SLOVENSKI STANDARD
oSIST prEN ISO 28881:2019

01-november-2019

Obdelovalni stroji - Varnost - Elektroerozijski stroji (EDM) (ISO/DIS 28881:2019)

Machine tools - Safety - Electrical discharge machines (ISO/DIS 28881:2019)

Werkzeugmaschinen - Sicherheit - Funkenerodiermaschinen (ISO/DIS 28881:2019)

Machines-outils - Sécurité - Machines d'électro-érosion (ISO/DIS 28881:2019)

Ta slovenski standard je istoveten z: **prEN ISO 28881**

ICS:

25.120.40	Elektrokemijski stroji	Electrochemical machines

oSIST prEN ISO 28881:2019 **en,fr,de**

DRAFT INTERNATIONAL STANDARD

ISO/DIS 28881

ISO/TC **39**/SC **10**

Secretariat: **SNV**

Voting begins on:
2019-09-20

Voting terminates on:
2019-12-13

Machine tools — Safety — Electrical discharge machines

Machines-outils — Sécurité — Machines d'électro-érosion

ICS: 25.080.01

This document is circulated as received from the committee secretariat.

ISO/CEN PARALLEL PROCESSING

Reference number
ISO/DIS 28881:2019(E)

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Published in Switzerland

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Foreword

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For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee [or Project Committee] ISO/TC [or ISO/PC] ###, *[name of committee]*, Subcommittee SC ##, *[name of subcommittee]*.

This second/third/... edition cancels and replaces the first/second/... edition (ISO #####:####), which has been technically revised.

The main changes compared to the previous edition are as follows:

— xxx xxxxxxx xxx xxxx

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

Introduction

This International Standard has been prepared to be a Harmonized Standard to provide one means of conforming to the Essential Safety Requirements of the Machinery Directive of the European Union and associated EFTA regulations.

This document is a type-C standard as defined in ISO 12100:2010.

The machinery concerned and the extent to which hazards, hazardous situations and events are covered are indicated in the Scope of this International Standard. In addition, electrical discharge machining (EDM) equipment and EDM systems are intended to be designed according to the principles of ISO 12100 for hazards which are not dealt with in this International Standard.

When requirements of this type-C standard are different from those which are stated in type-A or -B standards, the requirements of this type-C standard take precedence over the requirements of other standards for machines that have been designed and built according to the requirements of this type-C standard.

This International Standard defines required performance level and safety categories of the safety-related parts of the control system for EDM equipment and EDM systems as defined in ISO 13849-1.

The requirements of this International Standard concern designers, manufacturers, suppliers and importers of machines described in the Scope.

This International Standard also includes a list of informative items intended to be provided by the manufacturer to the user.

Machine tools — Safety — Electrical discharge machines

1 Scope

This International Standard specifies safety requirements and/or protective measures, applicable to EDM equipment and EDM systems, such as

— manually controlled EDM die sinking or EDM drilling machines;

— numerically controlled EDM die sinking or EDM drilling machines, and

— numerically controlled EDM wire cutting machines.

intended to be adopted by persons undertaking the design, construction, installation and/or supply of such equipment. This International Standard also includes information to be provided by the manufacturer to the user.

This International Standard is not applicable to arc eroding and electro-chemical machining equipment.

This International Standard takes account of the precondition of the intended use as well as the reasonably foreseeable misuse, in normal workshop environments and non-explosive atmospheres, including transportation, installation, setting, maintenance, repair and dismantling for removal or disposal of EDM equipment and EDM systems.

This International Standard is also applicable to auxiliary devices essential for EDM processing.

This International Standard deals with all significant hazards, hazardous situations or hazardous events relevant to EDM equipment and EDM systems, where they are used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer (see Clause 4).

This International Standard is intended to apply to machines manufactured after the date of publication of this International Standard.

