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Machine-tools safety — Safety requirements for the design and construction of work holding chucks

Sécurité des machines-outils — Prescriptions de sécurité pour la conception et la construction des mandrins porte-pièces

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 16156 was prepared by Technical Committee ISO/TC 39, *Machine tools*, Subcommittee SC 8, *Work holding spindles and chucks*.

Introduction

This International Standard was prepared to provide one means of conforming to the Essential Health and Safety Requirements of the Machinery Directive and associated EFTA Regulations.

Machine-tools safety — Safety requirements for the design and construction of work holding chucks

1 Scope

This International Standard sets out the requirements and/or measures to remove the hazards and limit the risk on work holding chucks which are defined in 3.1.

It covers all the hazards relevant to this component, as listed in Clause 4.

The requirements concern designers, manufacturers, suppliers and importers of work holding chucks.

It also includes information which the manufacturer shall provide for the user.

It is primarily directed to components which are manufactured after its date of issue.

2 Normative references

The following referenced documents are indispensable for the application 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 1940-1:2003, *Mechanical vibration — Balance quality requirements for rotors in a constant (rigid) state — Part 1: Specification and verification of balance tolerances*

ISO 3089:1991, *Self-centring manually-operated chucks for machine tools — Acceptance test specifications (geometrical tests)*

ISO 3442:1991, *Self-centring chucks for machine tools with tow-piece jaws (tongue and groove type) — Sizes for interchangeability and acceptance test specifications*

ISO 9401:1991, *Machine tools — Jaw mountings on power chucks*

EN 292-1:1991, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology*

EN 292-2:1991, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles and specifications* + Amendment 1:1995

EN 982:1996, *Safety of machinery — Safety requirements for fluid power systems and their components — Hydraulics*

EN 983:1996, *Safety of machinery — Safety requirements for fluid power systems and their components — Pneumatics*

EN 1005-2:2003, *Safety of machinery — Human physical performance — Part 2: Manual handling of machinery and component parts of machinery*

3 Terms and definitions

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

3.1
work holding chuck
clamping device with movable jaws to hold a workpiece designated hereinafter by “chuck”

NOTE Some chucks may be equipped with grooves or slots.

3.2
manually operated chuck
chuck in which workpieces are clamped with the aid of manual energy (e.g. by means of a key)

3.3
power-operated chuck
chuck in which workpieces are clamped with the aid of pneumatic, hydraulic or electric energy

3.4
centrifugally compensated chuck
chuck in which there is a system which permits compensation of the loss of clamping force due to centrifugal force

3.5
base jaw
radial moving part of the chuck which receives the top jaw

3.6
top jaw
element mounted on a base jaw for the clamping of workpieces

3.7
clamping force
algebraic sum of the individual radial forces applied by the chuck jaws on the workpiece

3.8
static clamping force
clamping force of the chuck before the chuck has been rotated

3.9
maximum static clamping force
maximum clamping force obtained when the maximum permissible input force (or input torque) is applied to a particular design

3.10
dynamic clamping force
actual clamping force when the chuck is rotating

3.11
clamping cylinder
cylinder which actuates the chuck with the aid of pneumatic or hydraulic energy

3.12
centrifugal force
force generated by rotation that tends to move all parts away radially from the axis of rotation of the chuck

NOTE The centrifugal force (F_c) is expressed in newtons (N).

$$F_c = m \cdot r \cdot \omega^2 = \frac{m \cdot v^2}{r} = m \cdot r \left(\frac{\pi \cdot n}{30} \right)^2$$

where

m is the mass, in kilograms, of the moving parts (usually jaws);

r is the distance, in metres, of the centre of gravity of the moving parts (usually jaws) from the axis of rotation;

ω is the angular velocity, in radians per second, of the centre of gravity of the moving parts (usually jaws);

v is the peripheral velocity, in metres per second, of the centre of gravity of the moving parts (usually jaws);

n is the rotational speed, in minutes to the power minus one.

3.13
input force
force acting on the chuck, applied from an external energy source which actuates the chuck mechanism

3.14
input torque
torque acting on the chuck, applied from an external energy source which actuates the chuck mechanism

3.15
rotational balance
equilibrium of all masses around the axis of rotation (any differences between the axis of rotation and the centre of gravity will cause imbalance)

3.16
maximum rotational speed
n_{max}
maximum rotational speed, in minutes to the power minus one, specified by the manufacturer for chuck with standard jaws in compliance with the manufacturer's instructions (see 6.2)

3.17
working rotational speed
n_w
rotational speed, in minutes to the power minus one, under machining conditions ($n_w \leqslant n_{max}$)

4 List of hazards

Significant hazards are

— crushing,

— entanglement,

— drawing-in or trapping,

— impact, and

— ejection of any exchangeable or moveable part.

