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Safety of thermal cutting machines

Sécurité des machines de coupage thermique

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 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*.

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

This International Standard has been created in recognition of the particular hazards that are presented by thermal cutting machines.

This International Standard is a type-C standard as outlined in ISO 12100.

When provisions of a type-C standard are different from those which are stated in type-A or type-B standards, the provisions of the type-C standard will take precedence over the provisions of the other standards for machines that have been designed and built in accordance with the provisions of the type-C standard.

The machinery concerned and the extent to which hazards, hazardous situations, and events are covered are indicated in the Scope of this International Standard.

Hazards associated with thermal cutting machines are well recognized, but the sources of the hazards are frequently unique to a particular thermal cutting system. The number and type(s) of hazard(s) is (are) directly related to the nature of the thermal cutting process and the complexity of the installation. The risks associated with these hazards vary with the type of equipment used, its purpose, and the way in which it is installed, programmed, operated, and maintained.

This International Standard is not applicable to thermal cutting machines that were manufactured prior to its publication date.

Safety of thermal cutting machines

1 Scope

This International Standard specifies the safety requirements and measures for machinery covering design, construction, production, transport, installation, operation, maintenance, and putting out of service.

This International Standard applies to machinery using thermal cutting and or marking processes such as oxy-fuel, plasma arc. This International Standard applies to machinery the basis of which is either designed as open gantry, cantilever machine, or the track of which is incorporated in the cutting table.

This International Standard does not cover design standards for specific tools, e.g. oxy-fuel hose standards, electrical requirements for plasma power supplies. Most tools used on thermal cutting machines have specific design standards.

This International Standard does not cover handheld cutting equipment and cutting equipment which is combined with a constrained tracking system mounted on the work piece.

Risks arising from thermal cutting tools may be covered by related standards.

Risks arising from laser radiation, except those caused by position indicating lasers, are not covered by this International Standard. Those risks are covered by ISO 11553.

Machines that combine thermal processes with other processes (e.g. grinding, drilling, milling, etc.) are only partly covered. Risks arising from these other processes may be covered by related standards.

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 3746, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane*

ISO 3821, *Gas welding equipment — Rubber hoses for welding, cutting and allied processes*

ISO 4871, *Acoustics — Declaration and verification of noise emission values of machinery and equipment*

ISO 5171, *Gas welding equipment — Pressure gauges used in welding, cutting and allied processes*

ISO 5172, *Gas welding equipment — Blowpipes for gas welding, heating and cutting — Specifications and tests*

ISO 5175, *Equipment used in gas welding, cutting and allied processes — Safety devices for fuel gases and oxygen or compressed air — General specifications, requirements and tests*

ISO 7289, *Gas welding equipment — Quick-action couplings with shut-off valves for welding, cutting and allied processes*

ISO 7291, *Gas welding equipment — Pressure regulators for manifold systems used in welding, cutting and allied processes up to 30 MPa (300 bar)*

ISO 8207, *Gas welding equipment — Specification for hose assemblies for equipment for welding, cutting and allied processes*

ISO 11202, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions applying approximate environmental corrections*

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

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

ISO 13854, *Safety of machinery - Minimum gaps to avoid crushing of parts of the human body*

ISO 13855, *Safety of machinery — Positioning of safeguards with respect to the approach speeds of parts of the human body*

ISO 13857, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*

ISO 15012-4[1)], *Health and safety in welding and allied processes — Equipment for capture and separation of welding fume — Part 4: General requirements for welding fume separation equipment*

ISO/TR 28821, *Gas welding equipment — Hose connections for equipment for welding, cutting and allied processes — Listing of connections which are either standardised or in common use*

EN 894-1, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — General principles for human interactions with displays and control actuators*

EN 894-3, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Control actuators*

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

IEC 60974-1, *Arc welding equipment — Part 1: Welding power sources*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
thermal cutting
cutting process that uses heat of different sources to melt or oxidize the material and a high speed jet to remove the liquid material

3.2
tool
any component to carry out a working process

Note 1 to entry: Working processes are, for example, cutting or marking.

3.3
aggregate
unit that carries one or more *tools* (3.2) and which is used to position the tools relatively to each other and/or to adjust the bevel angle of the tool(s)

3.4
cutting table
support for the work piece to be cut

3.4.1
dry cutting table
cutting table (3.4) not filled with water

1) To be published.

3.4.2
water table
cutting table (3.4) filled with water

Note 1 to entry: The work piece may be placed under, on, or above the water.

3.5
exhaust unit
unit to exhaust fumes and exhaust gases generated by the cutting process

3.6
exhaust system
system including *cutting table* (3.4), ducting, and *exhaust unit* (3.5)

3.7
marking process
method for applying markings on the surface of the work piece

3.8
movement envelope
area which can be reached by a moveable part of the machine

3.9
oxy-fuel cutting
thermal cutting (3.1) process using an oxygen/fuel gas flame to heat up the material to its ignition temperature and an oxygen jet to oxidize and remove the material

3.10
plasma cutting
thermal cutting (3.1) process using a constricted arc to heat up the material and a high velocity jet of ionized gas to remove the molten material

3.11
positioning laser
laser pointer to indicate the exact position of the machine

3.12
section
segment
partition of the *cutting table* (3.4)

Note 1 to entry: Sections are used to make exhausting more efficient. Flaps in each section allow the exhaust system to open the suction only to the currently active cutting area.