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

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 13849-2:2003, *Safety of machinery — Safety-related parts of control systems — Part 2: Validation*

ISO 13850, *Safety of machinery — Emergency stop function — Principles for design*

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

ISO 13857:2008, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*

ISO 14118, *Safety of machinery — Prevention of unexpected start-up*

ISO 7010, *Graphical symbols — Safety colours and safety signs — Required safety signs*[1)]

IEC 60204-1:2016, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 61000-6-2, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Immunity for industrial environments*

IEC 61000-6-4, *Electromagnetic compatibility (EMC) — Part 6-4: Generic standards — Emission standard for industrial environments*

IEC 61310-1, *Safety of machinery — Indication, marking and actuation — Part 1: Requirements for visual, acoustic and tactile signals*

IEC 61310-2, *Safety of machinery — Indication, marking and actuation — Part 2: Requirements for marking*

IEC 61558-1, *Safety of power transformers, power supplies, reactors and similar products — Part 1: General requirements and tests*

IEC 61800-5-2:2007, *Adjustable speed electrical power drive systems — Part 5-2: Safety requirements — Functional*

EN ISO 14119:2013, *Safety of machinery - Interlocking devices associated with guards - Principles for design and selection (ISO 14119:2013)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100 and ISO 13849-1 and the following apply.

3.1
electrical discharge machining
EDM
any machining process based on spark erosion

Note 1 to entry: Electrical discharge machining is generally abbreviated as "EDM".

3.2
EDM process
removal of material in dielectric fluid by electrical discharges, which are separated in time and randomly distributed in space, between two electrically conductive electrodes, and where the energy in the discharge is controlled

Note 1 to entry: The two electrically conductive electrodes are the tool electrode and the workpiece electrode.

3.3
EDM equipment
machine tool that includes all the necessary units for the process of EDM machining

EXAMPLE Generator, control circuits and dielectric fluid container.

3.4
EDM system
assembly of EDM equipment and other machines or devices, which are arranged, linked and controlled to function as an integrated whole

1) The graphical symbol collections of ISO 7000, ISO 7001 and ISO 7010 are also available online in the ISO web store. For more information, consult http://www.iso.org/iso/fr/publications_and_e-products/databases.htm

3.5
EDM die sinking
removal of material by spark erosion with a formed or bar-shape electrode to produce various shapes in the workpiece

Note 1 to entry: Shapes in the workpiece may be concave, convex and prismatic holes.

3.6
EDM drilling
removal of material by spark erosion with a tubular electrode to produce straight holes in the workpiece

3.7
EDM wire cutting
removal of material by spark erosion with a wire electrode to produce prismatic shapes in the workpiece

3.8
control circuit
<machine> circuit used for the control, including monitoring, of the machine

Note 1 to entry: For electrical equipment, see IEC 60204-1:2016, 3.1.10.

3.9
machine control system
system that responds to input signals from parts of machine elements, operators, external control equipment or any combination of these, and generates output signals causing a machine to behave in the intended manner, as specified in ISO 13849-1:2006, 3.1.32

3.10
numerical control
NC
computerized numerical control
CNC
automatic control of a process performed by a device, which makes use of numerical data introduced while the operation is in progress

[SOURCE: ISO/IEC 2806:1994, definition 2.1.1 — modified.]

3.11
electronic handwheel
manually operated control device that initiates and maintains an axis movement by pulse generation input to the numerical control during its rotation

3.12
enabling device
additional manually operated device used in conjunction with a start control and which, where continuously actuated, allows a machine to function

[SOURCE: ISO 12100:2010, 3.28.2 — modified.]

3.13
hold-to-run control device
control device that initiates and maintains hazardous machine functions only as long as the manual control (actuator) is actuated

[SOURCE: ISO 12100:2010, 3.28.3 — modified.]

3.14
dielectric fluid
<EDM process> non-conductive medium to improve the discharge effect, evacuate debris and cool the workpiece/electrode

3.15
flammable dielectric fluid
dielectric fluid used in EDM, characterized by its relative ease of ignition and relative ability to sustain combustion

3.16
flash point
minimum temperature at which the dielectric fluid used in the sinking EDM gives off sufficient combustible gas or vapour to ignite and sustain combustion

3.17
dielectric fluid container
tank system to keep the dielectric fluid in a condition suitable for EDM

EXAMPLE Filtering and cooling.