5 Safety requirements and/or measures

5.1 General

The appropriate means listed below shall be used during the design and construction of chucks in order to protect any person from being exposed to hazards:

a) the chuck and its proper actuating equipment (e.g. cylinder) shall be compatible (see 6.1.9);

b) the balance quality factor G shall be provided by the manufacturer's accompanying documents (see ISO 1940-1);

c) base jaws of chucks shall be positively prevented (e.g. by locking pins) from being flung out by centrifugal force (see EN 292-1:1991, 3.23.6);

d) chucks with mass greater than 20 kg shall be equipped with means (e.g. threaded holes) for their handling (see 6.1.1).

Verification: by checking the relevant drawings, inspection and type test certificate.

5.2 Special requirements

For compensated chucks, n_{max} shall be stated by the manufacturer.

For non-compensated chucks, n_{max} shall not exceed the speed corresponding to a calculated loss of 67 % of the total measured static clamping force with the manufacturer's standard jaws, e.g. hard top jaw of stated mass and at a stated radius of gyration positioned on the base jaws.

Verification: by checking the relevant technical file.

5.2.1 Power operated chuck

The chuck or chucking equipment (cylinders) shall be equipped with devices to ensure that the clamping force is effectively applied (e.g. travel sensors before stroke end).

In the event of energy supply failure to the actuators/cylinders, devices (e.g. check valves) shall be provided to ensure that the pressure is maintained for a period stated by the manufacturer (see EN 982 and/or EN 983).

Verification: by checking the relevant drawings and/or inspection.

5.2.2 Chuck wrench and similar equipment

The chuck wrench or similar equipment for manual jaw locking or manually tightening all types of chuck shall be designed so that they do not remain located in the rotating chucks. Wrenches, similar equipment, or their locating points within chucks shall either be spring loaded to be self-removing when released, or shall prevent (by interlocking) the rotation of the spindle when inserted.

Verification: by checking the relevant drawings and/or circuit diagrams and test report on the chuck or wrench.

5.2.3 Chucks with grooves or slots

Chucks fitted with grooves or slots open to the outer periphery shall be equipped with safety devices (e.g. pins) to prevent stops, counter balances or similar devices from being flung out of slots by centrifugal force.

Verification: by checking the relevant drawings and/or inspection.

6 Information for use

6.1 General

The following information shall be provided in the instruction handbook (see EN 292-2:1991, Clause 5 and especially 5.5).

6.1.1 Safety instructions for the proper use of the chuck including handling (see EN 1005-2) function, maximum rotational speed n_{max}, dimensions, necessary adjustments and fixing elements, permissible clamping ranges and pressure/forces of power drives.

6.1.2 Method for determination of clamping forces to allow the user to assess the suitability of the chuck for the machining operation.

6.1.3 Information on clamping force variation when the chuck is running with a standard jaw (e.g. hard top jaw) to allow the user to determine the dynamic clamping forces.

6.1.4 Maximum permissible mass of the jaw/top jaw at its maximum radius and at maximum rotational speed.

6.1.5 Maximum distance between the centre of gravity of the clamping jaw and the end face of the chuck.

6.1.6 Methods of determination for special top-jaw clamping forces.

6.1.7 Instructions for maintenance including lubrication and intervals between checks of static clamping forces.

6.1.8 Information for component interchangeability, with reference to ISO 3089, ISO 3442 and ISO 9401.

6.1.9 Description of the conditions to be fulfilled at the interface between the work holding chuck and its actuating equipment.

6.1.10 Information on the chuck mass, expressed in kilograms.

6.1.11 The compliance of the chuck and its accessories with the present International Standard.

Verification: by checking the instructions for use.

6.2 Instructions for operator

The following statements shall be included in the manufacturer's instruction handbook.

a) Hazards may arise from the characteristics of workpieces and machines used with a given chuck even if the specific requirements in Clause 5 are met. The user shall therefore consider such characteristics of workpieces (e.g. dimensions, mass and shape), and of machines (e.g. operating speed, feed and depth of cut) in order to remove the hazard arising.

b) The maximum permissible speed for the specific machining shall be determined by the user on the basis of the clamping forces required. This speed shall not exceed the maximum rotational speed of the work holding chuck.

c) For a special top jaw, the user shall calculate the dynamic clamping force for a particular chuck according to the method provided by the manufacturer in its instruction handbook.

d) Static-clamping-force measuring devices shall be used to check maintenance conditions at regular intervals according to maintenance instructions.

e) Residual risks may arise from failure to achieve a satisfactory quality of rotational balance.