3.13
time weighted average
TWA
quantitative average which is determined from the measurement of a sample, which has been taken over a known time interval, multiplied by the desired time interval expression, and divided by the total time of over which the sample was obtained

Note 1 to entry: For occupational exposure, a working shift of eight hours is commonly used as the averaging time. Values are typically expressed as a concentration of a contaminant in air, or decibels, in the case of noise exposure.

3.14
working area
area where operation of cutting/marking *tool* (3.2) is intended by design and/or manufacturer's specifications

3.15
overall stopping distance
distance travelled within the time interval between the actuation of the sensing function and the termination of the hazardous machine function

3.16
machine environment
sphere of influence of the machine

4 Significant hazards

The listed hazards (see Table A.1) assume foreseeable access from all directions, as well as unexpected start-up. Risks to both the operators and other persons who can have access to the danger zones are identified, taking into account hazards that can occur under various conditions (e.g. commissioning, set-up, production, maintenance, repair, decommissioning) during the life of the machine. The assessment includes an analysis of the effect of failure in the control system. Following the intended use of the machine which includes maintenance, setting and cleaning, the reasonably foreseeable misuse, the identification of the significant hazards associated with the machine, and risks shall be evaluated.

For identification and evaluation of hazards, ISO 12100 applies.

5 Safety requirements and protective measures

5.1 General

Machines covered by this International Standard shall meet the safety requirements listed hereafter.

With regard to hazards not covered by this International Standard, these machines shall be designed in compliance with the principles given in ISO 12100.

Machines, covered by this International Standard, shall be equipped with protective devices shown in the Table 1, column 2.

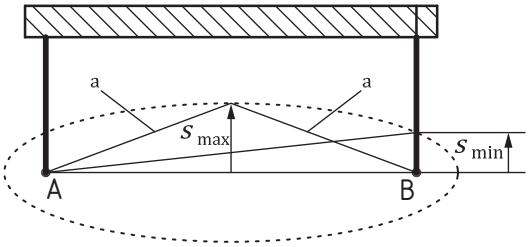
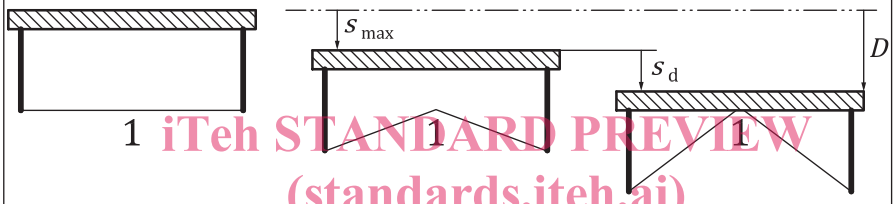
Machines requiring access to the movement envelope during operation require protective devices against collision with the gantry in the movement envelope. Protective devices against collision with the gantry in the movement envelope may not be required in all situations, e.g. for machines having construction-related short operating cycles, or a cutting table which is not suited for access due to its design.

5.2 List of safety requirements

Table 1 — List of safety requirements and/or protective measures and their verification procedures for cutting machines using thermal cutting processes

Hazard	Safety requirements and/or protective measures	Verification
1 Mechanical	**1.1 Risk of collision between the operator and the machine while the operator is on the ground** **1.1.1 Collision when the operator is unimpeded by obstacles** The lower limit of the protective devices shall start at ≤180 mm above the table. Otherwise, due to the variable thickness of work pieces, the lower limit of protective devices used may be set to 50 mm or less plus the maximum thickness of the work piece specified in the machine documentation, measured from the table. This applies to specified material thicknesses >130 mm. NOTE An example is given in Annex C. **1.1.1.1 General** The following conditions shall be fulfilled in case of collision with the body: — force, F < 150N; — energy, E < 10 J; — pressure, p < 50 N/cm^2. **1.1.1.2 Relative speed of the machine to the operator ≤15 m/min** The conditions described in 1.1.1.1 are met with a use of a bumper that is able to compress at least 4 mm (e.g. working clothes wrapping the body plus human tissues) and the collision area >3 cm^2. NOTE An example for a calculation is given in Annex D. **1.1.1.3 Relative speed of the machine to the operator >15 m/min** The conditions described in 1.1.1.1 shall be met using one or more of the measures below: a) bumpers to safely remove the operator out of the danger zone fulfilling the conditions of 1.1.1.1; b) bumper according to ISO 13856-3 which activates an emergency stop according to ISO 13850. The stroke shall be greater than the overall stopping distance. This bumper shall function without exceeding the conditions described in 1.1.1.1. The required performance level is C according to ISO 13849-1; c) emergency trip wire according to ISO 13856-3 which activates an emergency stop according to ISO 13850. The maximum prolongation of the trip wire shall allow for the overall stopping distance, D, without adding additional hazards to persons or other obstacles, see Figures 1 and 2. This emergency trip wire shall function without exceeding the conditions described in ISO 13856-3 and 1.1.1.1. The required performance level is C according to ISO 13849-1.	Visual inspection, calculation and measurement

Table 1 *(continued)*

Hazard	Safety requirements and/or protective measures	Verification
	 **Key** s_{max} maximum stroke (maximum travel of the machine to trigger the emergency stop function) s_{min} minimum stroke (minimum travel of the machine to trigger the emergency stop function) A, B emergency trip wire a Focal points of an ellipsis. **Figure 1 — Emergency trip wire**	Visual inspection, calculation and measurement
	 **a) Contact** **b) Triggered** **c) Stop** **Key** 1 person/obstacle (not moving) D overall stopping distance s_d stopping distance s_{max} maximum stroke (maximum travel of the machine to trigger the emergency stop function) **Figure 2 — Emergency trip wire function**	