3.18
work tank
<EDM equipment> unit surrounding the work area to contain the dielectric fluid for EDM processes

3.19
work area
<EDM equipment> space within the envelope of the machine where the EDM process can take place (inside and around the work tank)

3.20
generator
unit to convert the electrical power supplied to the EDM equipment and EDM system for the purpose of being used for spark erosion processing

3.21
electrical machining power
electrical power supplied to the EDM equipment and EDM system transformed by the generator in specific electric energy, supplied as a tool to the sinker/wire electrode and the workpiece, to perform machining by electro-thermal material removal

3.22
electrode changer
<EDM equipment> mechanism integrated with the machine to supply an electrode to the machine, in exchange for another electrode

Note 1 to entry: The changing device is expected to enable an operator to load/unload electrodes from outside of the work area.

3.23
workpiece changer
<EDM equipment> mechanism forming part of the machine to supply a workpiece or pallet to the machine, in exchange for another workpiece or pallet

Note 1 to entry: The workpiece changer/pallet changer is designed to enable an operator to load/unload the workpiece or pallet to the magazine from outside of the work area.

3.24
operating mode
possible mode for use of the machine

3.24.1
automatic mode (MO 1: Automatic)
mode for use under numerical control to achieve programmed sequential operation with the guards closed, until stopped by a program or an operator

Note 1 to entry: This term is equivalent to machining mode.

Note 2 to entry: For machinery having automatic setting programs, such operations are considered automatic mode.

3.24.2
setting mode (MO 2: Setting)
mode for use without electrical machining power, for operations in which adjustments for the subsequent machining are performed by the operator

Note 1 to entry: Measuring cycles (e.g. touching of the workpiece with a probe or electrode), checking the movement of the workpiece and/or electrode using the electrode and/or workpiece changer, checking/optimizing the injection or suction flushing, a dry run for checking the NC program, etc. are procedures forming part of the setting mode (see 5.3.2.2).

3.24.3
discharge alignment mode (MO 3: Manual intervention)
mode for use for specific alignment with the electrical discharge on and with the guards of EDM equipment temporarily open and alternative safety measures activated

EXAMPLE Exhaust air extraction adjustment, vertical wire alignment, dielectric fluid flushing adjustment and visual machining inspection.

3.24.4
service mode (MO service)
mode for service and maintenance tasks

Note 1 to entry: In MO service, the machining of a workpiece is not allowed.

EXAMPLE Axis calibration by e.g. laser, generator calibration, repeatability test

3.25
performance level
PL
discrete level to specify the ability of safety-related parts of control systems to perform a safety function under reasonably foreseeable conditions

[SOURCE: ISO 13849-1:2006, 3.1.23 — modified.]

3.26
mean time to dangerous failure
$MTTF_d$
expectation of the mean time to dangerous failure

[SOURCE: ISO 13849-1, 3.1.25]

3.27
electro-magnetic compatibility
ability of EDM equipment and EDM systems to function satisfactorily in their electro-magnetic environment without introducing intolerable electro-magnetic disturbances to anything in that environment

Note 1 to entry: Electro-magnetic compatibility is generally abbreviated as "EMC".

3.28
shielding
mechanical barrier or enclosure of conductive material intended to attenuate the emission/penetration of a varying electro-magnetic field into an assigned region

4 List of significant hazards

This clause lists all the significant hazards, hazardous situations and events, as far as they are dealt with in this International Standard, identified by risk assessment as significant for this type of machinery, and which require action to eliminate or reduce the risk.

NOTE 1 The purpose of risk assessment is to identify hazards, and to estimate and evaluate risk to be reduced and to transfer the remaining risk to the user (see Clause 6). There are many methods and tools available for this purpose and several are described in this International Standard. The method or tool chosen is largely a matter of industry, company or personal preference. The choice of a specific method or tool is less important than the process itself. The benefits of risk assessment come from the discipline of the process rather than the precision of the results: as long as a systematic approach is taken to get from hazard identification to risk reduction, all the elements of risk are considered (see ISO/TR 14121-2).

The list of hazards given in Table 1 is the result of a risk assessment carried out for all EDM equipment covered by this International Standard. The technical measures and information for use in Clauses 5 and 6 are based on the risk assessment and deal with the identified hazards by either eliminating them or reducing the effects of the risks they generate.

