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Machine tools — Practical guidance and example of risk assessment on electro-discharge machines

Machines-outils — Lignes directrices et appréciation du risque pour les machines d'électro-érosion

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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 39, *Machine tools*, Subcommittee SC 10, *Safety*.

Introduction

This Technical Report gives additional guidance to the manufacturer to use ISO 28881 by showing a process of the risk assessment based on type A and B standards.

Some documents (e.g. technical reports, guidelines) have already been published but they usually describe about the risk assessment only for machines or for control systems. Manufacturers need guidance that covers both aspects of machines and control systems.

This Technical Report deals with risk assessment for machine and control jointly, i.e. the result of the risk assessment carried out for significant hazards listed in ISO 28881:2013, Table 1, including the results of risk reduction by the protective measures described in ISO 28881:2013, Clauses 5 and 6 and the process of the selection of PL_r as described in ISO 28881:2013, 5.2, are shown.

This Technical Report, based on the following International Standards, is worked out in cooperation with JMTBA (Japanese Machine Tool Builder Association) and ISO/TC 39/SC 10.

— ISO 28881;

— ISO 12100;

— ISO 13849-1;

— ISO/TR 14121-2.

Machine tools — Practical guidance and example of risk assessment on electro-discharge machines

1 Scope

This Technical Report gives practical guidance on conducting risk assessment for machinery in accordance with ISO 12100, ISO 13849-1, and ISO/TR 14121-2. It describes the method, tools, and examples used to generate ISO 28881, to reduce the risk of potential harm on EDM equipment and EDM systems by persons involved in the design, installation, or modification of machinery (e.g. designers, technicians, safety specialists).

2 Information for the risk assessment

2.1 General

The following points should be considered:

— specifications of the EDM equipment and EDM systems (For example of limits of the machinery, see Table 1.);

— type of machinery (For examples, see Figures 1 and 2.);

— hazards and associated hazardous situations;

— estimated risk for each identified hazard and hazardous situations including intended use and any reasonably foreseeable misuse;

— evaluation of the risk and making decisions about the need for risk reduction.

Eliminate or reduce the risk by means of the three-step method in accordance with ISO 12100:2010, 6.1.

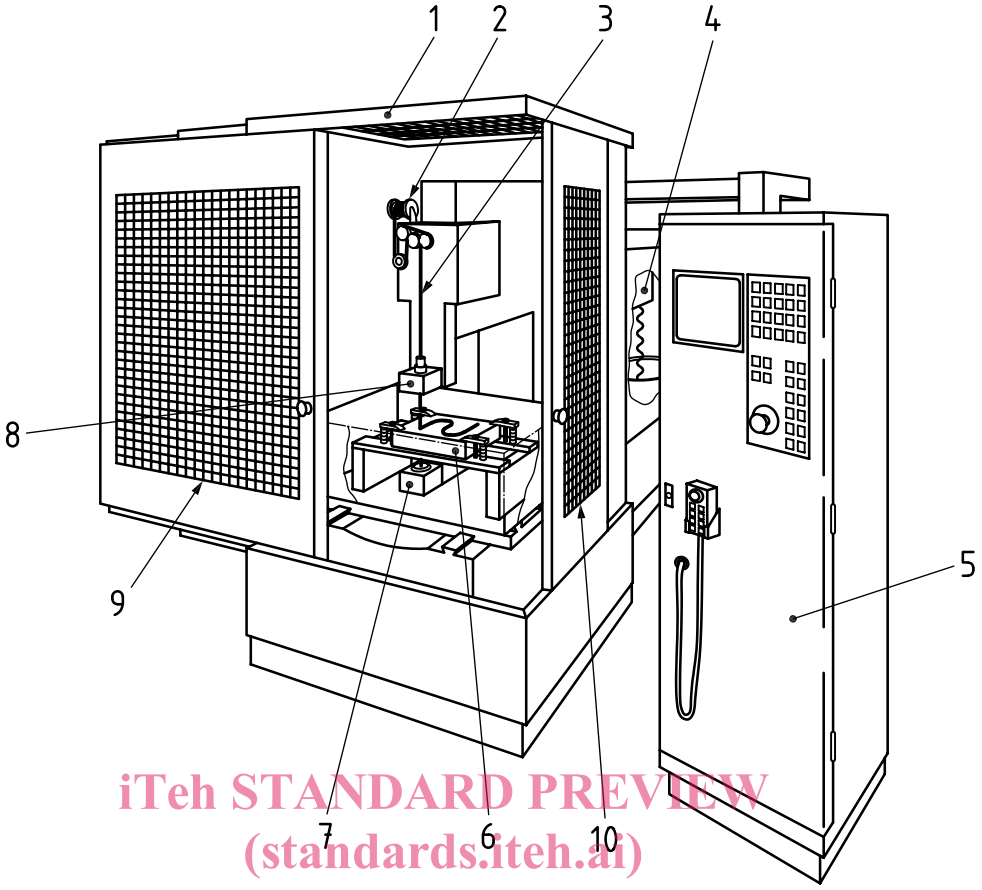
— step 1: inherently safe design measures;

— step 2: safeguarding and/or complementary protective measures;

— step 3: information for use.

