not designed in that way.

5.10 Waste handling

For welding fume separation equipment utilizing adequate containers or bags, it shall be possible to replace the 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 should not be reused. Such boxes or bags shall be labelled for one-time use.

Conformity shall be checked by visual inspection.

5.11 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 after (regarding the direction of flow) the filter.

Conformity shall be checked by visual inspection.

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.

5.12 Signals/indicators

5.12.1 General requirements for all equipment

Welding fume separation equipment used for separation 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 0,2 Hz and 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 standard might also be part of national legislation.

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:

  for 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.

Conformity shall be checked by visual inspection.

Warning signals for malfunction

Separation equipment shall be fitted with a device that indicates that the filter needs service (manual or automatic cleaning or replacement). When any malfunction exists, the control lamp shall not emit green light and the warning signals shall be active.

Conformity shall be checked by simulating a malfunction in order to test the function of the warning signal.

5.12.2 Additional requirements for equipment used for separation of carcinogenic substances

Carcinogenic substances require monitoring, at each individual work place, of airflow rate in the extraction duct.

NOTE The airflow rate is measured indirectly, usually by measuring the duct pressure.

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.

5.13 Exhaust and cooling 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.

Conformity shall be checked by visual inspection and measuring the air velocity.

6 Instructions for use

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

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 design of the capture device. In order to ensure adequate capture, the user needs information about the use of the device and its optimal positioning. This shall be given by the manufacturer in the instruction manual. Requirements on the technical performance of capturing devices are given in 5.3.2 to 5.3.4.

Conformity shall be checked by visual inspection.

NOTE On-gun extraction devices are covered by ISO 15012-3.

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

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 shall include information about the following:

   1) the intended use of the equipment, e.g. for welding and allied processes not for gouging and grinding;

   2) useable if fumes containing CMR substances are expected, e.g. generated by welding high alloyed steels or welding consumables with more than 5 % (Cr, Ni); or

   3) only if fumes not containing CMR substances are expected, e.g. welding of unalloyed steel.

b) The correct use of extractions devices, e.g. a captor hood, should be diametrically positioned so that the fume is drawn away from the welders' breathing zone.

c) The meaning of indicators and warning signals.

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

e) The temperature and atmosphere conditions for operation and storage.

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

NOTE There are different requirements contained in national laws 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 and marked W3 according to ISO 15012-1).

7 Marking

Each machine shall be marked in a distinct and permanent manner in accordance with ISO 12100:2010, 6.4.4 and IEC 60204-1:2005, 16.4.

If the requirements of this part of ISO 15012 are met, the manufacturer may label the equipment as being in compliance with this part of ISO 15012.

If the requirement of ISO 15012-1:2013, Clause 4 regarding separation efficiency is met, the manufacturer may label the equipment W3 as shown in ISO 15012-1:2013, Annex A.

If welding fume separation equipment is usable for separation of carcinogenic substances, it shall be labelled W3 according to ISO 15012-1.

Annex A
(informative)

Malfunctions and determination of minimum airflow

Tables A.1 and A.2 describe the most common malfunctions and the determination of the minimum airflow.

Table A.1 — Malfunctions

Type of malfunction	Most common causes of malfunctions	
	Single place capturing system	Central capturing system
Insufficient airflow, i.e. less than the minimum airflow to capture fume	— incorrect fan wiring — clogged filter or ducting — damaged ducting — damaged fan or controller	Additional to the malfunctions of single systems: — damaged dampers — too many dampers open — failure of the frequency converter
Insufficient filtration, i.e. evidence of fume downstream of the filter	— damaged filter — filter bypassed	

Table A.2 — Determination of minimum airflow

Types of capturing device	Determination
Captor hoods	In accordance with ISO 15012-2
Receiving hoods and enclosures	Visually determined at commissioning stage
On-gun extraction systems	In accordance with ISO 15012-3

Bibliography

[1] ISO 2602, *Statistical interpretation of test results — Estimation of the mean — Confidence interval*

[2] ISO 3966, *Measurement of fluid flow in closed conduits — Velocity area method using Pitot static tubes*

[3] ISO 5167 (all parts), *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full*

[4] ISO 5801, *Industrial fans — Performance testing using standardized airways*

[5] ISO 7731, *Ergonomics — Danger signals for public and work areas — Auditory danger signals*

[6] ISO 14341, *Welding consumables — Wire electrodes and weld deposits for gas shielded metal arc welding of non alloy and fine grain steels — Classification*

[7] ISO 16911, *Stationary source emissions — Manual and automatic determination of velocity and volume flow rate in ducts*

[8] ISO 17916, *Safety of thermal cutting machines*

[9] EN 842, *Safety of machinery — Visual danger signals. General requirements, design and testing*

[10] EN 1070, *Safety of machinery — Terminology*

[11] EN 1093-1, *Safety of machinery — Evaluation of the emission of airborne hazardous substances. Selection of test methods*

[12] EN 1093-3, *Safety of machinery — Evaluation of the emission of airborne hazardous substances. Test bench method for the measurement of the emission rate of a given pollutant*

[13] EN 1093-6, *Safety of machinery — Evaluation of the emission of airborne hazardous substances. Separation efficiency by mass, unducted outlet*

[14] EN 1093-7, *Safety of machinery — Evaluation of the emission of airborne hazardous substances. Separation efficiency by mass, ducted outlet*

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