NOTE 2 The designer's attention is focused on hazards which can occur during the life of the machine. The risk assessment assumes risks to both the operator(s) and other person(s) who can have access to the hazard zone(s) for conditions of intended use, including reasonably foreseeable misuse of the machine (see ISO 12100:2010, 3.23 and 3.24) for both spark erosion with automatic mode and operations requiring intervention (e.g. setting, maintenance and repair).

The significant hazards covered by this International Standard are listed in Table 1.

Particular attention is paid to hazards dealing with:

- electrical hazards (electrode voltage);
- flammable dielectric fluid (level, temperature, fire detection);
- hazardous substances (included in waste disposal, used filters, used dielectric fluid, electrodes and sludges);
- electro-magnetic emissions (radiated and conducted); see IEC 61000-6-2 EMC for immunity and IEC 61000-6-4 EMC for emission.

Table 1 — List of significant hazards and major sources of these hazards associated with electrical discharge machines

No.[a]	Hazard type	Hazardous situation action	Activity	Danger zone	Reference to Table 3
1	**Mechanical hazards:**				
1.1	Acceleration, deceleration (kinetic energy of elements in controlled or uncontrolled motion): being run over, impact	Movements of machine elements, failure of the control circuit	Setting, machining and maintenance	At and near the machine	A1, A2, A3, A8
1.2	Cutting parts, sharp edges: crushing and shearing	1.2.1 Workpiece clamping	Loading/unloading, reorienting	Between clamps and workpiece	A1, A2, A3
		1.2.2 Automatic workpiece/ electrode changing	Power-operated, workpiece/ electrode change	Envelope of workpiece/electrode motion	A1, A2, A3
		1.2.3 Moving parts (e.g. axes, rolling elements), failure of the control circuit	Manual operation, workpiece/electrode change	Between workpiece/ electrode and machine parts	A1, A2, A3, B4

[a] This list is derived from ISO 12100:2010, Table B.1.

Table 1 *(continued)*

No.[a]	Hazard type	Hazardous situation action	Activity	Danger zone	Reference to Table 3
1.3	Moving and/or rotating elements: entanglement	Manual or automatic workpiece/electrode changing, spindle rotation and wire rollers rotation, failure of the control circuit	Manual or power-operated workpiece/electrode changing and spindle rotation	Between workpiece/electrode and machine parts	A1, A2, A3, B4
1.4	High pressure: fluid injection or ejection	Hydraulic/pneumatic systems ejection, leakage, flushing and residual pressure	Setting, machining and maintenance	At and near the machine	A4
1.5	Rough, slippery surface: slipping, tripping and falling of persons (related to machinery)	Ejection or spillage of fluids and lubricants, trailing floor-mounted or loose connection cables	During and after machining and maintenance	Work tanks where whole-body access is possible, slippery floor and high working positions, area surrounding the machine	A6
1.6	Loss of stability: — unbalanced machine or parts — inappropriately fixed part of machine — lifted machine or parts by crane — transportation with overload	Impact, trapping and/or crushing by inclination and/or falling of machine	Machine assembly, transportation, installation and commissioning	At and near the machine	A9
2	**Electrical hazards:**				
2.1	Live parts (direct contact): electrical shocks to persons, effect on medical implants, shock	Contact with workpiece/electrode, wire/wire-path and contact with unprotected circuits	Process control, setting and maintenance	Workpiece, electrode, tooling fixture	B1, B2
2.2	Parts that become live under fault conditions (indirect contact): electrocution of persons, effect on medical implants, shock	Contact with parts of the machine which are not live during normal operation	Maintenance and service on the generator and/or the machine	At and near the machine, insulation of electrical cables and equipment	B1, B3
3	**Thermal hazards (not relevant to EDM):**				
4	**Noise hazards:**				
4.1	Manufacturing process (fluid pumps, moving and/or rotating parts, whistling pneumatics): hearing damage/loss or other physiological disturbances	Emission of hazardous noise from the EDM equipment or its auxiliary devices	During operation, setting, cleaning, maintenance and repair activities	At and in the vicinity of the machine or the auxiliary devices	C1
5	**Vibration hazards (not relevant to EDM):**				

[a] This list is derived from ISO 12100:2010, Table B.1.