Table 1 — Example of specifications of the EDM equipment and EDM systems

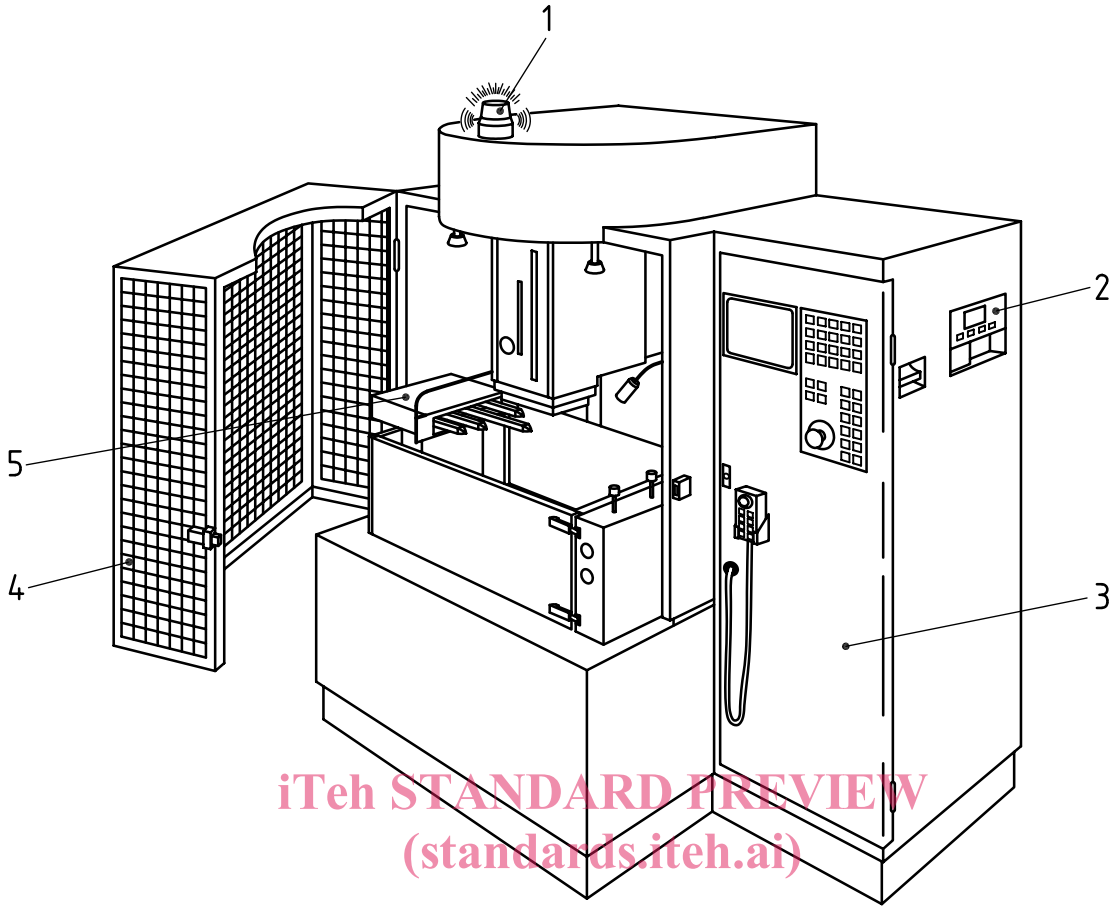
Items	Wire EDM	Sinker EDM
EDM machine figure	See Figure 1	See Figure 2
Power supply		
Input voltage	200 V a.c., three-phase	200 V a.c., three-phase
Electrical supply capacity	13,5 kVA	13,0 kVA
Compressed air	0,5 MPa to 0,7 MPa	0,6 MPa
	Equal to or more than 75 l/min	
Machine weight	2 000 kg	5 000 kg
Generator		
Type of circuits	Transistor pulse	Transistor pulse
	(energy retrieval type)	
Output voltage	300 V	200 V
Output current	50 A	60 A
Linear axis (X, Y, Z)		
Stroke (mm)	X350 × Y250 × Z220	X300 × Y200 × Z200
Output power	a.c. 0,6 kW	a.c. 1,0 kW
Feeding speed	1 300 mm/min	5 000 mm/min
Z-axis	With brake	With brake
	Without balancer	Without balancer
Rotary axis	Not applicable	C-axis
Output power		a.c. 0,5 kW
Electrode		
Size	Wire diameter: 0,1 to 0,3 [mm]	Not specified
Max. weight	10 kg	50 kg
Automatic tool changer	Not applicable	Applicable
Number of electrodes	1 spool	30 electrodes
Max. weight per electrode	10 kg	10 kg
Workpiece		650 × 450 × 195 mm
Max. size	800 × 600 × 215 mm	650 × 450 mm
Max. weight	500 kg	800 kg
Dielectric fluid		
Material	Water	Oil with flash point more than 60 °C
Container capacity	440 l	350 l
Installation environment		
Temperature	10 °C to 35 °C	10 °C to 35 °C
Relative humidity	35 % to 75 % (no condensation)	35 % to 75 % (no condensation)



Key

1	shielded enclosure with door(s)	6	workpiece
2	wire supply spool	7	lower wire guide
3	wire electrode	8	upper wire guide
4	wire evacuation	9	interlocking guard
5	electrical cabinet (generator)	10	fix guards

Figure 1 — Example of wire cutting machine



Key

1 local fire alarm
2 fire detection device
3 electrical cabinet (generator)
4 interlocking shielded guard
5 linear electrode changer

Figure 2 — Example of die sinking machine with linear electrode changer

2.2 Hazard identification on EDM equipment and EDM systems during the life phases

2.2.1 Whole life cycle of the EDM equipment and EDM systems

The phases of the life cycle of the EDM equipment and EDM systems considered to be significant in this example are the following:

— transportation (including in-house transport and movement);

— assembly, installation, and commissioning;

— setting and operation;

— cleaning and maintenance;

— fault finding and troubleshooting;

— removal, dismantling, and disposal.

2.2.2 Space limits

EDM equipment and EDM systems are assumed to be used in the industrial environment of the factory.

EDM equipment and EDM systems are assumed to be used in the environment without direct sunshine, dust, and water splash.

EDM equipment and EDM systems are not assumed to be used in the atmosphere having fire or explosion hazard.

Necessary area for all phases of the life cycle of the EDM equipment and EDM systems (i.e. installation, operation, maintenance, etc.) is assumed to be secured. However, concrete size is not specified here because it does not seem to be reasonable from the objective of this example.

2.2.3 Time limits

This example describes only the aspects of time limits which should be generally determined because it is not reasonable to specify concrete values here from the objective of this example.

— life of the machine;

— interval of inspection;

— interval of parts replacement;

— interval of cleaning and maintenance.

2.2.4 Use limits (intended use and reasonably foreseeable misuse)

Intended use and reasonably foreseeable misuse of the EDM equipment and EDM systems should be considered in each phase of the life cycle.

The EDM is assumed to be used by a person

— who is a trained operator,

— without visual or hearing impairment,

— without restrictions on physical ability of upper or lower limbs, or

— without usage of medical implants liable to be affected by electromagnetic radiation (e.g. pacemaker).

See Table 2 for example of lifecycle and task in automatic, setting, and discharge alignment operation on EDM equipment and EDM systems.

Table 2 — The phases of lifecycle and tasks in automatic, setting, and discharge alignment operation

Task, operator, and reasonably foreseeable misuse			
Automatic operation (machining)	**Description**	**Wire EDM**	**Sinker EDM**
	(1) Automatic workpiece preparation		
	— measuring workpieces (vertical, parallel, edge, etc.)	X	X
	— measuring workpieces (with high voltage)	X	X
	— measuring workpieces (with low voltage)	X	X
	(2) Automatic electrode preparation		
	— connection of wire electrode	X	
	— vertical wire alignment (adjusting by U-axis and V-axis)	X	
	— clamping electrode (with automatic tool changer)		X
	— measuring electrodes (edge, centre, etc.)		X
	(3) Making and verifying machining program		
	— programmed operation without electric discharge power	X	X
	(4) Tasks during processing		
	— starting process	X	X
	— intervention during processing	X	X
	— adjusting flushing pressure	X	
	— adjusting flushing pressure (injection, suction)		X
	— monitoring process condition	X	X
	— adjusting machining conditions	X	X
	— wire reconnection at break point	X	
	(5) Tasks after processing		
	— measuring workpieces (with high voltage)	X	X
	— measuring workpieces (with low voltage)	X	X
	— cutting wire electrode	X	
	(6) Automatic removal of core part		
	— preparation for cutting core part	X	
	— cutting core part	X	
	— removing core part	X	
	Automatic operation is intended to be carried out by — operators with appropriate knowledge and/or experience on the usage of machine and with full understanding of the instructions described in the information for use, and — persons under the supervision of such operators.		
	Reasonably foreseeable misuses in the automatic operation are — opening guards during programmed operation, — starting programmed operation with guard open, and — processing with inappropriate fluid level in work tank.		